BASIC MATHEMATICS EDUCATION AND GRADUATION FROM COMMUNITY COLLEGE: AN INTERPRETATIVE STUDY

by

ERIC FUCHS

A dissertation submitted to the Graduate Faculty in Urban Education in partial fulfillment of the requirements for the degree of Doctor in Philosophy,
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Abstract

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This research examines the relationship between basic mathematics courses and educational attainment at a City University of New York (CUNY) community college in the Bronx, where graduation rates hover at 25% or less even after students have attended classes for seven or eight years. Three-quarters of students leave college within the first three years after their original enrollment. This research examines the extent to which failure in mathematics basic courses is associated with the high dropout rate, low graduation rate, and length of time-to-degree.

The students in this study are primarily low-income Hispanics or Blacks. This research documents that the failure in basic mathematics contributes significantly to failure to graduate from a CUNY community college and offers a critique of the system that maintains this state of affairs. It also presents concrete steps for changing this situation. This research is an interpretive study that employs mainly qualitative data and descriptive analyses, though quantitative data are also used as part of the overall analysis. The fields of investigation included my practice in a basic arithmetic course at Highland

(a pseudonym) Community College, other basic mathematics courses at the college, and mathematics achievement data from several CUNY community colleges.

The theoretical framework encompasses sociocultural theory, the sociology of emotions, and educational psychology. The data resources included college and CUNY retention and graduation rates, autoethnography, students' autobiographies, questionnaires, and interviews with students and faculty. The research also examines community college structures, including policies, mathematics curriculum and mathematics pedagogy, and sociocultural and socioaffective factors that potentially mediate the graduation rate.

The study finds that quality teaching and implementing innovative structural changes in community colleges will increase the retention rate, improve the graduation rate, and shorten the time-to-degree without diluting the quality of academic content.

Dedication

To my father, whose words and wisdom continue to guide me, even in his absence.

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And to those who deserved to be acknowledged but were left out through my omissions, my apologies and a sincere thank you.

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Chapter 1

Community Colleges: Their Role in Higher Education

> If you want to get a lens on the future of our country...you have to understand what's happening at our community colleges, the largest and fastest-growing segment of higher education...A new report indicates that jobs for those with associate degrees are expected to grow twice as fast as the national average.
>
> But it's not enough to talk about access to college; it is attainment of a college degree that will most help students – and our country.
>
> (Matthew Goldstein, CUNY Chancellor, 2010)

Prologue

On March 31, 2010, we learned of the death of Jaime Escalante, the mathematics (hereafter referred to as math) teacher from Garfield High in Los Angeles who was immortalized in the movie *Stand and Deliver* and was the subject of a book by the *Washington Post* columnist James Matthews (Matthews, 1982). Every major newspaper carried an obituary praising Escalante's achievements and deep devotion to his students. As President Obama stated,

> Throughout his career Jaime opened the doors of success and higher education for his students one by one, and proved that where a person came from did not have to determine how far they could go. (White House, 2010)

Edward Jay Olmos, the actor who played Escalante in *Stand and Deliver,* told the Associated Press,

> Jaime exposed one of the most dangerous myths of our time — that inner city students can't be expected to perform at the highest levels. Because of him, that destructive idea has been shattered forever. (MSNBC, 2010)

From Garfield High to Highland

In many ways the students at Highland Community College (a pseudonym), where I have been teaching math for the last nine years, are like the Garfield High students portrayed in *Stand and Deliver*. Most are Hispanic/Latino from low-income households and families who do not have much experience with higher education. Many are new immigrants and not yet proficient in English. Many lack the study habits that can help them achieve their goals. Most cannot afford to buy textbooks, and many are more comfortable in Spanish than in English. Like the students at Garfield, my students are academically underprepared.

As Christopher Emdin asserts in his dissertation,

> These factors cannot be solely responsible for urban students' poor achievement...more often than not they support a counter-argument or alternate reason for poor achievement, which typically involves blaming the urban poor for their academic struggles. This stance carries an ideology that presents urban youth as disinterested in education and unwilling to learn. (Emdin, 2007)

While I do not dare to compare myself to Escalante, I see in him my own struggles and frustrations. Like Escalante, I have always been the odd man out, whether in Romania (coming from "an unhealthy social origin"), in Israel (wearing a tie in a country where ties were scorned even at weddings), in Montreal (where my French accent marked me as a European), or in the Bronx (where I was seen as an ex-Wall Streeter). Being "the other" has equipped me with sociocultural lenses to spot inconsistencies, idiosyncrasies, and absurdities, the very things many natives are often blind to. It is this perspective that informs my stance as a math educational researcher.

Stand and Deliver tells the story of Escalante's spectacular success guiding his students from fractions and percentages to Advanced Placement (AP) Calculus in one

year. If that journey sounds implausible, that's because it was. What the movie does not show the viewers is that it took Escalante five years before he taught calculus at Garfield High. The students shown in the movie were not the same students who passed AP Calculus. The movie never exposes Escalante's initial frustration with his students' lack of preparation in math; we never see him calling his old boss at Burroughs Corporation to see if he could get his job back. Eventually, Escalante rose to the challenge, and it was through drive, commitment, caring—and the support of Garfield's principal, Henry Gradillas—that Escalante was able to develop his math program.

The movie does hint at the obstacles Escalante overcame as an immigrant. He arrived in Los Angeles at age 32 without knowledge of English and worked as a busboy and cook while earning his associate's degree at Pasadena City College. Studying at a two-year community college did not prevent Escalante from transferring to California State University in Los Angeles where he earned his teaching credentials. Escalante did understand the role of schooling in the transmission of culture. In interpreting French sociologist Pierre Bourdieu's work, David Swartz maintains, "the educational system—more than the family, church, or business firm—has become the institution most responsible for the transmission of social inequality" (Swartz, 1997, p.190). Frustrated and weary from seeing his efforts constantly thwarted and undermined by the school administration and teachers' union, he left Garfield for another school and eventually returned to Bolivia.

Escalante achieved indeed some extraordinary success with urban students, whom he took from fractions to AP Calculus, not in one year, as portrayed in the movie, but in five years, as it was in reality. Escalante's methods and success, however, were not replicated

elsewhere, not even in his own school. But we must try to learn the right lessons from the movie and to correct the false impression that with tremendous devotion and sustained effort, spectacular academic success can occur virtually overnight.

Lessons from Escalante

If there is one lesson to learn from Escalante, it is that quality teaching and student achievement go hand in hand. This tenet constitutes a central postulate of this dissertation. Escalante shattered the myth that urban students are unable to achieve success in math and he seriously undermined the deficit perspective, all too prevalent in the educational establishment.

In his school, Escalante was the odd man out: He constantly had to fight against a hegemonic structure while advocating for his students and math programs. Escalante's department chair was a champion of the status quo: "You can't teach logarithms to illiterate kids who come to this school with a 7th grade education." The chair masked her deficit perspective through what appeared to be a concern for the students' well being: "I'm thinking of those kids. If they try and don't succeed, you will shatter what little self-confidence they have." Her quixotic solution for raising Garfield's rating was, "If you want high test scores, start by changing the economic level of the community." Although Principal Gradillas supported Escalante's ideas, he, too, believed that "these rooms are for remedial classes"; yet, despite the atmosphere of negativity and the culture of low expectations at Garfield High, Escalante never stopped believing that his students would raise to his level of expectation, as they surely did when they received 4s (well qualified to receive college credit) and 5s (extremely well qualified to receive college credit) on their AP Calculus exams.

Points of View

As discussed in Chapter 3 below, I learned at age 16 what it means to be uprooted in the middle of high school, be stripped of all material possessions, and be thrown into a totally new culture, which in my case was filled with amusing ironies. After leaving Romania, where I was called a "bourgeois Jew," I arrived in Nazareth, Israel, where I was called a "capitalist" by the *sabras* (native Israelis) and a "*Roumanische gonif* (Yiddish for Romanian thief) by the Polish immigrants whose familiarity with Romania was limited to "gypsies and Dracula."

It was only after the new Jewish immigrants arrived from Muslim countries, speaking Arabic and parading around the neighborhood on Sabbath mornings, their patriarchs clad in their finest silk *dushdasha* (pajama-like outfit), that my former Polish enemies ran to embrace me, shouting, "Comrade, we'd better stick together." Years later when teaching math at Highland, I reflected on what it was like being a new immigrant in Israel, surrounded by so many "aliens" with "bizarre" customs and a babble of tongues. There were African Jews in kaftans and Hassidic Jews in black wool suits and fur hats in the heat of August. There were pork-eating atheists who spent Yom Kippur, the holiest day of the year, on the beach while their more observant brethren spent the day fasting and in prayer. What was viewed as totally absurd by people who grew up in the dominant culture was perfectly natural for people who had grown up only 561 miles away (the distance from Bagdad to Haifa)—only two-thirds of the distance from Atlanta to New York and a fraction of the distance from Bucharest to the Bronx, or from Perth, Australia, to City High in Philadelphia. The distance in miles was the sociocultural equivalent of light years.

It was only recently that I understood why the Iraqi Jews wore their *dushdasha* on Saturday afternoons. They were a product of their parents' and grandparents' culture, which had taken on the similarities of the surrounding Arab culture in which they lived. Dressed as they were, the Iraqi Jews were adhering strictly to the fourth commandment:

> Remember the sabbath day and keep it holy. Six days you shall labor and do all your work, but the seventh day is a sabbath of the Lord your God: you shall not do any work—you, your son or daughter…
>
> (Exodus, 20: 8)

I imagine that in the eyes of a British soldier newly dispatched to Palestine in 1945, there were only two groups of locals: Arabs and Jews. Years later at Highland, I was guilty of the same stereotypical thinking during my first semester, when I viewed my Spanish-speaking students, about 60% of the student population, as one undifferentiated mass characterized by strong family traditions; a common religion; and a melodious, phonetic language. Eventually, I saw my students as they see themselves, by their or their parents' country of origin: Mexicans, with their fine diction and rich cultural heritage—claiming that parts of Texas and California belong *de jure* to Mexico—or Puerto Ricans, transnationals with one foot on the mainland and the other on the island who, separated by a short ferry ride from Anasco to Punta Cana, see themselves and their cuisine as distinctly different from that of the Dominicans. And then there are the Colombians and Hondurans, proud descendants of the Maya civilization. The majority, however, are the Dominicans of Washington Heights in Upper Manhattan, whose cultural practices and historical legacy are seen and felt throughout the entire region.

