9-2022

The Persistence of Exclusion in Developmental Math Courses in Community Colleges: The Search for Equity and Justice in Math Education

Dora P. Trujillo
The Graduate Center, City University of New York

THE PERSISTENCE OF EXCLUSION IN DEVELOPMENTAL MATH COURSES IN COMMUNITY COLLEGES:

THE SEARCH FOR EQUITY AND JUSTICE IN MATH EDUCATION

by

DORA PATRICIA TRUJILLO

A dissertation submitted to the Graduate Faculty in Urban Education in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

2022

The Persistence of Exclusion in Developmental Math Courses in Community Colleges:

The Search for Equity and Justice in Math Education

by

Dora Patricia Trujillo

This manuscript has been read and accepted for the Graduate Faculty in Urban Education in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy

_____	_____
Date	Anna Stetsenko Chair of Examining Committee
_____	_____
Date	Wendy Luttrell Executive Officer

Supervisory Committee:

Anna Stetsenko
Terrie Epstein
Eduardo Vianna

Abstract

The Persistence of Exclusion in Developmental Math Courses in Community Colleges: The Search for Equity and Justice in Math Education

by

Dora Patricia Trujillo

Advisor: Dr. Anna Stetsenko

This study examines how minoritized community college students taking developmental mathematics courses construct their math identities and how structures within academia affect this construction. It uses interviews and a focus group with open-ended questions to look beyond the quantitative studies examining the effectiveness of math developmental courses by exploring student narratives rather than statistical data. Both curricula and pedagogies need to be de-constructed so we may bring social change through diversity to the teaching and learning of mathematics at this level, as developmental math courses have become a systematized form of marginalization. In the process of de-constructing, we also need to illuminate how the mythologization of math has become another form of injustice in education. Mythologizing of mathematics is defined here as the belief by some instructors and students that only certain special people can understand and do well in mathematics—or that only certain lucky people are born with the "math gene." This investigation is a qualitative study of power relations both inside and outside developmental math classrooms in community colleges with the goal of interrogating models of teaching where it is the students themselves who are considered lacking or deficient, not the marginalizing pedagogical methods of intervention.

Acknowledgements

To survive the Borderlands
You must live sin fronteras
be a crossroads.
—Anzaldua, *Borderlands|La Frontera*
The New Mestiza

There were many people who were the crossroads of this journey, who transcended fronteras. Dr. Anna Stetsenko's invaluable guidance was crucial in the completion of this endeavor of love. Your scholarship guided me through these years and it will be my constant companion in the next chapters of my academic life. Here, I would like to express my deepest gratitude. To you, Dr. Stetsenko, I say:

One's-self I sing, a simple separate person,
Yet utter the word Democratic, the word En-Masse
—Whitman, *Leaves of Grass*

Dr. Terrie Epstein was also an immensely influential part of my academic journey. Feeling welcome in your classes, I learned to trust myself and embrace my otherness, my multiplicity. Your sense of humor and generosity, together with your scholarship, helped me carve a place in academia for my scholarly endeavors. I'm extremely grateful for all this and so much more.

Dr. Eduardo Vianna was an instrumental part of my academic journey as well. Your scholarship and commitment to social justice in education was a constant reminder of what I hope to accomplish as a mathematics educator. I would like to express my deepest gratitude for all your help.

Dr. Bill Rosenthal: I have always admired you as a scholar and educator. Words cannot express my gratitude for all you have done to make this possible.

And of course, all of you. Thank you for your insightful comments, suggestions and edits. I'm immensely in awe and in debt to you for all your help.

Dr. Milena Cuellar, mi amiga, you have always been my cheerleader. I'll be forever grateful for your encouragement and pep talks. I'm so thankful for our friendship.

To my kids, thank you for believing in me even when I felt I could not take one more step. You kept on telling me that I could do it. To my husband Niall, my darling, thank you for your support and patience. Your gentle words helped me in trying times and encouraged me in pursuing my dreams.

A mi abuelita Teresa y hermana Zoraida, que fomentaron en mí el amor al aprender les quiere dedicar estas líneas:

Hope is the thing with feathers
That perches in the soul,
And sings the tune without the words,
And never stops at all
—Dickinson, *Hope is the Thing with Feather*

Dedication

To all the students who through the years opened my eyes to the injustice and oppression in the developmental math classrooms. And to all those amazing students who gave me GOLD by allowing me to interview them and ask them to revisit traumatic memories.

And to Daniel and David, my beautiful sons. You have always been my North Star.

Table of Contents

List of Appendices

Chapter I: Introduction

Background and Rationale

Studies such as Cobb and colleagues. (2009) and Roesken and colleagues (2011), among others, investigate how students' experiences in learning mathematics affect their math identities. According to Anderson (2007), *math identity* is the ability to "participate within mathematical communities in such a way as to see [ourselves] and be viewed by others as valuable members of those communities" (p. 8). It is the students' positive or negative experiences in the math classroom that inform this construct.

Perhaps the students most impacted by this issue are those in community colleges required to take developmental math (DeM) courses, who encounter obstacles to higher education they cannot overcome. Many of these students come from minoritized communities lacking in educational and financial opportunities. In line with Limarys Caraballo (2012), I use "minoritized" as opposed to "minority" because no person is born a minority or takes on the identity of a minority; rather it is a subject position that is imposed on her. As such, developmental math courses in particular have become gatekeepers to higher education for them. A common approach to math instruction, rote learning and memorization without deep understanding, is a form of pedagogy that fails to make math accessible to students, and thereby less relevant to their everyday lives, and this only exacerbates their predicament. The pedagogical approaches found in developmental math courses often follow what Freire (1970/2000) labeled the *banking system*, which relies, for example, on memorization of formulas without discussion of their logic or utility. The pedagogy arising from the banking system assumes that students do not have any valuable knowledge to share or contribute to their own education, whereby the educator must "deposit" knowledge into the students' minds as though they were empty vessels.

As a result, these students may internalize a sense of helplessness around math, leading to the crippling behavior of math avoidance (Andersson et al., 2015; Gutiérrez, 2015; Lim, 2008; Martin, 2012; Solomon, 2007), defined here as the withdrawal from any kind of math participation. As math classrooms can be microcosms of the overarching sociopolitical contexts that limit educational choices for these community college students, it is important to examine how they construe and construct their math identities in these environments.

Most students attending community colleges do so for many compelling reasons such as not having good enough grades to be admitted to senior colleges and/or not having enough money to pay tuition there. In addition, the majority of community college students come from marginalized groups. These students may come from poor neighborhoods with impoverished schools struggling to offer their students a good education. As Nasir and Hand (2006) state, "School failure is created by societies (through the distribution of cultural capital) and not by [students'] strengths and shortcomings" (p. 453). As developmental math courses have primarily become the job of community colleges, these colleges have become the springboard needed for minoritized students, who are often not college-ready, to continue their education.

Developmental math courses have been thoroughly discussed and dissected by researchers, educators and policy makers, with some studies finding that when remediation works, it works very well for the few who go through the entire sequence. For example, in a multi-institutional study, Bahr (2008) found that students who successfully completed a developmental math sequence had academic outcomes comparable to those students that did not need remediation. However, Bahr advocates examining why remediation does not work for everyone. Moreover, many have criticized developmental math courses as expensive and generally ineffective. According to Bailey (2009), students in need of math remediation have a

lower rate of successful completion of the developmental math sequence, completion of their degree or transferring to a senior college than students who need remediation in writing or students who do not need any remediation at all. Therefore, Bahr finds that in certain cases, remediation can be effective, while Bailey indicates that remediation costs outweigh their return.

In another light, many educators and sociologists believe that students and educators actively engage in learning as a social process. Nasir and colleagues (2005) posit that learning is a cultural process in which learners and educators should dialogically engage in knowledge creation. These authors state, "Learning is a cultural process for everyone regardless of racial or ethnic group membership, class, or gender" (p. 499)—and, it could be added, no matter the placement in the hierarchical educational system. Nasir and colleagues also highlight the significant role of *belonging* in learning contexts. Developmental math courses that engage students by making full use of their cultural and historical knowledge may create a greater sense of inclusivity by practicing what Freire (1970/2000) calls *problem-posing pedagogy*. This is important because mathematics has been largely mythologized by many educators as difficult and unattainable except by the few, and consequently, many students feel that only certain "chosen ones" will perform well in mathematics. Community college students placed in DeM internalize this mythology as it feeds into their already negative feelings about math. Therefore, if they feel they are not "chosen" math people, they often give up in frustration, and math avoidance becomes a major issue for many. Math avoidance causes students to choose majors that require only a minimum of math coursework or even causes students to not follow the career path that they desire. How students perceive the relevance of developmental math courses in their lives and future careers should be investigated to find relevant pedagogy. Developmental math courses have become a systematized form of marginalization without having the correct

and relevant pedagogical approaches. A two-track educational system for those who require remediation and those who do not results in narrow educational choices for those in the former category, hence limiting their social mobility and their potential to subsequently escape marginalization.

LaGuardia Community College: A Model of Promise for Innovation and Inclusion

LaGuardia's lofty goal as a newcomer to the CUNY system was to address educational marginalization and provide a quality education to disadvantaged groups; however, despite promise in its early decades, in recent years, seemingly little progress has been made in helping its student population requiring math remediation**.**

LaGuardia Community College (LAGCC) began with a commitment to serve the educational needs of the working classes. It accomplished this goal from its inception by implementing cooperative education, which is a form of education that combines classroom-based education with practical work experience, by creating a basic skills program and by developing in-house technology for remedial math courses. Currently, however, despite the availability of promising commercial software platforms tailor-made for remedial math courses, this social contract with the working classes has faltered and now seems to be an unreachable goal, resulting in low graduation and transfer rates for these students.

The Beginning

One year after the inception of this college, administration and a faculty programmer developed in-house educational programming tailored specifically to students in need of remediation and thus, a special curriculum. LaGuardia Community College, in its first course catalog, boasted it was "the only unit of the City University of New York to offer a work-study program to all of its students" (1971, p. 2). Naming the college after the visionary political and

social innovator Mayor Fiorello La Guardia of New York City revealed that the concern was to champion the education of the children of the working class in a way never seen before. During the naming ceremony, Frederick Burkhardt (1970) stated how appropriate it was that the former "Community College Nine" was named after Mayor La Guardia, whose career Mr. Burkhardt described as "filled with color as well as daring, innovation, and courage." Joseph Shenker, LaGuardia's first president, clearly stated the school's pedagogical philosophy in the first student handbook:

> Student participation in the planning and organization of the college has been extremely encouraging, and it is my sincerest hope that the faculty, students, and administration will continue to work together to build an educational institution in which we can all take pride. (LaGuardia Community College, 1971, p. 5)

Fern Khan, the associate Dean for Adult and Continuing Education in 1971, in an interview with Andrea Ades Vasquez and Steve Brier (2015), recounted what the opening of LaGuardia Community College meant:

> LaGuardia brought a sort of special optimism, in a way, to, not only CUNY, but to communities in general. And, Joe Shenker was the first president at LaGuardia. He was the youngest president in the country at the time, he was 29 years old. And, he had a vision in terms of having LaGuardia become, not just a model for other community colleges, but also making a difference in the lives of adults and special populations, non-traditional populations. He wanted to make sure that we would impact the lives of children, of adults as learners, as parents, as community residents. (p. 1)

Despite its early mission propelled by the first faculty and administration, in recent years, the college and much of CUNY seems to be run on a business model rather than an educational one

as a result of the widespread purchase of commercial education platforms, where technologies may have improved, but pedagogical practices regarding remediation have stagnated. Williamson (2020) argues, "Platforms … transform pedagogic relationships into market exchanges and transactions, mediated through for-profit edu-business platforms that take a 'cut' of the fee while also benefitting from the extraction of transactional data between students and educators on the platform" (p. 17). So, the new platforms have injected the corporate into the educational, although the new technology has proven to be little more than a Band-Aid® for the serious underlying issues in math remediation.

Location, Location, Location

The college smelled like bread and gum.

—Sandy Watson (Vasquez & Brier, 2015, p. 14).

The location of the school was not accidental. The Board of Education's surveys highlighted Long Island City as a neighborhood without any CUNY institutions nearby and with families in the lowest income brackets and subpar educational achievement (LaGuardia Community College Division of Continuing Education, 1980). The chosen location for the school was in an industrial part of Queens. The Chiclets gum factory and the Silvercup Bakery were nearby, hence the scents that permeated the hallways of LAGCC's main building, which itself had once been a factory. Watson further stated, "A lot of our students were immigrant students, that, um, were in that community, because we were in Queens, Astoria" (Vasquez & Brier, 2015, p. 10). The coming of LAGCC was truly a local phenomenon.

The Background of Open Enrollment at CUNY

According to Goldway,

> City University chose to take the Free Academy's founding principle to its ultimate expression. Open admissions was intended to be the vehicle by which City University would respond to the changes in the city and in society. There would be a place in the University for any New York City public school graduate with a dream. (1997, p. 5)

According to Fabricant and Brier (2016), open admissions ensured that CUNY guaranteed all New York City high school graduates a place at either a community or senior college, commensurate with their GPA (p. 83). In 1961, the four senior colleges, City, Queens, Hunter, and Brooklyn, along with the three junior colleges—Staten Island, Bronx, and Queensborough—united to become CUNY (p. 67). The Governor of New York, Nelson Rockefeller, after imposing tuition on State University of New York (SUNY) colleges to bankroll the building of new SUNY campuses in 1962, demanded that CUNY end the tuition-free tradition on which the institution had been built. However, it seemed that the CUNY Board of Higher Education (BHE), student associations, and other New York City stakeholders were more determined than ever to keep the tradition of free tuition alive for all senior and junior colleges (p. 67). African Americans and Puerto Ricans were demanding entrance to the CUNY colleges by the mid-1960s. The New York City educational system had failed to educate these marginalized groups effectively, and Albert Bowker, who became chancellor in 1963, viewed remedial education as a way to level the playing field for these students (p. 69).

With the approval of Chancellor Bowker, two remedial programs were implemented at CUNY: College Discovery in 1964 at community colleges and Search for Education, Elevation, and Knowledge in 1966 at senior colleges. Despite these efforts in assisting disadvantaged African American and Puerto Rican students at CUNY, only 1,100 such students were admitted to CUNY colleges in 1968 (Fabricant & Brier, 2016, p. 80). Under Bowker's visionary

leadership, in 1966 CUNY agreed to an open admissions plan for senior and junior colleges. He had hoped to implement this plan by 1975, but his hand was forced by the events that took place at City College. In Spring 1969, following in the footprints of grassroots community struggles demanding better education for students of color in the public schools, African American and Puerto Rican students took over City College in a two-week protest and demanded that the CCNY administration provide a higher education that reflected their needs and reality. Students also took over other campuses throughout CUNY. After much unrest at CUNY campuses, on July 9, 1969, the BHE agreed to implement open admissions by the fall semester of 1970. Donal Farley, executive assistant to Seymour Hyman, CUNY Vice Chancellor for Campus Planning and Development under Bowker, stated, "Bowker was already projecting expansions of the University. Bowker was the leader [for open admissions]" (Medina, 2013). According to Farley, parents whose children were attending specialized schools such as the Bronx High School of Science and Stuyvesant High School did not like the idea of open admissions at CUNY. They felt that the academic standards were no longer rigorous—even though open admissions would be for the community colleges, and senior colleges would still be exclusive. In contrast African American and Puerto Rican students were determined to have open admissions at CUNY senior colleges as well.

The new student body after open admissions at CUNY was not academically up to the standards of the student bodies prior to open enrollment at, for example, City College, which, in 1965, required its entering students to have a high school average of 92 (Fabricant & Brier, 2016, p. 67). Therefore, student demographics changed with open admissions to include students with lower grades, particularly from high schools in disadvantaged neighborhoods where schools were failing to educate their students to prepare them for college. According to Mr. Farley,

remediation was a great concern at CUNY, specifically how to develop remedial programs, such as in math, appropriate to the needs of new student body. He stated, "this whole [remediation] industry was created within the university run centrally but also at the campuses" (Medina, 2013). This educational revolution was not happening only in New York City. In the words of Albert Bowker, "It was the goal of progressive looking states around the United States, to have open admissions. California, as I said, adopted it in 1960. It seemed more startling in New York somehow" (Edelstein, 1985).

The New College

After open admissions was implemented, the University was faced with an entirely new student demographic, and LaGuardia Community College would try to accommodate this population. The Free Academy, founded in 1847, was a model for the new community college. Horace Webster, President of the Free Academy, proposed that

> the experiment is to be tried whether the highest education can be given to the masses; whether the children of the people, the children of the whole people, can be educated; and whether an institution of learning of the highest grade can be successfully controlled by the popular will, not by the privileged few, but by the privileged many. (cited in Golway, 1997, p. 4)

In 1968, the Board of Higher Education passed a resolution to found Community College Nine, which later would be known as LaGuardia Community College. The new college, among other previously established CUNY institutions, would address the needs of New York in the current moment: a city with declining manufacturing jobs, changes in the composition of the workforce, the women's movement, and plural ethnicities. Goldway observed, "Somebody was

going to have to provide the new New York with an educated, well-trained workforce drawn from families and groups that higher education traditionally overlooked" (1997, p. 5).

The Opening of the College

With Joseph Shenker at the helm and in conjunction with Chancellor Albert Bowker, Community College Nine was built with the demands of open admission and co-operative education in mind. It would provide comprehensive community services to include cultural activities and continuing education, while offering three types of degrees: an Associate of Applied Science (A.A.S.) leading to the Career Option, an Associate in Arts (A.A.), and an Associate in Science (A.S.), the last two leading to the Transfer Option (LaGuardia Community College, 1971, p. 2). Bowker and Shenker hoped to encourage children of working-class New Yorkers to extend their education while training for a career. LaGuardia Community College opened its doors on September 22, 1971. Its first freshmen class came mostly from adjacent high schools and comprised 537 students: 312 women and 225 men. Its student body was "72% White, 19% black, 6% Puerto Rican, 0.8% Asian, 0.2% Native American and 3% other" (Golway, 1997, p. 17).

The admissions requirements were a New York City high school diploma or its equivalent. Students came from low-income or lower-middle-income families, which were attracted to LaGuardia because of "its signature program, co-operative education" (Golway, 1997, p. 18). LaGuardia's mission consisted of three main components: "formal instruction, cooperative internships and student services and counseling" (LaGuardia Community College, 1972, p. 8).

Dr. Roy McLeod, coordinator of the math area under the Natural Environment Division and later the chair of the newly minted math department, recalled that a feature of this new,

exciting venture was that the college started with divisions but no departments (personal communication, May 8, 2017). CUNY had given the school five years to form its departments. The college was divided into four divisions: Business, Language and Culture, Social Sciences, and Natural Environment.

The degree requirements were six credits in communication skills, nine credits in urban core curriculum, nine credits in cooperative education, and a combination of forty-three credits in major requirements credits and electives credits. The college offered associate degrees in business administration, accounting, data processing, secretarial science, and education. The grading rubric enforced at the time had the categories E (Excellent), G (Good), P (Passing), and NC (No Credit). LaGuardia offered three courses in its remedial program: Interpersonal Communications I and II, designed to help students become proficient in English; and Symbolic Communication, focused on basic mathematics concepts. The 1971–1972 course catalog stated that these courses were not mandatory for those students who were proficient in these requirements. The students' levels of proficiency were ascertained through the California Achievement Test, CUNY's placement test at the time. As indicated in the college's first self-study for reaccreditation, a student needed remediation if they scored below 12th-grade equivalency (GE) in reading or mathematics. The self-study report also revealed that, at the time, "the average LaGuardia student could read at a GE of 11.3 (38^{th} nationally-normed percentile for college freshmen), and had mathematics skills at 10.1 GE (32^{nd} percentile)" (LaGuardia Community College, 1974, p. 90).

McLeod (personal communication, May 8, 2017) remembers classes being capped at fifteen students. By the end of the school year, however, the remedial program was overhauled after the administration realized that the new incoming students scored 0.5 GE points lower than

the previous student body in both reading and mathematics. The new and improved remedial program required students who scored below 8.0 GE points in both reading and mathematics to take remediation courses in reading, mathematics, and study skills. This program was an integrated effort involving teachers, counselors, tutors, and lab technicians to ensure the advancement of the students. Students in need of remediation met with an academic counselor who would help them through the process of registration

By 1972, the Veterans Education Center had become part of the college (LaGuardia Community College, 1972, p. 17). This center was created to cater to Vietnam veterans who were returning home from the war and were accepted into this program with no admissions requirements as long as there were enough seats. The program was individualized and could last from three to nine months, according to the needs and goals of the student. It offered veterans basic academic skills courses and vocational counseling to prepare them for college. These courses included reading, writing, and remedial math courses. The center also offered a high school equivalency course. The veterans' educational benefits paid for this program.

In 1973, all divisions at LaGuardia complained about the unpreparedness of entering students, according to McLeod (personal communication, May 8, 2017). Senior colleges, as well, observed that students coming from LaGuardia were not prepared to do college-level work. LaGuardia administration and faculty revamped the school's remedial program by making all remedial courses co-requisite and forming an interdisciplinary committee to assess the progress of individual students in order to customize remedial services to students. A year later, CUNY pressured all its community colleges to align their grading system with the senior colleges. When interviewed by Vasquez and Brier (2015) for their oral history, Fern Khan remembered the Transfer Program, aka the Articulation Program, developed by Janet Lieberman, an administrator

and faculty member at LAGCC, in which students with an associate degree could transfer all sixty-six credits toward their bachelor's degrees. At the time, it was easier for a CUNY community college graduate to transfer to a senior college outside CUNY than within the university system.

The Founding of the Math Department

Roy McLeod (personal communication, May 8, 2017), the first chairperson of the math department formed in 1976, was originally the coordinator of the math area under the Natural Environment Division. Dr. McLeod was then an assistant professor in Nassau Community College and an adjunct professor at Hunter. He was offered a full-time job at Hunter but he felt he belonged at LaGuardia. In his own words: "What interested me was that LaGuardia was a new school and I could build it from the ground floor." In April 1971, McLeod was offered the position of math coordinator under the Natural Environment Division headed by Michael Hoban, despite McLeod not yet having his Ph.D. McLeod stated that even though Hoban had a Ph.D., he had never taught in a higher education setting, only in high school. Thus, the position of mathematics coordinator was offered to McLeod. He remembers the administration to be innovative, with Joseph Shenker at the helm as a very progressive liberal thinker. This sense of innovation was felt throughout LaGuardia.

The first remedial courses offered were MAT1 (arithmetic) and MAT2 (algebra), which were one-credit courses that met three to four hours per week. Dr. McLeod recalls that there had been a math lab to help the students with mathematics ever since LaGuardia had first opened its doors. The lab had a supervisor, Doris Charrow, as well as three lab technicians serving all students, but mostly remedial students who were required to take one math lab per week (personal communication, May 8, 2017).

The Introduction of Technology into Remedial Math Courses

The spirit of innovation of LaGuardia's founders extended to the development of instructional technology in order to facilitate math learning in remedial courses. As reported by Anthony Giangrasso (personal communication, May 8, 2017), Lenny Saremsky of the math faculty created Math Express, which he designed to help students with math lab work, homework and test taking. Later, the math faculty, spearheaded by faculty programmer Kathergama Natha and head of division Michael Hoban, designed and implemented an in-house program called Homework Helper to accomplish this goal.[1] At one point, Homework Helper was even sold commercially. Most importantly, the use of this software was free to all students. (Unfortunately, with the advent of commercially developed software platforms such as MathLab—a computer algebra system created in 1964 by Carl Engelman at MITRE, a federally funded not-for profit corporation—the college is no longer motivated to create in-house programs tailored specifically to LaGuardia's population in need of remediation, as we shall see in a later section.) All this innovation occurred under the leadership of Roy McLeod. According to Rudy Meangru (personal communication, May 8, 2017), this in-house software was developed for students to practice the CUNY Assessment Test, now called the CUNY Elementary Algebra Final Exam. Somehow these in-house innovations came to a halt with the expansion of commercial mathematics-remediation software programs. Math remediation became big business, and everyone benefited except the students in need of remediation, who continued to take the same course over and over without passing although each student was charged a sizable fee for the use of the platforms to complete their assignments and take quizzes and tests. Pearson, Educosoft, Aleks, the Carnegie Foundation for the Advancement of Teaching, and McGraw Hill Education

[1] The faculty interviewees could not recall the exact dates of the inception of the development of the software programs. There is nothing further recorded in the archives.

were the big names on campus for developmental math at LaGuardia. We may think that this new and *improved* technology would have been the answer to remediation, but, as the 2012–2016 and 2016–2020 CUNY Master Plans show, the need for math remediation has increased, while in all other areas it has decreased. At LaGuardia, the use of online software platforms is unique to developmental math courses and is not found in developmental reading or writing courses. However, it seems that prepackaged commercially developed software outside the colleges is not the answer for remediation, at least not in CUNY community colleges. The educational policies and reforms put forward by power players have taken control away from the affected communities. These follow what Spring (2015) calls the *rational choice paradigm,* the assumption "that humans act according to their calculations of costs and benefits" (p. 7). These policies and reforms promote "education as primarily an economy activity" (Spring, 2015, p. 5), rather than a social/human activity. Under a system that privatizes the education of the underprivileged (such as many community college students) to the benefit of the powerful, we can see the objectification of the oppressed (Freire, 1970/2000).

As of now, open educational resources (OER), in conjunction with the online course management and assessment system Lumen OHM (Online Homework Manager) costing $25 per semester, are being implemented at CUNY colleges. It does help to minimize the cost of textbooks, but educators need "to move beyond a free version of the status quo" (McDermott, 2020, p. 10). In other words, the use of OER needs to reflect relevant curricula and pedagogies in which students' voices and realities are very much part of the course design.

In 1999, Herman Badillo, then the chairperson of the CUNY Board of Trustees' chairperson, organized a successful campaign to end open admissions at CUNY's senior colleges (Gunderson, 1999). Since that time, community colleges have struggled to perform the job of

remediation in mathematics. The 2016-2020 CUNY Master Plan indicated that developmental math courses have become gatekeepers for educationally disadvantaged African American and Latin@ students at community colleges, as many take these courses several times unsuccessfully, while others assigned to these courses never enroll in them, thus preventing their graduation.

Addressing Researcher Positionality

As a Latina math educator in an urban community college, I have seen firsthand the results of the stratifying and oppressive form of math education practiced in developmental math courses. One of the results is math avoidance. As a consequence of math avoidance, many students delay enrolling in remedial coursework. For those students who do take developmental math courses, many do not pass. Of this group, the majority forgo retaking this course beyond this point. Hence, many do not graduate to go on to four-year colleges. This phenomenon is not new; there are many studies documenting the educational system's failure, impeding students from successfully completing the developmental math sequence imposed by the current educational system and how these failures shape their math identities (Bahr, 2012; Bailey, 2009).

Time and again, students have come to me on their first day in developmental math class to tell me, "It's do or die. I need to finally pass this course. I have taken all required courses for my associate's but I cannot pass this one. I may not graduate and transfer to a four-year college." My students have told me how they hate and fear mathematics and how, based on this fear, they have chosen careers that require a minimum of math or no math at all. They tell me of their negative experiences with mathematics and how they could never understand how math was relevant to them. They tell me that when they asked their teachers for clarification of math concepts in previous classes, they were told to just memorize and ask no questions. For them,

mathematics became something only few can do. Math was mythologized for them, potentially limiting their futures.

I see this mythologizing of math as another form of injustice in education. Due to political and educational policies, remediation is primarily the job of community colleges. Higher education is seen to be more of an impossible dream for these marginalized community college students. Moreover, these courses are often taught via the banking system (Freire, 1970/2000) without valuing students cultural and historical knowledge. This type of pedagogy perpetuates the belief that only certain types of people can "do" math and does not acknowledge the everyday tasks in which students engage in math. Community colleges may become more like vocational schools instead of springboards to higher education for those who can neither afford the costs nor meet the standards of four-year colleges. We need to equalize math education by demythologizing mathematics.

Math should not be used to further oppress marginalized communities. I have seen how this mythologizing of mathematics prevents students from reaching their educational and economic potential. They have to be content with choosing careers that have a minimum of math requirements instead of careers they truly are passionate about but have more math requirements. I have seen how despite failing the school's math requirements time and again, students continue to take the required developmental math courses in the hope of finally passing them and going on with their higher education goals. When I look at my students at the beginning of the semester, I see warriors not giving up despite an educational system that has taught them hopelessness. I see them as courageous activists claiming their right to be educated.

What is Missing? Gaps and Theories Considering Difference as Deficiency

Many quantitative studies examining developmental math courses tend to take a macro view of this problem. They do not address the reasons why some students, after being placed in a developmental math sequence, do not successfully complete the required courses. These quantitative studies, which take a deficit perspective, often portray minoritized students in community colleges as monolithic, or as a homogenous group and by implication, inferior. Nasir and colleagues (2005) argue, "What makes essentializing so dangerous is not the attention to perceived continuities, but the implied assumption that those who differ from American middle-class norms are somehow deficient" (p.490). Minoritized students live in between two cultures and two ways of looking at themselves, and this "in-between-ness" is not viewed as normal or worthy of contributing to society by the educational system and society at large, and, thus, for example, students of color are "deprived of the cultural capital necessary to succeed" (Trueba, 2002, p. 20).

In contrast, qualitative studies take a micro view of math learning, examining it as a cultural practice as well as for its impact on overall identity, agency, and math identity. These studies at last bring the voices of the students to the forefront; however, they do not yet examine how community college students placed in DeM construct their math identities, what drives this construction, and how this construction affects their career choices and, thus, their social mobility, which is something I hope to remedy with this study. Studies highlighting these three important parts of student math identity construction should address social justice in math education, so this aspect is essential to investigate, but not in isolation: math identity is impacted by teachers' attitudes, curriculum, pedagogy, and educational policies as well. Each factor informs the other. We must investigate how our cultural and educational institutions shape community college students' math identities and what we as educators can do to transform the

status quo, not simply reference statistics. Educators have a responsibility to actively change notions of what math education is—and could be. A holistic approach is needed, drawing from statistical studies as well as current and ongoing qualitative investigations and now, students' own lived experiences as the basis for this study.

An Educator's View

A true mathematician-as-educator will be comfortable exploring math concepts and developing a space with her students to explore how mathematics can be useful for their current and future lives. In creating this collective space, the teacher must relinquish authority and value students' cultural and historical knowledge. Stetsenko (2017) highlights the importance of the agentive collective work at the root of social change: "Development represents a collaborative and continuous 'work-in-progress' by people as agents of social change who struggle for their unique authorship and contribution to social practices in a world fundamentally shared and co-created with others" (p. 325). Math educators should humbly partake of this social exchange in which they have the opportunity to create a space in which students agentively pursue equity and justice in math education.

D'Ambrosio (1985) observed that in antiquity there was a divide between math for the aristocracy and math for the masses. He states, "This distinction between scholarly and practical mathematics, reserved for different social classes, [was] carried on by the Romans with the 'trivium' and 'quadrivium' and a practical training for laborers" (p. 44), guidelines for math instruction for the elite and non-elite, respectively.[2] Similarly, today, math education stratifies math learners into the elite—the few who can understand math well—and the masses—the

[2] Trivium was the lower division of the seven liberal arts in medieval universities consisting of grammar, rhetoric, and logic; quadrivium was the upper division of the seven liberal arts consisting of arithmetic, music, geometry, and astronomy.

majority for whom math is an enigma and unreachable. Currently, we can see this stratification with community college students assigned to DeM, whose negative math identities bar them from higher education. Developmental math courses have a “hidden curriculum,” in which students are communicated unspoken academic, social and cultural messages that they are “less than” because they need to take developmental math, which disempowers and oppresses students. It is a not-so-hidden form of oppression.

Chapter II: Literature Review

Essential Terminology

One of the most important terms in this research, *identity*, may be described as "the way we define ourselves and how others define us" (Anderson, 2007, p. 8). A term connected to identity is *subject position*. While identity is how we and others view ourselves and each other, subject positions determine our placement in socially constructed worlds based on these worlds' discourses and values. Subject positions may limit our agency (Olitsky, 2006, p. 747). *Agency* refers to the ability to author oneself while engaging with the world in which individuals not only participate but contribute to the development of knowledge in their communities of engagement (Stetsenko, personal communication, 2016). According to Anderson, *math identity* is the ability to "participate within mathematical communities in such a way as to see [ourselves] and be viewed by others as valuable members of those communities" (p. 8).

A term related to practice as an important part of the learning process is *legitimate peripheral participation*, which identifies learning as a social process in which newcomers have become experienced members of their community through practice (Lave & Wenger, 1991). *Funds of knowledge*, a concept associated with difference as a learning tool, is the knowledge culturally and historically transmitted and acquired by individuals and families in order to function well in their cultural contexts (Greenberg, 1989; Tapia, 1991; Velez-Ibañez, 1988, as cited by Moll et al., 1992). Another term related to funds of knowledge is *Discourses*, which Barton and Tan (2009), drawing on Gee (1996), describe as inclusive ways of knowing, subsuming but not limited to written or spoken language (p. 51). An additional related term, *design experiment* is a research method that focuses on a pedagogical practice problem in which certain theories of learning and teaching are developed and evaluated with the goal of applying

them at other sites as well (Barton & Tan, 2009, p. 53), aiming at a "fundamental social transformation" (Gutiérrez & Jurow, 2016).

Two other important terms related to identity and agency are *figured world* and *third space/hybrid space*. A *figured world* is a sphere of meaning-making in which people, through Discourses, are assigned certain positions, and acts are interpreted as valuable or not according to the values of this socially and culturally constructed world (Holland et al., 1998, p. 52). A *third space/hybrid space* is a space in which the school's values, Discourses and canonical knowledge merge with the students' communities, funds of knowledge, and their own Discourses.

Learning|Teaching as a Cultural Practice

In the curricula and pedagogies implemented in most developmental math courses, learning is a process of the individual mind only (Lave, 1996). Hence, in these courses, learning is an individual responsibility instead of a collective one. A social theory of learning, rather than a cognitive one, emphasizes learning as a social process and not just a process of the individual mind (Lave, 1996; Nasir, & Hand, 2006; Wenger, 1998). This standpoint is important because marginalized students should not be blamed for being unsuccessful within a system that has made social inequality natural (Lave, 1996). Lave (1996) also suggests that in a social theory of learning, the focus is on learning as opposed to teaching. Lave argues that "learners…constitute the working conditions for teaching rather than the other way around" (p. 159). This concept is quite powerful because it emphasizes learning as a social process driven by problem-posing pedagogy instead of the banking system (Freire, 1970/2000). Thus, this social theory of learning does not assume as natural the hierarchical social structure of U.S. schools (Lave, 1996). Likewise, Stetsenko (2017), through the lens of the Transformative Activist Stance (TAS), views learners as the driving force for teaching. TAS allows for each teacher-learner to be a co-creator

of a collective future-in-the-making. However, Stetsenko does not view this effort as an individual process, but rather, in line with Markova (2012), as a "dialogical [ontological]" endeavor (as cited by Stetsenko, 2017, p. 174). This teaching-learning process is a collective re-claiming of our forever-evolving humanity. Moreover, Stetsenko extends "development and teaching-learning [as]collaborative processes of an activist nature" (p. 327), in which teachers-learners cooperate to re-imagine an education that centers not on the mere co-construction of knowledge but on the "active project of becoming human" (p. 336). TAS goes beyond other models of education whose focus is an education that is relevant to learners (p. 340). For Stetsenko, this is not enough: education must militate for change in which student activist identities and agencies are facilitated and supported.

Furthermore, when educating community college students who come from marginalized groups which have been stripped of their humanity and whose funds of knowledge and Discourses have been devalued, an education that is relevant to learners—created with them, not for them—is not merely reactive. It is, borrowing from hooks (1994), an act of courage and activism. Thus, teaching and learning that refuses to take a monolithic view or to position learners as deficient goes very much hand-in-hand with TAS's position of an education that facilitates "an active and agentive exploration" (Stetsenko, 2017, p. 341) of learners' unfolding humanity. This type of teaching and learning not only questions the structures constricting the development of learners but also helps in dismantling such structures. Teaching that denies our natural tendency to be seekers of the knowledge which leads to equity and justice strips us of our evolving humanity. Moreover, teaching that does not consider students' current and future realities outside the classroom cannot translate into learning. Lave (1996) states,

> Here I take the view that teaching is neither necessary nor sufficient to produce learning, and that the social-cultural categories that divide teachers from learners in school mystify the crucial ways in which learning is fundamental to all participation and all participants in social practice. (p. 157)

In the development of curricula and pedagogies of developmental math courses, we should consider the realities of our students and how these realities can enrich classroom learning and teaching. Barton and Tan (2009) claim that acknowledging and using student funds of knowledge and Discourses can help to transform academic spaces and academic knowledge. Likewise, Nasir and colleagues (2005) state that "Moving toward equity will occur as we create learning environments that connect in deep ways to the life experiences of all students" (p. 499). Thus, these spaces transform from foreign—and at times hostile—spaces to familiar and inviting spaces of learning in which students have a say in their education and in the construction of academic knowledge. Making teaching and learning relevant to students who come from marginalized groups implies a revolution, since their funds of knowledge and Discourses have been deemed deficient and in need of remediation. Recognizing their epistemological value is taking a transformative activist stance. In 1994, bell hooks recognized the need to connect knowledge to students' lived experiences and stated, "[Students] rightfully expect that my colleagues and I will not offer them information without addressing the connection between what they are learning and their overall life experiences" (p. 19).

Moreover, a social theory of learning in which learners are the locus of teaching puts to rest the notion that learning is a mental activity in which only a few exceptional learners can participate. In other theories of developmental learning, those learners who cannot are labeled "dis-abled" (Lave, 1996, p. 149). The social theory of learning highlights the inadequacies of the

traditional educational system and puts the responsibility where it belongs: with the school system. Therefore, community colleges must examine their assessment process for students required to take developmental math courses. The learning and teaching processes in the developmental math classroom must be examined as well. Wenger (1998) states that learning becomes stagnant when the real world is substituted for "a closed system that shelters a well-engineered but self-contained learning process" (p. 275). Additionally, he claims that "codification of knowledge [into a reified subject matter] …lift[s] knowledge out of practice and thus…obviate[s] the need for (and complexities of) participation" (p. 265). Students in these classrooms should be invited to engage in a learning process that emphasizes legitimate peripheral participation in which students can experience how these mathematical concepts apply to their current and future lives.

A social theory that does not acknowledge racism and injustice as part of the design of our social, educational, and political structures cannot result in policies and pedagogical practices that can bring social justice to math education. Lave (1996), drawing on Olsen's (1995/1996) ethnographic study of immigrant children in a high school near San Francisco, argues that "Americanization" is an incidental form of "racialization" in which immigrant students are separated into groups racially. Lave defines Americanization (more generally, assimilation) as the transformation of immigrant students' national identities to generalized racial or ethnic identities, for example, from Colombian or Ecuadorian to Latina. (p. 160). Hence, educational institutions should find ways to integrate diversity and difference as a way to enrich the educational experiences of its students.

Difference as a Cultural Tool for Learning

A social theory of learning that does not take into consideration race and culture fails to acknowledge schools as sociopolitical spaces. Nasir and Hand (2006) observe, "Although the view of culture put forth in sociocultural accounts certainly facilitates analyses of everyday learning and development from a cultural perspective, it rarely addresses the political nature of culture" (p. 463). Hence, just recognizing difference and diversity is not enough unless we admit that by the nature of their design, our educational institutions are political spaces.

Through a design experiment, Barton and Tan (2009) created a sixth-grade science lesson plan in which the school and students' knowledge and Discourses merge to create a third space/hybrid space. Drawing on Moje, Ciechanowski, Kramer, Ellis, Carillo and Collazo (2004), Barton and Tan view this space as a tool in which these epistemological forms coalesce. The authors examine the physical, political and pedagogical transformations of the hybrid space. According to the authors, the classroom went from being a sterile, unfamiliar space to a vibrant, familiar space for both the students and their families. In this hybrid space, students' knowledge was valued, and students were involved in the development of lesson plans for a unit on food and nutrition. A natural extension of Barton and Tan's work is to examine how the merging of school and student knowledge and Discourses may be translated into more inclusive STEM curricula and pedagogies. Nasir and colleagues (2005) argue that for youth from nondominant groups, the hegemony of middle-class values in the school system limits opportunities for a better future. For Nasir and colleagues, "equity is not about offering or producing sameness, but about enabling youth to appropriate the repertoires they need to in order to live the richest life possible and reach their full academic potential" (p. 499). Diversity should not be viewed as something to be fixed, but as an asset that can be used to further more inclusive curricula and pedagogies (Gutiérrez et al., 2000 as cited by Nasir et al., 2005, p. 498). Nasir and colleagues

warn that essentializing ethnic or racial groups leads to curricula and practices in which difference is not part of the learning process (p. 490). The desire or impulse from the school system to create sameness among students of non-dominant groups is in opposition to not only the realities of these students but to how the system treats students from dominant groups. Nasir and Hand (2006) point out that "while upper class schools stress autonomy, self-expression, and leadership, lower class schools are structured to foster compliance and the following of orders" (p. 453). In other words, upper class students are trained to become independent thinkers with a view to govern, while lower class students are trained to passively comply, cogs in the capitalistic machine created by the dominant group.

Nasir and colleagues (2005) view the ability of immigrant youth to adapt to different contexts as part of their learning process. According to these authors, "Adaptive expertise is crucial for youth from the nondominant groups who typically face and must be able to address extreme societal challenges" (p. 490). This need to adapt to contexts that can be hostile is viewed as an asset by some. Trueba (2002) posits that the flexibility and endurance of immigrants and their future children combined with their ability to take on different identities while adapting to their adopted country are untapped resources. These untapped resources should be viewed as cultural capital in a global society. He states that "a general resiliency associated with the ability to endure hardships and overcome obstacles will clearly be recognized as a new cultural capital that will be crucial for success in a modern diversified society, not a handicapped [one]" (p. 7). Trueba argues that the multiple identities immigrants take on as members of a new community and members of their own ethnic communities give them the ability to work with diverse groups. However, neither Nasir and colleagues nor Trueba defines "adaptation." Do they mean the ability to take on tools afforded in the different contexts they inhabit to create and expand new

knowledge and identities? Or do they mean assimilation, which can be perceived as annihilation of immigrants' cultural capital, to re-create the hegemony of dominant White middle-class values? Nasir and colleagues argue that social justice in education is not found through sameness but by allowing students to appropriate the necessary tools to reach their true potential. Hence, it may be interpreted that Nasir and colleagues' implicit definition of adaptation includes learners' ability to expand and evolve their repertoires of identities without having to renounce any of them (p. 499). Likewise, Trueba states that assimilation can never work for most immigrants, as their success and flexibility come from being able to inhabit several worlds (p. 10). Thus, Trueba's definition of adaptation is one in which resilience, creativity, and appropriation of tools leads to expanding and evolving knowledge and identities.

Another point of contestation is how cultural capital is defined and by whom. Indigenous peoples perceive cultural capital differently from the Europeans who colonized the Americas. Trueba (2002), for example, emphasizes the importance of cultural capital in his research, but a further extension might be needed to investigate how multiple ethnic, racial and cultural identities in action differ from the imposed positionalities given to immigrants by the dominant group. Thus, identity construction is another concept needed to be examined through the lens of the social process of learning.

Identity and Agency as Social Constructs

Identity formation must be investigated to bring about an education in which social justice is a priority. It must be examined through the lens of the learning process using social theories. Nasir and colleagues (2005) observe that learning not only involves the mind but also other developing processes such as identity formation. We must further examine the intersections among identity construction, curriculum, and achievement of minoritized students (Caraballo,

2011), such as immigrants. It is imperative to examine how minoritized students construct their identities so that the school Discourses of achievement and engagement—that is, curricula and pedagogies—may be examined in this regard. Sfard and Prusak (2005) explain that "the notion of identity is a perfect candidate for the role of 'the missing link' in the dialectic between learning and its sociocultural context" (p. 15), further arguing that the concept of identity can be used to study learning. The authors define identity as "stories about persons" in which the gap between what the learners are at the moment, *actual identity*, and what the learners want to become, *designated identity*, can be bridged by learning (p. 18). Examining the sociocultural and political contexts of teaching-learning processes is paramount in that they affect the identity formation process among minoritized math students.

In order to obtain social justice in education, identity formation must be examined using social theories while learners are engaged in the process of learning. One way to do this is by framing social justice in education through an *identities-in-practice theory* (Caraballo, 2011). Identities-in-practice reflects how students engage in learning while doing, rather than functioning as idle receptacles for knowledge (Freire, 1970/2000). Faircloth (2012) observes that through the framework of identities-in-practice, educators can bridge the gap between students' identities and learning. By developing student voices through their own learning experiences, students are authoring themselves, finding the connections between their identities and school-based learning. Identity construction may also be viewed from a historical perspective. By drawing from the works of Vygotsky, Bakhtin and Mead, Holland and Lave (2009/2019) examine how social practice highlights the "historical production of people". The authors emphasize that the central focus for both Social Practice Theory and Cultural-Historical Activity Theory is activity; Social Practice Theory in particular stresses the historicity of identities-in-

practice and how the diversity of learners frames their struggles. This framework highlights how identities form in practice and emphasizes how identity formation is temporal and contextual and does not take place in a vacuum. In the same vein, Stetsenko (2017) posits that the TAS perspective of learning and identity is not one of mere reactions to the status quo but of re-imagining a collective future in which each person co-creates and co-imagines a world in which communities of practice are re-inventing and re-imagining themselves. The aim of this endeavor is social justice and the development of human beings who are forever evolving, learning and engaging in the development of a just world. Stetsenko also points out that if proper cultural tools are provided to learners in the teaching/learning processes, these tools can become for the learners "...tools of *their own* agency, selfhood, authoring, and activism" (p. 340).

Furthermore, as Langer-Osuna and Nasir (2016) stress, social justice must be at the forefront of education research at all levels: classrooms, school Discourses, and educational structures. The authors examine educational research through the lenses of race, culture and identity. They examine how at first social science theories dehumanize minoritized groups by the use of racial deficiency theories such as eugenics and later on, through the use of cultural deficiency theories. They also discuss how Black scholars work to humanize minoritized groups by portraying race as a social construct and scrutinizing the practice of schools prioritizing and normalizing White middle-class culture over other cultures. The authors claim that poststructural and critical theories help to illuminate the role of power in shaping identity development (Langer-Osuna & Nasir, 2016, p.731). While critical race theorists place the focus of school Discourses on the identities of the dominant group, poststructuralists focus on how these Discourses conceive identities through subject positions, where the institution assigns an identity, which may be internalized or rejected (Langer-Osuna & Nasir, 2016, p.731). These two

perspectives support the investigation of the Discourses of the figured world of developmental math.

The schools' canonical knowledge and Discourses must be interrogated for how they affect the construction of learners' identities. In examining this interrelatedness, the undercurrents of the hegemony of White middle-class values—which are tacit yet obscured in the classroom—must be illuminated. Caraballo (2012) states that the figured world of achievement is controlled by three forms of discourse—equity, effort and colorblindness—and describes how these Discourses hide the biases inherent in White middle-class-inclined curricula and pedagogies. In particular, colorblind discourse hides how White middle-class perspectives are valued while diversity is not. The knowledge that minoritized students bring to the classrooms is not viewed as an asset but ignored and not considered an important part of canonical school knowledge. Caraballo discusses how, through the discourse of equity, a better education for marginalized students is formulated as "...filling a void or lack, rather than as a productive impetus for change" (p. 46). As these forms of discourse affect learners' identities and agency, educational structures need to be deconstructed and examined to bring about more inclusive curricula and pedagogies. This analysis of educational structures can be achieved through the realization that identity formation is a social enterprise. In an important conceptual move, Hand and Gresalfi (2015) posit identity construction as a collaborative endeavor among persons appropriating socially constructed artifacts within socially constructed worlds (p. 190). The authors posit that in classrooms in which students have more agency in the construction of knowledge, their identities are more "multifaceted" and positive (p. 199).

Thus, in classrooms in which diversity is embraced and viewed as an asset, learners from minoritized groups appropriate Discourses that benefit and support a fluid and flexible identity

development in which their cultural identity is not deemed as defective or lacking. Hand and Gresalfi (2015) pinpoint that classrooms that are pedagogically situated in a problem-solving system rather than the banking system, bring about identities that are complex and positive instead of static and negative. Identity construction needs to be addressed from the view that curricula and pedagogies have an effect on the complexity, fluidity, and positivity of such construction. Hence, policies that affect minoritized students need to consider how what transpires in the classrooms affects minoritized students and how it has an impact on their career choices. Classroom interactions that normalize dominant Discourses and devalue alternative Discourses must be examined in order to highlight how these Discourses oppress students from nondominant groups. Caraballo (2012) expands on this position by stating that

> we must engage the social and multicultural imagination of scholars, researchers, and educators by promoting the development of situated, context-based curricula and fostering new understandings of curricula and academic achievement that incorporate the narratives and perspectives of students from a wide range of backgrounds in the interest of democracy and social justice in education. (p. 55)

Therefore, curricula and pedagogies must reflect students' realities and engage in creating a democratic world inside and outside classrooms.

Caraballo (2017) calls for researchers, educators and students to re-design and re-imagine curricula and pedagogies "that disrupt marginalizing discourses about literacy" (p. 586), empowering learners and communities and their knowledge. The author suggests that these marginalizing Discourses must be examined in order to "expos[e] curriculum and pedagogy as raced, classed, and gendered, rather than neutral" (p. 602). Thus, new curricula, pedagogies and spaces of learning must be constructed in which learners and educators actively participate as co-

creators of knowledge. Caraballo argues that in the figured world of achievement, once curricula and pedagogies are examined, minoritized students can find ways to author their identities across different contexts and to negotiate what it means to be a high-achieving student. In sharing this approach, I believe that community college students enrolled in DeM also must carve identities in the figured world of developmental math that places math as the entrance to the world of higher education, rather than as, too often, a gatekeeper for these students.

Faircloth (2012), emphasizing the importance of engagement in learning, observes that the connection between students' identities and learning can be strengthened when the gap between the students' lived experiences—their daily realities— and school culture can be bridged. Her research can be extended to explain the type of curricula and pedagogies which can bridge this gap and engage learners. However, the author does point out that students' voices should be heard in the development of curricula and pedagogies, a connection essential in order to attract more minoritized students to careers that require intensive math courses by making these courses relevant to their experiences in the present and future. Moreover, Faircloth proposes the investigation of pedagogical practices that support connections between students' identities and learning and "explore more thoroughly the development of student voice and its impact on students' experiences of learning" (p.193). Hand and Gresalfi (2015) posit identity construction "as a joint accomplishment between individuals and their interactions with norms, practices, cultural tools, relationships, and institutional and cultural contexts" (p.190). The authors argue that classrooms which are pedagogically problem-posing instead of based on the banking system bring about identities that are complex and fluid. I hope to pick up where Hand and Gresalfi have left off by investigating how the complexity of these identities translates into other contexts such as community colleges. Thus, in one view, identity development needs to be

addressed from the view that this concept is a shape-shifter as learners go from one context to another.

In addition, Trueba (2002) posits that multiple ethnic, racial and cultural identities should be viewed as cultural capital instead of being socially and culturally handicapped. Trueba writes, "To assume that each person has only one fixed identity relatively unchanged across the cultural and social experiences that differentiate individuals is simplistic and reductionistic" (p.10). The author observes,

> A simple unilinear acculturation or assimilation process from one culture to another would not be functional or even possible for most immigrants. In fact, their resilience and "success" (defined in terms of psychological adaptation and social mobility) and their powerful influence in mainstream society are the result of their creative ability to become an "other" and participate in different worlds. (p.10)

Trueba argues that the multiple identities immigrants take on as members of a new community and members of their own ethnic communities give them the ability to work with diverse groups. He stresses that immigrants, who live in two worlds, bring social and cultural capital to their new community, and included in this new community is the educational system. Trueba's concept of identity fluidity as cultural and social capital supports an inclusive and diverse education that allows for its students to pursue their ever-evolving potential and search for a just society in which they will always question the status quo.

Resources afforded to learners and how they affect identity formation must be examined as well. Nasir and Cooks (2009) explore identity and learning as two interrelated but distinct processes through three types of identity resources—*material resources, relational resources*, and *ideational resources*—and two different trajectories of identities—inbound and peripheral

practice-linked. Material resources are contextual artifacts which support learners in their practice of becoming part of a community of learning. Relational resources are the relations that learners have with others in a learning context which support them in becoming part of the community of practice. Ideational resources are how learners see themselves in relation to others and how they view their place in this setting according to the values of the figured world they inhabit. Nasir and Cooks observe, "Within these figured worlds, identity is constructed as individuals both act with agency in authoring themselves and are acted upon by social others as they are positioned (as members, nonmembers, or certain kinds of members)" (p.41). Thus, Nasir and Cooks highlight the importance of the resources afforded to students. Minoritized students, whose cultural knowledge is deemed as lacking or defective, may experience a sense of not belonging, which can be detrimental to the formation of positive identities.

Similarly, Olitsky (2006) discusses how subject positions created by school Discourses limit and constrain students' visions of themselves in the future. These Discourses stratify students into those that should study science and those who should not, replicating the advantages and disadvantages found in a society based on class and race. The author reveals how these Discourses limit students' views of themselves as deserving learners of science. Olitsky states, "the division of people into subject positions is tied to power relations, as those who are classified as 'the special people who understand' gain access to knowledge, authority and/or privilege" (p. 749). Hence, if the proper tools are not afforded to students to help in their development of identity and agency, then the educational system fails its mission to fully educate its students. Students placed in DeM in community colleges already have a history of feeling not "smart enough" because of their perceived lack of math skills. These students believe that they are not good at math and that only a chosen few can learn and understand math; meanwhile, in

their everyday lives, many of these students continually apply math concepts in order to take care of themselves and their families, for example, they pay bills, look for bargains, and create budgets to maximize their poor to modest incomes. Educators need to be aware of the Discourses that limit students' agency, education and economic mobility.

How students internalize canonical school Discourses must be examined as well. According to Caraballo (2011), the discourse of equity is internalized by students, who create binaries in terms of the subject positions of race/ethnicity and effort/achievement. Urrieta (2007) advances the notion that in figured worlds, learners can redesign who they are or who they perceive themselves to be and be agentive (p.120). As learners, we have the potential to deconstruct and reconstruct figured worlds. Urrieta extends this to how, in figured worlds, there is a rank and an order through which students not only learn the structure and distribution of power, but also transfer it to society and communities (p.121).

Hence, given the right tools, minoritized students can transform their figured worlds into structures that support and value diversity, and this change would be transmitted to society at large. White and Lowenthal (2011) state that in order to play an important part in academia, achieve social mobility and make academia more diverse, minoritized students must first learn the academic discourse they call *codes of power*. Codes of power are the privy forms of knowledge needed to negotiate the system and to learn the Discourses of academia itself (p. 285). The authors argue, "Because of the strong link between language and identity, many minority students equate the appropriation of academic discourse with 'acting White,' and thus as a negation of their own cultural identity" (p.287). This argument puts the blame once again on the individual for failing to internalize academic codes of power instead of the oppressive structures that hold minoritized students to be lacking.

However, White and Lowenthal (2011) acknowledge that "[b]ecause specific kinds of literacy are not neutral and are not equally shared across peoples and cultures, discourse communities are more often than not exclusionary" (p.290). Therefore, the authors argue, minoritized students should learn the codes of power, and by codes of power, they do not simply mean the literacy-specific language, but also the practices of academia. Likewise, Caraballo (2017) writes, "[t]he gap between the explicit/visible and implicit/(in)visible expectations is particularly difficult for lower income students of color to bridge because they are less likely to come from backgrounds whose parents or close family members are immersed in academic contexts and are privy to some of their unwritten rules" (p. 596). Minoritized students are not taught these codes of power, nor are these students valued for what they bring to academia. However, there are ways in which developmental math students most certainly bring value to the classroom, like offering different ways of approaching a math problem; as such, they are bringing in new kinds of mathematical knowledge to the classroom. Towards this end, White and Lowenthal recommend, for example, that code-switching be encouraged in order to emphasize that no single literacy is superior to another, or in other words, that every minoritized student and educator has a right and obligation to embrace their multiplicity and their in-betweenness (Anzaldua, 1987/2012).