It is the same story with the Black students, who make up the other 40% of Highland's population. Initially, I did not know what terminology to use when referring

to these students. There are Americans of several generations who consider themselves true African-Americans. There are students from Benin, Senegal, and Cameroon with whom I speak French. The Caribbean-born see themselves by the city and island of origin: if born in Kingston, they see themselves as Jamaicans. If born in Port-au-Prince they see themselves as Haitians. If born in San Juan or Port-of-Prince, they see themselves as Trinidadians. Their speech inflections are as varied as their places of birth. I'm sure they find my accented speech unusual, too. To relate better to my Spanish-speaking students, I recently taught myself Spanish, finding the language extremely useful not only when speaking to my students in the hallways and cafeteria but also in the classroom when I am attempting to bridge the cultural gap. My students find my Romanian-Mexican accent not only surprising but also quite amusing! With all the differences among my students, there is one common denominator: They all want to graduate with an associate's degree and all are in my class struggling to learn fractions.

In explaining Pierre Bourdieu's work in *Reproduction*, David Swartz notes that the education system performs three central functions: an "internal" function of conserving the cultural heritage, an "external" function of reproducing social-class relations, and a third function of "legitimation" (Swartz, 1997). When I grew up in Romania, contradictions between home and school culture or values were always resolved in the school's favor.

After being denied entrance to the coveted Young Pioneers Movement (Communist Boy Scouts) in second grade and unable to get my red tie because I did not come from a family of peasants or menial workers, I lashed out angrily and accused my father of being an "exploiter of the masses." I even packed my belongings and moved in with Aunt

Sophie and Uncle Joseph, who as factory workers had a much "healthier" social origin than my capitalist parents. My hope was that my new residence would qualify me to receive the coveted Pioneer red tie without delay. Alas, weary of a steady diet of polenta and tea— my aunt and uncle claimed that is all they could afford on their meager workers' salary—I sold my socialist principles for the Wiener schnitzel and Hungarian pastries I missed, lovingly prepared at home by Mrs. Huluban, our Transylvanian cook, and begged my father to take me back. I did not know at the time that my father, uncle, and aunt were in cahoots teaching me a lesson, not to be so eager to adopt the hegemonic ideology of my school system.

Culture, Learning and Teaching

The pedagogical approaches described in this research are grounded in sociocultural theory, which emphasizes the influence of peers, adults, and culture on developing students. According to Lev Semyonovich Vygotsky, social interaction leads to changes in human thought and behavior and varies from culture to culture. Throughout this research I have stressed the centrality of *quality* teaching, especially for basic math students in community colleges. Teaching is not just a skill learned in a college teacher-preparation program but a complex sociocultural activity that partly works outside the realm of consciousness (Vygotsky, 1978).

This notion is best illustrated by a story related by Albert Shanker, past president of the United Federation of Teachers and of the American Federation of Teachers, and his wife, who were in Israel and asked to visit a housing project occupied by recent Jewish immigrants from Yemen. Shanker wanted to see how the family members had habituated themselves to their receiving culture. Accustomed to living in tents, Yemenis were used

to eating their meals while sitting on the ground. To help the new immigrants become acclimated to their new country and culture, the Jewish Agency for Israel (*sochnut*) provided them with apartments and furnishings in an effort to persuade them to eat from tables. When the guide escorting the Shanker couple knocked on the door of a family, they were warmly greeted and invited into the home where, to their surprise, they saw the family members eating from the table turned upside down with the legs up (Shanker, 1996).

The story above illustrates how easily reform efforts can backfire or be misinterpreted. Like the Yemeni family who resisted eating from a table, teachers can resist attempts to change aspects of their teaching. A study commissioned by the National Advisory Committee on Mathematical Educational concluded that in elementary schools

> Teachers are essentially teaching the same way they were taught in school. Almost none of the concepts, methods, or big ideas of modern mathematics have appeared in this median classroom.
> (Conference Board of the Mathematical Sciences, 1975, p. 77)

Although that study was made in 1975, little progress appears to have made over the years. That is because the shared cultural beliefs that underlie teaching are firmly rooted in the teachers' pedagogy. The following reflections produced by two student teachers, Violante Rucci and Ambika Kumar (pseudonyms), in the fall of 2009 confirm this viewpoint:

October 15, 2009
Violante Rucci
Fractions Interview
When I reflect back to my days of learning fractions in elementary school, I feel I was mostly following rote instruction. I was always busy finding out common denominators and LCMs for any fractions I saw. It was not only impractical but also time consuming and sometimes it needed long and never-ending multiplications, divisions and other calculations. This is the way I learned in my elementary school and in middle as well as

> high school. With little or no surprise, I continued working the same way with fractions even when I came to college. But the most surprising part was that I never realized I have been doing a tough task with fractions all my life…I always converted the mixed numbers into improper fractions and then followed the same rule of finding a common denominator to move forward with the fraction solution.

Ambika wonders why solving problems with the same mnemonic gives two different results:

> I think in US we are taught in a different way to find a common denominator. Here, we simply multiply both the numerator as well as the denominator by the same number to match the other denominator. One major difference I find with problem solving methods with parenthesis is the sequencing of PEMDAS [Parentheses-Exponents-Multiplication-Division-Addition- Subtraction] and BODMAS [Brackets-Order-Division-Multiplication-Addition-Subtraction]. As a student, I learned the sequence of BODMAS in which division comes before multiplication. But in PEMDAS which every student here is taught, multiplication comes before division. I have always wondered why it is that there are different sequences of a problem when each sequencing could also end up giving us different answers.

Like learning, teaching is a form of cultural enactment (Sewell, 1999). Learning to teach is regarded as cultural production, which involves reproducing and transforming existing forms of culture (Tobin & Roth, 2006). My stance is that teaching is partly innate, partly learned, and largely influenced by previous teachers and the surrounding culture—thoughts, beliefs, values, and actions. Exemplary teachers often distinguish themselves by deviating from standard practices and generating new practices, as Jaime Escalante did at Garfield High School.

Student Voices

Using math autobiographies as a teaching and assessment tool in community colleges is not widespread. It is easy to see why. College instructors probably feel constrained by the amount of material they have to cover, so why would they add to their workload by

imposing an assignment whose value may be perceived as questionable at best?

I have learned much about my students through their polysemic and polyphonic artifacts, consisting of math autobiographies, self-reflections, and narratives writings, segments of which are reproduced in this study. The only modifications I have made are in point-size and line spacing (in order not to have one student's voice dominate another's). The artifacts encompass a wide spectrum of topics relating to the students' culture, family, education in general, and math education in particular. All the students were 18 years or older when the course began and all signed the approved IRB consent form. At the start of the course, I explained to the students that any written material they produced might be used in my research but that their identities would be concealed. Unless indicated otherwise in this study, I have used pseudonyms for the names of the community colleges in the Bronx and for the names of my students.

Here is Ana Gomez, a Bronx-born Hispanic student, whose career goal is to become a nurse. Ana likes math. In small group work and in the lab she was extremely helpful to other students.

Ana Gomez, Math01A

09-17-2009

MATH AUTOBIOGRAPHY

Hello professor! My name is Ana Gomez I'm 19 years old of age and my major is nursing. My favorite subject is math and never had any difficulties in the subject. I have no children my main focus is to accomplish my goal to become a registered nurse. I went to two different high school which where Harry s Truman, and Emily and Carey private school. I did part time at Beth Israel nursing school and im very familiar with faculties in the school. Nursing school is too expensive that's why I decided to attend a community college. I thought I was pretty good at math because it seemed to come pretty natural for me and I always got good grades on tests.

I live in the Bronx mostly all my life so im very familiar with the neighborhood around the campus. IF I could summarize the one thing I've heard people say

about choosing a career, it is to do something that you love. I know that I enjoy taking care of people and helping others, which is why I've decided to become a nurse. I believe the combination of my personal and professional experiences make me an excellent candidate for a student in the nursing program. I love math....I enjoy working on math. I tutor math to my brother and I really enjoy seeing someone who finds math difficult succeed in math....it is very rewarding to know you have helped someone understand math.

Charlotte Mallette, born in Guyana, arrived in the Bronx seven years ago. Motivated by a strong love for children, Charlotte aims to become a pediatric nurse:

AUTOBIOGRAPHY
CHARLOTTE MALLETTE

MATH 01A-Sept 16, 2009

Hi Prof.

My name is Charlotte Mallette. I am 19 years old. I was born is Guyana. I came to New York at the age of 12 years old. I have six brothers and three sisters. In my home i have to do most of the house work because I am the oldest child that is living in my parents house, but that will never be a reason i don't do my home work.
I graduated from Bronx Regional High School. I am a hard worker, and I don't like to be wrong. I try my best with everything I do. In class I am good with my work, but on test I get scared, and I forget what to do. Math is one of my favorite subject, because that is what my parents mostly teach me math and it kind a struck with me. My life time goal is to become a pediatric.

The reason I want to become a pediatric is because I love kids, and that is what I am best at. I love to see them laugh, smile, and find enjoy in the littlest things, and i love to make them happy. I can tell when they are sad or something is hurting there l little heart:like they have a sickest and they know that there is no core for it, or that they are hungry and they know that they have nothing to eat.

There was a little boy that is about to be three years old at the end of the month, so smart for his age but away hungry because is parents don't have much to give him to eat. So when I see him I away giving him something. That is what make me happy, and that is what make him happy, so we both have a smile on our faces. I came to Highland Community College because i heard about there nursing program and they woman basket team. I cant wait until i am finish with school so i can start on my life plan.

Charlotte, an excellent student, got an A on the final. Another success story was Liya Williams, an African-American mother from the Bronx and liberal arts major. Even though it took a while for Liya to receive her financial aid to purchase a used textbook, she found creative solutions to keep up with her homework. Liya, who was repeating the course, got an A- in the class.

Oct 06, 2010

Liya Williams
Math 0A

Coming into Highland I took Math 01A during the summer. The problem is once I took the exam I failed, this has led me up to now. If you haven't notice I am not the best at Math in; Junior high school. It wasn't until I reached high school that math itself has caught my attention. I am upset to say that I do not have the math text book yet. Unfortunately I am waiting for my financial aid to clear. But come to find out the first 3 chapters are provided online. I also must add that I like your pyramid in which you canceled out E for exponents in using PEMDAS. I am looking forward to taking this Math 01A class with you, for the rest of this semester.