Agency or self-authoring is a concept that is paramount in the development of identity. Hence, Holland and Lachicotte (2007) examine the concept of identity through their analysis of sociocultural research using Meadian (Mead, 1910, 1912, 19,13,1925, 1934) conceptualizations of identity framed in Vygotsky's (1978, 1982, 1984a, 1984b, 1986, 1930/1993) concepts of self-development. Meadian identities are defined as "social and cultural products that people transact in practice and at some point begin to direct to themselves" (Holland & Lachicotte, 2007, p.134),

while Vygotsky's concepts of self-development highlight culturally active roles in identity formation by showing how people organize and internalize their sense of selves by the use of culturally constructed artifacts. These processes of organization and internalization of identities help "to control one's behavior and, thus, have agency" (Holland & Lachicotte, 2007, p.109). Also, one of Vygotsky's main concepts is the capacity for people to escape the restrictions imposed by outer or inner influences "through the active construction and use of symbols" (Holland & Lachicotte, 2007, p.109). These concepts are important in the investigation of how community college students assigned to DeM construct their math identities, as they clarify how the figured world of developmental math and its Discourses hinder student formation of a positive math identity and how the students refuse the constrictions of this figured world and its Discourses.

Likewise, Holland and Lave (2009/2019), framing their ethnographic works in social practice theory, emphasize "processes of history in person"—how people through the use of socially constructed artifacts develop a persona, escaping the constrictions of their contexts, and "historically institutionalized struggles"—tensions and differences among groups who have a different historical trajectory (p.13). In the construction of math identity, there are struggles for justice in math education. They are those who believe that certain groups cannot understand math, while others believe that education should be made relevant to all. Syed and colleagues (2011), using as a common point the concept of identity and its link to educational achievement, examine theory and research in the fields of developmental and social psychology, education, and sociology, focusing on three synergic points: prejudice and stereotype, the role of social support, and the availability of options for identity development. The authors state that each of these fields can offer "complementary and distinct insights into the question of how identity is

associated with the academic experiences of URM [underrepresented ethnic minority] students" (p. 445). The authors further state, "URMs may become aware of negative stereotypes about their achievement potential, leading them to question their abilities and disengage from school" (p. 444). Community colleges are the springboard to a four-year college for many minoritized students; thus, community colleges must actively engage in developing curricula and pedagogies that eliminate negative stereotypes from their Discourses. Syed and colleagues point out how "researchers demonstrated that African Americans underperformed on [intelligence] tests when they believed them to be diagnostic of their ability, compared with African Americans students who did not believe the test diagnostic. No such difference was observed for White students" (p. 446). Subject positions or negative stereotypes can have a negative effect on identity construction. Thus, schools have the great responsibility of combating these types of Discourses. Syed and colleagues take macro and meso views, instead of a micro view; this last can highlight how minoritized students accept or reject negative stereotypes, the limitations for minoritized groups to develop a positive math identity and how these limitations impede their involvement in STEM (Science, Technology, Engineering and Mathematics) fields.

Caraballo (2012) posits that investigating the construction of identities and acceptance or rejection of positionalities in minoritized students and the Discourses of the academic world of achievement may lead to "curricula and pedagogies of hope" (p.55). There is a need for further exploration of how minoritized students' realities can be brought into the world of achievement, integrating such experiences into mainstream academia and quantifying or qualifying this positive imagery.

Development of Math Identity and Its Contexts

Quantitative and qualitative studies have endeavored to understand why students from non-dominant groups, especially community college students, placed in DeM seem not to obtain the necessary college math skills to successfully continue with their higher education goals. Quantitative studies take a macro view of this matter; these studies do not investigate how curricula, pedagogies, educational, social, cultural and political contexts affect the development of the math identities of these students. Qualitative studies take a micro view of this conundrum; however, Kaspersen and colleagues (2017) imply that having an accurate measurement of math identity will bring about a better understanding of this issue. Other qualitative studies examine pedagogies and school Discourses, but do not expand their research into how these students view their identity formation and how identity construction affects their career goals and, hence, their economic mobility. Lave (1996) posits that a social theory of learning, rather than an individual psychological one, helps us to see learning not as static, but as a process that can be helped or hindered by the social environments where learning takes place. As such, construction of math identities can be viewed not only as a mental process, but as social process as well, in which socially constructed frameworks and their Discourses aid the construction of positive math identities among community college students.

Macro View of Developmental Math

Quantitative studies take a macro view of community college students placed in DeM and the institutions they attend. These studies have shown that the majority of students enrolled in DeM do not successfully complete the developmental math sequence (Bahr, 2012; Bailey, 2009). Bailey (2009), using longitudinal data, tracked 250,000 students from the National Education Longitudinal Study database over three years, examining the students placed in DeM, the effectiveness of these developmental courses and the cost of these courses to the students. The

author suggests that remedial courses are not effective since a large number of students do not successfully complete the sequence in which they are placed. However, Bailey posits that programs in which students' interests are part of these developmental courses are likely to produce success. He also argues that part of the problem with developmental programs is not having a common consensus of what it means to be college ready. The author claims that

> the existing approaches to assessment for developmental placement should be reconsidered and perhaps replaced with an approach that tries explicitly to determine what a student will need to succeed in college generally rather than one that aims to identify a somewhat narrow set of skills a student possesses at a given point (p.24).

The author states that one possible way to make these programs successful is to consider students' interests in the development of these programs. Bailey recommends a national consensus of what it means to be college ready, rigorous research in tracking students with weak academic skills through their first years in college, and development of courses specifically tailored for students below and above the cut-off point with peer support to accelerate their engagement with college-level courses. Why some students successfully complete the sequence, while others do not is a topic in need of further analysis.

On the other hand, Bahr (2012) explores the link between attrition among students placed in remedial courses with different levels of skill needs and how students are placed in a developmental sequence. According to the author, when students' point of entry is lower in the remedial hierarchy, "low-skill remedial students," these students are more likely to withdraw from the remedial course sequence than students whose point of entry in the remedial sequence is higher, or "high-skill remedial students." Bahr suggests that one of the reasons for high attrition among low-skill remedial students is the number of remedial courses they need to take.

He uses a quantitative methodology to highlight the difference in college-level skill attainment among students with different points of entry to remedial courses. The author writes, "Absent understanding of *when* in the remedial sequence students of lower initial skill are being lost at greater rates than are students of higher initial skill, one cannot reasonably expect to understand *why* the differential loss is occurring or to develop effective interventions to stem the attrition" (p.662). He emphasizes that "in both the remedial math and writing sequences, the likelihood of delaying the first remedial course was greater among students who began the sequence at lower points of entry than it was among students who began at higher points of entry" (p.686). He observes that delaying the initial developmental course, which seems to be a pattern more prevalent with low-skill students, proves to be counterproductive for these students. Bahr recommends that we need to explore what the students placed in developmental sequence courses are doing between the time they stop attending the developmental sequence and the time they withdraw from college. He argues that the answer may lie in helping these students in either following a vocational track or attaining college level competency in math and writing.

Moreover, Bahr (2008) claims that for those students who successfully finish their math remediation requirements, education attainment is comparable to those who did not need remediation. The author bases this claim on a multi-institutional study he conducted with math remedial programs in 107 community colleges. According to the author, math remediation in higher education is successful. He argues that further investigation is required to determine why more students do not successfully remediate. He argues that "identifying methods of increasing the rate of successful remediation in math should be a topic of central concern to all stakeholders in the community college system," and states, "Further research is needed to elaborate the obstacles that are hindering successful remediation for so many" (p.446). The author asserts that

when students successfully remediate, their long-academic attainment is comparable to those students not in need of remediation. Hence, the author argues that remediation from that point of view is quite successful. The author states, “When mathematics remediation works, it works extremely well” (p.445). He recommends investigating what is impeding successful remediation for the majority of students placed in DeM. Bahr’s study focuses on those who successfully remediate rather than on those who do not and on the reasons for their doing so. Further, we need to discuss how each institution designs and implements its developmental math course curriculum or pedagogy and likewise placement tests and other scores placing students in these courses.

Fong and colleagues (2015), using data from the National Postsecondary Student Aid Study of community colleges in California, analyzed the progression of students placed in a developmental math sequence. The authors posit that we need to understand the connections between students and the institutions they attend and the nuances of these connections (p.722); thus, they added variables detailing student demographics, institutional characteristics, and developmental math level placement, making their study more descriptive. They observe that in smaller colleges, the passing rates for students taking developmental math courses are higher than in colleges with a large population of minoritized students. These colleges have higher tuition and tend to be vocationally driven. The authors note that in a study by Melguizo and colleagues (2014), of nine colleges in a major city, there was much variation in the assessment and placement of students requiring math remediation. Therefore, comparing math placement across colleges does not provide an accurate picture of math skills among these students. They acknowledge that those low-skill students who do take the remedial math sequence starting with the lower-level entry math courses are as successful as the student entering at a higher level of

math remediation. Fong and colleagues write, “Though only a small number of students make it through to the highest levels, these progression rates are illustrating that persisting students are ‘catching up’ and even exceeding their peers who were initially placed into higher courses” (p. 739). However, this is a macro study, which cannot examine the micro nuances of identity formation. In other words, while the study fully analyzes the relationship between students and institutions, its purpose is not to delve into the social implications of curriculum design and pedagogy for students enrolled in DeM.

These studies provide thorough macro examinations of attrition in remedial-sequence courses, but as researchers we have yet to examine how students in these courses construct their math identities, how past and present experiences in the math classroom affect their decisions to delay or stop taking remedial courses, and how their career choices are affected by these decisions. To examine how community college students assigned to DeM construct their math identities and how these identities affect their career choices, it is important to understand which students we lose at a higher percentage and what can be done to reverse attrition. Education that addresses social injustice cannot overlook the fact that our educational system lacks equity when it comes to educating the marginalized—all the more so in math education. Hence, math remediation is a key issue in my work for social justice in math education.

Micro View of Math Identity Formation

Some researchers believe that lack of a basic agreement about the concept of mathematical identity among educators and researchers needs to be addressed. Kaspersen and colleagues (2017) posit that even though mathematical identity—as with most scientific concepts—is “multi-dimensional and situated,” it can be conceptualized as measurable if it is situated as invariant in certain contexts and the tools—traits or characteristics that make a student

good in doing math—are used to measure change from context to context. The authors also claim that they have shown that "the social structure of being mathematical" can be measured "within an activity"—in other words, the context will define which tools to use in order to measure math identity in that context (p. 181). The authors underscore what it means to be a "strong math student" or a "weak math student" in certain social structures, writing, "We have claimed that the social structure of being mathematical is theoretically independent of individuals' mathematical identities" (p. 175). Kaspersen and colleagues state that we can apply the same method used in the sciences to measure multidimensional concepts and render them measurable within specific contexts. They conclude that social structures should be considered when measuring mathematical identities, and they acknowledge that multiple dimensions and subdimensions of math identities exist. According to Kaspersen and colleagues, mathematical identity is difficult to pin down since identity is relational by nature and there is a general "lack of consensus on ontological, epistemological and methodological issues [which] has complicated measurements of mathematical identities" (p. 163). The authors suggest that if math identity can be conceived as one-dimensional and constant as most multidimensional and situated scientific concepts are. However, the authors highlight three problems in measuring mathematical identity: first, that it is difficult to define; second, that its multidimensional nature cannot be measured with a uni-dimensional tool; and three, that the "basic requirement of measurement" implies invariance over time, although mathematical identity is a situated concept which changes over time. Though the authors align themselves with Cultural Historical Activity Theory (CHAT), sociocultural and sociopolitical implications of being a "strong math student" or a "weak math student" are not a part of the study. It may be a fruitful avenue of inquiry to examine the contexts in which these activities are happening and how students are historically positioned inside and outside the

classroom, while addressing the cultural and political implications of certain types of pedagogies and account for the evolution of math identity.

Math Identities as Narratives

Unlike Kaspersen and colleagues (2017), other researchers do not see the need to find an exact tool to measure mathematical identity in isolation and, instead, discuss its formation using social theories that allow for the fluidity, contextual and historical nature of this construct to be addressed (Anderson, 2007; Andersson et al., 2015; Black et al., 2010). Anderson (2007) discusses the identity of mathematics learners using four "faces" of mathematics learning: engagement, imagination, alignment, and nature, which he defines in the following way: engagement-oriented students see themselves as competent and part of the community of math; imagination-oriented students see themselves in their present and future using math; alignment-oriented students abide with the institutional requirements for math in order to obtain a better future education; and nature-oriented students believe in the "math gene." The author states that the four faces of identity are used to understand how students develop their math identities. Because he disagrees with the existence of the "nature" face of math identity, Anderson (2007) concentrates on the other three faces. Using the faces of engagement, imagination and alignment, Anderson offers some recommendations to teachers to help students develop positive math identities by emphasizing the social perspective of learning. Anderson pinpoints how membership in the math community helps construct a more positive math identity in students. Therefore, schools, teachers, and other places of learning should develop a more creative problem-solving and meaning-making pedagogy and curriculum. He also notes that mathematics should be demystified, asserting that math is a human construct; hence, any other human being can create or recreate math concepts. Further, he recommends that for the *engagement face*,

educators develop math tasks that emphasize creativity, problem-solving and meaning-making over quick one-correct-answer problems; for the *imagination face*, he recommends that educators emphasize how math is part of students' daily lives and how it will be part of their future lives and careers; for the *alignment face* of math identity, he recommends that the educational system make math part of the course requirements for high school and that educators be informed about the math requirements of students' career choices. He highlights how students' social participation in a classroom is associated with the formation of their identities as mathematics learners. Anderson (2007) posits that identities are fluid and contextual and a social construct. He states, "All students can become mathematics learners, identifying themselves and being recognized by others as capable of doing mathematics" (p.13).

Likewise, Roesken and colleagues (2011), in order to examine students' views of themselves as math learners in general and advanced math courses at Finnish secondary schools, operationalized seven dimensions of math learning: ability, effort, teacher quality, family encouragement, enjoyment of mathematics, difficulty of mathematics, and success. They found that three of these dimensions—ability, success, and difficulty of mathematics—had a great influence on which courses students choose—general or advanced math. The authors emphasize the distinction between beliefs and views, stating that beliefs address "a more cognitive side of the affect," while views allow them to focus on cognitive and noncognitive dimensions of math learners. Roesken and colleagues address students' views of themselves as math learners and a suggested extension of this research is to examine the structural impediments that students find in the math classrooms in which Discourses and subject positions only limit their math learning and math identity.

In another study, conducted in a Swedish high school, Andersson and colleagues (2015) posit that the involvement of students in mathematical activity which was made meaningful to them by the pedagogical choices of their instructor would shape their identity narratives (p. 145). *Identity narratives* are defined by the authors as the stories about a person in a given practice (p. 146). Citing Wagner and Herbel-Eisenmann (2009), the authors propose that making math more relatable to students could "bring different discursive possibilities for students' identity narratives" (2015, p. 145). Andersson and colleagues further suggest that identity narratives are fluid and shaped by whether students have or lack relatable mathematical engagement in different contexts. The authors further state that identity narratives manifest as compliance to assigned identity without questioning social contexts or agency in the form of re-imaging identity narratives. An example of such contexts includes the sociopolitical school context outside the classroom, which helps define what kind of teaching manifests itself in the classroom (p. 146).

To conduct their study, the authors followed 38 students enrolled in a high school social science program, which attracted students who were interested in going on to higher education but did not enjoy mathematics. Andersson and a mathematics teacher from the program organized a math course with relatable topics which followed the recommendations outlined by this program. Andersson and colleagues (2015) drew upon Sfard and Prusak's (2005) description of identities to define students' math identities "as what students said about themselves in regard to their mathematics education" (2015, p. 148). According to Sfard and Prusak (2005), in these kinds of narratives, identities are formed by transforming the verb *to do*, an action verb, into the verb *to be*, a stative verb. In other words, "I like to do math" becomes "I'm good in math" and "I do not like to do math" becomes "I'm a math hater" (2015, p.148). This distinction between the

verb *to do* and the verb *to be is* crucial because math identities go from being complex to being rigid when students go from describing themselves as "I like *to do* math" or "I *do not* like *to do* math" to "I *am* good at math" or "I *am not* good at math." The authors' analysis of student narratives emphasized how tasks and situations involve immediate environmental factors, such as activities, actors and tools, all of which impact the production of students' narratives. Their engagement in meaningful tasks and situations transformed their narratives back from *being to doing,* making these narratives more fluid and less rigid. The findings suggest that changes, such as teaching mathematics in a manner more aligned with student interests and in a setting in which the students have a say in the tasks and situations, may lead to less avoidance of mathematics courses. Such changes may also support a shift in students' mathematics identities as they focus on *doing* and not on *being.* This highlights, yet again, the authors' view of math identity as fluid, not a predetermined characteristic, and as influenced by the pedagogical choices of instructors. The authors refer to the school's sociopolitical context as an outside factor affecting what happens in the classrooms, so classrooms as sociopolitical spaces might be a logical outgrowth of this observation.

In sum, Anderson (2007), Andersson and colleagues (2015) and Roesken and colleagues (2011) examine students' math identities through their self-narratives, emphasizing the contextual and social aspect of math identity and its fluidity. We see how math identity may become an active verb, *to do,* which supports fluidity and agency when math classroom curricula and pedagogies are relevant to students' experiences and present and future interests; on the other hand, math identity may become a stative verb, *to be,* a rigid view of the self when the pedagogies of math classrooms emphasize rote memory tasks. We must stress that educational structures and their Discourses influence how we see ourselves and how we are seen by others.

Social Activity Theories Framing Math Identity Formation

In other studies, researchers framed identity formation in social activity theories. For example, Black and colleagues (2010) use and extend the concept of leading activity to leading identity as attributed to Leont'ev (1981), Stetsenko and Arievitch (2004) and Beach (1995, 1999) to help understand how students' value and view learning mathematics in reference to their future career objectives. Through the lens of CHAT, these authors theorize identity and the concept of 'leading activity' developing a framework that explores how leading identity and its further development change students' engagement and view of mathematics learning. The authors define leading activities as "those which are significant to the development of the individual's psyche through the emergence of new motives for engagement" (p. 55). Black and colleagues emphasize the historicity of math identity formation. The authors point out that the worlds we inhabit serve as a support or limitation in the co-authoring of ourselves as math learners, while mathematically engaging in the past and present with these worlds. Black and colleagues also emphasize the hierarchical structure of identities "within the self" (p. 57). The authors state that the concept of a leading activity allows for an identity that is complex with hierarchies that shift depending on the contexts' leading activities, begging the question of how pedagogy and curriculum influence the development and shift of students' leading identity and their agency. In order to investigate the construction of math identity in students assigned to DeM, we must understand the students' motivation and future aspirations to continue their education. Hence, understanding how leading identity develops and shifts vis-à-vis curriculum and pedagogy is essential to forge a math education that reflects the desire for equity and justice. We educators and policymakers need to understand how pedagogy and curriculum affect the development of leading identity and agency for students placed in DeM in higher education

On the other hand, Cobb and colleagues (2009) put forward an analytical tool—the nature of the mathematical activity, which entails specific calculational steps producing an answer versus analytical discussion to demonstrate an understanding of mathematical concepts—in order to examine the math identities and agencies that students develop in different types of math classrooms, depending how authority is distributed in the classroom. The authors state that this analytical tool, or "interpretive scheme," can be useful in developing more relevant math curricula and pedagogies. The authors develop an "interpretative scheme" ensuring that detractors cannot blame them for having vague or ill-defined concepts of math identity. They define students as having two types of agencies: *disciplinary agency* and *conceptual agency*, the former of which may be viewed as a misnomer because as defined by Cobb and colleagues, students who engage in *disciplinary agency* repeat knowledge given to them by their teacher instead of co-creating or actively participating in their learning. Disciplinary agency does not involve the kind of agency as defined by Stetsenko (2017) as taking an active part in learning, that is, being a co-creator. Cobb and colleagues' scheme for analyzing math identities may lead to further investigation of the connection between their definitions of agencies and how these agencies impact mathematical identity construction. Cobb and colleagues state, "Authority concerns the degree to which students are given opportunities to be involved in decision making about the interpretation of tasks, the reasonableness of solution methods, and the legitimacy of solutions. Authority is therefore about 'who's in charge' in terms of making mathematical contributions" (p.44). They further point out that the kind of learning and agency students engage with is related to how authority is distributed in the classrooms. They emphasize that "the resulting accounts of students' developing personal identities can be directly related to the classroom microculture that constitutes the immediate context of their mathematical

development" (p.64). Hence, student agency, like student identity, may come forward in different ways based on the pedagogical choices made by instructors. The authors explore two different kinds of identity construction and agencies that contribute to such formations. The scope of this work does not extend to how these different identities and agencies impact the development of a more positive formational outcome, something I would like to explore in the future.

Moreover, Darragh (2015) suggests that using a "performative lens" to analyze why students who do well in mathematics still cannot see themselves as "math people" explains why many of these students avoid studying mathematics in higher education, if possible. Darragh uses a performative lens to analyze how students' math identities are affected by students' scripts/narratives of what it means to be "good at math." She observes that students who decide not to fulfill their secondary education math requirements are hindering their entrance into higher education. Darragh states as we continually practice at being math learners, we see ourselves as math learners and become math learners. The author states, "Identity [is not] to be understood here as something internal that is then performed. Rather, it is the performances and repeated performances that constitute identity, that is, a sense of self" (p. 86). She highlights that "A consideration of the stage is necessary to fully understand any performance, as the stage can constrain or enable performances in significant ways" (p.86). As she further notes, "It is almost impossible to think about a performance without considering the audience" (p.86). She states that we must consider our audiences as they may construe, support or limit our performances as math learners differently. She further points out that one member of the audience is "the self" (p.87) and as such we see ourselves as "a certain type of person" (p.87). She states, "Whilst we all know what the word 'understanding' means, we may not all have a similar way of conceiving

what it means to understand mathematics" (p.98). The author explores math identity through a performative lens, which implies that through our actions we become a certain type of person. The value of this analysis of math identity is that it demystifies math as something only a few can do/understand; of course, we need to explore how the students develop the concept of "understanding mathematics" and how their construction of identities is affected by their definitions of "understanding mathematics." Darragh acknowledges that we need to analyze what types of performances are enabled by institutions and how these performances have evolved. The author posits that we need to take math off of its pedestal and make it reachable to all students in order to let them know that they can have a "good at math" identity without hindering the other identities students have often valued, such as "being a cool soccer player" (p.100). She also mentions how parents and schools have imposed certain "scripts" about being good at math, but it would be interesting to know if she plans to further explore what makes students accept or reject these "scripts." Indeed, we need to investigate the distinguishing features present in those students who can see themselves as "good at math" despite the negative "scripts" forced on them by their cultural, social and educational microworlds.

Hernandez-Martinez and colleagues (2011) examine the claim of transition from school to college math as problematic. The authors collected data through interviews done with students before the transition and after the transition and found that the students, regardless of being successful or not, viewed the experience positively and as a possibility for growth not only cognitively but also socially. The authors use Cultural Historical Activity Theory (CHAT) as their main framework. Hernandez-Martinez and colleagues define identity as the "'self in practice' through [a person's] engagement in activity" (p. 122). The authors write, "We want to distance ourselves from other related concepts, such as personality, character or nature, that

could suggest biological characteristics or given attributes of individuals; instead, we see individuals as active participants in social practices and consequently, constructing their identities through the relationships they develop within social institutions and groups" (p. 122). Hernandez-Martinez and colleagues, framing math identity formation in identity-in-practice theory, emphasize the social, historical, reflexive and shape-shifting nature of this construction. The authors used the students' voices to analyze the concept of identity in transition and if I may suggest, as a follow-up study, Hernandez-Martinez and colleagues might explore the Discourses of the contexts' students inhabited before and after the transition. These Discourses need to be explored because Discourses shape and are shaped by contexts and the individuals in these contexts.

Grootenboer and Jorgensen (2009), drawing from Jo Boaler's (1997, 2002a, 2002b, 2003, 2008) studies on characteristics of effective classrooms and Leone Burton's (1999a, 1999b, 2001, 2002) research on mathematicians' work habits and their communities, posit that agency helps students achieve a deeper understanding of math. They state that a classroom in which students behave as mathematicians—most crucially, acquiring deep understanding over procedural knowledge—can lead the way to a more engaging and agentive way of learning mathematics. The authors use three dimensions to examine the concept of working as a mathematician: *cognitively/affectively, socially/culturally*, and *mathematically*. This article points out one of the many problems in the teaching and learning of mathematics is the rote procedural methods used in math classrooms, instead of methods which strive for deep understanding of the material. Grootenboer and Jorgensen write, "[Participants in the study's] sense of agency was not based on their knowledge, attitude, aptitude or ability to single-handedly complete the investigation, but rather on being able to contribute something to the shared

dynamic that emerged as they engaged with the task collaboratively" (p. 262). Grootenboer and Jorgensen opine learning that promotes mathematical behavior—in particular being co-creators of knowledge as opposed to rote-memory math regurgitators—that allows for math learners to become mathematicians instead of 'users' of mathematics. They note, "Perhaps in our attempts to make mathematical knowledge more accessible to students we have kept the knowledge but lost the mathematical behaviors, and in the process the mathematical experiences of the classroom can no longer be regarded as 'mathematical'" (p. 262). The authors recommend the creation of classrooms in which learning mathematics is more like "working as a mathematician" in order to have a more engaging pedagogy of mathematics. (p. 265). However, the authors did not address the oppressive structure in place that does not allow for certain students' knowledge to be valued. The current study examines how students create their math identities, with the goal of leading to creating classrooms where students behave more like mathematicians in the field and more actively engage in math learning.

Solomon (2007), using Wenger's (1998) community of practice as a framework, examines the math identity of first-year college undergraduate students. She highlights how practices in the teaching and learning of mathematics in higher education can marginalize potential mathematicians of minoritized groups, such as women. The pedagogy used in these classrooms is mostly what Freire (1970/2000) called the Banking System, in which students are seen as empty vessels without valuable knowledge to contribute to the practice of mathematics as professional mathematicians. She states that despite some students aspiring to continue with fields requiring knowledge of math, they do not have a sense of inclusivity, but rather of exclusivity in their undergraduate community of practice. She writes, "The analysis presented here indicates, however, that some potentially successful students develop negative relationships

with mathematics which marginalise them and can turn them against further study" (p.93). She focuses on three modes of Wenger's community of practice: alignment, imagination and engagement. Solomon highlights how women, through the lens of imagination, try to understand and find "links and patterns" in math, while men are just satisfied with following the rules and getting good grades. Solomon asserts that in the group of students with whom she conducted her study, self-efficacy did not necessarily equate to students' future engagement in the mathematics community. The author suggests that even though students have a wide range of learning experiences in their math classes, they may, nevertheless, see themselves as following incomprehensible rules while ending up liable to fail (p.84). The author posits that viewing themselves as rule-followers and not rule-makers implies a negative association to alignment, since rule followers do not own and cannot contribute to the creation of rules, values or standards of communities of practice.

Solomon's (2007) hypothesis is illustrated in the contrast between student responses according to gender. Four male students did not question the *following the rules* dimension of their math learning; for them, getting good grades was more important than understanding the material. Solomon thus concludes that male students' identities as "good students getting good grades" was more important for them than their identity as math learners. Further, Solomon finds that these students view themselves as belonging to their undergraduate community, not to the wider community of mathematicians at large; in other words, they see themselves as rule-followers, not rule-makers. In contrast, one of the female students did not equate following the rules without understanding to a sense of belonging to membership in either the undergraduate community or the wider community of mathematicians; according to the author, females see themselves as not belonging to the mathematics community despite not equating following rules

with belonging. Solomon, in her examination of identity through *alignment, imagination* and *engagement,* posits that participatory pedagogical methods allows for accessibility in mathematics learning, changing students from rule-followers to rule-makers. Solomon reasoned that pedagogical practices, prioritizing understanding over performance, need to be applied at the undergraduate level in order to avoid marginalization of "potentially successful [math] students" (p. 93), that is, rule-makers in the mathematics community. The author recommends "challeng[ing] dominant discourses, and…work[ing] towards greater transparency in the discipline of mathematics." It may be added that a more inclusive curriculum and pedagogy—in which the contributions of different cultures and minoritized groups are highlighted and students are allowed to question the why of the rules—are needed.

Gender and Race in Math Identity Formation

Nosek and colleagues (2002) discuss the connection between gender and mathematical inclination, viewing gender identification as a binary concept: male or female. The authors designed two studies using four types of implicit associations between gender and math orientation: *math attitude, math identity, math-gender stereotype* and *gender identity*. They state that even though participation in math and science is the same for males and females, females are more likely to choose majors that do not involve much mathematics. Nosek and colleagues assert that "gender differences in performance are associated with gender differences in participation," even though there is evidence from self-reporting that stereotypes do not really predict gender participation (p.45). The authors believe that self-reporting measurements, which are explicit measurements, may have influenced the results of previous studies; thus, they use implicit measurements that are less likely to be "under conscious control [of the student]" (p. 45) and more likely to give a more accurate picture of the association between math identity and gender.

The Implicit Association Test (IAT) is used "to measure implicit attitudes, identity, and stereotypes" about mathematics (p. 45) by comparing the speed of student responses to certain pairs such as *math + pleasant* and *math + unpleasant*. These tasks also measure associations between math identity and the self. The explicit tasks consist of questionnaires measuring students' inclination toward math. The studies examine the connection between the gender stereotypes that students harbor and their math preference/inclination. The authors posit that stereotypes may play a subconscious role in students' attitudes towards math or science even though students believe they are agentive in this choice. Nosek and colleagues recognize that group membership, such as gender, can vary. Thus, in the second study a strong identification with one or the other gender is considered in order to examine the association between gender identification and math/science attitude. The authors conclude that gender stereotypes and math preferences are strongly connected. Nosek and colleagues examine how some learners of mathematics, despite considering themselves to some degree *good at math,* still do not see themselves as active participants in the mathematics community.

Lim (2008) examines the experiences of two African-American adolescent girls in sixth-grade math classrooms, one in an advanced math class and the other in a grade-level math class, and how the lack of cultural, social, and "knowledge-based" support in their math education impacts their future schooling choices. Quoting Bourdieu and Passeron (1990), Lim defines cultural and social capital as "a set of particular cultural, social, and linguistic characteristics possessed by the people of a certain background" (p.305). She stresses how cultural and social traits support the hierarchical and biased nature of the school system and affect the learning behaviors of students. Lim recognizes that during early adolescence, social capital is key in the formation of math identity due to the importance of peer-relationships. Lim posits that we must

investigate “the point of intersection of class, ethnicity, culture, and gender in girls’ everyday experience of learning mathematics” (p.304). Several important factors in math education, such as the normalization of White middle-class values in which individual work and effort are rewarded rather than collective work; the pathologizing of minoritized cultural values in which certain types of behaviors such as working in groups and use of other forms of linguistic syntax is viewed as deficient; and not questioning the logic behind math concepts is viewed as proper, must be examined to highlight how certain social and cultural capital is deemed as lacking and deficient. All these factors affect how minoritized students viewed learning in math classrooms

Gainor and Lent (1998), through the framework of social cognitive career theory investigates racial identity attitudes of first year African-American students in a predominantly White public college, examining interests and career choices in relation to math. The authors posit that role models do not play a part in their interests and career choices. However, internalization of racial pride has a positive impact on social persuasion towards math and science career choices (p. 410). The authors conclude, “Only self-efficacy and outcome expectations produced significant paths to math course enrollment intentions, suggesting that students’ beliefs about their math capabilities and the consequences of taking math courses were overriding factors in their desire to pursue such courses” (p. 409). Gainor and Lent observed that pride and security in racial identity are great motivators for African-American students to pursue careers in the STEM fields. As Gainor and Lent point out, “Where students are foreclosing their math options due to unrealistically low self-efficacy, program elements can be designed to help students reinterpret the nature of their past performances or obtain new, incrementally graded success experiences (e.g., through math refresher courses)” (p. 411). The authors explored which variables have positive, negative or no impact on the academic interests of African-American

students and career choices as related to math. It may be interesting if Gainor and Lent were now to discuss the effect of the school's Discourses on the racial identity of the African-American students and how, in turn, these Discourses affect their math identities.

Larnell's 2016 study examines African-American students' learning experiences in developmental math courses in a 4-year college using Sfard and Prusack's (2005) "framing of identity as narrative" and Martin's (2000) "framing of mathematics socialization and mathematics identity." Larnell observes that mathematics proficiency has become a primary source of inequality in education: "The combination of curricular gatekeeping and racialized disparities is a particular cogent rationale—an equity-oriented rationale—for further and intensive study" (p.2). The author notes that there are multiple contextual Discourses in such communities and that educational institutions affect the formation of math identity. However, Larnell concentrates on the kind of math identities African-Americans construct as students placed in these DeM courses and how these math identity constructions reflect the students' experiences in these courses. He recommends "further research in academic and racialized identities" (p. 27) and "a need to study the experiences of learners in NCBR [non-credit-bearing remedial] mathematics courses" (p. 27). A logical outgrowth of this discussion would be further examination of the history and context of the African-American students' math identity formation and how the Discourses in the educational institutions compete with the students' cultural and social Discourse. This study is interested in examining how students placed in DeM construct their math identities; in furthering this interest, it extends to the historical and contextual nature of this framework.

Martin (2012) argues that educational research that does not examine how African-Americans learn mathematics using their "the socio-cultural reality," only comparing them to

White math learners, as if normalizing White middle-class behaviors is framing "Black children and their competencies … in negative and detrimental ways" (p. 48). He notes that inequalities must be historically and contextually framed instead of using deficit dogmas, such as the posited genetic, cultural, and intellectual inferiority of minoritized groups. He emphasizes that theoretical frameworks can be exploited to further these deficit dogmas, such as the racial achievement gap. Martin states, "It is equally true that, wherever they live and learn, and no matter what the circumstances, Black children are also among the most resilient" (p.52). Much of the research done about developmental math courses in community colleges involves this deficit framework for the mathematical learners in these courses. The lack of contexts in these studies pathologized these students, mostly African-Americans, Latin@s[1] and the poor. He recommends, "Future research about Black children and mathematics might also examine how these children respond to ideologies of Black inferiority as they are manifested in schools and classroom contexts where discourses about so-called racial achievement gaps prevail" (p.52). This is an important issue as it is key to understanding how minoritized learners accept or reject negative stereotypes about their math proficiency.

Walker (2012) examines *mathematical spaces* that African-American mathematicians inhabit during their childhood and adolescence. The author argues if such spaces are purposely created for minoritized students, then these students will have a better opportunity to develop a positive math identity. Walker writes, "It is important to consider how people's mathematics identities might be cultivated in spaces within schools, outside of schools, and in spaces in-

[1] I prefer to use the term Latin@, instead of Latinx. I feel that Latinx anglicizes the terms Latina and Latino and cancels or negates certain genders. I also feel that the arroba icon, @, allows for a Spanish pronunciation and, by the nature of its design, includes both genders as well as gender noncomforming and non-binary people.

between, and how these experiences might contribute to the development and dissemination of mathematical knowledge" (p. 66). In other words, the creation of spaces in which students' positive math identities are encouraged would lead to a more productive attitude towards math in marginalized groups such as African-Americans; Walker further states, "We should build on out-of-school spaces that support mathematics socialization and also re-imagine the mathematics classroom to be a space that not only provides opportunities to learn meaningful mathematics, but supports mathematics identity development and positive socialization experiences" (p.79). Walker argues that mathematical spaces experienced by African-American mathematicians in their childhood and adolescence contribute to the development of a positive math identity and encourage them to pursue a career in the field of mathematics; thus, these types of spaces should be constructed for minoritized students in order to improve their experiences with mathematics learning. The author recommends that schools create mathematical spaces for minoritized students and that these spaces will also allow for better understanding of "how to improve mathematics teaching and learning for [minoritized] students in particular" (p. 81). However, Walker does not consider that these spaces should give these students the opportunity to develop their math skills and that they should also support the ability of minoritized students to question mathematics' typically Eurocentric stance.

In summary, matters of race in math pedagogy have been addressed from many angles. Nosek and colleagues (2002) examine how stereotypes play a role in how minoritized groups view their math proficiency and their ability to be part of the math community. Gainor and Lent (1998) discuss factors influencing the career choices of African-American students as related to math. Larnell (2016) investigates the math identity formation of African-Americans students placed in DeM, while Lim (2008) and Martin (2012) examine how White middle-class values are

used as the yardstick by which to measure minoritized populations, their math proficiency and their right to be part of the math community. Walker (2012) concentrates on how mathematical spaces inside and outside math classrooms for African-American students influence their math learning experiences. These researchers may consider and adapt some crucial elements to their theories: for example, the school Discourse effect on racial and math identities; the Eurocentric perspective of math curricula and pedagogies, and the right for minoritized students to question and reject this perspective; and the historical and contextual nature of math identity formation, which is paramount in this discussion. The key message here is that the creation of spaces inside and outside of math classrooms that embrace diversity and reject stereotypes may encourage more positive math identities among marginalized groups such as women and people of color.

Social Justice in Math Education

Rochelle Gutiérrez (2013) states that math education researchers and educators must examine not just identity but also power dynamics in math education in order to focus on justice rather than equality. She argues that, as math educators, we should not just teach a math concept, but also ask the question of who benefits from students learning such a concept. Gutiérrez states that over the last ten years, teaching and learning in math education have been examined using a sociocultural lens, but now it is time to use a sociopolitical lens examining identity and power in math education. According to the author, research examining power structures has not gained much favor among academia and educational policy makers, creating a major impediment to developing a more equitable math education. She states, "Those who have taken the sociopolitical turn seek not just to better *understand* mathematics education in all of its social forms but to *transform* mathematics education in ways that privilege more socially just practices" (p. 40). She notes schools' discourse and knowledge production reflects society's

power hierarchies. These dynamics mirror what is defined as knowledge, what knowledge is privileged in society. She observes that the concept of self-actualization very seldom forms a part of our definitions of success. She asserts, "Researchers and practitioners who espouse a sociopolitical frame of mind (in particular poststructuralists) see identity as something you do, not something you are" (p. 45). She points out that framing research in math education through the lens of ethnicity obscures who defines the concept and to what purpose. Gutiérrez argues that socio-politically inclined math education researchers must question the contextual nature of math identity formation and who profits from these math identities. She emphasizes, "Without the voices of marginalized people commenting on their interpretation of the mathematical practices in which they are engaged, we are unlikely to fully understand the possibilities of other arrangements in mathematics education" (p.52).

Gutiérrez (2013) emphasizes the political lens we need for this deconstruction of schools' Discourses in order to understand how a more just math education can be achieved. She writes, "I argue that it is from the views of subordinated individuals and communities that we will learn how to rethink mathematics education" (p. 39). Gutiérrez's research may lead to the exploration of how minoritized students internalize or reject these Discourses or examine the effect of Discourses on their career choices, which may provide some additional answers. In exploring how community college students construct their math identities, we need to deconstruct the Discourses that they have been exposed to through their math education and the impact these Discourses have had on their present lives and future careers.

Leonard and colleagues (2010), using cultural relevant pedagogy (CRP) and social justice pedagogy (SJP) as frameworks, promote pedagogies of relevance and social justice by examining, providing examples, and making recommendations for such pedagogies. The authors

state that even though these types of pedagogies are useful in bringing a sociopolitical lens into the classroom it is "a complex enterprise." Quoting Tillman (2002), the authors define culture as "a group's individual and collective ways of thinking, believing, and knowing, which includes their shared experiences, consciousness, skills, values, forms of expression, social institutions, and behaviors" (p. 262). Further, Leonard and colleagues observe that educators cannot look at their students as monolithic nor can they make a blueprint into which all topics and all classrooms fit. They additionally observe that in using these theoretical frameworks, math educators must avoid being reductive by essentializing culture in mathematics. The authors emphasize that "cultural competence" as defined in CPR and SPJ must entail an engagement with learning in which math learners question the social structures and can re-imagine and re-create these frameworks and themselves. Leonard and colleagues write, "Teaching for social justice should instill students with new knowledge of the world as it should be to reconstruct society and lead to social change" (p. 268). The authors recommend that math student|teachers experience examples of CPR and SJP in their methods courses and "apply and reflect on their own in field experiences" (p. 267). They state that we cannot essentialize minoritized math students; my question is whether minoritized math learners will be involved in the design of these types of pedagogies. In order to redesign curricula and pedagogies for developmental math courses, we must co-design and co-create pedagogies in cooperation with minoritized students that they will view as relevant.

Nasir and de Royston (2013) examine power and identity through a sociocultural and sociopolitical lens in math practices outside the classroom. They use cultural and social capital as a way to see what knowledge is viewed as valuable or not in math classrooms. The authors state, "Learning is not only about taking on new knowledge structures but also about personal

transformation, about becoming" (p.266). Nasir and de Royston equate cultural practice with power as capital, which is produced by constructing identities through active engagement in cultural practice. The authors observe that the math practices of minoritized math students should be discussed in math classrooms, and they question why "informal" mathematical knowledge is or is not valued within the school Discourses. Nasir and de Royston (2013) also observe that math inequalities must be viewed as the result of unfair contextual power dynamics and not as the result of any deficiency in minoritized groups. According to the authors, "We as researchers must add to our analytical repertoire the tools to examine how issues of power and identity are at play within and across in-school and out-of-school learning settings" (p.284). The authors highlight how certain cultural and social capital is valued over others, especially the cultural and social capital that emphasizes rote memory over deep understanding and so-called "street math." By extension to their theories, further investigation might encompass how minoritized students can contribute to the development of curricula and pedagogies that bring about social justice in math education by making their mathematical practices outside the classroom an important part of mathematical curricula.

Valero (2004) argues that there is a need for the socio-political perspective in math education research. She also questions how math education researchers "exercise power with [their] research in mathematics education" (p. 1). The author states that we must question how math education researchers develop a theoretical framework that influences curricula and pedagogies in math education as these investigations are "subjective" in nature. Valero discusses the different theories of learning used to investigate mathematics and how they contribute to an individualistic view of mathematics learning instead of questioning the education structural deficiencies. She writes, "Dowling (1998) has referred to the *myth of participation* as the

conviction the people are handicapped to participate in society if they do not understand and are not able to use mathematics in a critical way" (p. 4). Valero emphasizes the political, social, and contextual nature of mathematics learning and reminds us, "The constitutive relation between micro and macro context … is a salient feature of a socio-political approach in mathematics education research" (p. 14). According to her, researchers of math education should consider "power [as] a defining element of both mathematics education practices and research" (p. 16). Valero brings a very important point to mathematics education research. We must acknowledge the sociopolitical context of math education; otherwise, we will return to the kind of research that only addresses what is happening in the classroom without looking at the macro and meso contexts that decide what is taught in the math classroom. Valero's investigation leads to the conjecture of how this sociopolitical perspective in math education research can be translated into curricula and pedagogies that improve the teaching-learning processes of minoritized students engaged in math learning.

In brief, Gutiérrez (2013), Leonard and colleagues (2010), and Nasir and de Royston (2013) examine power dynamics and its influence on math identity formation through sociocultural and sociopolitical perspectives. The authors offer compelling arguments ready for concrete translation of these perspectives into math curricula and pedagogies, which are greatly needed to improve the situation of minoritized students.

Latin@ Philosophy

Gutiérrez (2015) posits that math educators should not only question tensions and contradictions in our work but also embrace these tensions and contradictions in order to avoid oversimplification and becoming static in our struggle for a math education that acknowledges and works against systemic oppression. The author argues that the road for a just education is not

only reflection but also action: “It is important to resist intellectualizing the struggle, and instead live it. Living it means action, such as taking risks in our everyday work” (p.267). Here, Gutiérrez calls for a form of activist teaching in which pedagogies enacted in math classrooms reflect the realities of our students. Gutiérrez suggests that math educators should not only interrogate whiteness in math teaching and learning but also be actively involved in the dismantling of what she terms “White supremacists’ capitalist, patriarchal policies” influencing math education. The author posits that math educators should illuminate how White supremacist and patriarchal dominance engulf math education inside and outside the classroom. Gutiérrez also advocates for minoritized educators-learners to embrace our in-betweenness—what she calls *Nepantla*—in which living between two worlds gives us the ability to dismantle the hegemony of patriarchal White middle-class values as normal. She explains, “Nepantla is the space of neither and both, the space between worlds, between day and night, between being asleep and awake, between male and female, between life and death...Nepantla is also a form of moving through life, a form of being part of the cosmos, a back and forth balancing motion that grounds itself in no single space” (p. 259). Gutiérrez connects living between two worlds with the ability to see the other person’s point of view. According to the author, in Nepantla we feel connected to our otherness and, hence, to others. Gutiérrez notes that having contradictory identities gives us an advantageous point of view because we can see our world through multiple lenses. She writes, “The point of identifying and deconstructing White supremacist capitalist patriarchy is not to replace it with another form of supremacy, so a new group is in power. Rather, individuals who seek to deconstruct White supremacist capitalist patriarchy aim to dismantle all systems of oppression” (p. 269). She thus warns against all forms of oppression. Gutiérrez emphasizes how math educators should use contradictions found inside and outside the classroom not only to

question how they contribute to maintaining White supremacist patriarchy's hold on math education, but also to identifying how educators can deconstruct these systems of oppression. A logical extension to Gutiérrez's work is to examine how living in two worlds can be used to explore the construction of math identity among minoritized learners.

Demystifying Mathematics as Social Justice in Math Education

Several authors call for the demystification of mathematics, as a means of endowing students with a socially equitable math education. D'Ambrosio (1985) calls for more relevant curricula and pedagogies in the math education of minoritized groups using the rich history of mathematics in different cultures, which he coined as *ethnomathematics*. D'Ambrosio, in discussing the concept of ethnomathematics, investigates the socio-cultural, economic, and political contexts that have influenced the development of mathematics. The author defines ethnomathematics as "the evolution of the concepts of mathematics in a cultural and anthropological framework" (p. 44). D'Ambrosio notes that in order to develop relevant curricula and pedagogies in math education, ethnomathematics must form part of research methods (p. 47). The author highlights how the mythologizing of mathematics has its roots in White Western dominant groups. D'Ambrosio observes that there is a contrast to be made between what Plato called "scholarly mathematics" and ethnomathematics. He explains the history behind these two kinds of mathematics. D'Ambrosio makes the distinction between "scholarly math" as the kind of math that only a few can accomplish—a science—whereas ethnomathematics is math for the masses. D'Ambrosio observes that while practical mathematics became increasingly scholarly during and after the Industrial Revolution, while scholarly mathematics maintained its place as exclusive knowledge for the privileged class only. He writes, "For effective educational action not only an intense experience in curriculum

development is required, but also investigative and research methods that can absorb and understand ethnomathematics" (p. 47). D'Ambrosio recommends research methods that investigate the social history of mathematics, highlighting the connection between the sociocultural, economic, and political factors in the development of mathematics. Ethnomathematics is proposed by the author to be taught in Third World countries. In one perspective, distinguishing what should be taught in these countries as opposed to developed nations will not contribute to the advancement of social justice in math education. All learners in all countries alike should be able to obtain an education that fosters their economic mobility.

We, therefore, must investigate the educational structures that have marginalized learners, not contribute to their oppression. My research will highlight student voices and how students construct their math identities within the given structures that marginalize them. My work is specifically aimed at investigating how community college students assigned to DeM do so. This examination of evolving identities is intended to explore students' past, present and future experiences with mathematics in order to further their career choices rather than encumber them with math avoidance behaviors; instead, we will empower them to pursue professions in a wide variety of fields.

In conclusion, my research will address several gaps in the current literature. For example, we need to more closely examine Eurocentric assumptions and the historical and contextual underpinnings of math identity formation of students required to take developmental math courses. Current research emphasizes a macro view of the cultural, educational, social, political and economic structures that shape these students' math identities but I will develop a micro approach by gathering their collective narratives and partaking in this dialogue as a fellow learner. A further avenue of inquiry, the perception by students of the relevance of

developmental math courses in their lives and careers, is urgent as well. The needs of minoritized students must be questioned against the backdrop of White middle-class values. I will further investigate how developmental math classes have become a systematized form of marginalization, where many current studies on developmental math courses emphasize policy over learners by using a theory of deficit rather than investigating educational structures and their Discourses and how they affect math identity formation among minoritized students.

Chapter III: Methodology

Introduction

The research approach used for this study is qualitative. This study examines the effectiveness of math developmental courses by exploring student narratives. Interviews (see Appendices A and B) and a focus group with open-ended questions (see Appendix C) were conducted to obtain an understanding of how students placed in DeM construct their math identities and how structures within academia affect this construction. Most studies examining developmental math in higher education are of a quantitative nature. Their main question is, "Why can't students placed in developmental math courses successfully complete the math sequence?" These studies delve into the cost of educating students from marginalized groups such as Latin@s and African-Americans to make them college-ready. Bailey (2009) states that most students placed in developmental courses rarely graduate (p. 14). Math identity is recognized in several studies as an important part—if not the leading part—of the learning process and how socially designed structures and their Discourses may promote or hinder a positive math identity among marginalized students (Caraballo, 2011; Nasir et al., 2005; Sfard & Prusak, 2005).

Thus, this study aims at examining how marginalized students' math identities are constructed and how structures and Discourses in the figured world of developmental math in community colleges contribute to this formation.

Research Questions

This study addresses the following research questions:

1. How do students required to take developmental math construct their math identities?

2. How do cultural, educational, social, political and economic structures shape students' math identities?
3. How have developmental math classes become a systematized form of marginalization?

The driving force behind most developmental math courses has always been to fix what is deemed lacking in minoritized students' education by an established assessment system at community colleges. Thus, it is paramount to examine how community college students required to take remedial math construct their math identities and the effect of this process on their future careers.

Theoretical Framework

This study moves beyond the studies analyzed in the previous chapter by contextualizing students' lived experiences with math education and how these experiences shape their math identities. One theoretical framework used to contextualize students' experiences is Cultural-Historical Activity Theory (CHAT) as defined by Vygotsky (1978). CHAT is a theoretical framework in which the individual and the environment are part of "a complex system that [co-creates] consciousness through human participation in activities" (Vygotsky, 1978, as cited in Yamagata-Lynch, 2010, p. 15). This investigation explores the student narratives behind the statistical findings of quantitative studies enumerating how many students are required to take developmental courses, how many actually take them, how many advance and how many go on to graduate from community college and continue their education (Bahr, 2012; Bailey, 2009).

A Critical Theory approach investigates power relations in and out of classrooms in order to challenge a deficit-based perspective of education, which advances the belief that some students are destined to fail while it neglects to interrogate the structures that generate this

failure. This study examines the cultural know-how that students who take developmental math courses possess and how they can apply this know-how in their courses in order to be successful.

In examining the power dynamics of math education in higher education at the developmental level, a sociopolitical lens investigates the binary assessment system, a "pass-fail" mentality used in community colleges to place minoritized students in developmental math courses. Post-structuralism affords the tools to examine the institutional Discourses that help shape the math identities of community college students placed in DeM. Rochelle Gutiérrez (2013) states, "The meanings that people make of themselves and of their world are the result of political struggles they undergo as they negotiate discourses" (p. 43). Here, discourses refer to uppercase "D" Discourses, which is defined as ways of being, knowing, expressing, and communicating one's self, and are different from lower-case "d" discourses, which refer to written and spoken communication. Thus, classrooms are not just learning spaces but political spaces in which students construct their identities and determine their placement in these academic settings.

Transformative Activist Stance (TAS), as developed by Anna Stetsenko (2017), is used to investigate how college students reclaim their humanity, thereby leading to social justice in math education. A sharp lens is needed to comprehend how minoritized community college students negotiate their worlds and self-author. Along these lines, Latin@ Philosophy Theory highlights the in-betweenness of minoritized community college students and how this interstitial space drives their agency and math identities. It helps to interrogate the curricula and pedagogies of developmental math courses which question their students' cultural capital.

Research Design

Merriam and Tisdell (2016) observe that "Qualitative researchers are interested in understanding how people interpret their experiences, how they construct their worlds, and what meaning they attribute to their experiences" (p. 5). There are several methods of data collection in qualitative research, including observation and visual or textual analysis. In order to understand and examine how developmental math affects students placed in these classes, their narratives need to be brought to the forefront. One-on-one interviews and a focus group allowed for their epistemological and ontological truths to be the core of this study. I chose these two different methods in order to elicit two different kinds of information: individual participants' experiences and beliefs, and their collective perceptions of the ideal math classroom. As noted by Onwuegbuzie and colleagues (2009), some focus group participants may not contribute to the group discussion due to several factors such as shyness, lack of confidence or interest in the topic being discussed (p. 7). Thus, the one-on-one interviews gave participants, especially the hesitant, the space to contribute to the research without competing with other more self-assured participants. Once rapport and comfort were established, I invited participants to engage in a focus group. Taking part in the focus group was optional. Out of the 12 participants, 11 were able to participate. One student did not participate due to a scheduling conflict. The focus group was designed as a two-fold instrument: first, to give participants the knowledge that they were not alone in this struggle and second, to have a space in which like-minded people could discuss what curricula, pedagogies and assessments in the DeM classrooms should look like. According to Kitzinger (1995), focus groups may help their participants "explore and clarify their views in ways that would be less easily accessible in a one to one interview" (p. 299).

Participant Selection/Sampling

Creswell (2014) points out, “In the entire qualitative research process, the researcher keeps a focus on learning the meaning that the participants hold about the problem or issue, not the meaning that the researchers bring to the research or that writers express in the literature” (p. 186). Therefore, in order to bring the voices of students placed in DeM to the forefront, interviews and a focus group were used to examine past and present experiences inside and outside their math classrooms. Creswell (2014) further relates that “The idea behind qualitative research is to purposefully select participants or sites (or documents or visual material) that will best help the researcher understand the problem and the research question” (p. 189). Due to the pandemic, 12 participants who had taken or were taking developmental math in LaGuardia Community College were sought out two different ways: first, by sending emails with an attached flyer (see Appendix E) to LaGuardia’s Mathematics, Engineering, and Computer Science Department (MEC) faculty who were teaching developmental math courses such as MAT099: Fundamentals of Algebra, MAT117: Algebra and Trigonometry, and MAT119: Statistics and Elementary Algebra, explaining the nature of the study and how the participants would be compensated for participating in the study. This came with the request that the flyer be shared with their students and I be allowed to visit their synchronous class meetings once to explain the nature of the study. Second, the same flyer was posted on LaGuardia’s Facebook page with the permission of its administrators in order to seek more participants at different stages of degree completion. Snowball sampling was also used by asking the first participants to query their current or former developmental math classmates if they would be interested in participating in this study. This type of sampling makes it easy for “locating a few key participants who easily meet the criteria…established for participating in the study” (Merriam & Tisdell, 2016, p. 98). IRB approval was obtained at the Graduate Center, the advisor’s affiliated

institution before flyers were sent out, participants selected and interviews conducted. Participants ranged in age from 18 to 48 years old; there were 11 females and 1 male; their countries of origin were Sri Lanka, Tibet, Ecuador, Mexico, Paraguay, Brazil and the USA; they were at various stages of degree completion from first year to second year, with some having studied at the college for five years, while others had already graduated and were in the process of transferring to four-year colleges.

Interviews

Once the participants agreed to be part of this study, an email was sent with a Zoom invitation and an attached consent form (see Appendix F) to be read before our first meeting and to be signed in front of the researcher during the meeting. Then, an oral consent form (see Appendix G) was read and the written consent form was discussed, signed and witnessed; dates were secured for the first, second and third one-on-one meetings. Participants were made aware that there was a potential risk for loss of confidentiality as well as a potential risk of discomfort while answering the questions, but there were procedures in place to minimize these risks, such as encrypting data and providing referrals to LaGuardia's Wellness Center. Further, it was made clear that there was no actual direct benefit to participating in this study besides the cash payments for each meeting, but that there may be a larger benefit to students in the future in that it may bring about real change in developmental math classes.

There were three audio-recorded one-on-one Zoom meetings with each participant. The first two Zoom meetings were interviews with open-ended questions. The third one-on-one meeting was a debriefing meeting to clarify the researcher's interpretations of the previous interviews. The participants were compensated via Cash App with $10, $20, and $30, respectively, for these three Zoom meetings.