Another student who found innovative ways to substitute for a textbook was Davonte Arzu, a 24-year-old African-American male, who has a positive outlook on life and a great sense of humor, both of which mask his hard life growing up. Davonte, whose major is nursing, got a B+ in the class.

DAVONTE ARZU
SEPT 2009 --MATH 01A

MY AUTO BIOGRAPHY

MY NAME IS DAVONTE ARZU , I AM 24 YEARS OLD . I SPENT MY PAST FIVE YEARS LIVING ON MY OWN . GROWING UP I ALWAYS HAD IT VERY HARD . MY MOTHER WAS NOT ALWAYS IN MY LIFE. I SPENT MOST OF MY LIFE FROM FROM HOME TO DIFFERENT HOMES . I SPENT MOST OF MY TIME WITH MY FATHER , HE NEVER WANTED ANY RESPONSIBILITY FROM THE BEGINNING . GROWNING UP I KEEP MY SELF AWAY FROM THE NEGATIVE CROWD . COMING OUT OF JUNIOR HIGH SCHOOL MY GRADES WAS EXCELLENT , GOING INTO HIGH SCHOOL MY GRADED DROP DRASTICALLY FROM A+ TO A D- SKIPPING CLASSES WAS A USUALLY THING FOR ME IN HIGH SCHOOL.

I REALIZE THAT MY HOUSE HOLD WAS PLAYING A NEGATIVE INFLUENCE IN MY LIFE . MY FATHER WAS A VERY ABUSIVE MAN PHYSICALLY AND MENTALLY . ONCE LOOK UP FOR THE ATTEMPTED MURDER OF HIS WIFE . HE ASLO TALKS DOWN ON HIS KIDS CRUSHING MY SELF ESTEEM AND MY SISTERS . I EVENTUALLY SAID THATS ENOUGH I HAVE TO FINISH SCHOOL SO I CAN LEAVE THE ABUSE OR I WILL END UP IN PSYCHOLOGICAL WARD . MY HIGH SCHOOL GRADUATION CAME , I GRADUATED WITH DESCENT GRADES . I SOON APPLY FOR A HOSPITAL JOB AND WAS ACCEPTED AS AN RECEPTIONIST I EVENTUALLY SWITCH DEPARTMENTS FOR MORE HOURS . I SOON SWITCH DEPARTMENT FOR MORE HOURS . I SOON HAD ENOUGH MONEY TO MORE . MY CREDIT WAS EXCELLENT AND EVENTUALLY FOUND A PLACE I CAN CALL HOME . MY DIRECTOR CALLS ME IN OFFICE AND SAYS YOU NEED TO GO BACK TO SCHOOL PLEASE! DON'T WASTE YOUR LIFE AWAY. SHE ALSO LET KNOW THAT I AM TWO COMFORTABLE WITH RECEIVING A CHECK . NOW I AM BACK IN SCHOOL GOING PART TIME AND MY FUTURE IS LOOKING BRIGHT . TEXTBOOKS ARE VERY EXPENSIVE SO I MADE MOST OF MY COPIES IN THE LIBRARY . MY MAJOR IS NURSING AND IS LOOKING TO BECOME A NURSE IN MY HOSPITAL ONE DAY. ALL OF MY PROFESSORS ARE GREAT I LIKE THEM ALL . GOD HAS BLESS ME SO MUCH AND HAVE SOMETHING GREAT PLAN OUT FOR ME IN MY FUTURE .

Lamar Jackson, born in Jamaica, attended schools in the Bronx starting in third grade. Lamar believes that people of color are disproportionally represented in the city's jails and wants to pursue a career in criminal justice. He worked very hard in the class, in which he received an A-, not only in mastering concepts but also in helping other students as a coteacher. In the words of fellow student Manuela Vidal, "Lamar's explanations were clearer than any teacher I ever had, and he has more patience than them."

09/12/09-Math01A
A Biography

My name is Lamar Jackson. I was born on a tiny Caribbean island called Jamaica, I migrated to the United States at the age of 9. For me it was a culture shock. I had could not adjust to cruelty practiced by me peers. I also think teachers could not understand me because some were just as mean as kids. My lunch money and pencils were always taken away from me. Even in the teachers presence I did not feel safe because they would not stop the abuse when it happened in their presence. Teachers would write on my report

that I had no tools although my mom made them aware that I left with three writing instruments each day.

One day my mom came to school to speak with the class teacher about a laceration to my face. The teacher claimed it was an accident. During the visit the AP passed by and not knowing it was my mom struck me in the forehead. The teacher quickly apologized for him. Fortunately, my mom being an educator gave him a chance.

My mom ended sending me to Catholic school but life was n different. I could describe myself as a social misfit. All I recall Elementary school life and to name a few my gains were a broken nose, loss of a tooth, lacerations to my face , damage to the eye and poor report cards. My teachers recommended for special testing 3 times. My mom took me for each of the testing. Twice the SBST team (School Based Support Team) told her to show the school proof that I should remain in general education and on my 3rd visit they placed me in a high school they claimed was less aggressive.

I attended Hawthorn Cedar Knoll High School in Westchester County from 9th to 12th grade. I obtained Life Science, Global History and US History in the Regents High School Exams and English and Math at the regent's competency level (RCT). I did everything I was told to do in math but I still did not pass it at the regents level. I graduated with a local diploma on June 2009.

I was accepted by Highland to do an associate degree in Criminal Law. But, I flunk the entrance test. I am aware I am starting at the lowest level and have placed more stress on my mom's pocket book. However, I am determined to become a lawyer. Today, when I think of the kids in jail who were abused and was not so fortunate to have parents like me; I feel obligated to work to assist gullible youths and in doing so I will be an asset to my country.

Not every student likes math, but they all understand they need a passing grade in order to graduate. Math does not come easy for Yolanda Perez. Through conscientious efforts she is bound to succeed.

Sent: Tuesday, September 15, 2009 11:23 PM
Subject: autobiography Math

My name is Yolanda Perez. I was born in Dominican Republic raise in the Bronx. I'm 21 year old. I went to Walton High school and graduated, receive a high school diploma. I'm now attending Highland. Community College . My major is Computer Information Systems (Web Page Design). I'm taking this math class for the second time. Math and myself are not really close friends… I really don't like math at all, but I could defend myself in some ways. I really look forward to learn as much as possible, and be able to pass this class and get it over with…

Ariel Rojas impressed the class with his knowledge of history and love of animals. In his words, "Everyone has to hate something, and I chose to hate math, my worst subject ever starting with fifth grade. How can you learn by heart lots of formulas that don't make any sense to me? I have a good memory for numbers. In history, at least, the numbers make sense, but in math they don't."

Sept 13, 2009

Hello my name is Ariel Rojas, and I am 19yrs old. I attended a small high school in Evander Childs named Bronx Aerospace Academy. Math was never my favorite subject I actually dislike it. My favorite subject is History. I am currently attending Highland Community College for Animal care And Management. I always wanted to be a zoologist or marine Biologist. I love animals and I want to work to defend them for the ASPCA. Math was always my worst subject, I always tried to remember everything like formulas but I always forgot them. In seventh grade I had to go to summer school because of math. Now I'm trying to do my best in math because in my curriculum I have to take other math classes.

I Use to love Math when I was in 5th Grade but I lost my touch for it. I would probably be very good at math if I paid attention more in class when I was in high school. Math 01A is a pretty easy course I would have passed the test but I failed by 2 points because I was a little rusty. I would have passed the assessment test but I took a year off when I graduated from high school so I had forgotten a lot.

In due time, Ariel began making sense of math. He became an active participant in small groups and started helping other students in the math lab sessions. Ariel got an A- on the final exam.

In contrast to Ariel, whose attitude toward math deteriorated in middle school, Hector Acevedo loved math all the way up to high school. Hector attributes his loss of interest in the subject to a new teacher who made math boring and could not maintain classroom discipline. As a result, his grade dropped by more than 20 points from the one he received in middle school.

HECTOR ACEVEDO
Math 01A Hector Acevedo Fall 2009 9/9/09
My name is Hector Acevedo. In my early years I was very advance in math. While my peers were just learning how to multiply, I was already multiplying double and triple digit numbers. I use to love math and my dad always pushed me to do good in school. Middle school I was still a math wiz and my teacher was very proud and impressed. A couple of month went by and I was sent to an advance math class with my friend who was also very good at math. I stayed there for a while but then I decided to drop the advance math class and go back to my old regular math class. Its not that I didn't understand it. Its that my teacher just made the class way more fun for us, and I don't regret leaving.

In high school I had a math teacher who was new. First time teaching, as you can imagine all the chaos in the room. He didn't know how to control the class. The students didn't listen and when he taught it was so boring everyone just went to sleep. I lost every interest in math I had. Soon I fell behind and didn't really learned much. So now I'm not as good in math as I use to be when I was younger. My math grade dropped by 20+ points since middle school. It was just awful.

Today I attend your class at HIGHLAND in the Bronx. I already learned something. I learned not to relay on PEMDAS but instead use the step pyramid. His class is very interesting and its very hard to sleep in there. He keeps us entertained by sharing stories and comparing math to every day experiences. I'm looking forward to see what else he will teach us and I'll try my best not to disappoint him.

Ever so shy, Hector always kept to himself in class and referred to me in the third person as a sign of respect (unlike Spanish, English lacks a formal form of the second-person pronoun): "I'm looking forward to seeing what else he will teach us and I'll try my best not to disappoint him." Hector did not speak with me unless it was necessary. He declined my invitation to be a coteacher, even though it was apparent that he was grasping all math concepts rapidly. Hector got an A+ in the class.

Another shy person I could not persuade to become a coteacher is Flavio Sanchez, a Dominican-born student interested in the medical field. Flavio got an A on the final exam and in the class.

From: Flavio Sanchez
> Math Autobiography > 09/14/09
.
I was born may 17 1989 in Dominican Republic, I lived In Dominican Republic for ten years with my mother, sister, and bother. Until my father who lived here decided to bring us over, he came over here when I was about two years old, but now he lives over there

again.

I went to a lot of middle schools because I kept moving around, I went to three different middle schools and I was always a straight A student until high school that was, freshman year was good but then the rest of the school year I kind of slack which is why I dropped out and started working until I chose to get my General Equivalency Diploma and applied for college. This is my first semester and so far I can say is going pretty good and your class is one of my favorites because you are a good teacher. Math have always been one of my favorite subject, I always been good at it because my father was a math teacher in the Dominican Republic and he always helped me with my math and I guess it's in the genes.

I honestly don't think I should be in your class because I find math 01A too easy but I can be wrong, I decide to stay in your class because I been out of school for a while and maybe I need to refresh my memory. You might not see me talking much in class for now because am a very quiet person, but I'll come around. I still don't have your book because of some financial aids problems but am keeping up with your class and the homework. I still don't really know what I'm going to study but at least I'm coming to school, I just want to do something that's fun, makes me successful and gives me a wealthy future.

Well yea I think this is about everything I could come up with, so once again my name is Flavio Sanchez I'm a twenty year old Dominican boy that has a lot of hope for his future and success.

And yes my father is still in the Dominican Republic, he wont be coming back over here that i know of and now he doesn't teach math anymore and when he did it was in the Dominican Republic.

I don't have a career choice yet, i was thinking maybe studying radiology or being a Psychiatry but i don't know yet.
I Have a older sister who is 24yrs old, she graduate from Alfred university and went to NYU for grad school, she wants to be a teacher, she is marry to an army soldier and have a daughter who is 1 1/2, she recently moved to Washington state with her husband.

P.S sorry i missed your class my car broke down this morning on my way over there, please let me know if we have any homework or assignments for next class. See you Monday morning.

Anthony Colon sees the value of math to practical situations, such as shopping, taking measurements in carpentry, and in accounting and banking:

From: Anthony Colon
Prof
Mathematics was always an interesting subject to me. But there were always some problems and equations that confuse me in math. I always liked the basics in math like multiplying subtracting and adding etc. I never really had any defficults with them. There was always something about fraction that seems to confuse me for some reason reduceing them is the problem with me.i think that math is something everyone needs to learn and adapt it to their every day life because you need it in life to survive in society and the community that we all share together as a whole.

For example an everyday life situation encludeing math is shoping if you are going to buy something in the store you will need to use math because if you don't know how to use money you will either get ripped off or pay to much for what you are purchasing. Life it self is all about numbers and measurements. Say you want to become a carpenter one day you going to need how to use your measureing skiils involving centermeters and inches or length width area and volume. Or if you want to work in a bank doing accounting you have to know how to count cash and know percentage.

When I was in high school and junior high school math was my favorite subject because multiplying and adding was fun and simple.i know that college is something new for me and the work is going to be twice as more challenging and intense so I'm going to need to work harder but I know I have the capacity and ability to accomplish anything that I want so if there is any problem that I have I will discus it with my amazing and brilliant professer and I know that he will teach me well as he has done already. For example in high school they taught me this horrible and confuseing way to solve problems using PEMDAS and thanks to his pyramid way of doing it things are much more clear for me.

Observations

Not many of my students have led a sheltered life. Some were raised in nurturing, tight-knit families. While they attended Highland, these students had their parents or grandparents care for their young children. Other students grew up in disjointed families where they endured abuse or even violence at home or in school. Some of the students were the children of teachers who nurtured their intellect and encouraged them to excel, while others were left to fend for themselves. A few students perceive themselves as "strong" or "adequate" in math; many students did well in elementary school math, only to fall by the wayside in middle school or high school. Their writing samples convinced

me that most students do not understand the abstract jargon in math textbooks. Almost all of the students wrote about their teachers in elementary, middle, or high school. At times a good teacher inspired or motivated them to succeed, but more often than not a bad teacher caused a student turn away from the subject. By the same token, many students admitted to cutting class, not doing homework, fooling around in class, and being uninterested in math.

From their autobiographies, I learned that students equate math with calculations rather than problem solving. Fractions, percentages, and word problems continue to be "scary subjects" even after many years of exposure. The students' overreliance on rules and algorithms has hindered their conceptual understanding. Some autobiographies were submitted after the students had taken part in a class discussion on the order of operations. Except for those whose early education was in a different country or language, all had been taught to use the mnemonic PEMDAS, which stands for *Please Excuse My Dear Aunt Sally*, to help them remember the order in which to perform the arithmetic and algebraic operations: first parentheses followed by exponents, multiplication, division and then subtraction.

The widespread use of PEMDAS warrants mention. As a perfect example of cultural reproduction, students learn the mnemonic from their teachers, who in turn learn it from their teachers and math textbooks. Textbook publishers have been using PEMDAS and other mnemonics for almost a century. No wonder many people falsely believe that PEMDAS is a principle agreed upon by mathematicians; curiously, mathematicians and many of them have never heard of the mnemonic. In hundreds of exams I have corrected in my nine years at Highland, I have seen the word PEMDAS scribbled in the margins of

nearly every exam booklet. From student interviews, I learned that PEMDAS is the one thing—in some cases, the only thing—that has "stuck" from all their years of math education.

In her autobiography, Ambika noted that the equivalent acronym BODMAS [Brackets-Order-Division-Multiplication-Addition-Subtraction] is used in other countries, such as Great Britain. The difference between PEMDAS and BODMAS is the sequence of the letters M and D, versus D and M, implying that operations can be done in a different sequence according to the acronym a student uses! As discussed later, many students interpret the mnemonic literally without understanding the underlying logic. As a result they think that $4 - 2 + 1$ equals 1.

Some students wrote reflection pieces on their experiences in the classroom or math lab. The term *virtual manipulatives* refers to the software we used in the math lab; these and other tools are described in greater detail in Chapter 6. Appendix A contains selected student reflections on my class teaching. The reflections helped guide my lessons and point out where I needed to improve my pedagogy.

Community Colleges and Educational Attainment

The last 30 years have been marked by a steady decrease in the level of educational attainment at four-year colleges and universities in the United States. The data show that less than 60% of students are graduating from college (Bowen, Chingos, & McPherson, 2009). During the last year, a wealth of articles has been appearing in scholarly journals and the popular press on why educational attainment at public community colleges is highly consequential for the United States. On July 14, 2009, President Obama unveiled the American Graduation Initiative aimed primarily at community colleges, which the

President called an "undervalued asset in our community." In his words,

> Now is the time to build a firmer, stronger foundation for growth that will not only withstand future economic storms, but one that helps us thrive and compete in a global economy. It's time to reform our community colleges so that they provide Americans of all ages a chance to learn the skills and knowledge necessary to compete for the jobs of the future. (www.whitehouse.gov, 2009)

The American Education Initiative is a $12 billion program aimed at producing 5 million additional college graduates by 2020. Pointing out that nearly half the students who enter community college fail to graduate within six years, the President said that a significant portion of the funds would be allotted to innovative strategies to promote college completion through the College Access and Completion Fund. (www.whitehouse.gov, 2009).

Centrality of Teaching

This dissertation examines the centrality of quality teaching in basic math classes at public, two-year community colleges, which have been shouldering the burden of educating low-income minority students in urban areas. Because their lives and previous education have not prepared them for postsecondary work, most new students must take non-credit-bearing basic courses in math, reading, or writing, or all three subjects.

The evidence shows that the sequence of study in basic math courses does little to support student success: Most students languish in basic courses semester after semester, even after they have completed most courses in their major. Frustrated, almost three-quarters of a cohort withdraw from college within three years of enrollment. For those who remain, the time-to-degree can stretch out to seven or more years of college attendance. Understanding the forces driving these outcomes should be important to

anyone who is concerned about the economic prospects for this country and the building of human capital in the Bronx.

The solution does not lie in placing blame on the high schools the students previously attended or in abandoning the students but in instituting changes that will help them advance beyond basic courses toward college completion. In this study, I argue that by improving teaching, redesigning basic course curricula and syllabi, providing more support (such as counseling and mentoring), and using new materials and technology, it is possible to increase retention and graduation rates and shorten the time-to-degree substantially. These changes will not happen overnight. As Jaime Escalante's story shows, real improvement takes time. I believe that the benefit gained from acting on the recommendations of this research will more than compensate for the effort that will be required.

Graduation Rates at Highland

As discussed later in Chapter 4, the low graduation rates from CUNY's community colleges have important implications for both taxpayers and students. Given the current funding shortage as a result of the deep recession in which the United States finds itself, I wonder whether the taxpayers get their money's worth when only 25% of a cohort graduates and this after six years. If three-quarters of the students in community colleges never graduate, what does this mean in terms of disillusionment and lost opportunities for entering the middle class? The following vignettes attempt to help answer that question.

Sandra's story

It is late August 2000, a happy time for the 979 new first-year students at Highland. They

have smiles on their faces, excitement in their voices, and are brimming with the enthusiasm of youth, perhaps a bit apprehensive of what lies ahead. All are looking forward to a wonderful college experience, hoping to earn their share of the American Dream that a college degree will bring. One student is Sandra N. Brown enrolled in Highland's psychology program.

Like Sandra, most students hope that three or four years of study combined with the juggling of work and domestic responsibilities will lead to a better life. After all, job prospects are favorable in their community, particularly in the health care industry, the largest in the United States today. According to the Bureau of Labor Statistics, a high rate of job creation is expected in the health care field between 2010 and 2018 (www.bls.gov, 2010).

The students have all chosen a career area: medical assistant, information technology, or different specializations in health and human services. When they finish, jobs are waiting for them right there in the Bronx. Three years might seem like a long time at age 18 or 19, but it is totally doable given the tenacity of these young people.

Flash forward to May 2003. On the beautiful Highland lawn, surrounded by majestic buildings, Sandra is lined up with the other students waiting for the commencement ceremony to begin. Searching through the happy faces in the crowd, a person would have a hard time finding the other students in Sandra's cohort; only 71 are graduating with her. Sandra is the valedictorian.

Anyone who takes public transportation would recognize Sandra's smiling face from the CUNY ads in the Metropolitan Transit Authority (MTA) buses. She has just completed an interdisciplinary study at three four-year CUNY colleges. She earned her

bachelor's degree in May 2008 and a master's degree in history this past year. Just recently, Sandra was accepted in a Ph.D. program at Harvard University with a five-year fellowship valued at $200,000.