Focus Group

All 12 participants were invited to participate in a Zoom audio-recorded focus group to discuss three questions (see Appendix C) that were generated based on the one-on-one interviews. Out of the 12 participants, 11 were able to attend the Zoom focus group and they were compensated with $40 sent via Cash App. The first question re-addressed how their experiences with math affected their lives in general, for instance, their career choices, while the last two allowed them to voice their views on pedagogies and assessments enacted in their math classrooms and how these should be altered to attain a more just and relevant math education. Before our meeting, I sent participants an email reminding them to update their Zoom display names to their pseudonyms and to keep their camera off if they preferred that option. Some participants did not change their display names to their pseudonyms but all of them kept their camera off. At the beginning of the Zoom meeting, I read the focus group script (see Appendix D) to them, and then I shared my screen containing the focus group questions. I requested that they identified themselves with their pseudonyms every time they talked because I was not able to see who was talking while sharing my screen. I read each question aloud. The interviewed students began sharing their experiences and perspectives and commented on each other's answers. At the beginning, they seemed to be a little reluctant, but as they started listening to each other's lived experiences, they opened up and even commiserated with one another. The most compelling part of this meeting was when one of the participants asserted that assessments in developmental math courses should highlight students' strengths and not their weaknesses. She stated that individualized projects should be a way to assess students' understanding of the math concepts studied in class. All participants agreed with that the tests given in these courses

were highly unfair. I felt that the interviewed students found in their fellow participants a sense of camaraderie.

Trustworthiness

Quantitative research depends on numbers and statistics. Thus, the instruments used to collect data in quantitative studies are intrinsically replicative and repetitive. The qualitative study design takes a more naturalistic approach than the quantitative study, yet rigor must be part of its design. This study follows Merriam and Tisdell's (2016) three criteria: credibility, reliability, and transferability as explained below.

Credibility (Internal Validity)

Credibility is the most important criterion (Guba & Lincoln, 1989), for it establishes whether or not the results are to be trusted and the implementation of new policies or changes to social and educational issues are warranted. In this study, rapport and trust were created between participants and researcher by establishing confidentiality, guaranteeing that their identities would be anonymous by using pseudonyms chosen by the participants and assuring participants that only the audio part of our Zoom one-on-one interviews and focus group would be used. The data analysis included both "taped-based analysis" and "note-based analysis" (Onwuegbuzie et al., 2009, p. 4). Furthermore, this study uses triangulation by querying twelve participants identically who were at different stages of their degree completion in one-on-one interviews (Shenton, 2004). Some of the participants were in their first semester, while others were in their second year, and others had already graduated from LAGCC and were transferring to four-year colleges. According to Shenton (2004), although one-on-one interviews and focus groups "suffer from some common methodological shortcomings since both are interviews of a kind, their distinct characteristics also result in individual strengths" (p. 65), and, for these reasons, these

types of tasks were included in the study. Member checks (Merriam & Tisdell, 2016) were also enacted by a one-on-one debriefing meeting with each of the twelve participants to review the researcher's interpretations and to expose any intentional (or unintentional) misinformation or lies (Shenton, 2004). The use of In Vivo coding also ensured that the participants' meanings were not misconstrued. Further, being open to negative cases puts the research in perspective because they challenge the emergent hypotheses (Patton, 2015) and are an important part of the analysis stage of this study because they mitigate researcher bias.

Reliability or Consistency (Dependability)

Reliability addresses the replicability of a study using the same participants, the same context and the same methods, a feature of quantitative studies. In qualitative studies, the question is not whether the results can be replicated, but "whether the results are consistent with the data collected" (Merriam & Tisdell, 2016, p. 251). The strategy of triangulation suggested by Merriam and Tisdell (2016) has been discussed above in the credibility section. Another suggestion is the audit trail (Guba & Lincoln, 1989), in which the researcher keeps a research journal while conducting the interviews. In my research journal, I documented my reflections and my First- and Second-Cycle coding after each interview and the focus group.

Transferability (External Validity)

Transferability questions whether the study findings can be generalized to the same or similar situations, yet, human beings are forever changing, and even if the same participants are asked the same questions, they may answer differently because of experience and maturity. In qualitative studies, the "burden of proof for claimed transferability is on the receiver" (Guba & Lincoln, 1989, p. 241) and not on the researcher, where the researcher's responsibility is to give

a thick or detailed description of the phenomenon being studied in its context (Shenton, 2004). This study is informed by these and the above research strategies.

Chapter IV: Analyzing and Understanding the Data

They gave me gold.

It is with much trepidation that I begin this chapter. My participants trusted me with their precious narratives outlining their traumatic experiences with mathematics. I want to do justice to the revelations of their struggles. I feel I will not be honoring their voices if I do not do my utmost to bring this data to light. For me, this study has evolved into a form of midwifery and I am a sort of midwife. Something precious will be forthcoming, and I need to be relentlessly careful and rigorous to help in its birth.

I feel that the numerous quantitative studies researching the issue of developmental math and its failure to work successfully for all have not done justice to the incredible courage of these students. The need for equity in developmental math education calls for qualitative research which brings student perspectives to the forefront. This was accomplished through two one-on-one interviews and a one-on-one debriefing meeting to clarify interpretations of these interviews with a pool of 12 respondents and a focus group with 11 participants of those 12 respondents. I purposely chose to first use one-on-one interviews to give participants who were placed in DeM a safe space to discuss their traumatic and painful experiences in the math classrooms. Zoom added an extra layer of comfort by allowing them to participate in this study from a familiar and/or chosen space while still allowing a personal connection between the participant and the researcher (Gray et al., 2020). Participants were asked to change their screen names to a previously chosen pseudonym and to turn off the Zoom video control. I also assured them that I would be using Zoom audio files only and no Zoom video files. This qualitative method gave the participants an opportunity to share their experiences, beliefs and cultural backgrounds. Further, by interviewing each participant individually, it was ensured that there would be no competition

for attention with other participants more vocal in their opinions and statements. A later focus group was used to collectively discuss the influence of math in the participant's lives and develop a space in which they could discuss relevant curricula and pedagogies along with equitable assessment tools.

Interview Analysis

After each interview, I reflected in my research journal, uploaded the Zoom audio files into Temi—an audio-to-text automatic transcription app—and edited the transcripts. I started the pre-coding process using the First Cycle coding method of In Vivo to capture the participants' views. After Second Cycle coding, the following themes were identified:

- Otherness: language, race/skin color, mental health, and shame
- Math as Right or Wrong
- Math as Rote Memory vs. Deep Understanding
- Math as Relevant
- Teacher|Student Relations
- Self-Authoring|Agency
- School Discourses|Hierarchies
- Family|Friends|Community Influence
- Math as a Myth

Otherness

This is a theme which continually revealed itself in the coded data. There were four different facets/subthemes to this theme: language, race/skin color, mental health, and shame. Otherness is the sense of not belonging, compounded by the feeling that somehow there is something wanting or lacking in the self that prevents it from becoming part of the worlds

inhabited. This sense of otherness is acquired through the inhabited figured worlds' Discourses, such as school, which values certain ways of knowing, speaking, and doing (Holland et al., 1998; Olitsky, 2006; Holland & Lachicotte, 2007; Urrieta, 2007; Barton & Tan, 2009; Caraballo, 2011, 2012, 2017). Anzaldúa (1987/2012) tells us, "Culture forms our beliefs. We perceive the version of reality that it communicates" (p. 38). In other words, culture, in the form of school Discourses, shapes our worlds. It shapes our sense of self.

Language

One participant relates in her narrative how not knowing the dominant language shaped her whole school experience and especially, her experiences in math classrooms.

Dora: I want to take you back to your first experience with math. Can you remember that?

Nick: If we're talking about when I was young…

Dora: Really young.

Nick: I was not born in this country. I came here from a Spanish-speaking country.

Dora: Do you mind telling me where you're from? I'm from Colombia.

Nick: I'm from Mexico. I came from Mexico not knowing the language. My parents didn't really teach me English. My mother knew it, and my father understood it, but they thought as to not have me lose that language, that I would pick it up and it's very easy for children to pick it up at a very young age. So, I felt very intimidated by the other students that were my age and they could count, and they could speak to the teacher. I had to have another teacher in the room because I didn't speak that language. I guess even from a young age, it affected me having a second teacher in the room because *I felt like I was never, essentially, the same as*

my other classmates because there was always something holding me back, whether it was with math or language-wise.

This state of in-betweenness/Nepantla (Gutiérrez, 2015) felt by Nick and other English language learners was viewed as a deficit rather than an asset (Trueba, 2002) by the social construction of her elementary school and its Discourses.

Nick: They would take me out for an hour or two [to the Resource Room], and they would take out other kids that didn't know English. They were, essentially, teaching us everything, like how to count, how to do this, how to speak, how to read. But I feel like because they pushed the idea and they made us think that we didn't know the language and we couldn't understand the teachers in the classroom, but we could understand the teachers that were in the resource room because they spoke Spanish, I feel like they were thinking that *we weren't as intellectually advanced as the other students, so they were holding us back.* I feel like that really held me back a lot in my years in elementary school.

Nick's sense of otherness accompanies her throughout her school years.

Nick: …because I spent my hour in [the Resource Room], it stopped me from going to my club activities. We have band, we have art, we have drama, we have those things.

Gutiérrez and Rogoff (2003) observe, "Treating cultural differences as traits…makes it harder to understand the relation of individual learning and the practices of cultural communities, and this in turn sometimes hinders effective assistance to learning" (p.19). English language learners were viewed monolithically and as lacking because they did not have skill in the dominant

language. In the figured world of this elementary school, if you did not know the dominant language of the group, there was something wrong with you.

I can empathize with this sense of otherness. In general, non-native speakers who acquire a language after around twelve years of age have what is called *phonetic deafness.* Phonetic or phonological deafness results in the faulty processing of certain non-native speech sounds, such the trouble Spanish speakers have distinguishing between the [v]and the [b]sound or the difficulty pronouncing initial "s" consonant clusters, as in "school," [skul], where these speakers will tend to put an 'eh' sound in front, such as eh-school. I have always been self-conscious about my accent. I have heard many accents in academia but my experience is that certain accents are viewed as acceptable, while others are not. I recall working as a math tutor in LAGCC math lab when I was 18 or 19 years old, and my then-boss, Doris Charrow, asked me to tutor an older man in statistics. Doris recommended me highly to this man, and I could see he was quite excited about learning from me. As soon as I opened my mouth, I could see from the expression on his face that he wanted nothing from me. My accent turned him off to my ability to explain statistics in an easily comprehensible way. My accent has stopped me many times from engaging in intellectual discourse with my peers due to embarrassment. I feel great empathy for students like Nick because I, too, have traveled her path.

Race|Skin Color

Another participant related how having a different skin color, not being *blanquita,* or white, made her feel like she did not have the right to ask for any kind of educational resources.

Dora: Tell me about your experiences, past and present, in your math classes.

T.G.: Going back to elementary school, I struggled with math. I always have struggled with math. I want to say that I guess my school didn't provide me resources. I

went to a private school in Brooklyn, a Catholic School. *Most of my classmates were white. Very few students were of color*. My household, I want to say, didn't have much education background, so most of my homework I had to do on my own and try to figure it out. That's why I also struggle. My parents really didn't understand my homework, so I had to do it on my own. Of course, my school didn't give me resources, and *I didn't feel comfortable asking for help either because I didn't feel like I belonged there either.*

T.G. elaborated further why she felt like she did not belong:

Dora: Give me an example of having a bad experience or experiences in a math class.

T.G.: My bad experiences were in elementary school and a little bit in high school. It wasn't too much in high school, but most of it was in elementary school just because *I always felt I wasn't welcomed in my elementary school*. I don't know if it was a race thing. I'm young, I didn't really understand it. But now as an adult, I'm like, *"Maybe my teachers were a little racist,"* because all my teachers were white, too. *You didn't really see that many students of color in private Catholic schools*. The community I always lived in was predominantly Spanish, *but you didn't see that many Spanish kids in the Catholic School.*

Now, when I look back at it and I think about it as an adult, my teachers didn't really like me. I saw that with my sister because my sister also went to that same Catholic school. When I talk to my sister now as an adult, we try to understand *why we weren't liked.* The only thing we can come up with was because *most of our other classmates were white, and we noticed they weren't treated the same way that us students of color were treated.*

My sister as well also struggles with math. Whenever I felt like I needed my teacher to stop, she would get upset. I remember she was like, "*If you guys* can't keep up, *you guys* can do extra homework at home." But if I'm not understanding the material at school, how do you expect me to do more work at home? It doesn't make sense.

Mental Health

An unexpected finding was that mental health exacerbated this sense of otherness. One participant explains how her mental health issues kept her from engaging in school:

Dora: You told me that you felt that you didn't put in the effort and your grades could go from 75% to 95%. Even though you feel that you're pretty good at math, you just didn't want to do it. Why do you think you didn't want to do it at the times when you were like, "Eh, I'm not going to do it?"

Jo: I wouldn't really say it's in relation to math. I would say it's more due to relations, like my mental health, the state that I was in at the time. *I had a lot of anxiety and depression at the time that I wasn't dealing with and I would cut classes and I wouldn't put any effort into any class at all.* It wasn't just math.

Dora: It's not like math was the one that triggered the anxiety, it was something else.

Jo: Yeah.

Nasir and colleagues (2005) view "learning not merely as a cognitive process, but as intertwined with multiple aspects of development—including identity and emotion" (p.499). Learning does not happen in a vacuum; we must view our students in a holistic way. Minoritized community college students are especially vulnerable and we as math educators need to be aware of the mental and psychological needs of our student body.

I feel great empathy for Jo's pain. Chronic depression and anxiety are challenges that some LAGCC students face in addition to math anxiety. For students like Jo, "it wasn't just math" that was driving poor performance: In my years as a math educator at LaGuardia I have found that we need to address mental health issues in order to create a safe space for learning. Jo expressed that anxiety and depression kept her from engaging with any kind of learning, mental health issues exacerbating an already precarious learning situation. Teaching and learning are about safe spaces for all students including those with mental health issues, not just about curricula, syllabi and pedagogies.

Shame

This theme can stand alone but it may be subsumed under the *otherness* theme. According to the Merriam-Webster Dictionary, the definition of "otherness" is the quality or state of being *other* or different, while shame is a painful emotion caused by consciousness of guilt, shortcomings, or impropriety. Many of the participants shared having this intense feeling of shame by being put on the spot by their math teachers or made to feel like they were different/other because their style of learning was different.

Ali describes how one teacher in her middle school zeroed in on the "shy kids."

Dora: This teacher that you talked to me about in middle school, everybody was afraid of her and they didn't want to ask questions, they didn't want to come to the board. They were afraid that he/she would yell at them – did you say "yell?"– and critique them.

Ali: It was a woman. She was very strict. *She would pick on the shy kids* and tell them to come in the front and tell them to write down their answers. You can tell she gets

mad when you don't get the question right. I think the way she taught us or her attitude, I feel like that affected a lot of people. It affected the way we learned math.

Shame is a strong feeling that impedes students from participating in the learning process in the classroom. Another participant recounts how feeling shame stopped him from participating in group work.

Dora: Can you give me an example of having a bad experience in math class? It could be any time from the past to present?

M.P.: Well, usually in the past, since I was really not that great at math, if we had to work in a group, I usually had to *pull back and not participate out of fear of getting the wrong answer or not knowing, or not really having that confidence.*

M.P. recalls how certain teachers made him feel shame because he did not get the right answer.

Dora: Now, I'm going to be more specific, and we're going to concentrate on the teachers, the instructors. What have your experiences working with your math teachers been like?

M.P.: Overall, throughout my whole life?

Dora: Yes.

M.P.: Elementary school wasn't too bad. I did have a few teachers maybe early on I would say, first grade perhaps, and maybe third grade, a couple of grades early on in elementary school that didn't seem that warm and friendly, and it seemed as if I didn't know what I was doing and I would get the wrong answer, I almost felt like more of a punishment or *I'd be made to feel a little less than.*

In this excerpt, M.P. relates his feeling of shame and how getting the wrong answer in his math classrooms made him feel somehow "less than." In his math classrooms, mistakes were not part

of the learning process but something to feel ashamed of. He felt exposed to the rest of his classmates as lacking. Walker (2017) asserts, "Shame is closely linked to fears of social exclusion and rejection and is culturally specific" (p.359). M.P.'s sense of otherness was linked to this fear of social exclusion and rejection by his peers and teachers in classrooms in which mistakes were not an integral part of learning. In these classrooms, mistakes meant something was wrong with one's cognitive abilities.

Math as Right or Wrong

This theme goes to the heart of why some students, especially students enrolled in DeM, view math as a non-relevant subject and those who want to be considered "good at math" believe that you need to get all your answers right. This erroneous outlook leads students to believe that mistakes are not part of the learning process in math, that struggling is not part of learning. Many developmental math classrooms rely on multiple choice tests in which students are marked either right or wrong regardless of the steps taken to arrive at the answer. Requiring only correct answers and utilizing assessment tools such as multiple-choice tests do not allow for innovation and creativity, which is at the heart of mathematics. Classrooms that emphasize what Freire (1970/2000) called the "banking system" do not present the true nature of mathematics. Mathematicians are innovative and creative risk takers. However, as students placed in DeM learn in their math classrooms, only those that have the correct answers are considered "good at math." In these types of classrooms, there is no room for mistakes; in other words, there is no room for innovation and creativity. We need to teach our students that ambiguity is part of the learning process. Drawing from the work of Burton (1999a, 1999b, 2001, 2002) and Boaler (1997, 2008), Grootenboer and Jorgensen (2009) emphasize the importance of allowing students to learn mathematics while *working as mathematicians* and create classrooms in which these

behaviors are the driving force behind the math learning process. They state, “Unlike traditional classrooms where rote-and-drill learning, textbook-based exercises and strong teacher direction dominate, mathematicians employ practices that are quite different from school mathematics practices” (p.262).

Besides collaborative work, one of the main behaviors of mathematicians is living with the uncertainty of the creative mathematical process (Burton, 1999a). Math is not just right or wrong.

In the following excerpts, participants give a description of math as a subject where there is no room for mistakes. Here, Jenni and I talk about her negative experiences in math classrooms, past and present:

Dora: How do you feel about math?

Jenni: My feeling about math is complicated because I don’t really like it, but I guess I have to take it.

Dora: You don’t like it?

Jenni: No, I don’t like it. It’s very stressful.

Dora: You feel that you have to take it, and it’s very stressful. Can you tell me why you think math is very stressful?

Jenni: Because sometimes I don’t get the formulas that are involved in math. Other times, word questions, I don’t get, and I would usually get them wrong. *It’s stressful getting incorrect answers.*

Dora: I want you to put yourself in a class, and I want you to tell me how you think and feel about being in a developmental math class. How do you feel about being in a developmental math class?

Jenni: I would feel anxious, I guess. I would worry if the teacher would call on me to see *if I have the right answer*, I guess.

Dora: You had bad experiences? Did I hear you correctly?

Jenni: Yes, experiences.

Dora: Bad experiences, okay. What kind of bad experiences did you have?

Jenni: I guess being called out by *not knowing the right answer* and being told to have tutoring, I guess.

Most students enrolled in DeM have learned from very early experiences in their math classrooms that getting the wrong answer is not acceptable and only those that are "smart" get the right answers. Wrong answers are to be avoided at all costs. This culture of "only right" or "only wrong" gives math learners the notion that they are only learning when they have the correct answers. Jenni's examples of positive and negative experiences in the math classroom highlight this culture of right or wrong.

Dora: I want you to think through your whole schooling, and I want you to see if you can find one time in which you felt good about being in a math class.

Jenni: One good experience I had was actually recent in my senior year in high school. It was actually the first year I felt good about math since I was doing good with my grades in math. I remember being with my group. They asked a question, and I immediately answered, and *I felt really proud of myself since I knew the answer* since I'd been paying attention in class, and I actually understood what the question was asking for and knew the answer. I was really proud of that.

Dora: Now, I want you to give me the same kind of example, but with a bad experience in a math class.

Jenni: I guess a bad interaction I had was when another group were discussing—disagreeing—with my answer since they thought they were correct, and I thought I was correct. It was a back-and-forth argument over which answer was correct or not. We would have to call our teacher to see who's correct. Then, *it made us feel bad because we thought both of us would have the right answer, but we didn't.* We would all be confusing what the answer would be. That's one bad interaction I had with one group.

Jenni should have been proud of both experiences, but after the one where she was behaving like a mathematician, she felt like a failure because she was not taught to feel comfortable with ambiguity, with the struggle that is learning.

Math as Rote Memory vs. Deep Mathematical Understanding

Usually, the mathematics learning in the DeM classrooms involves rote memory tasks in which students need to memorize formulas and how to apply them without a deep understanding of why and when to apply them. When I asked M.M. to complete the sentence starter: "Mathematics learning is…" She answered without any hesitation: "a lot of formulas." DeM classes tend to emphasize rote memory tasks where students must practice over and over without acquiring a deep understanding of them. Grootenboer and Jorgensen (2009) assert, "Moving away from tasks that can be solved through the application of formula[*sic*] that are applied in a rote, lock-step manner is critical in fostering learning environments that encourage deep learning" (p.262). Deep understanding cannot be attained through mere memorization of formulae, and to that end, the authors emphasize the importance of engaging students in activities where they are creators of mathematics (p.262). Activities involving deep thinking without the pressure of getting the right answer may develop a deeper understanding of the

mathematical processes and concepts at hand. The authors propose that in trying to simplify math for students, math learning|teaching in the classrooms has been stripped of its true mathematical nature and its mathematical behaviors (p. 262).

Math as Relevant

In the majority of DeM classrooms, learning involves what Freire (1970/2000) calls the "banking system." Participants are often asked, for example, about the importance of learning certain math concepts if they aren't going to use them in their daily lives. Many times, students assigned to DeM ask, and rightly so, "Why do I need to know this when I cannot apply it to everyday life, to real life?" They do not see the relevance of this kind of math or this kind of learning. In the following excerpt, one participant states how she does not see the relevance of learning geometry, even though her example involves algebra:

Dora: Before you took geometry, how did you feel about math? Did you feel like, "I'm good at math"?

M.M.: Yeah. I've always been pretty good with algebra. That was the first time I ever took geometry. That traumatized me a bit.

Dora: You were saying that you didn't make the effort.

MM: I didn't put in the effort because I looked at it in a way, "When am I ever going to use the slope of A and B and C and stuff like that in real life?" So, I didn't really care.

Dora: It wasn't relatable to your future life. You were saying, "I'm not going to use this in the future."

M.M: Yes.

M.M. shared her feelings for math in middle school, stating, “Honestly, math was my favorite subject back then. But then, going into high school and I got into geometry, that’s where I was like, ‘Okay, this is a waste of time.’” She asserted further, “all you need is adding, subtraction, multiplication, and division, that’s it.” Yet, another participant contended, “I don’t think math should be eliminated the same way I don’t think English should be eliminated if you don’t like writing, but I think there must be better ways of doing it.” Andersson and colleagues (2015) emphasize the importance of making math meaningful to the math learners (p. 158).

Some of the participants stated that they perceive the developmental math courses as necessary to continue their education and as a refresher to knowledge they had forgotten. Other participants stated that, due to the good fortune of getting great professors for these courses, their self-esteem improved because they were made to feel math was not beyond their reach as their past school experiences had made them feel.

M.S. explains how she viewed the developmental course she was assigned as a refresher that helped her remember material that she learned in high school and helped her register for other college-level math courses.

Dora: What did you feel when you were assigned to a developmental math class?

M.S.: Well, since I didn’t graduate high school in the United States, I thought I needed to do something like that, especially because I graduated in the 1990s from high school. I was out of school for a long period. I thought *this math that I did in 096 was very important for me to remember what I learned in high school* because you end up forgetting everything if you don’t use it, especially. I thought it was very important for me to get into my other classes. Math 096 was important, I think so.

Dora: You were okay with being assigned to that class, being placed in that class.

M.S.: Yes, I was okay, mm-hm.

Dora: Do you think that you benefitted from that class?

M.S.: Yeah. *The benefit is because you learned something that you already learned before, but it reminds you and it's good for your future classes* because you need it to get into Math 115 or 120. Any kind of math you needed to have the basics of elementary algebra, for example, so I think it's very important to do that.

Dora: It did benefit you because it was a refresher.

M.S.: Yes, it was a refresher of what I learned back in the days in high school. I came back to college after quite a few years. You end up forgetting if you're not in school. It was very good for me. I like it.

In the following conversation with M.P., he states how this course has given him a self-esteem boost:

Dora: Do you think the math classes you have taken will benefit you in any way or form?

M.P.: *Outside of having a little confidence or a little more self-esteem of having put in a little work and passed them, I think that's probably the extent of math benefiting me.*

Dora: Okay. You think they have boosted your self-esteem and nothing else.

M.P.: Yeah.

Dora: Okay.

M.P.: After passing – *because I passed Math 099 and that felt like a good achievement* – and I'm in the middle of Math 115 right now, which will be my last math, and I'm doing fairly well in it. *After this math, I might feel a little accomplished.*

Dora: That means that you're good at math?

M.P.: Yeah.

My question should have been instead: "This means that you like to do math?" because students' math identity narratives such as, "I'm good at math" or "I'm not good at math" are more rigid and of a stative nature (Andersson et al., 2015; Sfard & Prusak, 2005). These narratives limit the infinite potential of students' development and view learners as having innate abilities or limitations. Math identity narratives such as, "I like to do math" or I do not like to do math" become more active, more fluid (Andersson et al., 2015; Sfard & Prusak, 2005). In the words of Stetsenko (2017), "You're not bound by some "pre-determined 'natural' limitations." Development is a "work-in-progress" (p. 335).

M.P.'s past traumas with mathematics, leading to his belief that he was not a "math person," have had a lasting effect. M.P. still believes that the developmental math he took offered him no other benefit except for "having a little more self-esteem"—which is an amazing accomplishment despite the deficient curricula and pedagogies enacted in the math classrooms he attended as he reported. I see M.P. and other participants' desire to continue their education despite their math anxiety. They were taking "their own activist stances" (Stetsenko, 2017), claiming their right to an education previously denied to them.

Teacher|Student Relations

Some participants recount how teachers who were patient, friendly and innovative created classrooms in which they felt safe to participate and to make mistakes, while those teachers who expected only correct answers created an environment of boredom at best—and fear at worst.

Here Ali recalls how her entire class was affected by the different attitudes and expectations of her teachers.

Dora: Tell me your experiences past and present in your math classes.

Ali: When I was maybe in First Grade, we did have a teacher, *she was a very nice teacher.* I think *we did learn a very good amount of math with her*. When we came to middle school, it changed. There was this teacher. *She was a very strict math teacher, and everybody was scared of her and nobody wanted to go to school*. I feel like that affected our ways of learning because we were scared to ask a question or raise our hand or go up to the board to write our answers because we were scared it was going to be wrong and she was going to yell at us and everything. *I feel like that affected me and many other people in my class.*

It appears that while Ali and her classmates learned a great deal with her elementary school teacher, her middle school teacher's negative attitude was detrimental to learning and engendered fear. In Ali's narrative we can see how this idea of math being "right or wrong" was inculcated by this teacher, setting these children up for a potential lifetime of math anxiety. Teacher attitude needs to be explicitly considered in further studies of classroom pedagogy in relation to math anxiety.

Self-Authoring|Agency

A pleasing finding was that some participants viewed their negative history with math as something that was unrelated to their cognitive abilities, but rather was the teacher's responsibility. Ali explains how the environment in her classrooms affected learning, and just who created that environment:

Dora: Why do you think you felt good about yourself in one class and not in the other class?

Ali: It counts the environment you're in. In the past, the environment was negative and pressured and stuck, and you just didn't want to be there. Then, in high school or

right now, the environment is positive, more free, more fun. Obviously, that affects the way you learn and everything. It's the environment.

Dora: What do you think creates that environment?

Ali: The teacher creates the environment. The teacher plants the environment in the room because if you have a mean, strict teacher, you already know how the year is going to go. When you have a nice, positive, joyful person helping you, you know it's going to be a good year. You can tell by the teachers.