But let's return to the lawn at Highland in 2003. Sandra's classmates are cheering as she strides to the podium to deliver her inspiring words in the commencement address. The graduates are beaming with joy because a better life awaits them. But what happened to the other 902 students in their cohort? It is unlikely that many came to today's ceremony. Some are too consumed with worry about the summer classes they have to take or retake.

In fact, out of the original August 2000 cohort of 979 students, only 596 were still on the campus on September 11, 2001, because 383 had already dropped out of school. When 9-11 was commemorated a year later, only 410 students were still enrolled. By the time Sandra and her 71 classmates received their degrees, two-thirds of the cohort had left school without a degree.

Besides the 72 students who received their degrees in May 2003, another 247 students from Sandra's cohort came back to Highland in September 2003. These were the students determined to graduate, no matter how long it took. Indeed, out of this group 70 more graduated in 2004, but 57 had dropped out. The story repeats year after year, with fewer students from the cohort graduating and more students dropping out.

By the summer of 2008, when Sandra received her bachelor's degree from CUNY, only 213 of her colleagues had received their associate's degree from Highland. Because only 19 of the original cohort were still enrolled at Highland in the fall of 2009, when Sandra entered the Ph.D. program at Harvard in the fall of the next year, no more than

225 students (23% of her original cohort) will have earned their associate's degrees at Highland.

One might argue that the picture is more complex than what I have just described, since some students in Sandra's cohort did not drop out but transferred to another college and eventually graduated. Although this might be true for a handful of students, the overall picture does not change. Without an associate's degree or passing score on the COMPASS, these students could not have transferred to a four-year college.

Nevertheless, the overall picture remains the same. Highland's graduation rate is frozen at about 25% eight years after initial enrollment; the percentages do not change much in subsequent years. Melody, another student, whose story appears below, is a tenacious student who is determined to graduate more than 20 years after her original enrollment. She embodies traits such as determination and persistence. Most students, however, lack the financial means and wherewithal to persist; instead, they simply drop out of college.

Melody's story

Melody Johnson, a student in a basic algebra class, asked if she could talk to me after class. Below is a rendering of our conversation:

> Melody (bursting into tears): *I'm lost, I don't know what to do, I'm desperate…*
> EF: What's wrong?
>
> Melody: *I'm trying, I'm trying, I go to tutoring, but I know I will fail the class.*
> EF: We still have several weeks left.
>
> Melody: *This is not going to help. The pace is too fast. I took the more basic algebra course twice, and twice I failed. I wanted to take it a third time, but since they changed the program in basic math, that class is not given no more. They forced me to take your class, which is much harder and moves too fast for me. I don't get the basics. Also, I don't know why do they force me to study all this*

material. It is not necessary for Human Services. Besides, I paid $600 for your class, and I can't afford that.
EF: Your major is Human Services?

Melody (crying): *Yes, but I will never make it. I'm 44-years old. I've been in this college from 1987. Yes, I stopped a couple of times, like 2003 and 2008; I had another baby. I really want to work in Human Services, but this math is killing me.*
EF: Please talk to your advisor, and have your advisor call me. Maybe you should be tested. Not everyone is wired for math in the same way. I'm sure that there are lots of areas in which you are more talented than I am. Please have your advisor call me.

Melody: *Thank you so much, and have a good day. I'll follow up as you said.*

Melody may be an extreme case of a student still trying to graduate after 20 years; however, the fact remains many students do fail basic math courses repeatedly, and it is this failure that prevents them from moving ahead in school and in life. The socioeconomic impact includes money invested but never recouped, the cost of opportunity lost in time and money, and the failure to fill job openings with people who are motivated and would make good professionals had it not been for their inability to pass basic math courses the relevance of which to their vocational interests is questionable at best. As a public institution, the college's mission is educational attainment for all. The health of the greater community depends on it. The present graduation rates, which harbor huge disparities based on race and income, are unacceptable because of their implications for social mobility. Being part of CUNY, Highland is well poised to address these disparities. The true measure of Highland's success will be a sizeable increase in the number of students who *finish* their associate's degree, not just start it. My hope is that future students at Highland will benefit from this research, making the college's mission of "transforming lives" a reality.

The Study

A principal proposition of this study is that present policies and practices at community colleges make the associate's degree unattainable for most students. As Chancellor Goldstein stated, nationwide "the three-year graduation rate at urban public community colleges is about 16 percent" (Goldstein, 2010). For those who do graduate, the time-to-degree can stretch out to eight years or more.

It is of interest to the community, the taxpayers, the students, and other stakeholders to have the students earn their associate's degrees in the shortest time possible. As this research shows, however, the interests of the students and the community are not necessarily aligned with the interests of the community colleges, when the reality is that only 8% or less of the students of an incoming cohort have their lives transformed after three years of full-time college attendance.

The findings of the study are not limited to the group of students studied or even to the Bronx. All over the country community colleges are struggling with the same problems of increased enrollment, reduced budgets, unprepared students, low retention rates, low graduation rates, and lingering students. My hope is that educators, scholarly researchers, administrators, and politicians will find the study helpful and will follow up on the recommendations in Chapter 7 in their attempts to arrive at creative solutions that will benefit the students they serve.

Purpose of the study

The purpose of this study is two-fold. The first goal is to determine the extent to which basic math education courses help or hinder the graduation rate of Highland's full-time

students. The second goal is to examine the effect of transformative tools and pedagogical practices grounded in sociocultural theory on the attitudes, morale, and performance of students enrolled in a basic arithmetic class at Highland in the fall of 2009.

Hypothesis

My hypothesis is that basic math courses at Highland contribute to the low retention rate, long time-to-degree, and low graduation rate of students enrolled in an associate's degree program.

Significance of the study

CUNY has already instituted several innovative and promising higher education opportunity programs such as Search for Education, Elevation, and Knowledge (SEEK) in senior colleges and Accelerated Study in Associate Programs (ASAP) and College Discovery in community colleges. This study complements CUNY's efforts—well under way—to help students with the lowest entering credentials finish their degree. This study also joins the efforts of other researchers all over the country aiming to increase college retention rates and improve educational attainment.

Through their open-admissions policy, CUNY community colleges have successfully met the explicit part of their mission of providing "equal access and opportunity for students, faculty and staff from all ethnic and racial groups and from both sexes." Since *access t*o higher education is not synonymous with educational attainment, an implicit part of CUNY's mission has yet to be met: Helping the most vulnerable students *finish*

college within the three-year norm so that they, too, can take their rightful places in their communities and society at large.

This study should be of interest to all CUNY community college presidents in their attempts to meet the explicit *and* implicit parts of their mission. This study will, I hope, also be of interest to other members of the American Association of Community Colleges (AACU) and to anyone interested in improving math teaching and learning at the post-secondary level.

Ethical Issues

This research is intended to be both critical and transformative. As a result, certain parts of the dissertation may raise questions about deeply engrained pedagogical practices, policies, and procedures in the college culture and structure. To limit my bias, I relied on official data from CUNY's Office of Institutional Research and Assessment (OIRA), Highland's transcriptual data, and the students' transcriptual data. While researching my own practice, I was guided by the three ethical principles, respect for persons, beneficence and justice, as stated in *The Belmont Report*, published by the National Commission for the Protection of Human Subjects of Research (The Belmont Report, 1979.)

All students participated voluntarily in the research, and their identity and confidentiality was protected. At the time of the study, all participants were over 18 years old, signed the IRB consent forms, and agreed to be audio and video recorded. There was no potential harm to students' welfare: on the contrary the students benefited from the research, since mastering math concepts they struggled with would greatly increase their chance to graduate from college.

Since I had no students in the class who were recognized as learning disabled by the college's disability service department, there was no need to provide special accommodations: extended time during the tests or the use of calculators during quizzes, exams or final. In classroom and lab, when translating a math term to Spanish for the benefit of newcomers, I made sure that this act would not be perceived as favoritism by students who had a poor command of that language.

Scope and limitations

In addition to the data obtained from one basic arithmetic classroom I taught at Highland in the fall of 2009, I examined longitudinal data of several hundreds of my own students dating back to 2002, as well as official CUNY data for the last 10 years. This is archival data for which IRB approval was not required. In this research I do not attempt to translate potential benefits associated with recommended changes in policy, curriculum, pedagogy, or cultural practices into exact dollar figures, nor do I attempt to predict the potential percentage of increase in retention or graduation rates.

Research methods and methodology

In this research, I see my role as that of an interpretive *bricoleur*, the French word for a maker of quilts. According to Norman Denzin and Yvonna Lincoln, "the interpretative *bricoleur* produces a *bricolage*—that is, a pieced-together set of representations that are fitted to the specifics of a complex situation" (Denzin & Lincoln, 2003, p.5). The research is strongly grounded in sociocultural theory and critical pedagogy but uses elements of educational psychology in certain classroom situations.

The research examines social life as enacted in basic math education in Highland at three levels: macro, meso, and micro. The macro level examines structures in several fields among which the classroom is only one (that is, fields are nested within one another). The wider structure expands the boundaries of research to include the rest of Highland and other CUNY community colleges. The meso level consists of interactions at the classroom level. The micro level consists of face-to-face interactions among the students and between my students and me. As a field of investigation for examining those interactions, I used a basic arithmetic class I taught at Highland in the fall of 2009. Throughout the text, in addition to my standpoint, I am using student-produced artifacts to gain a polyphonic and polysemic understanding of the social life in my classroom.

Authoethnography

My involvement as a participant in the research is documented through autoethnography. This means I was both an observer and an active participant in the study. I saw myself as a teacher and a researcher at the same time, in the way Joe Kincheloe suggests in *Teachers as Researchers* (Kincheloe, 2003). I documented my participation through video and audio recordings, extensive note taking, and daily reflections. I expect my research to pave the way for future studies, build a culture promoting improved basic math education in CUNY community colleges, and help increase graduation rates.

Ethnographic methods

I used two cameras in the classroom, one aimed at the chalkboard and the other aimed at the students. In the math lab where 40% of our classes were held, the video recording was done by one of the students. After watching the video recording several times, I selected

short vignettes and replayed them as part of the cogenerative dialogues which my students and I held in the lab. Cogenerative dialogues (cogen) are meetings, or safe places, where participants in an interaction, such as teachers and students, talk about a situation to articulate why things happened the way they did (Roth & Tobin, 2001). The purpose of cogen is to help participants learn new ways of interacting across differences in age, ethnicity, social class, and gender.