Here, Ali places the onus where it belongs. In this excerpt and the one above, she rejects the notion that learning is merely an individual process and views it as a social process in which the "environment" created by her middle school math teacher affected her learning.

School Discourses|Hierarchies

Schools' figured worlds and Discourses shape how students see themselves and their classmates. Caraballo (2011) observes, "Institutions such as schools and prisons exercise control or regulate society by normalizing mainstream perspectives as natural and pathologizing those outside the norm as deficient, lacking, or abnormal" (p.167). Nick recounts how she and her classmates as second language learners were made to feel they were lacking because their first language was not English.

Dora: So, you're telling me that you and other classmates that didn't speak the language were taken out for an hour or two to this Resource Room in which you were being taught the same thing that was being taught in the classroom to your other classmates—but in Spanish.

Nick: Essentially, yes.

Dora: I love that you said they pushed the idea that because you didn't understand the English-speaking teachers, they made you feel that you were not as—You said something…

Nick: *Intellectually advanced.*

Dora: Intellectually advanced. They pushed that idea into you. You said that you felt that they held you back.

Nick: Yes.

Dora: But you said that your mother didn't want you to be put in a class with two teachers, but she wanted you to continue going to the Resource Room. Did I understand that right?

Nick: Yes.

Dora: Let me write that down. She didn't want you to go to a class with two teachers. You can explain that to me in a few minutes. Keep on going.

Nick: I had friends that were in the two-teacher classrooms. Essentially, what it was that the classrooms were pretty big. They were like 30 kids. Basically, one teacher can't give the attention to every single student, so in a two-teacher classroom, the teachers could split it up amongst themselves, like, "You take these 15 kids, and I'll take the other 15 kids" to give them more attention.

Dora: More attention.

Nick: …to where it's needed.

Dora: Did they have any labels, these two-teacher classrooms, or they didn't have any labels whatsoever?

Nick: I'm not sure.

Dora: I'm asking you this because I'm wondering why your mother didn't want you to go into those two-teacher classes.

Nick: It was because of the way that I was… *I remember it because it was something that could've changed me.* Okay, essentially, I was called into the assistant principal's office, and she explained to my mom the idea of the two-teacher classrooms, which at the time was brand new to us. It was my first time in middle school, and I'm the oldest one in my family, so we had never heard of this before.

My mom was not very adamant in letting me join. She said, "No, I would rather her to continue to be in the normal classrooms." *That's what she called it: the "normal classrooms."*

Dora: Oh, she called it "normal." So, how did she refer to the other ones?

Nick: She didn't refer to them as anything. She just said that it's not what I want my daughter to be in. *Our classrooms were numbered weirdly*, and *you kind of knew through the numbers who the intellectual kids were, who the regular kids were, and who the slower kids were.* That idea of the numbering of classrooms is what people think of a *hierarchy*, in a sense, *between the students, like, "You're better than me," or "I'm better than you, because I'm in this classroom."*

Dora: Okay. Oh my god. Nick, sorry.

Nick: It's okay.

In Nick's narrative, we can see how her school Discourses manifested in negative treatment of English Language Learners. They reported that the school made them feel like there was something wrong with them because they spoke languages other than English. In Nick's words, they were deemed to be not as "intellectually advanced." The school hierarchy was also made

evident in its use of streaming classes (the grouping together of students with similar abilities) and the numbering of these classes. According to Nick, everyone knew who was perceived to be "better" according to this hierarchy, thereby labeling a portion of students as less-than or deficient in their capacity to learn. The school Discourses marginalized Nick by labeling her as other, and by implication, insufficient.

Family|Friends|Community Influence

Expectations are great influencers in the development of a positive or negative math identity among students placed in DeM. Anderson (2007) recognizes that "Through relationships and experiences with their peers, teachers, family, and community, students come to know who they are relative to mathematics" (p. 7).

In the following interview excerpt, M.P. explains how his family did not expect much from him when it came to math. I do not know if this still influences his math identity, but his success in developmental math, college level algebra and stock trading may have knocked down this misconception of his math potential.

Dora: Did anybody say to you, "Math, you have to study hard for it," or anybody say, "Math is very important," or, "Forget about math. You can do without it?"

M.P.: I think if anything, I remember my mom not really…well, *my parents were very good at knowing my limits and knowing what I could do and couldn't do*. They never really placed expectations that really weren't expected of me. If anything, they encouraged. They said I could do it as encouragement. If anything, my mom just said, *"You're going to have to study a little bit harder than the other kids."* She tried to put it in my head that I still could do it regardless, it would just take me a little more work.

Dora: Okay. Your brother didn't talk to you about it or your father didn't talk to you about it or anybody else outside your family?

M.P.: No, not that I can remember.

Another student discusses how the low expectations in DeM classes hindered her math learning:

Dora: Besides the teacher not wanting to be there and finishing the lesson too soon, then just dismissing the class, and not including everybody in the class, what else did you see that you didn't like or that you perceived?

A.K.: The target grade in college is 65% or 75% max. *They don't care if you get more.* It's great if you do, but their target is low. They just want you to pass so you don't have to take it again. In high school, that wasn't the case; they wanted you to get a 90%, 95%, 100%, so you could get to college.

A.K.'s observation of low expectations in DeM classes highlights Caraballo's (2011) call for "[m]inoritized students, in particular…[to] construct academic identities and position themselves against a discourse in which they and their peers are framed as more likely to disengage from and fail in schooling than to succeed" (p. 172).

Math as a Myth

Mathematics has become mythologized not only by students placed in DeM but by some math educators as well. In her 2016 book, *Mathematical Mindsets,* Jo Boaler states that some math educators see themselves as the guardians of mathematics and would only allow students they perceive as the best to advance to higher mathematics (p.95). This elitism serves as a form of gatekeeping for minoritized students. However, the mythologization of math pervades our society. In this study, 6 out of 11 focus-group participants believed that there are people who are just naturally good at math.

Below, Ali provides an example of someone she knows who is good a math:

Dora: Do you think there are people who are just naturally good at math?

Ali: Yeah. Yeah, for sure.

Dora: Can you tell me why? Can you explain why you think that way?

Ali: I don't know why. My dad, he's very good at math, very good. He adds big numbers in his head and subtracts them. He doesn't need a calculator or paper, pen. I guess my big sister got that from him because he used to take her when she was maybe 10 to his job, present everybody, and she used to be the tiny cashier. Everybody used to give her tips and all that.

Moreover, another student, T.G., expands on the type of people that are mathematically inclined:

Dora: Do you think there are people who are naturally good at math?

T.G.: Yeah, those are the people who end up being accountants and CPAs and actually study finance and work at Wall Street and things like that. That's actually my brother. My brother loves math. Even now, sometimes I'll ask him, "Hey, can you help me," and he'll help me right now.

Now, T.G. is majoring in nutrition and culinary management and is well aware of the role math plays in her future career. She's also a runner and explains in great detail how she uses math in this activity:

Dora: You're saying that you run marathons for charity groups. So, how does that influence your learning about math?

T.G.: Well, with math you have to calculate your distance, your speed, and your time. I usually wear a watch. I see if I'm going to fast the first few miles, I know I need to slow it down because I'm going to be gassed the last two miles in my

marathon. Calculating my pace, making sure I'm at my pace. Let's say, it's 12 minutes per mile, I know it's okay. But if I see it's dropping to 11, 10, 9, I'm going to be gassed by the last few miles. There's this term that we say "hitting the wall." I'll be too tired to finish the rest, I could potentially get hurt as well. So, making sure I'm consistent with my time and my nutrition, too, because as I'm running, I'm also making sure that every 30 minutes, I'm either drinking water, having a snack or something as well.

T.G., despite demonstrating a level of expertise in and insight into mathematics, still believes that some people are naturally good at math— and that she's not. Other students such as P.V., believe that some people are naturally "good at math," even though their explanations reveal an environmental factor as well:

Dora: Do you think there are people that are naturally good at math?

P.V.: Yes. No doubt about it.

Dora: Can you explain that to me?

P.V.: I don't know the science behind it, but I do believe there are people who have either a genetic predisposition or a combination of genetic predisposition, DNA, plus environmental dispositions that make certain languages easier. I think the language of math, the language of reasoning and the processes of math is very different obviously, than the reasoning and the logic and the language of words. I really see it as two different ways of communicating. I think certain people are better at certain things. I don't think that you should be limited by any of that. My LaGuardia professor said that, basically. He was bad at math, but then he really, really worked hard and he got better, then he really liked it. Now he likes it and he's good at it.

But initially, he came from…there's a natural thing there. If you tell me to study the next four years, 10 hours a day math, I will never be that comfortable. I don't believe that's possible. I really don't.

It was a pleasant realization that those students who do not believe in the genetic or natural "math giftedness" squarely assign mathematical competence to the environment and to the resources offered to students inside and outside the math classrooms.

Dora: Do you think there are people who are just naturally good at math?

Sarah: I don't think there are people who are naturally good; I think there are people who have more support and help to fully understand it. I think it's also important to start getting that help early on as well so they're not so far behind when they enter high school. I always was told by my parents that it was important to study and try to get good grades. I think having that positive influence is really good for anyone.

Another student's explanation highlights how having the right type of experience helped her see math in a more positive perspective:

Dora: Do you think there are people who are just naturally good at math?

Jo: I used to think that way, but since I've been in college, it's that they've never been taught in a way that was easy for them to learn and understand. I think I already told you in the last meeting, I used to struggle with math. I was good at it, to a point, but when I was taught in a way that was easier for me to understand and comprehend, it was a problem-solving thing for me. I liked it a lot more. It was more like a puzzle almost.

Jo is taking the first step in reclaiming her humanity by reclaiming her "s/objective reality" (Stetsenko, 2017, p. 199). According to Stetsenko, reality is formed by historical social

practices which are constantly being changed by actors working in unison in search of their individual aspirations, and these actors are, in turn, being changed by this world they are actively/agentively changing. Hence, s/objective reality, as viewed by Stetsenko, is "profoundly material and deeply humanized (or meaningful) at the same time" (p. 199). Yet, Jo's positive and negative experiences with math learning|teaching highlight the often-passive roles of students assigned to DeM in the figured world of developmental math.

These one-on-one interviews gave students placed in DeM the opportunity to voice their experiences and views of developmental math classrooms and how they impact their present lives and future higher education goals. Their narratives took center stage, and as such, they got to tell their stories to me and to themselves.

Focus Group Analysis: Voices from the Trenches

After conducting all one-on-one interviews and one-on-one debriefing meetings with the 12 participants, we agreed on a day and time to conduct a focus group. Only one student was unable to attend due to a scheduling conflict. The following three questions emerged from the interview analysis:

1. How have your experiences with math influenced your life?
2. What would your ideal math class look like?
3. If you could create a math test, what would this test look like? And how would you grade this test?

The focus group audio recording was transcribed and analyzed for coding purposes. Using In Vivo Coding, the transcribed recording of the responses to the three questions were grouped into codes encompassing the following themes:

- Math as Threat|Gatekeeper

- Math identity
- Math as relevant
- Teacher Attitudes|Discourses|Pedagogies
- Math Classrooms
- Math Assessments

Math as a Threat|Gatekeeper

Several of the students perceived math as a "*threat*." Math was an obstacle keeping them away from their higher education goals. P.V. saw it as something that "*could bring down everything else, all of my strengths, all of my determination*." She questioned, "*how many people don't actually do what they want to do because of math?*" M.P. described how math kept him from going back to school: "*It made me stay away from going back to school because I didn't want to go back to college to just have to take math and fail."* Yet, students assigned to DeM find their way back to school through these developmental math courses, some with very successful outcomes.

Math Identity

According to Anderson (2007), "Through relationships and experiences with their peers, teachers, family, and community, students come to know who they are relative to mathematics" (p. 7). Answers to Question 1 illustrate how the participants' relationships, experiences and expectations from the figured worlds they inhabit shape their relationship with mathematics. P.V. and M.P. describe a fraught relationship with math from a very young age because of lack of support or low expectations. However, P.V. and M.P. 's relation to math became more positive after successfully completing their developmental course, while other students' view of math and their view of themselves as math people changed from positive to negative. Gee (2000) states,

"The kind of person one is recognized as 'being,' at a given time and place, can change from moment to moment, can change context to context, and, of course, can be ambiguous or unstable" (p.99).

Teachers Attitudes|Discourses|Pedagogies

A few of the participants discussed how having teachers that made math learning enjoyable changed their perception of math and them as math learners, while other participants described teachers creating classroom environments in which getting wrong answers or asking questions were negatively viewed. M.S. recalled how she felt in a class in which the professor did not like his students to ask questions: "*I felt like, 'Oh my god, I'm so stupid asking this question,' because he let me feel that way."* Another participant, M.M., added that certain language used by her instructor made her feel like she shouldn't be asking any questions: "*I was the only one asking questions in the class, she would tell me, 'But how do you not know this? This is so easy.'"*

Caraballo (2011) states, "Minoritized students, in particular, must construct academic identities and position themselves against a discourse in which they and their peers are framed as more likely to disengage from and fail in schooling than to succeed" (p.172). Caraballo underscores the minoritized students' struggle against an academic discourse that fails them. M.M. explained her struggle against such a discourse: *"I even had a math group, a WhatsApp group, for the math class, and I would be like, 'do you guys all understand this, or am I literally the only one?' They were like, 'No, I don't understand either.' So, I'm like,' Why don't you guys speak up?'* This student questioned the discourse that framed her as lacking, instead of viewing herself as a deficient. She puts the onus where it belonged, on the instructor's discourse, but also on her fellow students' failure to intervene on their own behalf with the instructor.

Math Classrooms

Students emphasize that an ideal classroom would be a safe place for every math learner. They would feel comfortable with making mistakes and asking questions. One student emphasizes that a more *"hands-on math"* would make math learning more enjoyable instead of "*just listening to a teacher*." This goes hand-in-hand with Freire's (1970/2000) "problem-posing education." The "*just listening to a teacher"* education experience by students placed in DeM is the "banking system of education" in which students are assumed to be empty vessels to fill with knowledge, lacking epistemological value to contribute to their own education. Freire addresses this issue by highlighting how banking education "den[ies] people their ontological and historical vocation of becoming more fully human" (p. 84).

Math Assessments

Students agreed that the final grade shouldn't come from just two major tests. They agreed that two tests could not represent how much they had learned in class. P.V. suggested that in-depth research papers can benefit those students who are not good at test taking. Other students mentioned how multiple-choice tests do not represent what they really know. M.S. shared her frustration with these tests, "*I did the whole thing correctly. In the answer, I didn't round the answer correctly. I failed because of that."* Jo Boaler (2016) proposes, "The best teachers I have worked with who have to give grades have used students' mathematics work rather than test performance—recording, for example, whether they asked questions, show mathematics in different ways, reason and justify, or build on each other's thinking. In other words, they assess the multidimensionality of math" (p.167). Boaler's assertion emphasizes the students' observations and how present math assessment promotes more of a feeling of doom than real learning. One student remarked, "*What do you want them to take away, an experience*

that they think sucked and was horrible, and they never want to think about that again and not learn anything, or do you want them to actually learn something, improve something and take away something positive from that experience?" Assessments in developmental math classrooms should stress the multifaceted nature of mathematics. Behaving like a mathematician involves posing questions, proposing different ways of solving problems, linking different ideas or methods of solving—and feeling comfortable with—ambiguity (Boaler, 2016). Math is not just performing rote memory tasks and getting right answers to one-dimensional questions; rather, it reflects the complexity of nature.

Developmental Math in the Time of COVID

At the beginning of the spring semester, 2020, due to COVID-19, The City University of New York (CUNY) decided to implement distance or remote learning. Distance or remote learning, also called distance education, e-learning, and online learning, is a form of education in which the main elements include physical separation of teachers and students during instruction and the use of various technologies to facilitate student-teacher and student-student communication and interaction.

It would be a lost opportunity if I do not mention the impact of COVID on students placed in DeM and developmental math courses. All of the students interviewed for this study except one had taken or were taking developmental math during the pandemic when CUNY went remote. Their overall opinion is that somehow distance or remote learning afforded them the kind of attention and safety that face-to-face classes did not offer them, with the exception of one or two participants.

Attentiveness

A.K. had taken the same developmental math course, MAT117, three times with the same teacher. She felt that her instructor was more attentive to her students and their needs in the remote learning medium. In this excerpt A.K. explained herself.

Dora: You took it with the same teacher three times?

A.K.: Yes.

A.K.: "I just took a Zoom course with her, and she was great. There were no students to bother her, so she did what she had to do in the Zoom classes. She recorded everything, and I would re-watch the videos over and over again. That was more beneficial for me since I passed since the last two times, I took the remedial course in class with her because the students, they were very rowdy. We've done groups before, but it was once or twice, and I felt like she wasn't completely engaged with us back then. But now, when I needed help, she's there. She was on Zoom call, and she answered most of my questions. I felt a more individual approach, I guess you could say."

Ali concurred, *"I think I like it better through Zoom or video chat because he can give his attention to everybody. When you have a question nor something, you can message him through the chat."*

Approachability

A.K. and Ali both stated that this medium made their instructors seem more approachable. They could reach out to their instructors via Zoom or chat and they would receive individual attention without any distractions or interference from their fellow classmates. T.G. found his professor approachable because he was concerned about his students' well-being during the pandemic: *"This past summer was a great experience just because we connected with the professor on a personal level. We would talk before and after class about things because the*

pandemic was also happening. I guess, in a way, he was also trying to…He understood that we have personal lives at home. We're home trying to pass the math class, the pandemic is going on, maybe some of us lost our jobs, lost family members and whatever, but he took the time to get to know us, teach us at all of our paces–not just one person, but all of the students."

Flexibility

This was another important factor. Ali felt that online instruction gave her the ability to complete her assignments on a flexible schedule while working: "*It's very flexible because he gave all our homework at once, and it's due in December on a specific day, but we can work on as much homework as we want. It's not like high school or middle school that they give you an assignment every day. It's very flexible, and it works for me since I started working."*

Technologies

Other students felt that during the pandemic, technologies such as videos included in online assignments or videos recorded by instructors gave them the time to go over concepts they did not understand. For example, M.P. reported, "The math videos that accompanied the homework and the assignments were very helpful, and they were very easy to grasp." M.P. and Jo perceived communication and collaboration technologies such as WhatsApp supported the formation of study groups that enabled them to communicate with their classmates and help each other to understand concepts they found difficult.

Anxiety

One participant, on the other hand, identified the remote learning experience as detrimental to her learning style. Jenni stated, "*I felt anxious actually because this is college math, and it's different from high school. Since it's remote learning, I was worried about how I was going to learn and if I was going to have good grades, actually, since I'm a visual learner."*

Jenni felt she needed problems written on the board in order to learn math effectively, and that the online medium did not provide that instructional modality for her.

COVID affected students placed in DeM in various ways. Some found distance learning to be the right medium for their learning; others did not.

An Overview of Otherness, Relevance, Discourses and Agency

The most salient theme among students enrolled in DeM is the daunting sense of otherness. Otherness in the form of language, race/skin color, mental health, and shame were discussed by students placed in DeM as obstacles isolating them from their learning communities in their math classrooms. According to Anderson (2007), "[Social] participation includes not only thoughts and actions but also membership within social communities" (p.7). One of the students, Nick, recounted how getting assigned to the Resource Room kept her and her fellow English Language Learners from participating in the school's extra-curricular activities such as band, drama and art. Nick felt that throughout her school years she felt isolated. She said, "*I felt like there were barriers, there was exclusion. There was little to no acceptance, and I felt there wasn't an opportunity to grow."* T.G. is another student describing her sense of isolation in the Catholic school she went to during her elementary school years. She recalled how she was treated differently by her Catholic school teachers because she did not know the language when she started school in kindergarten, and her skin color was darker than those of her classmates. She described how in a conversation with her younger sister, who also went to the same Catholic school, they realized they were made to feel like they were less than their classmates—the majority of her classmates were white. T.G. recalled thinking, "*I always felt I wasn't welcome in my elementary school. I don't know if it was a race thing. I was young. I didn't really understand it. But now as an adult, I'm like, 'Maybe my teachers were a little racist,' because all my*

teachers were white, too. You didn't really see that many students of color in private Catholic schools." T.G. felt rejected by her teachers and, thus felt unwelcomed by a school that should have been a safe place of learning for her and other students of color. She and other participants described how they stopped asking questions in their math classrooms because the teachers would get upset with them for, in their opinion, making the other students fall behind. Barton and Tan (2009) explain, "Exclusion works most powerfully as self-exclusion when student self-censor and cease to participate in class…" (p. 70). This form of exclusion is powerful indeed because it isolates and suppresses agency. This silence on the student's side legitimizes figured worlds, which causes the violence of exclusion. In return, these figured worlds, through their Discourses, place the student in a subject position of disengagement and failure.

Discourses that value certain ways of knowing, being, doing, and speaking generate this sense of otherness. Some of the students' traumatic experiences had to do with how these Discourses, manifesting in linguistic form (discourses), at home or in math classrooms, framed students placed in DeM as failing at learning math. Some of these Discourses were as innocuous as, "*But it's so easy how to get this. How do you not know this?*" or as detrimental as, "*If 'you guys' can't keep up, 'you guys' can do extra homework at home*" or ones meant to be benevolent such as, "*You're going to have to study a little bit harder than the other kids.*" Caraballo (2011) reminds us, "Minoritized students, in particular, must construct academic identities and position themselves against a discourse in which they and their peers are framed as more likely to disengage from and fail in schooling to succeed" (p. 172). Students enrolled in DeM described how they have to overcome these Discourses, positioning them as lacking when it came to math learning. A participant described how he was deterred from going to college for a long time because of his fear of math. Knowing that he had to take math—and the possibility of failing it—

was a heavy burden for him. However, despite this fear, he managed to enroll at LaGuardia Community College and to his delight was able to successfully complete his developmental math requirements, passing college level algebra as well. Now, he knows that he, too, is able to do math despite all the negative Discourses in the figured worlds he inhabits. Another participant explained how her fear of math kept her from getting the degree she needed to obtain the education she always craved and was denied by her parents and her school experiences: "*For me, my experiences were always negative with math because I was always failing it, especially in high school. When I got older, it just got harder for me. It made me stay away from going back to school because I didn't want to go to college just to have to take math and fail. I always went back and forth over the past few years about going back to college, but math was one of the main reasons why it took me a little longer."*

These negative Discourses create trauma that students assigned to DeM battle in order to pursue their education goals. Another participant recounted how her professor made her question her math abilities: "*He didn't like you to ask questions. He actually thought that you knew already. He was a professor, so he thought we should know as much as he did. I didn't like it because a lot of times I had a question, and I felt like, 'Oh my god, I'm so stupid asking this question.*'" Caraballo (2017) poses, "the enacted curriculum is what students and teachers experience in the classroom as a figured world of achievement, in which discourses produce and regulate certain behaviors as acceptable and unacceptable" (p.588). In the above example, this teacher created a curriculum in which to ask questions is to be mathematically inept, where the true nature of mathematics learning was ignored. Discourses can also be implemented in the designation and assignation of school classes. Nick described her elementary school hierarchical position of classrooms and students: "*Our classrooms were numbered weirdly, and you kind of*

knew through the numbers who the intellectual kids were, who the regular kids were, and who the slower kids were. That idea of the numbering of classrooms is what made people think of a hierarchy in a sense, between the students, like, 'You're better than me,' or, 'I'm better than you, because I'm in this classroom.'" In that regard, Martin (2012) states, "Frameworks are helpful but any framework or theory can be misused and applied to confirm or reify deficit ideologies" (p. 60). The numbering scheme for Nick's school classrooms perpetuates the marginalization of certain students. Yet, this sense of failure, of a negative math identity, can be overcome if the students placed in DeM classes experienced teachers who pedagogies allow and embrace mistakes and questions as the natural part of math learning.

As previously discussed, otherness in the form of language, race/skin color, mental health and shame came to the forefront as an impediment for students assigned to DeM to create a positive math identity. Cobb and colleagues (2009) conclude, "The resulting accounts of students' developing personal identities can be directly related to the classroom microculture that constitutes the immediate context of their mathematical development" (p. 64), and if I may add, their homes' microcultures as well. Some students placed in DeM recalled having no support at home or at school to develop as math learners. Others can still repeat word for word what was said to them: "*You cannot... You're incapable of..."* These experiences isolated them and kept them from being part of the mathematical communities in their own classrooms and affected their perspective of them in relation to mathematics for years to come. One student, Ali, remembered how she recognized herself as a person who did not like to do math: *"Coming up from middle school, I had the idea of hating math and everything. I think I had the mentality of middle school math being evil or bad."* Ali blamed her middle school teacher's impatience for her hatred of math.

A pleasant discovery was that some students enrolled in DeM did not see themselves as intrinsically deficient but as lacking the necessary academic support to succeed in math learning. Ali refused to see herself as deficient, acknowledging that the blame lay with the teacher's pedagogies. Ali recounted how during high school her experiences in the math classrooms were of a more positive nature. Ali described her experiences there throughout her school years as "*an emotional rollercoaster."* Math classrooms in which "*kids want to learn or come to class*" let her experience math as something attainable.

According to Anderson (2007), our identities in progress are formed by our historical and projected experiences with other actors (p. 8). One important discovery was that some students assigned to DeM such as Ali, who encountered mostly negative experiences in math classrooms, used an active verb, "do," to express her feelings about math as a result: "*I do not like to do math."* Likewise, Sarah and Jo, with the same mix of positive and negative experiences in math classrooms, do not believe that there is a genetic predisposition for anyone to be mathematically inclined, but rather that with the necessary support anyone can thrive as a math learner. For example, Sarah explained, *"I do not think there are people who are naturally good; I think there are people who have more support and help to fully understand it." Or, Jo, who changed her view of a genetic propensity for math skill: "I used to think that way, but since I've been in college, it's that they have never been taught in a way that was easy for them to learn and understand."* While other students assigned to DeM whose experiences were more or less the same instead used the static verb "be" as in, "*I'm not good at math,'* in their math identity narratives and believed there is a genetic proclivity to have an affinity for math. Andersson and colleagues (2015) note, "Thus, expressions such as 'I'm a math hater' or 'I'm dumb in

mathematics' cannot be attributed as a characteristic of the student's self. They are rather related to the possibilities that pedagogical discourses make available to students" (p. 145).

The students placed in DeM interviewed had at different times during their school years encountered microaggressions that made them perceive themselves as lacking the ability to learn math, and if they encountered math classrooms in which pedagogies allowed for mistakes and questions, they then would realize that their math learning had very much do with the amount and type of support they encountered in their figured worlds. For example, Beth remembered how a developmental math professor created a positive space for learning: *"He's like, 'It doesn't matter if you're wrong, you're trying, you're learning.'"* She recounted how she enjoyed going to this class and felt very much part of the math learning community and how she and her classmates helped each other learn math. Sadly, some students placed in DeM, even after successfully completing their developmental math courses and having successfully created lives and careers in which math plays an important part, still doubt their math acumen. One participant could not believe that she got an A in her developmental math class: *"I got an 'A.' I don't think I deserved an 'A,' really. I think I deserved an 'A' for the effort, trust me, because I really tried hard."* Her grades added up to an 'A,' but because of her negative lived experiences with math learning, she could not believe that she deserved to be recognized for her abilities. Some students assigned to DeM, despite their negative views of mathematics, still manage to successfully complete their developmental math courses and continue with their higher education goals. Still, there is a disconnection between their success in life and in careers with practical math while maintaining the underlying belief that math is still irrelevant to their education because of negative associations with their past math classes.

Students assigned to DeM want to know why they need to study something they perceive as irrelevant to their present and future lives. One participant, P.V., posed that the lack of understanding of why they need to study math automatically renders the subject irrelevant. Solomon's (2007) study explains this further: "…mathematics can only be made accessible to all in a participatory pedagogy which encourages exploration, negotiation and ownership of knowledge, and the development of a corresponding identity of participation" (p. 92). In other words, math learning can become relevant and attainable to math learners through pedagogies that create spaces of agency and innovation. P.V.'s perspective highlights how *rote memory vs. deep understanding* is linked to students enrolled in DeM inability to see the relevance of the knowledge acquired in developmental math courses. Yet, this participant admitted that she sees how math can help in problem-solving situations. This comment exemplifies the need for developmental math to be taught as a multidimensional subject.

There is a need to develop curricula and syllabi that stress math tasks of a problem-solving nature rather than those requiring rote memorization. Relevance cannot be made explicit to students placed in DeM if math is not taught with deep understanding as a goal. The math that is taught in the classroom needs to be placed in context for the learner in both the natural world and in daily life situations. As a consequence, self-authoring|agency will become part of the learning process in which teacher and learner become intertwined, with deep understanding of the subject matter as well as a deep understanding of its relevance. Once math teachers|learners see that mathematics is not a "*right or wrong*" subject and that making mistakes is part of the learning process, math learners may cease to question math's relevance but instead see it as one more important part in their journey to become agentive beings involved in changing themselves and their worlds.

Agency is denied to students placed in DeM when they are viewed by Discourses, curricula and syllabi as "other" and lacking funds of knowledge to contribute to their own education. Often, the expectations from teachers are that students assigned to DeM will fail if they do not sit silently while they, as oracles, dispense math wisdom and fill the empty vessels before them. Math should not be viewed as a mythological ritual to which only a few initiates may be admitted.

Mathematics needs not only to be taught multi-dimensionally to demonstrate its relevance to learners, but this approach must be extended to the assessment process as well. Students placed in DeM, with their history of math anxiety and math avoidance, have related that math tests often appear to be one dimensional, where only the one "right" answer is important. Many participants interviewed expressed their frustration, anxiety and fear with math assessments, noting that they really do not benefit many students placed in DeM. One student related how, after doing all the proof work correctly on a problem, she failed to round the answer correctly and therefore received zero points for her efforts on that question. She could not understand how the preliminary work leading to the calculation of the final answer was not counted towards her grade. She complained, "*You give a wrong answer, that's it. They don't care if your work, the whole page, is correct."* These types of tests do not account for deep understanding of the processes involved in manipulating math problems, nor of the innovation and creativity required to do so. Another participant did not see the logic behind being assessed for 90% of a course grade by only two timed tests administered in the classroom under the pressure of having only correct final answers counted. Gutiérrez (2013) warns, "...what constitutes success is largely driven by discourses of achievement and proficiency on standardized exams, tangible outcomes that can be measured in some way" (p. 43). These

assessments based on the school's Discourses of achievement and proficiency discount students' funds of knowledge. Assessments such as these are one-dimensional and limit success to "rule-followers, not rule-makers" (Solomon, 2007, p. 85), thus robbing marginalized math learners of their agency in learning.

Thus, it was important to share a space with students placed in DeM where they could voice their experiences and views of developmental math courses. Out of their voices came the themes and subthemes discussed in this section. These clarify how students placed in DeM view developmental math courses and their impact on their present and future lives. Caraballo (2017) underscores this observation, "…students construct and negotiate identities, as students construct themselves by building on the 'narratives' that are available to them in the figured world of the classroom" (p. 590). Students placed in DeM create and re-create their identities as math learners, some of them realizing that math, after all, is not something that only a few chosen ones can understand, but is accessible to all.

On one hand, the interviewed students chronicled histories of math learning fraught with traumas, but many also described the good fortune of finding developmental math instructors who were able to make math learning more accessible. However, despite most of the participants successfully completing their developmental math courses, they still believe that math is not a subject they relate to or can learn easily.

The participants in this study gave me gold, and I hope that their voices will guide our pedagogies, curricula, syllabi and educational policies. As Gutiérrez (2013) eloquently states, "I argue that it is from the views of subordinated individuals and communities that we will learn how to rethink mathematics education" (p.39). Community college students placed in developmental math deserve to be heard and we must take heed of their wisdom.

Chapter V: Discussion and Conclusions

Meaningful findings in the coded data of this qualitative study give voice to students placed in DeM experiences in math classrooms and how they construct their identities as math learners within the academic structures they inhabit. Using one-on-one interviews and a focus group, this study examines this construction through the following research questions:

1. How do students required to take developmental math construct their math identities?
2. How do cultural, educational, social, political and economic structures shape students' math identities?
3. How have developmental math courses become a systematized form of marginalization?

Here I present my core findings and distill the main message of my study:

Otherness

Otherness—and a sense of alienation—permeate this study. The data analysis suggests that students placed in DeM negative experiences with mathematics only accentuate their perception of misalignment with those they view as "good at math." The results of this study indicate that students placed in DeM, despite successfully completing their developmental math courses, still do not view themselves as being "good at math." Students placed in DeM who successfully complete their developmental math courses seem to be surprised and happy—many even proud—but they still do not see themselves as part of the community of math learners. Developmental math pedagogies, curricula, and syllabi amplify this sense of otherness by emphasizing rote memory tasks and one-dimensional tests that lack the space to engage students in creativity and innovation, and hence, agency. Mathematics for them underscores their sense of otherness in a subject many of them deem as a threat.

How do students placed in DeM construct their math identities?

The Social Practice Theory and Cultural-Historical Activity Theory (CHAT) frameworks used in this study highlight how identities form in practice and emphasize how identity formation is temporal and contextual and does not take place in a vacuum. Yet, the math identities of students placed in DeM do not seem to shift as easily, even in developmental math courses in which instructors embrace a pedagogy in which mistakes are viewed as part of the learning process and questions are welcomed; this may be due to the very nature of scripted curricula, syllabi and assessment tools used in developmental math courses. Sfard and Prusak (2005) explain that "the notion of identity is a perfect candidate for the role of 'the missing link' in the dialectic between learning and its sociocultural context" (p.15). The authors define identity as "stories about persons" in which the gap between what learners *are* at the moment, *actual identity,* and what learners want to *become*, *designated identity,* can be bridged by learning (p.18). Yet, the data in this study suggest otherwise in the case of students placed in DeM. This may be partly due to teaching methods and assessment tools use in developmental math courses that stifle creativity, innovation and agency. Further, when it comes to math identity construction, the analysis suggests that even those students placed in DeM who successfully complete their math developmental requirements and have great instructors for their developmental math classes still perceive themselves as not "good at math." The following statements are from such students placed in DeM:

"I got an 'A.' I don't think I deserve an 'A,' really."

"[Math] doesn't stress them out as much as someone like me, where they get overwhelmed."

"If I were really good at math, I would choose something like engineering. Or now that technology is becoming a bigger thing, I would love to learn how to code or something related because those types of majors, you need to be really good at math."

Successful completion of developmental math requirements did not translate to a positive math identity in some students placed in DeM. They still believe that there are certain people who are naturally good at math, and they are not them:

"…I do believe there are people who have either a genetic disposition or a combination of genetic predisposition, DNA, plus environmental dispositions…"

"Yeah, I do think there are some people that it comes a little easier to."

Even those participants who do not believe that there is a genetic disposition can still cannot see themselves as people who can excel in math or in a career that involves a lot of math.

For example, Nick's response regarding a natural predisposition to being good at math:

"I want to say 'yes and no.' When I say 'yes,' I feel like there are people who are good at mathematics probably because of how they grew up in the sense that I grew up differently environment-wise, school environment…"

Yet, she stated that math has curtailed her career choice. She did not want to pursue a field that required a lot of math. Solomon (2007) writes, "…some potentially successful students develop negative relationships with mathematics which marginalise them and can turn them against further study" (93). Even in developmental math courses in which instructors rightly view mistakes as part of the learning process, students cannot see themselves as part of the math learning community. This may be due to the fact that most of the math learning occurring in

developmental math courses involves rote memory, and certain Discourses (certain ways of knowing) are promoted over others, such as memorization of formulas without deep understanding, which is then assessed by one-dimensional multiple-choice tests.

How do cultural, educational, social, political and economic structures shape the math identities of students placed in DeM?

The data analysis indicates that math identity formation is shaped by home microcultures and the Discourses of the math classroom. Students interviewed for this study discussed how certain Discourses and pedagogies accentuated their sense of otherness.

> *"It was very tense. It was hard to participate. You didn't feel comfortable because she would literally scream at you like, 'What? That's not correct,' in that way."*
>
> *"I wasn't able to speak up because I didn't feel comfortable in speaking it."*
>
> *"I have a tough teacher…He never wanted to answer your questions, and he was very tough."*
>
> *"I want to score high, and sometimes in math it works like this: if you make one little mistake, one number, you get a wrong answer, so it's a lot of pressure on you when you do a math test."*

Lisa Darragh (2015) stresses, "We need to look at institutional practices such as streaming and consider the effect it may have on disenabling students to recognize 'good at mathematics' performances in themselves…" (p. 100). Developmental math courses have the potential to either hinder or help create a more positive math identity for the student

How have developmental math courses become a systematized form of marginalization?

Students placed in DeM have, at times, taken the courses they were placed in too many times, impeding their academic progress, like A.K., who took a developmental math course with the same instructor three times. Caraballo (2011) reminds us, "Institutions such as schools and prisons exercise control or regulate society by normalizing mainstream perspectives as natural and pathologizing those outside the norm as deficient, lacking, or abnormal" (p. 167). There seems to be a need to re-think the tools used in developmental math courses in order to de-stigmatize this type of math learning—which requires multi-dimensional math teaching.

Relevance

The analysis identifies the problematics regarding the relevance of math in students placed in DeM as another important finding of this study. Students placed in DeM in this study perceived mathematics as irrelevant to their present and future lives. They could not see the importance of memorizing numerous steps and formulas without understanding how to use them in daily life. Students placed in DeM remarked how rote memorization takes precedence over deep understanding in developmental math courses and in math classrooms in general. Participants expressed that they found it difficult to relate to and identify with a subject that does not require creativity but only memorization. Sarah's comment underscores this point:

> Sometimes math doesn't make sense to me because it doesn't always seem logical to me. It's like, "Why do we have to do this rule specifically? Why do we do that specifically?" I always ask why in my head because some things don't make sense. But I realize you don't ask questions in math; you just remember.

And this is further highlighted by Anderson (2007): "They must participate within mathematical communities in such a way as to see themselves and be viewed by others as valuable members of those communities" (p. 8). How can students identify as math learners if they are not allowed to

make mistakes, ask questions, and engage in an agentive form of learning? In other words, they are not allowed to behave like mathematicians or as co-creators of their own education. Students placed in DeM are simply asking for math classrooms where questioning and exploration are part of the learning process.

How students placed in DeM construct their math identities

How students placed in DeM see themselves as math learners is impacted by the figured world of developmental math Discourses. As Andersson and colleagues (2015) relate, "Students' identity narratives, which sometimes are expressed as boredom, rejection and disengagement with mathematics, are configured according to the possibilities that the different contexts for mathematical activity provide" (p. 145). Many of the students placed in DeM interviewed in this study see developmental math courses as necessary for continuing their education but still cannot see themselves as having any connection to a math learning community due to the teaching methodology they experience.

How do cultural, educational, social, political and economic structures shape the math identities of students placed in DeM?

The issue of relevance extends to the type of mathematical operations students are tasked with learning. Participants in this study stated multiple times that they did not see the need to learn any math further than the arithmetic operations of addition, subtraction, multiplication and division.

> *"…that class had me, "Whew, Dios mio." So, yeah. You need math, but I think all you need is adding, subtraction, multiplication, and division, that's it. All that other stuff, do you really need it in everyday life? That's how I think of it. I know I'm not the only one."*

Caraballo (2017) reports the findings of Knight and Marciano (2013): "...authentic preparation for college and life must also be culturally relevant…in an increasingly global and multicultural society" (p. 603). The data suggest that students placed in DeM cannot see as relevant any knowledge that devalues them (and their funds of knowledge) as potential co-creators of their own education.

How have developmental math courses become a systematized form of marginalization?

Developmental math, with its rote memory tasks and one-dimensional assessments, appears to represent marginalization to those like A.K., who have to take a developmental course multiple times until passing it, or even to those who successfully complete it yet still do not feel "smart enough" to pursue a chosen careers involving mathematics. Caraballo (2011) frames this marginalization when she states, "Minoritized students, in particular, must construct academic identities and position themselves against a discourse in which they and their peers are framed as more likely to disengage from and fail in schooling than to succeed" (172). Keeping students placed in DeM trapped in a hamster wheel of failing and retaking courses again and again or keeping them away from their dream careers—even after successfully completing their developmental math course—is a form of marginalization. The relevance of math is connected to the lack of clarity students have regarding how it impacts their everyday lives; a participant highlights this point:

> *"From what M.S. and M.M. were saying and my experiences as well. It seems that there is a lack of understanding, broadly speaking, of why it is important to study math at this point."*

Memorizing numerous formulas and applying them without understanding the how and the why is a futile task leading nowhere. As suggested by another participant, being exposed to real-life

scenarios and tackling hands-on tasks may broaden this understanding and foster appreciation for the study of math.

Most students placed in DeM interviewed perceived placement in developmental math as a necessary step as it is one of the requirements granting them entrance into higher education.

> *"On one hand I was annoyed…On the other hand, it's, 'Remember there's an exam here. Remember you have to pass this.' It's not even about getting an 'A' it's about you have to pass this."*

> *"I wasn't surprised. It was something I pretty much knew would happen. It didn't come as much of a surprise, but it was still disappointing because now, I was presented with having to face math again with no real good experience prior to that. It was a little daunting and scary."*

> *"…if you're in remedial classes that says something already about you."*

Some participants may perceive developmental math as a trauma they need to endure in order to continue with their education.

The perceptions of students placed in DeM of otherness and lack of relevance of mathematical knowledge learned in these classes have been found in this study to be obstacles to the construction of positive math identities. These perceptions seem to feed off of one another in a vicious cycle: when students placed in DeM feel isolated because they do not understand certain mathematical concepts, they cannot see the relevance of this knowledge; conversely, when relevance of this type of knowledge is not make available in their math classrooms (through deep understanding), then they perceive themselves as "the other." The teaching tools used in developmental math courses seem to engender a sense of disconnectedness from both the

community of math learners and its scholarship, thereby hindering the agency of students placed in DeM, thus marginalizing them further.

As a math educator, I was deeply touched by the stories the interviewed students shared with me. I found their incredible courage and willingness to tolerate an educational system that marginalized them extremely moving. They encouraged me to continue research that may lead to reforms in math education in which diversity, creativity, innovation and agency are very much part of developmental math courses. They gave me gold and entrusted me with their narratives, so it is incumbent upon me to ensure their voices are heard loudly and clearly by math educators and educational policy makers. We need to create math classrooms that promote social justice and equity in math education.

In conclusion, using CHAT to analyze interviewed students' narratives, the data analysis revealed that the sense of otherness seems to be more permanent than expected among students placed in DeM, even those who successfully complete the developmental math sequence. Through their narratives, participants emphasized how the Discourses and pedagogies enacted in these courses make them feel as the other. According to Langer-Osuna and Nasir (2016), poststructuralists focus on how school Discourses which, "typically center on identities of the dominant culture," conceive identities through subject positions, where the institutions assign an identity, which may be internalized or rejected (p.731). The data analysis of this study found that the subject positions of lacking or deficient imposed on students placed in DeM seem to be readily internalized by its students.

Similarly, students placed in DeM cannot see as relevant any knowledge that devalues them and their funds of knowledge as potential co-creators of their education. Nasir and colleagues (2005) state, "Moving toward equity will occur as we create learning environments

that connect in deep ways to the life experiences of all students" (p. 499). Furthermore, in 1994, bell hooks recognized the need to connect knowledge to students' lived experiences and stated, "[Students] rightfully expect that my colleagues and I will not offer them information without addressing the connection between what they are learning and their overall life experiences" (p. 19). Recognizing the epistemological value of students assigned to DeM will help in the creation of math classrooms which make crucial connections between learning and students' lived experiences (Barton & Tan, 2009; hooks, 1994; Nasir et al., 2005). Making teaching and learning relevant to students who come from marginalized groups implies a revolution, since their funds of knowledge and Discourses have been deemed deficient and in need of remediation. Recognizing their epistemological value is taking a Transformative Activist Stance (TAS) (Stetsenko, 2017).

Finally, the administrators', teachers' and researchers' gazes should be on the institutions and their Discourses that have created this sense of otherness among students assigned to DeM. We need to re-mediate the system that marginalizes our students.

Gutiérrez and colleagues (2009) provide us a map of how to do this:

> …re-mediation of the learning ecology involves the reorganization of the activity system, including the social organization of learning, the social relationships, the division of labor, and the artifacts in use. The intercultural and hybrid nature of human activity, including classrooms and other learning environments, makes polycultural strategies and solutions an effective means to respond to diversity (p.236).

We need to create learning spaces in all math classrooms that encourage innovation, creativity and agency in our students by embracing diversity.

Study Limitations

I should stress that my analysis has been primarily concerned with how students placed in DeM construct their math identities and that my findings are restricted to LaGuardia Community College students placed in DeM. However, LaGuardia Community College's diverse student body is not unique to its campus. According to CUNY's Master Plan 2016-2020, its students represent the "remarkable diversity of New York City." Thus, the findings in this study may be extended to other CUNY community colleges.

Another limitation of my research was COVID. Even though I was able to develop rapport with the students who took part in this study, I feel that Zoom was not the ideal medium to form a closer relationship among the students, a sense of kinship. They did indeed talk to each other during the focus group, but the solidarity elicited among them may have been transitory since they preferred anonymity. A sense of camaraderie, in my view, would have been essential to encouraging a conversation in which each participant would see themselves as part of a group seeking the common goal of a math education that makes sense to them, and not being the *other* in a perceived group of "good at math" learners. However, participants appeared to feel more comfortable in their anonymity and may have been more willing to share perspectives and experiences without feeling they might be judged by the other participants.

To summarize, this study has addressed the question of how students assigned to DeM construct their math identities; how cultural, educational, social, political and economic structures further shape them; and how developmental math classes have become a systematized form of marginalization. Students placed in DeM perceptions of otherness and relevance impede the formation of positive math identities, while Discourses in their figured worlds further stigmatize them and magnify their marginalization.

Quantitative studies take a macro view of the math remediation problem without any input from those that are affected the most, students assigned to DeM. Educational policies and educational reforms for developmental math courses have been mostly of a 'top down" nature. Gutiérrez (2013) underscores this: "I argue that it is from the views of subordinated individuals and communities that we will learn how to rethink mathematics education" (p. 39). Hence, I felt that a qualitative study—a micro view—was needed to bring to the spotlight the voices of students placed in DeM in order to encourage educational reforms at the developmental math level that really make sense to those whom these reforms seek to help. I applied CHAT as the theoretical framework to contextualize students' experiences; Critical Theory to challenge the deficit-based perspective of developmental math education and examine its power dynamics; and TAS to investigate how community college students enrolled in DeM "reclaim their humanity" (Stetsenko, 2017). Within this paradigm, I conducted one-on-one interviews and a focus group in which 12 participants described their experiences with math inside and outside developmental math classrooms.

Recommendations

Future research may be extended to multiple CUNY community colleges to acquire a more comprehensive understanding of how students assigned to DeM construct their math identities and how relevant they perceive their math courses to be. Another avenue for further study is longitudinal research which follows students placed in DeM throughout their years in higher education and examines the progression of both their math identity formation and their views on math relevance and, finally, how these views may have affected their career choices.

Another area in need of exploration is participatory research in which students enrolled in DeM, math educators and educational policy makers create a pilot program in developmental math simulating how professional mathematicians apply their knowledge.

The analysis of student input underscores the need for math classrooms that allow for creative, innovative and agentive learning. We do not have to reinvent the wheel. We just need to abandon the idea that rote memorization is what counts for math learning. We need to create math classrooms that embrace mistakes and struggle. Of course, it would be ideal if these types of pedagogies and curricula were implemented from pre-K to 12th grade, but while we wait for math educators and policy makers to catch up with this concept, we need to implement, across developmental math courses in our community colleges, pedagogies and curricula that "enable students to see mathematics as an open, growth, learning subject and themselves as powerful agents in the learning process" (Boaler, 2016, p. 171). Creating developmental math classrooms in which students are allowed to develop artifacts (such as apps or visual representations of mathematical concepts to assess their math learning) can take the place of one-dimensional multiple-choice assessments. Students placed in DeM views need to take center stage. Caraballo (2012) highlights the need for this: "…we must engage the social and multicultural imagination of scholars, researchers, and educators by promoting the development of situated, context-based curricula and fostering new understandings of curriculum and academic achievement that incorporate the narratives and perspectives of students from a wide range of backgrounds in the interest of democracy and social justice in education" (p. 55). We must engage in developmental math education reform and research that promotes social justice.

Equity in Higher Education: A Broken Promise?

In 1970, open admissions finally opened the doors to African Americans and Puerto Ricans to CUNY colleges after much unrest at CUNY campuses in 1969. This new student body was not academically prepared for college as The New York City educational system had failed to educate them effectively. Albert Bowker, who became chancellor in 1963, viewed remedial education as a way to level the playing field for these students (Fabricant & Brier, 2016). This is a promise that CUNY has endeavored to champion yet it has not been able to keep:

> "A considerable number of students have successfully passed through the traditional developmental sequences and have gone on to earn a college degree. Too many other students, however, have been temporarily or permanently derailed because they were not able to achieve basic skills proficiency" (The Connected University: CUNY Master Plan 2016-2020, p. 24).

CUNY promises "to engage in research that [leads] to significant pedagogical and curricular improvements" (The Connected University: CUNY Master Plan 2016-2020, p. 25). Unlike quantitative studies and other "top-down" research, my research hopes to highlight students placed in DeM voices and engender meaningful research that engages our students in the development of relevant pedagogies and curricula for developmental math courses. The foundation of LaGuardia Community College presented a democratic model of a pedagogical philosophy involving students "in the planning and organization of the college" (Shenker, 1971-1972, p.5). It was a noble promise to address educational marginalization and provide a quality education which would open the doors to higher education to disadvantaged groups. We need to remember this promise and fulfill it.

Appendix A

Interview 1 Questions

1. Tell me about your experiences, past and present, in your math classes.

2. What did you feel when you were assigned to a developmental math class? Do you feel this class benefited you? If yes, how?

3. Can you give me an example of having had a good experience in math class? For example, this might relate to your interactions with another student; interactions working in groups; test taking; self-esteem; math concepts; and feeling successful.

4. Please give me an example of having had a bad experience in a math class.

5. What have your experiences working with your math teachers been like? Give an example of a teacher you liked or learned from, and how she enabled you to learn or like math.

6. Give an example of a math teacher you did not like or learn from. What were the problems with the teacher's approach?

7. Overall, how would you describe the environment in your math classes, past and present? In other words, did you feel welcome in the class or did you feel isolated?

8. If you had to give me 3 or 4 words or phrases that describe your overall experiences in math classes, what would they be?

Appendix B

Interview 2 Questions

Last time, we talked about your experiences in math classrooms. Today I would like to ask you some general questions about math outside of the classroom.

1. What role do you think math has in your daily life? Please give some examples of how you use math in daily life.

2. How has your cultural background influenced the way you learn math? For example, what are your parents and community members' attitudes and beliefs towards math? How do these attitudes and beliefs affect your attitude/beliefs toward math?

3. Do you think that there are people who are just naturally good at math? Explain.

4. Tell me how your experiences with math have influenced your career path choices, if at all.

5. Do you think the math courses you have taken and will take will benefit you in any way or form? Explain.

OK, now I'm going to give you some sentence starters and ask you to complete the sentence.

6. Developmental math classes are...

7. Math is…

8. Math learning is…

9. The math class is…

10. Math teaching is…

Appendix C

Focus Group Questions

1. How have your experiences with math influenced your life?

2. What would your ideal math class look like?

3. If you could create a math test, what would this test look like? And how would you grade this test?

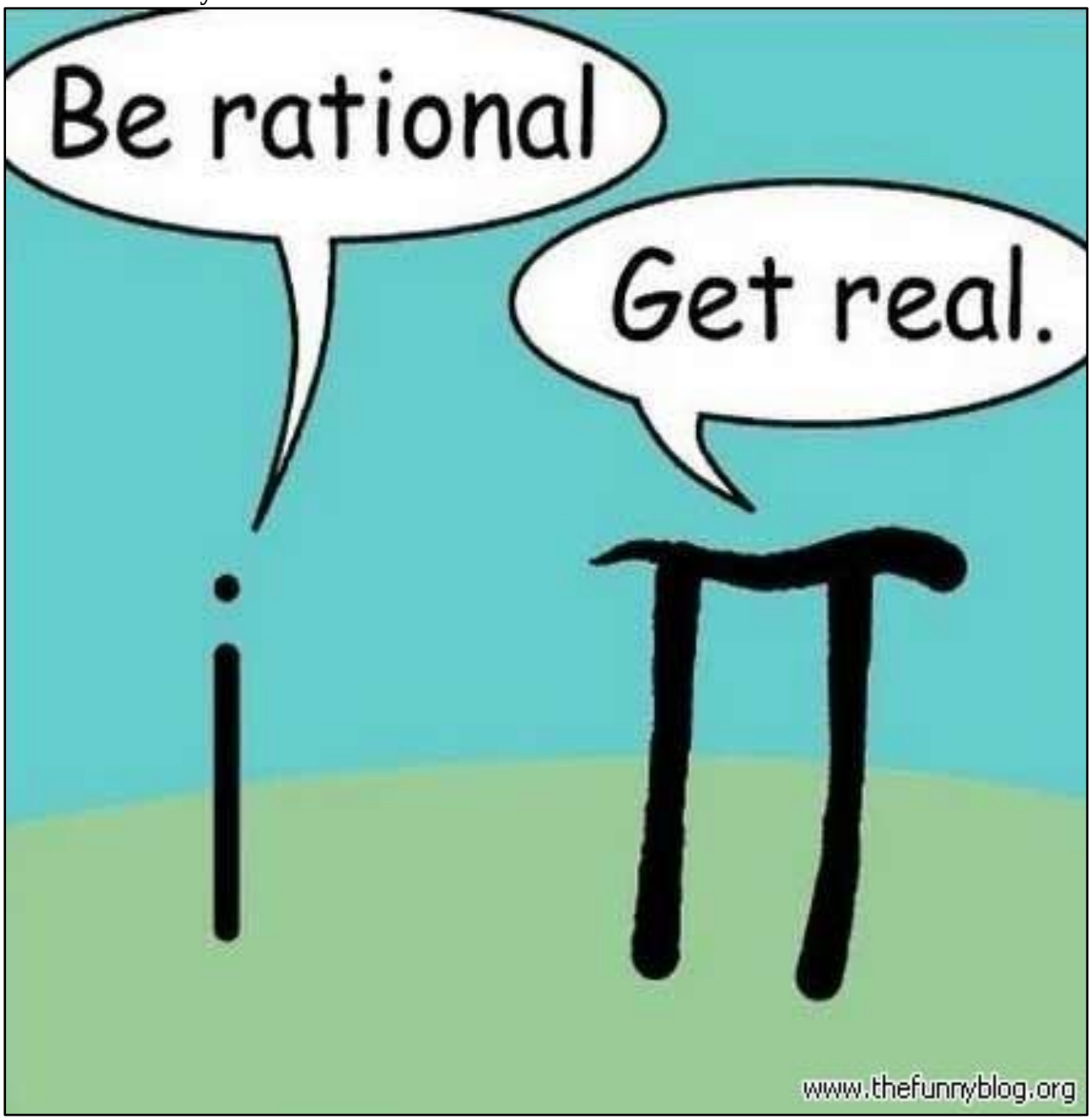
Appendix D

Focus Group Script

Thank you again for participating in my study. As I mentioned previously, the purpose of this study is to learn about your past and present perspectives and experiences with mathematics. In this space your voices, your comments and your perspectives are paramount. So, please share and comment on each other's narratives as much as you want. There is no right or wrong. There are only your truths, your experiences. I want to hear them and to honor them.
Now, you have signed the consent form indicating that I have permission to audio record our conversation. Are you still OK with me recording our conversation today?

Appendix E

Recruitment Flyer



Are you taking a developmental or remedial math course this semester?
If yes, you're eligible to participate in three one-on-one 20 to 30 minutes interviews and an optional focus group to learn about your past and present views, perspectives and experiences with mathematics. You will be compensated
for your time with $10 for the first interview, $20 for the second interview, $30 for the third interview and $40 for the focus group.
To participate, please contact Dora Trujillo at dtrujillo@lagcc.cuny.edu

YOU MUST BE AT LEAST 18 YEARS OLD TO PARTICIPATE.