My pedagogical at Highland were also influenced by the experience I gathered through participation in the Teacher Academy, an undergraduate program aimed at developing future math and science teachers. For two semesters I supervised my student teachers' practica at an urban middle school and two urban high schools. These activities afforded the development of insights into different pedagogical practices applicable to a curriculum similar to the curricula enacted in my own basic math classes at Highland. In this study I use the present tense when describing the teaching of future elementary school teachers, since this is an ongoing activity.

Autobiography

I used autobiography to help explain my formation as a math educator and educational researcher. My travails with absorption and integration into new countries and with learning new languages helped me empathize with the students in my classes. Throughout the study I have explored times when I observed a change in my thinking about how to teach a concept or help my students understand important concepts in math. The use of thought-prompts to myself helped me realize when I was on the right or wrong track, felt overwhelmed by new knowledge, or was frustrated because the help I gave a student was not fruitful. Chapter 3 traces my formation as a teacher and researcher by

recounting my own story and recalling times when new insights or information pushed me to consider something about myself that I had not previously considered. This study is peppered with autobiographical nuggets, whether in relationship to my work with students or my reflections on what worked, what did not work, or what I can change in my teaching. I have encouraged my students to use autobiography and reflections in order for me to be able to relate to them and to help them clarify their own thoughts. I have used student reflections to reformulate and adapt lesson plans and to choose examples to which students can better relate.

Data collection and analysis

This study employs multiple data sets, some quantitative and some qualitative. The quantitative data consisted of the following: a) CUNY's Office of Institutional Research and Assessment (OIRA) tables on enrollment, demographics, graduation rates, retention rates, and time-to-degree. The tables contain: (a) data for the entire university, senior colleges as a group, community colleges as a group, and individual colleges; b) Highland's Office of Institutional Research—data on student rates of passing/failing COMPASS tests in math and reading, data on repeating basic classes in math and reading, and data on the relationship between students' grades in remedial classes and students' retention and graduation rates; and c) Transcriptual data from Highland's registrar for several hundred students in my basic math classes between 2002 and 2010; this includes enrollment data, grades, and scores on the COMPASS placement tests and assessment tests.

Through the examination of these data (see Chapter 4), I gained a better understanding of the extent to which passing or failing a basic math class (or even

passing a math class with a low grade) is a predictor for failing subsequent basic math courses and for a student being retained or dropping out of college. I also collected and reviewed extensive data sets that included student-produced artifacts, questionnaires, interviews, videotapes, and notes taken following cogen.

Student-produced artifacts

This dissertation gives voice to my research participants: the students in my basic arithmetic class. I feel that any research that neglects to include such sociocultural components fails to grasp the complexity of human interactions in classroom teaching and learning.

The students' artifacts are of two types: a) autobiographies which helped me better understand the students' past and present difficulties with math and b) reflections on President Obama's nationwide speech on education and on in-class teaching and learning. Even though all students watched the President's speech at home or saw excerpts of it in the lab, only a few submitted a written reflection. We engaged in cogen on the elements of the speech only after I had collected the students' work. That way the students' written opinions were not influenced by insights gained during the cogen their reflections. From students' reflections on the President's speech, we learn that the students were inspired and motivated by the President's words; at the same time they came to believe that success in academia and in life is entirely within their grasp.

As with autobiographies, all reflections were optional assignments. Most students stated that writing reflections on teaching and learning was entirely new, but they considered it a useful exercise. Some students provided several reflections during the semester, their busy schedule and lack of proficiency in written English notwithstanding.

I encouraged the students to try to answer one or more of several questions in their reflections on classroom teaching: What did I learn this week? What was the homework this week? What new topics did I learn and what did I struggle with? What did I like or dislike in the class activities or teaching? What suggestions do I have for changing or improving the teaching and learning of math in our class?

Interviews

In this research I made extensive use of interviews with my students in order to better understand the sociocultural factors contributing to their basic math education. I also conducted interviews with other teachers at the Highland and Concourse math departments. The purpose of these interviews was to understand teaching practices pertinent to basic math education. Ultimately, I obtained and analyzed data on enrollment and grades in remedial classes and on college graduation from the college from the department of testing and evaluation.

The combination of cogen, interviews, and questionnaires, and students' artifacts helped me take the pulse on the students' learning difficulties; their opinions on teaching, curriculum, syllabus, and pedagogy; and their openness to learning math through different methodologies and methods, including the use of technology.

Questionnaires

As part of data collection, I distributed questionnaires to learn more about the students' attitudes toward and confidence in doing math. I administered the questionnaires twice, once at the beginning and again toward the end of a course. That way, I was able to examine changes in the group's attitudes toward math learning. Each questionnaire took

10 or 15 minutes to complete. I guaranteed the students that their answers would remain confidential.

Coteaching

Wolff-Michael Roth explains that in coteaching, "two or more individuals work at each other's elbow to enhance the learning experience of students" (Roth, 2005). Two teachers, two students, or a teacher and a student can simultaneously coteach. When one coteacher explains a concept to the class, another can seize on a teaching moment that might otherwise pass unnoticed.

In my study, the class met twice a week for 75 minutes each time. The Wednesday session met in the classroom; the Friday session met in the lab. I had three coteachers in the class. In the lab two and sometimes three students circulated around the room helping their classmates who were working in pairs. One coteacher was familiar with all aspects of the technology while the other two were advanced in math. I realized long ago that students often learn best from their peers.

Teaching with technology

During the fall 2009 semester, only half the classes in my basic arithmetic course were held in the classroom. I held the rest of the classes in the technology lab, where students worked at their own pace. Seated in pairs in front of computers, the students experimented with fractions, factoring, decimals, percentages, proportions, and probability. I describe in Chapter 6 the software and methods I used to promote students' understanding of basic math concepts.

The use of computer technology allowed me to address the different ability levels in the class, an objective that often proves difficult to meet in a traditional classroom. In the lab session I gave students a list of progressively difficult questions on various math topics; each pair advanced at its own pace. When stronger students worked with weaker ones, the weaker students benefited from peer tutoring, while the teaching that the stronger students did clarified and reinforced the concepts in their own minds.

I also made extensive use of self-paced instruction and small-group work to supplement whole-class instruction. With the help of three students—who acted as coteachers— my effectiveness in the classroom was multiplied several times. In their reflections and face-to-face interviews, students expressed their enjoyment in using technology, a novel experience for most. Many students played with the computer math games at home, sometimes with their children.

Cogenerative dialogue

In cogen all participants provide equal levels of input; there are no privileged voices in the discussion. Students are free to express their thoughts or feelings on education, pedagogy, classroom interaction, and interaction with other fields (school, home or community). There is no time limit imposed on a student who is talking and no interruptions of the discourse are allowed (Tobin, 2005).

I used cogen in my teaching practice at Highland not just as a method but also as a methodology to resolve contradictions in my teaching practice. The students' participation in cogen was voluntary; they understood that their participation had no bearing on their grade. To accommodate the students' busy schedules, we held our cogen sessions in the lab during class as well as the break.

Summary of Chapters

The six chapters of this dissertation are more or less self-contained to allow readers with a particular interest in a subject to turn directly to that chapter without having to read the preceding one.

Chapter 1: Community Colleges: Their Role in Higher Education

In this chapter I discuss the role of math in opening or closing the gates to graduation from community colleges and I explain why community colleges represent the only higher education option for many low-income minority students with low entering credentials. Community colleges play an important role in rectifying disparities between advantaged and disadvantaged students by giving everyone equal access to higher education. I detail the purpose of the research, the methods used, and the study hypothesis.

Chapter 2: From CUNY to Highland

In this chapter I discuss the development of community colleges and then narrow my focus from the global (international) picture to the national, state, city, borough (the Bronx), and ultimately to the role played by basic math courses in graduation from community college.

Chapter 3: My Formation as an Urban Math Educator

This is an autobiographical chapter describing my formation as a math educator and education researcher. I explain the influence that my upbringing and education have had

on my early stance on teaching and math teaching; discuss the twisted path I have traveled in becoming a math educator and education researcher; and provide a summary of the courses, readings, and classroom experiences that have played a pivotal role in my current theoretical schemas.

Chapter 4: The Truth in the Data: Locking the Gates

In this chapter I examine the relationship between math education, graduation rate, and time-to-degree. I conclude that failure and repeated failure in basic math courses has a negative effect on students' chances of graduating. I also discuss the COMPASS placement test and how the score on that test affects a student's chances of graduating from college.

Chapter 5: What's Happening in Basic Math Courses?

In this chapter I look specifically at macrostructures: college policies, interviews with professors and the administration, and the students' culture. I also a) examined the relevance of some curriculum topics to the students' majors, b) found out the extent to which technology is being used in the classrooms, and c) investigated the relevance of teaching to the students' various cultures. I also obtained and analyzed data from other community colleges and interviews at them. To better understand what is going outside my classrooms, I interviewed teachers and administrators at Highland and some teachers from Concourse.

Chapter 6: Making the Difference

In this chapter I describe innovative pedagogy and transformative tools to improve the

teaching and learning in a basic arithmetic class in the fall of 2009. These tools include cogen, coteaching, small group work, and teaching with technology. Specific methods for data collection were students' autobiographies, reflections, questionnaires, interviews, and videorecording.

Making Sense

In this research I identify basic math as a gatekeeper to graduation. The students in this study are CUNY's most vulnerable. They have the lowest entering credentials and are predominantly low-income minority students or immigrants. The evidence shows that the sequence of study in basic math does little to support student success and that the relevance of these courses to the students' vocational interests and career area is questionable.

For some students, math is a prerequisite for their major; these students get trapped in the basic math sequence at the beginning of their studies. For many other students, however, basic math is not a prerequisite for most courses in their major, as seen in Highland's *Fall 2009 Registration Guide and Schedule of Classes.* These students end up completing the courses in their majors but cannot graduate until they have completed the basic math sequence. Frustrated by their inability to pass the basic math courses, they drop out of college. For those who do remain, the time-to-degree can stretch out to seven or eight years.

Chapter 2

From CUNY to Highland

"If you don't know where you're going, any road will get you there."

(The Cheshire Cat in *Alice in Wonderland)*

After discussing the initial purpose of community colleges and their changing landscape over the decades, I narrow my focus to the two CUNY community colleges in the Bronx, where most students are placed in basic math courses as a requirement for graduation. The evidence shows that many more students are placed in basic math classes than their equivalents in reading or writing. In this chapter I examine the role basic math courses play in helping students to complete or in hindering them from finishing their associate's degrees. I also provide important context for the detailed discussions that follow in Chapter 5.

The Development of Community Colleges

For many high school graduates from low-income, minority families with low entering credentials, the only choice of college is a community college. There are over 1,000 community colleges in the country with a total enrollment exceeding 6.2 million students. *CollegeBoard*'s website explains the role of community colleges:

> Community colleges were developed, and still exist, to serve as a bridge from high school for two major purposes. The first is to serve as a bridge from high school to college by providing courses for transfer towards a Bachelor of Arts (B.A.) or Bachelor of Science degree (B.Sc.)
> The second function of community colleges is to prepare students for the job market by offering entry-level career training, as well as courses for adult students who want to upgrade their skills for workforce re-entry or advancement.

It is the second function of community colleges, providing students with career training

in fields such as nursing, health education, human services, social work, that is the subject of this dissertation. At Highland most students are enrolled in the associate's degree program, though some do transfer to a four-year institution upon completion of their studies.

When community colleges, previously referred to as junior colleges, were first formed in 1901, they were intended to fill an empty niche in higher education. Viewed as an extension of high school and a step toward transferring to a four-year college, they provided a pathway for students to develop their skills for college coursework or offered vocational or entry-level career training. In December, 1947, President Truman's Commission on Higher Education recommended "the extension of free public education through the first 2 years of college for all youth who can profit from such education" (Truman, 1947), greatly enhancing the community colleges' role as great social equalizers by opening their doors to everyone.

With their open admissions policy, community colleges not only provide urban students with the ability to develop learning processes that will help prepare them for college-level courses but also offer an associate's degree that can lead to a better-paying job than a high school or equivalency diploma can. In this dissertation I argue that social justice is achieved not merely by offering students an equal opportunity to enter college but by ensuring their success and completion of their associate's degree.

Meritocracy: The Neoliberal Mantra

Upon entering Highland, my students believe that the associate's degree is well within their reach and that the degree will open the door to opportunity. In September 8, 2009, most of my students were much too busy with work and the new school term to watch

President Obama's back-to-school speech. I was prompted to encourage my students to watch the replay on YouTube after reading the narrow-minded comments of so many parents around the country who, swayed by conservative politicians and the media, decided to keep their children home rather than send them to school where their young minds would be poisoned by "communist propaganda." After watching the President's speech, several students wrote their reflections.

Flavio was impressed with the President's urging students to stay in school:

From: Flavio Sanchez
Obama's Speech on Education
09/22/09

First of all I want to start by saying I like the way Obama talks and greet his audience with energy and sense of humor otherwise it would've been a boring speech to the students because that's how it should be done when the crowd is mostly young students. Obama made a lot of important points and examples to the students to keep them motivated on going to school and making a bright future for them self, letting them know that parents and teachers have responsibilities to help them with their education but that is the student responsibility to try by going to school, doing their homework, paying attention in class, etc.

I think Obama gave a great speech to those fellow students, teaching them and telling them that they need education and that they will be so much better in the future if they go to school and graduate, for example I like when he said "You cannot drop out of school and just drop into a good job, you need to have training for it and work for it and learn for it" that's a great way to tell students not to drop out of school and show them they won't be as successful as they can be if they continue with their studies . I also like when he told them that the future of America depends on them that if they quit on school they're not jus quitting on them self they quitting on their country and that twenty years from now they going to be the next doctors, inventors, teachers, police officers, etc., but they will not be successful if they don't complete their education, he told them that every little knowledge they learning in class will be needed to create and help the future.

President Obama gave a lot of example with students who faced and are still facing hard challenge who didn't give up on their studies and set goals for them self including himself and his wife Michelle Obama, the first lady. He explain that having no adult influence, having no money, living in a bad neighborhood, etc. shouldn't be used as an excuse for neglecting their homework, cutting class or miss behaving in class, that where they are today doesn't have to determine where they'll end up in the future. I like when he said "asking for help isn't a sign of weakness is a sign of strength" he ends the

speech by telling them to get serious, to put their best effort to everything they do, to not let their families down nor their country down but most important to not let them self down.

This speech gave me the motivation to continue my studies it showed me that all those excuse I used for messing up in high school was all crap, maybe if Obama was the president four years ago I would've graduate from high school but any who I decide to get my GED and now I'm in college and will graduate in a couple of years with a profession I don't know which one yet but am going to do it, I won't let my family or myself down like Obama said.

Zoraida Alvarez was also impressed with the President's speech. The message she heard was, "there should be no excuse for interrupting your education and students should do their best to t take this wonderful opportunity to learn."

Zoraida Alvarez
September 21, 2009

Obama

President Obama talks about how hes making sure us students are getting everything we need to proceed with our education. He tries to make sure parents get the message from making sure that parents stay on top of us and make sure we get the homeworks done before anything. He makes sure that teachers are teaching and doing there job and making sure they push us to our best and inspire us to do our best of the best. Obama though believes that all of these all good structure for us to get our knowledge and education, but Obama says none of these things will become and any use or effect if we us students don't put our part and work hard and take full responsibilities on what us students are suppose to do like pay attention in class, parcipating, homeworks and projects that we are require to do in class to proceed our education and learning.

He as well, believes you won't find what u want to become in life or what u want to do if you don't go to school and learn these wonderful subjects and materials that are being taught in the class room by our teachers whether we want to become lawyers, teachers, doctors, police officers and so on. He says there shouldn't be an excuse from stoping you from your education because we all students come from different countries and around the world and we all have been through our ups and downs and struggles in life or experiences we may have had. Obama says we have the ability and the choice to choose what we want to do in life and what we want to become, just because we went through or ups and downs and struggles shouldn't be a stop sign why we cant continue on our education, at the end of the day is the choice and the hard work we us students put in.

He believes at the end of the day we as students have the choice to and the freedom to choose our path to the future of our education.

He says even thou as I said before us students may have had our bumps and bruises and we may have fallen and gone through challenges, we shouldn't stop. You don't quit you get up and continue how would you learn if you don't fall here and there, you get up again and keep trying to until you reach to your best because in life you must work hard and well to get what u want or what you want to become in the future.

Coming to my conclusion I believe Obama is very correct on students should make the best of themselves and take this wonderful opportunity to learn and see the world and what they may want to become in life. I do believe you must work hard for what you want, it just dosen't fall from the tree. I believe we have our own minds and the choices we make it depends on us. We all know the right from wrong so we should be able to make our own decesions and the path you take on education, what ever becomes of it is on you. I student believe on working hard focusing no matter what situations your in, you can leave it outside cause your in a classroom receiving that knowledge that might help to reach your goals and make a great use of it and be that cop, doctor etc.. you may want to become.

Anthony is a true believer that the opportunities are there; all he has to do is take advantage of them. In Anthony's words: "I am so grateful because I have so many opportunities and im [*sic*] going to take advantage of it [*sic*], in order to get a good career you need to have a good education."

Anthony Colon

September 22, 2009

Reflection on obamas education speech

My opinion on this speech is that it was very motivating and inspiring. This lecture really changed my whole perspective on how to learn. I think that anybody can do anything that they want as long as they put their mind and hard work and dedication to it. His speech really had an impact on how I see my life and how people see and handle themselves. No matter what people are going threw in life if you think you have it bad there are people who have it worse. You have to just believe in your self and preservier

threw it. Because in my life I've been threw a lot of things and got into a lot of trouble and I never gave up I kept trying and trying and if you want to be successful it takes hard work. You are not always going to succeed in life if you fall and give up that's just negative energy and thinking. The right way of thinking is saying if you fall get up and keep going and that's what is going to make you fulfill your destiny and dreams. A great example is president obama he didn't grow up wealthy with both his parents and didn't always fit in with everyone else but he still stood focused and set a priority and said im going to be someone and look now he is the president of the united states of America. Education is extremely important and you have to get it I am so grateful because I have so many opportunities and im going to take advantage of it, in order to get a good career you need to have a good education. There are so many kids out there who don't really have the support or money to even go to school that's why president obama is trying hard to get us young kids better and more comfortable classes and schools so that we can proceed and make progress in a way that it will benefit us all as a whole.

I was deeply moved and I thought of Anthony's reaction above when only seven days later I received an e-mail explaining the reason for a class absence:

From: Anthony Colon
Sent: Tue, September 29, 2009 2:12:48 PM
im sorry i missed ur class today i had to move back to my moms house
things were not workin in the shelter in queens
so im more stable were im at now and it will be faster for me to get to class

Lamar was concerned about whether there is a gap between promises and the ability to carry them to a successful implementation:

Lamar Jackson

09/21/09

Analysis of President Obama's Education Speech

On Tuesday September 8, 2009 president Obama addressed the nation about the value of education. For me this speech was a message to students, parents, educators and all those responsible for growing up children.

In his speech he stated what was possible for children to make achievements. He encouraged students and parents to rise above the politics that exist in Washington for a long time. He told them to be brave and try new ideas until they find one that is suitable to give students a chance in life. President Obama did not say success was easy. He made a connection to himself and his wife that poverty did not prevent them from getting a world class education and that any child can do the same.

Obama's speech also stated the opportunities students can have in order to make success in life. For example, scholarships voluntary services etc. He said good jobs can be located anywhere there is an internet connection. Also, the most valuable skill you can sell is your knowledge. He also urged students to get educated so other countries will not out-compete them for jobs. Obama said "We are a nation that our future depends on the education of our children. ''This means the success of our country depends on the ability students have when they graduate.

People critize the activity he set for students in his speech but I think that is normal because we live in a country with free speech.My opinion on the speech is positive. My only concern is will he and those responsible, carry out the promise mentioned to make things work? Or will they vote him out of office before the job can be?