Appendix F

Consent Form

THE CITY UNIVERSITY OF NEW YORK
LaGuardia Community College
Mathematics, Engineering and Computer Science Department

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Title of Research Study: *The Persistence of Exclusion in Developmental Math in Community Colleges: The Search for Equity and Justice in Math Education*

Principal Investigator: Dora P. Trujillo, Ph.D. Candidate at CUNY Graduate Center
M.Phil. in Urban Education at CUNY Graduate Center
M.A. in Applied Mathematics, Queens College
B.A. in Pure Mathematics, City College of New York
Adjunct Lecturer at LaGuardia Community College

Faculty Advisor: Anna Stetsenko, Ph.D. in General and Developmental Psychology
Professor in the Ph.D. Programs in Human Development and in Urban Education at the CUNY Graduate Center

You are being asked to participate in a research study because you have taken or are taking a developmental math course.

Purpose:

The purpose of this research study is to ascertain how cultural, educational, social, political and economic structures shape the math identities of students placed in developmental math courses and how students placed in developmental math perceive the relevance of these courses to their present and future lives. Your participation in this study may improve the design of curricula and procedures enacted in developmental math classes.

Key Information:

Taking part in this study is entirely voluntary. I encourage you to discuss this study with your family and friends and take your time to make your decision. If you have questions, you can contact me at dtrujillo@gradcenter.cuny.edu. If you decide to participate, you must sign this form, indicating that you want to take part.

If you agree to take part in this study, you are agreeing to your involvement and commitment. You will have three one-on-one interviews and one optional focus group via Zoom. Each interview will last from 20 to 30 minutes. These interviews will be conducted during the months of December, 2020 and January, 2021.

There is potential risk to loss of confidentiality as well as potential risk of feeling discomfort while answering the questions, but there are procedures in place to minimize these risks.

There is no actual direct benefit to participating in this study but there is hopefully a larger benefit to students in the future. Your participation in this study may bring real change in developmental math classes.

Procedures:

If you volunteer to participate in this research study, I will ask you to do the following:

1. Sign this document and return it to me. I will send it to you via DocuSign and you will send it back using this app at no cost to you. You will receive an email notification to click a link to open the agreement on any internet-enabled device (like a mobile phone, tablet, or computer). Tabs and simple instructions will guide you through the signing process, including adopting an electronic signature. On our first interview call, we will go over this document and you will still have the opportunity to withdraw from this study.
2. Once I receive your signed consent to participate, we'll agree on a time and date to do the first one-on-one interview via Zoom. This will consist of open-ended questions about your math experiences. It will last 20 to 30 minutes.
3. We'll agree on a time and date for the next one-on-one interview. It will also last from 20 to 30 minutes. This second interview will involve open-ended questions about your attitudes, feelings and beliefs about math and how these attitudes shape their career path choices.
4. At the third one-on-one interview, we will discuss my interpretation of your answers from the first two interviews.
5. The last meeting will be a focus group in which all participants will have the option to engage or not in a group discussion of the questions asked in the first two one-on-one interviews.

Audio Recording:

To ensure the accuracy of my findings, all interviews and the focus group meeting will be audio recorded for later transcription and review by me. You cannot participate in this study unless you consent to audio recording. These interviews will be stored in my MacBook Air laptop and will be encrypted and password protected. I will be the only one with knowledge of this password.

Time Commitment:

Your participation in this research study is expected to be only for the months of December, 2020 and January, 2021 with three one-on-one interviews and focus group each lasting 20 to 30 minutes.

Potential Risks or Discomforts:

Research procedures described above may involve risks that cannot be anticipated at this time. If we learn of anything that may affect your decision to participate, I will inform you as soon as possible. You will then have a chance to reconsider your continued participation in the research. You may not receive any direct benefit from your participation in this research study. However, the possible benefit you may experience from this study is that your voice in these courses will be heard by those who design the syllabus and procedures enacted for these courses such as academicians, college presidents, math department chairpersons, course coordinators, and math instructors.

Payment for Participation:
Each participant will receive a payment of $10 for the first interview, $20 for the second interview, $30 for the third interview and for $40 the focus group meeting. The total amount is $100.00 if you participate in all sessions. These payments will be sent through Cash App immediately after each session.

New Information:
You will be notified about any new information regarding this study that may affect your willingness to participate in a timely manner.

Confidentiality:
I will make my best efforts to maintain confidentiality of any information collected during this research study which may identify you. This information will only be disclosed with your permission or as required by law.

We will protect your confidentiality by using pseudonyms instead of your name when discussing your comments or views. Publications and/or presentations that result from this study will not identify you by name.

Participants' Rights:

- Your participation in this research study is entirely **voluntary.** If you decide not to participate, there will be no penalty to you, and you will not lose any benefits to which you are otherwise entitled.

- Your participation or nonparticipation in this study will not affect your grades, your academic standing with CUNY or any other status in the College.

- You can decide to withdraw your consent and stop participating in this research at any time without any penalty.

Questions, Comments, or Concerns:
If you have any questions, comments, or concerns about the research, you can contact:
Dora Trujillo, Ph. D. Candidate at dtrujillo@gradcenter.cuny.edu and dtrujillo@lagcc.cuny.edu

If you have any questions about your rights as a research participant, or if you have any comments or concerns that you would like to discuss with someone other than me, please call the CUNY Research Compliance Administrator at 646-664-8918 or email HRPP@cuny.edu. Alternatively, you may write to:

CUNY Office of the Vice Chancellor for Research
Attn: Research Compliance Administrator
205 East 42nd Street
New York, NY 10017

Participant Signature for Audio Recording:
If you agree to audio recording, please indicate this below.

_____I agree to audio recording.

_____I do **NOT** agree to audio recording.

Signature of Participant:
If you agree to participate in this research study, please sign and date below. You will be given a copy of this consent form.

_____
Printed Name of Participant

_____ _____
Signature of Participant Date

Signature of Individual Obtaining Consent:

_____
Printed name of Individual Obtaining Consent

_____ _____
Signature of Individual Obtaining Consent Date

Appendix G

Oral and Internet Consent form Script

THE CITY UNIVERSITY OF NEW YORK
LaGuardia Community College
Mathematics, Engineering and Computer Science Department
Oral and Internet-Based Inform consent Script

Title of Research Study: *The Persistence of Exclusion in Developmental Math in Community Colleges: The Search for Equity and Justice in Math Education*

Principal Investigator: Dora P. Trujillo, Ph.D. Candidate at CUNY Graduate Center
M.Phil. in Urban Education at CUNY Graduate Center
M.A. in Applied Mathematics, Queens College
B.A. in Pure Mathematics, City College of New York
Adjunct Lecturer at LaGuardia Community College

Hello and thank you for your interest in participating in this study.

You are being asked to participate in this research study because you have taken or are taking a developmental math class. The purpose of this research study is to ascertain how cultural, educational, social, political and economic structures shape the math identities of students placed in developmental math courses and how students placed in developmental math perceive the relevance of these courses to their present and future lives. Your participation in this study may change the design of curricula and procedures enacted in developmental math classes.

If you agree to participate, I will ask you to take part in three one-on-one audio-recorded interviews and one optional focus group via Zoom. Each interview and the focus group will last from 20 to 30 minutes. These interviews will be conducted during the month of October, 2020.

There is potential risk to loss of confidentiality.

There is no actual direct benefit to participating in this study but there is hopefully a larger benefit to students in the future. Your participation in this study may bring real change in developmental math classes.

Data identifiers such signature, name and email will be stored in my MacBook Air. These identifiers will be encrypted and password protected. No one but me will know this password. In discussing and publishing my findings, pseudonyms instead of your actual names will be used.

Your participation in this research study is entirely **voluntary.** If you have questions, you can contact Dora Trujillo, Ph. D. Candidate at dtrujillo@gradcenter.cuny.edu and dtrujillo@lagcc.cuny.edu. If you have questions about your rights as a research participant or if you would like to talk to someone other than the researchers, you can contact CUNY Research Compliance Administrator at 646-664-8918 or HRPP@cuny.edu

References

Anderson, R. (2007). Being a mathematics learner: Four faces of identity. *The Mathematics Educator, 17*(1), 7-14. http://math.coe.uga.edu/tme/Issues/v17n1/v17n1_Anderson.pdf

Andersson, A., Valero, P., & Meany, T. (2015). "I am [not always] a maths hater": Shifting students' identity narratives in context. *Educational Studies in Mathematics*, *90*(2), 143-161.https://doi.org/10.1007/s10649-015-9617-z

Anzaldua, G. (2012). *Borderlands/La Frontera: The new mestiza*. (25th Anniversary ed.). Aunt Luke Books. (Original work published 1987)

Bahr, P. R. (2008). Does mathematics remediation work? A comparative analysis of academic attainment among community college students. *Research in Higher Education, 49*(5), 420-450. https://doi.org/10.1007/s11162-008-9089-4

Bahr, P. R. (2012). Deconstructing remediation in community colleges: Exploring associations between course-taking patterns, course outcomes, attrition from the remedial math and remedial writing sequences. *Research in Higher Education, 53*(6), 661-693. https://doi.org/10.1007/s11162-011-9243-2

Bailey, T. (2009). Challenge and opportunity: Rethinking the role and function of developmental education in community college. *New Directions for Community Colleges*, *2009*(145), 11-30. https://doi.org/10.1002/cc.352

Barton. A., & Tan, E. (2009). Funds of knowledge and discourses and hybrid space. *Journal of Research in Science Teaching, 46*(1), 50-73. https://doi.org/10.1002/tea.20269

Beach, K. (1995). Activity as a mediator of sociocultural change and individual development: The case of school-work transition in Nepal. *Mind, Culture and Activity, 2*(4), 285-302.

Beach, K. (1999). Consequential transitions: A sociocultural expedition beyond transfer in education. *Review of Research in Education, 24*, 101-139. https://doi.org/10.2307/1167268

Black, L., Williams, J., Hernandez-Martinez, P., Davis, P., Pampaka, M., & Wake, G. (2010). Developing a 'leading identity': The relationship between students' mathematical identities and their career and higher education aspirations. *Educational Studies in Mathematics, 73*(1), 55-72. https://doi.org/10.1007/s10649-009-9217-x

Boaler, J. (1999). *Experiencing school in mathematics: Teaching styles, sex and setting. British Journal of Educational Studies*, *47*(3), 289–. Basil Blackwell Ltd., etc.

Boaler, J. (2008). Promoting 'relational equity' and high mathematics achievement through an

innovative mixed ability approach. *British Educational Research Journal, 34*(2), 167-194. https://doi.org/10.1080/01411920701532145

Boaler, J. (2016). *Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages, and innovative teaching*. Jossey-Bass.

Burkhardt, F. (1970, December 5). *What's behind the name?* [Text of remarks by Dr. Frederick Burkhardt at naming ceremony for Fiorello LaGuardia Community College]. City University of New York. https://academicworks.cuny.edu/cgi/viewcontent.cgi?article=1001&context=lg_arch_events

Burton, L. (1999a). The practices of mathematicians: What do they tell us about coming to know mathematics? *Educational Studies in Mathematics, 37*(2), 121-143.

Burton, L. (1999b). Mathematicians and their epistemologies—and the learning of mathematics. *Mathematics Education I*, 87.

Burton, L. (2001). Research mathematicians as learners—and what mathematics education can learn from them. *British Educational Research Journal, 27*(5), 589-599. https://doi.org/10.1080/01411920120095762

Burton, L. (2002). Recognising commonalities and reconciling differences in mathematics education. *Educational Studies I Mathematics, 50*(2), 157-175.

Caraballo, L. (2011). Theorizing identities in a "just(ly)" contested terrain: Practice theories of identity amid critical-post structural debates on curriculum and achievement. *Journal of Curriculum and Pedagogy, 8*(2), 155-177. https://doi.org/10.1080/15505170.2011.624939

Caraballo, L. (2012). Identities-in-practice in a figured world of achievement: Toward curriculum and pedagogies of hope. *Journal of Curriculum Theorizing, 28*(2), 43-59. https://journal.jctonline.org/index.php/jct/article/view/364

Caraballo, L. (2017). Students' critical meta-awareness in a figured world of achievement: Toward a culturally sustaining stance in curriculum, pedagogy, and research. *Urban Education, 52*(5), 585-609. https://doi.org/10.1177/0042085915623344

City University of New York. (2012). *CUNY Master Plan 2012–2016*. https://www.cuny.edu/wp-content/uploads/sites/4/2014/12/masterplan.pdf

City University of New York. (2016). *CUNY Master Plan 2016–2020*.

Cobb, P., Gresalfi, M., & Hodge, L. L. (2009). An interpretive scheme for analyzing the identities that students develop in mathematics classrooms. *Journal for Research in Mathematics Education, 40*(1), 40-68. https://doi.org/10.5951/jresematheduc.40.1.0040

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods Approaches* (4th ed.). Sage.

D'Ambrosio, U. (1985). Ethnomathematics and its place in the history and pedagogy of mathematics. *For the Learning of Mathematics, 5*(1), 44-48. *https://www.jstor.org/stable/40247876*

Darragh, L. (2015). Recognising 'good at mathematics': Using a performative lens for identity. *Mathematics Education Research Journal, 27*(1), 83-102. https://doi.org/10.1007/s13394-0140120-0

Edelstein, Julius C. C. (1985, May 15-17). *Oral history interviews with former CUNY Chancellor Albert Bowker* [tapes 2-4]. *CUNY Digital History Archive*. http://cdha.cuny.edu/items/show/18.

Fabricant, M., & Brier, S. (2016). *Austerity blues: Fighting for the soul of public higher education.* Johns Hopkins University Press.

Faircloth, B. S. (2012). "Wearing a mask" vs. connecting identity with learning. *Contemporary Educational Psychology, 37*(3), 186-194. https://doi.org/10.1016/j.cedpsych.2011.12.003

Fong, K. E., Melguizo, T., & Prather, G. (2015). Increasing success rates in developmental math: The complementary role of individual and institutional characteristics. *Research in Higher Education, 56*(7), 719-749. https://doi.org/10.1007/s11162-015-9368-9

Freire, P. (2000). *Pedagogy of the oppressed.* (30th Anniversary ed.). Bloomsbury Academic. (Original work published 1970)

Friedheim, B., & Vasquez, A. A. (2014, July 23) *John Hyland oral history interview.* CUNY Digital History Archive. http://cdha.cuny.edu/items/show/51.

Gainor, K. A., & Lent, R. W. (1998). Social cognitive expectations and racial identity attitudes in predicting the math choice intentions of Black college students. *Journal of Counseling Psychology, 45*(4), 403-413. https://doi.org/10.1037/0022-0167.45.4.403

Gee, J. P. (1996). *Social linguistics and literacies: Ideologies in discourses.* Falmer Press.

Gee, J. P. (2000). Chapter 3: Identity as an analytic lens for research in education. *Review of Research in Education, 25*(1), 99-125. https://doi.org/10.3102%2F0091732X025001099

Goldway, T. (1997). *LaGuardia works: LaGuardia Community College, the first 25 Years. CUNY Digital History Archive.* http://cdha.cuny.edu/items/show/1201.

Gray, L. M., Wong-Wylie, G., Rempel, G. R., & Cook, K. (2020). Expanding qualitative

interviewing strategies: Zoom video communications. *The Qualitative Report, 25*(5), 1292-1301. https://doi.org/10.46743/2160-3715/2020.4212

Grootenboer, P., & Jorgensen, R. (2009). Towards a theory of identity and agency in coming to learn mathematics. *Eurasia Journal of Mathematics, Science & Technology Education, 5*(3),255-266. https://doi.org/10.12973/EJMSTE/75277

Guba, E. G., & Lincoln, Y. S. (1989). *Fourth generation evaluation.* Sage Publications.

Gunderson, C. (1999). *The struggle for CUNY: A history of the CUNY student movement,1969-1999*. https://eportfolios.macaulay.cuny.edu/hainline2014/files/2014/02/Gunderson_The-Struggle-for-CUNY.pdf

Gutiérrez, K. D., & Jurow, A.S. (2016). Social design experiments: Toward equity by design. *Journal of the Learning Sciences, 25*(4), 565-598. https://dx.doi.org/10.1080/10508406.2016.1204548

Gutiérrez, K. D., & Rogoff, B. (2003). Cultural ways of learning: Individual traits or repertoires of practice. *Educational Researcher, 32*(5), pp.19-25. https://doi.org/10.3102/0013189X032005019

Gutiérrez, R. (2013). The sociopolitical turn in mathematics education. *Journal for Research in Mathematics Education, 44*(1), 37-68. https://doi.org/10.5951/jresematheduc.44.1.0037

Gutiérrez, R. (2015). Nesting in Nepantla: The importance of maintaining tensions in our work. In N. M. Russell, C. Haynes, & F. Cobb (Eds.), *Interrogating Whiteness and relinquishing power: White faculty's commitment to racial consciousness in STEM classrooms* (pp. 253–282). Peter Lang. https://www.researchgate.net/profile/Rochelle-Gutierrez-2/publication/305000272_Nesting_in_Nepantla_The_importance_of_maintaining_tensions_in_our_work/links/577e989608ae5f367d33d6a1/Nesting-in-Nepantla-The-importance-of-maintaining-tensions-in-our-work.pdf

Gutiérrez, R. (2016). Strategies for creative insubordination in mathematics teaching. *Teaching for Excellence and Equity in Mathematics, 7*(1), 52-60. https://www.todos-math.org/assets/documents/TEEM/teem7_final1.pdf#page=52

Hand, V., & Gresalfi, M. (2015). The Joint accomplishment of identity. *Educational Psychologist, 50*(3), 190-203. http://dx.doi.org/10.1080/00461520.2015.1075401

Hernandez-Martinez, Black, L., Williams, J., Davis, P., Pampaka, M., & Wake, G. (2011). Students' views on their transition from school to college mathematics: rethinking 'transition' as an issue of identity. *Research* in *Mathematics Education, 13*(2), 119-130. http://dx.doi.org/10.1080/14794802.2011.585824

Holland, D., & Lachicotte, W., Jr. (2007). Vygotsky, Mead, and the new sociocultural studies of identity. In H. Daniels, M. Cole, & J.V. Wertsch (Eds.), *The Cambridge companion to Vygotsky* (pp. 101-135). Cambridge University Press. http://dx.doi.org/10.1017/CCOL0521831040.005

Holland, D., Lachicotte, W., Jr., Skinner, D., & Cain, C. (1998). *Identity and agency in cultural worlds.* Harvard University Press.

Holland, D., & Lave, J. (2019). Social practice theory and the historical production of persons. In A. Edwards, M. Fleer, & L. Bøttcher (Eds.), *Perspectives in cultural-historical research: Vol. 6. Cultural-Historical approaches to studying learning and development* (pp. 235–248). Springer. https://doi.org/10.1007/978-981-13-6826-4_15 (Reprinted from "Social practice theory and the historical production of persons," 2009, *Actio: an International Journal of Human Activity Theory*, *2*, 1–15, https://kansai-u.repo.nii.ac.jp/?action=pages_view_main&active_action=repository_view_main_item_detail&item_id=783&item_no=1&page_id=13&block_id=21)

hooks, b. (1994). *Teaching to transgress: Education as the practice of freedom.* Routledge.

Kaspersen, E., Pepin, B., & Sikko, S. A. (2017). Measuring STEM students' mathematical identities. *Educational Studies in Mathematics, 95*(2), 163–179. https://doi.org/10.1007/s10649-016-9742-3

Kitzinger, J. (1995). Qualitative research: Introducing focus groups. *BMJ, 311,* 299-302. https://doi.org/10.1136/bmj.311.7000.299

Knight, M. G., & Marciano, J. E. (2013). *College ready: Preparing Black and Latina/o youth for higher education—A culturally relevant approach.* Teachers College Press.

LaGuardia Community College. (1971). *Course catalog: 1971–1972*.

LaGuardia Community College. (1972). *Course catalog: 1972–1973*.

LaGuardia Community College. (1974). *Middle States self-study*.

LaGuardia Community College Division of Continuing Education. (1980). *LaGuardia Community College—An assessment of the needs of the Western Queens community, 1980*. LaGuardia Community College. https://cdha.cuny.edu/items/1781

Langer-Osuna, J. M., & Nasir, N. S. (2016). Rehumanizing the "other": Race, culture, and identity in education research. *Review of Research in Education, 40*(1), 723–743. https://doi.org/10.3102/0091732X16676468

Larnell, G. V. (2016). More than just skill: Examining mathematics identities, racialized narratives, and remediation among black undergraduates. *Journal for Research in Mathematics Education, 47*(3), 233-269.

https://doi.org/10.5951/jresematheduc.47.3.0233

Lave, J. (1996). Teaching, as learning, in practice. *Mind, Culture, and Activity*, *3*(3), 149–164. https://doi.org/10.1207/s15327884mca0303_2

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge University Press.

Leonard, J., Brooks, W., Barnes-Johnson, J., & Berry, R. Q., III (2010). The nuances and complexities of teaching mathematics for cultural relevance and social justice. *Journal Teacher Education*, *61*(3), 261–270. https://doi.org/10.1177/0022487109359927

Leont'ev. (1981). *Problems of the development of mind. Progress.*

Lim, J. H. (2008). The road not taken: Two African-American girls' experiences with school mathematics. *Race Ethnicity and Education. 11*(3), 303-317. https://doi.org/10.1080/13613320802291181

Martin, D. B. (2012). Learning mathematics while Black. *Educational Foundations, 26*(1/2), 47-66. https://eric.ed.gov/?id=EJ968817

McDermott, I. (2020). Open to what? A critical evaluation of OER efficacy studies. *In the Library with the Lead Pipe*, February. http://www.inthelibrarywiththeleadpipe.org/2020/open-to-what/

Medina, D. (2013, August 16) *Before Open Admissions there was a lot of the haves and the have-nots –An oral history interview with Donal Farley on open admissions*. *CUNY Digital History Archive.* http://cdha.cuny.edu/items/show/5012

Melguizo, T., Kosiewicz, H., Prather, G., & Boss, J. (2014). How are community college students assessed and placed in developmental math? Grounding our understanding in reality. *The Journal of Higher Education, 85*(5), 691-722.

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation.* (4th ed.). Jossey-Bass.

Moll, L.C., Amanti, C., Neff, D., & Gonzalez, N. (1992). Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms. *Theory into Practice, 31*(2), 132-141. https://doi.org/10.1080/00405849209543534

Nasir, N. S., & Cooks, J. (2009). Becoming a hurdler: How learning settings afford identities. *Anthropology & Education Quarterly, 40*(1), 41-61. https://doi.org/10.1111/j.1548-1492.2009.01027.x

Nasir, N. S., & de Royston, M. M. (2013). Power, identity, and mathematical practices

outside and inside school. *Journal for Research in Mathematics Education, 44*(1), 264-287. https://doi.org/10.5951/jresematheduc.44.1.0264

Nasir, N. S., & Hand, V. M. (2006). Exploring sociocultural perspectives on race, culture, and learning. *Review of Educational Research, 76*(4), 449-475. https://doi.org/10.3102/00346543076004449

Nasir, N. S., Rosebery, A. S., Warren, B., & Lee, C. D. (2005). Learning as a cultural process: Achieving equity through diversity. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 489–504). Cambridge University Press. https://doi.org/10.1017/CBO9780511816833.030

Nosek, B., Banaji, M. R., & Greenwald A. G. (2002). Math = male, me = female, therefore math ≠ me. *Journal of Personality and Social Psychology, 83*(1), 44-59. https://doi.org/10.1037/0022-3514.83.1.44

Olitsky, S. (2006). Structure, agency and the development of students' identities as learners. *Cultural Studies of Science Education, 1*(4), 745-766. https://doi.org/10.1007/s11422-006-9033-x

Olsen, L. (1996). *From nation to race: The Americanization of immigrants in a high school of the 1990s.* (Original work published 1995)

Onwuegbuzie, A. J., Dickinson, W. B., Leech, N. L., & Zoran, A. G. (2009). A qualitative framework for collecting and analyzing data in focus group research. *International Journal of Qualitative Methods*, *8*(3), 1–21. https://doi.org/10.1177/160940690900800301

Roesken, B., Hannula, M. S., & Pehkonen, E. (2011). Dimensions of students' views of themselves as learners of mathematics. *ZDM*, *43*(4), 497–506. https://doi.org/10.1007/s11858-011-0315-8

Sfard, A., & Prusak, A. (2005). Telling identities: In search of an analytic tool for investigating learning as a culturally shaped activity. *Educational Researcher*, *34*(4), 14–22. https://doi.org/10.3102/0013189X034004014

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, *22*(2), 63–75. https://doi.org/10.3233/EFI-2004-22201

Solomon, Y. (2007). Not belonging? What makes a functional learner identity in undergraduate mathematics? *Studies in Higher Education, 32*(1), 79–96. https://doi.org/10.1080/03075070601099-473

Spring, J. (2015). *Economization of education: Human capital, global corporations, skills-based schooling.* Routledge.

Stetsenko, A. (2017). *The transformative mind: Expanding Vygotsky's approach to development and education.* Cambridge University Press. https://doi.org/10.1017/9780511843044

Stetsenko, A., & Arievitch, I. M. (2004). The self in cultural-historical activity theory: Reclaiming the unity of social and individual dimensions of human development. *Theory and Psychology, 14*(4), 475-503. https://doi.org/10.1177/0959354304044921

Syed, M., Azmitia, M., & Cooper, C. R. (2011). Identity and academic success among underrepresented ethnic minorities: An interdisciplinary review and integration. *Journal of Social Issues, 67*(3), 442–468. https://doi.org/10.1111/j.1540-4560.2011.01709.x

Tillman, L. C. (2002). Culturally sensitive research approaches: An African-American perspective. *Educational Researcher, 31*(9), 3-12. https://doi.org/10.3102/0013189X031009003

Trueba, H. T. (2002). Multiple ethnic, racial, and cultural identities in action: From marginality to a new cultural capital in modern society. *Journal of Latinos and Education, 1*(1), 7–28. https://doi.org/10.1207/S1532771XJLE0101_2

Urrieta, L. (2007). Identity production in figured worlds: How some Mexican Americans become Chicana/o activist educators. *The Urban Review, 39*(2), 117–144.

Valero, P. (2004). Socio-political perspectives on mathematics education. In P. Valero & R. Zevenbergen (Eds.), *Researching the socio-political dimensions of mathematics education: Issues of power in theory and methodology* (pp. 5–23). Springer. https://doi.org/10.1007/1-4020-7914-1_2

Vasquez, A. A., & Brier, S. (2015, January 22). *Oral history interview with Joan Greenbaum, Fern Khan, and Sandy Watson of LaGuardia Community College*. CUNY Digital History Archive. https://cdha.cuny.edu/items/show/2331

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press. https://doi.org/10.2307/j.ctvjf9vz4

Wagner, D., & Herbel-Eisenmann, B. (2009). Re-mythologizing mathematics through attention to classroom positioning. *Educational Studies in Mathematics, 72*(1), 1–15. https://doi.org/10.1007/s10649-008-9178-5

Walker, E. N. (2012). Cultivating mathematics identities in and out of school and in between. *Journal of Urban Mathematics Education, 5*(1), 66–83. https://doi.org/10.21423/jume-v5i1a173

Walker, J. (2017). Shame and transformation in the theory and practice of adult learning and education. *Journal of Transformative Education, 15*(4), 357–374. https://doi.org/10.1177/1541344617699591

Wenger, E. (1998). *Communities of practice: Learning, meaning and identity*. Cambridge University Press. https://doi.org/10.1017/CBO9780511803932

White, J. W., & Lowenthal, P. R. (2011). Minority college students and tacit "codes of power": Developing academic discourses and identities. *The Review of Higher Education*, *34*(2), 283–318. https://doi.org/10.1353/rhe.2010.0028

Williamson, B. (2020). Making markets through digital platforms: Pearson, edu-business, and the (e)valuation of higher education. *Critical Studies in Education*, *62*(1), 50–66. https://doi.org/10.1080/17508487.2020.1737556

Yamagata-Lynch, L. C. (2010). Understanding cultural historical activity theory. In *Activity systems analysis methods: Understanding complex learning environments* (pp. 13–26). Springer. https://doi.org/10.1007/978-1-4419-6321-5_2