Much as I admired the President's speech, which was eloquent and inspiring, I was troubled by the neoliberal overtones accentuating meritocracy, implying "If I can do it, you can do it." In other words, if an African-American man can become President of the United States 46 years after the signing of the Civil Rights Act, you can become a nurse or technician simply by going to college and investing the necessary time and effort. But, as David Harvey asserts, the neoliberal theory

> takes the view that individual liberty and freedom are the high point of civilization and … that individual liberty and freedom can best be protected and achieved by an institutional structure, made up of strong private property rights,

> free markets, and free trade: a world in which individual initiative can flourish is quite different from the actual practice of it. (Harvey, 2006)

The neoliberal overtones reminded me of Napoleon's quote above, espousing the ideals of the French Revolution, *liberté, égalité, fraternité*, and implying that every soldier was given a fair chance of becoming a marshal in the French Army. As Napoleon declared, "Every soldier carries a marshal's baton in his knapsack." History proved that a simple foot soldier could reach the highest rank. Pierre Daumesnil, a private, did become a general in the French Army and a Baron of the Empire (Ryan, 2003). My mathematical mind tells me, however, that before embracing meritocracy ideals, students should consider the likelihood of a positive outcome to their efforts. Reading my students' reflections, I was surprised that they all seemed to believe that the middle class life was within their reach. Chapter 4 explains is some detail why this is no more than a dream for most students taking basic math classes.

International, National, and Urban Context

An examination of the math achievement of U.S. students compared to students in other countries reveals significant differences between the two groups. Every four years Trends in International Mathematics and Science Studies (TIMSS) compares more than 40 participating countries in math and science education. TIMSS is a world-wide assessment and research project that addresses concerns about the quantity, quality, and content of mathematics and science instruction.

Data are collected from many teachers and nearly half a million students in grades 4, 8, and 12. Out of 46 countries that participated in TIMSS in 2003, fourth graders in the United States scored above the average, but their scores were significantly lower than

those of their counterparts in Singapore, Hong Kong, Japan, Chinese Taipei, Flemish Belgium, the Netherlands, Latvia, Lithuania, the Russian Federation, England, and Hungary (Van De Walle, Karp, & Bay-Williams, 2010).

My own observations are consistent with the finding of James Hiebert, who directed the mathematics part of the TIMSS 1999 video study of math and science teaching in seven countries (Hiebert & Ball, 2005). Indeed, most students whom I have met over the years while in graduate school and who studied in Singapore, Japan, Chinese Taipei, or the previous Eastern Block European countries have described to me the math programs that stressed good number sense and the ability to analyze and solve complex mathematical problems.

A comparison between the top-achieving countries and the United States in the lower grades shows that the American curriculum covers many more topics, but the mastering of those topics is shallower. In a typical U.S. class the teacher starts by reviewing previous material or homework, proceeds to demonstrate a problem on the board followed by the students practicing similar problems at their desk and ultimately being assigned similar problems as homework. By contrast with U.S. low-level content classes—in which students keep solving repeat exercises modeled by a teacher but with different numbers—in countries scoring high in math a much higher percentage of the classes is characterized by a high-level mathematical content, i.e., solving complex problems (Van De Walle, Karp, & Bay-Williams, 2010).

To what extent do national averages account for the discrepancy in math achievement between urban students and their more affluent counterparts who benefit from better-prepared teachers and extensive shadow education? *Shadow education* is a term

describing extensive, after-school, private tutoring; one-on-one tutoring; learning centers; test-preparation classes; cram schools; and other services that parallel the school curriculum and strengthen students' performance. Shadow education, prevalent in many Asian nations, has spread to the West and is widely used in private schools and affluent school districts, such as in District 2's Community Education Council in Manhattan.

The participants in this study are at a distinct disadvantage compared to their more affluent counterparts who have access to excellent public schools and extensive shadow education and well-educated parents who will do anything to help their children get ahead and succeed academically. My views in this section have been shaped by my experience as a teacher and by many years of tutoring children in grades 3-8 in public and private schools in Manhattan.

As opposed to the deficit perspective adopted by many educators who blame the students, especially urban students, for their math weaknesses or the neo-conservative perspective, which blames the weak and non-uniform curriculum, I am looking at institutional faults. I argue that these faults can be corrected through better teaching and pedagogy; by modifying curricula and syllabi; and by making better use of classroom time, materials, and technology.

In math education, I find that students all too often a) display an inability to do mental math, b) are terrified of fractions, c) struggle with word problems or problems requiring mathematical logic, d) want to be shown the algorithmic way of *how* to solve a problem rather than try to understand *why*, and e) have no feel for numbers or number sense. In elementary school, students spend much time doing drills at the end of which they obtain a number as a result. Whether that number makes sense is not a goal for most children.

In my opinion, their time would be better spent solving problems requiring integration of facts, critical thinking, and integrating math concepts. Mental math—so critical for obtaining a number sense—is no longer taught or encouraged, as many pedagogues and teachers equate it with rote memorization, something it is not. I discuss in greater detail the virtues of mental math in Chapter 3 and provide a rationale for learning and practicing mental math skills to all students, young and mature.

CUNY Community Colleges

For most urban students in New York City seeking academic training, CUNY presents an excellent alternative to the New York State University (SUNY) schools. Besides its lower tuition for city residents, CUNY offers a high-quality education and the ability to work and commute to school, thereby cutting down on expenses. As stated on the university system's website, CUNY's population of 226,000 is divided among 152,000 enrolled at senior colleges and 74,000 enrolled at community colleges. The CUNY college network comprises 11 senior colleges and six graduate and professional schools. With the exception of Staten Island, there is at least one CUNY community college in every borough: one in Manhattan, Borough of Manhattan Community College, referred to as BMCC; two in the Bronx, Bronx Community College, referred to as BCC, and Hostos Community College, referred to as Hostos; two in Queens, La Guardia and Queensborough; and one in Brooklyn, Kingsborough.

Decreases in CUNY funding

Since tuition covers only a small percentage of their operating costs, the operation of CUNY colleges depends greatly on state and local government support. The last few

years have been particularly difficult. The world-wide financial crisis has had negative effects on CUNY funding.

In a report issued last January and entitled "New York State Underinvestment in Public Higher Education," the Fiscal Policy Institute (FPI) states, "Increased enrollment at SUNY and CUNY simply hasn't been matched by a similar increase in funding." Furthermore, while "next year's classes are expected to be larger than ever…the State budget proposal recommends a decrease in support for public higher education" (FPI, 2009).

Page 15 of the FPI Report states that, in adjusted 2008-2009 dollars per full-time equivalent (FTE) student, New York State's aid to CUNY has decreased in the last 16 years by 26%. On the following page, the report points out the following:

> CUNY's drastic decline in state funding (26%) has been offset in recent years by the increase in New York City's contribution—which is now 31 percent above the level it was at [sic] in 1991/1992. (FPI, 2009).

In 2009 this information was worrisome in light of New York City's budget deficit, exacerbated by the economic downturn and the worst performance since the Great Depression on Wall Street, the latter being a major source of revenue for the city. In the conclusion section the FPI Report states,

> Coming out of this recession, New York should also be looking to increase opportunities for people of color and to expand the middle class. Public higher education is an important part of any strategy to help reduce economic polarization and to address longstanding racial inequality in the state. Especially in the current economic environment, New York has a strong interest in counteracting the years of underinvestment in SUNY and CUNY by increasing state and local investment. (FPI, 2009)

CUNY students

New York State Education Law states the following about CUNY:

> [It is] supported as an independent and integrated system of higher education on the assumption that the university will continue to maintain... provision of equal access and opportunity for students, faculty and staff from all ethnic and racial groups and from both sexes" (CUNY mission statement).

The law requires CUNY to "remain responsive to the needs of its urban setting." Naturally, for immigrants and low-income minority students, who were most affected by the economic downturn of 2008 and 2009, the chances of finishing college will diminish if they cannot afford the tuition or do not get sufficient financial aid. The evidence suggests that students in Manhattan, Queens, Brooklyn, and the Bronx flock to the community college closest to their home. Table 2.1 below compares senior colleges with community colleges' student population breakdown by race/ethnicity. Table 2.2 provides the percentage breakdown for each one of the community colleges. In the tables the percentages are rounded to the nearest percent and the student numbers were rounded to the nearest thousand.

Table 2.1

CUNY Students --Total Enrollment by Race/Ethnicity (the three major racial/ethnic groups only). Fall 2006

	Total	Black	Black	Hispanic	Hispanic	White	White
All CUNY	226,000	63,000	28%	56,000	24%	72,000	32%
Senior Colleges	152,000	39,000	26%	32,000	21%	57,000	38%
Community Colleges	74,000	24,000	32%	24,000	32%	15,000	20%

Based on CUNY Office of Institutional Research and Assessment Table: ENRL_0030

Table 2.2

CUNY Community Colleges--Total Enrollment by Race/Ethnicity and College Fall 2006

	Amer. Indian / Native Alaskan	Asian / Pacific Islander	Black	Hispanic	White	Total
BMCC	0.1%	14%	39%	31%	16%	18,000
Highland	0.1%	4%	41%	52%	3%	9,000
Concourse	0.1%	4%	33%	60%	3%	5,000
Kingsborough	0.1%	12%	32%	14%	41%	15,000
LaGuardia	0.2%	21%	22%	38%	18%	14,000
Queensborough	0.3%	24%	28%	23%	25%	13,000
Total	0.2%	15%	32%	32%	21%	74,000

Based on CUNY Office of Institutional Research and Assessment Table: ENRL_0030

As the table above shows, Black and Hispanic students predominate at most community colleges. In the Bronx, Black and Hispanic students represent over 90% of the student population, with the percentage of Hispanic students alone exceeding 50% at each college.

As for gender distribution at CUNY community colleges, women constitute about 60% and men about 40% of the students. The female-to-male ratio is even more

pronounced among Black and Hispanic students: Of the 23,900 Black students, 65% were female in 2006. Of the 23,600 Hispanic students, only 37% were male (OIRA, 2008).

Basic courses in CUNY community colleges

Until 1998 CUNY maintained an open-admissions policy in all its postsecondary institutions and offered remedial courses for students who were under-prepared for college-level coursework. A new policy came into being after 1998, when Mayor Rudolph Giuliani and Governor George Pataki agreed to a plan to discontinue offering basic courses at all CUNY four-year colleges. Under that new plan, students who failed placement exams in reading, writing, or math were to be directed to a two-year community college. The plan would have affected about 1,000 students every year (New York Times, 1998).

Mayor Giuliani, who strongly opposed basic courses at the college level, named a task force to investigate how CUNY was spending the $110 million dollars it received each year in subsidies from the City of New York. To quote Mayor Giuliani,

> If we are promising a college education, we should deliver one...and if we stay on the present course, that isn't going to happen...I'm sure this task force will make recommendations that dramatically change that course and re-establish for CUNY college-level work. (New York Times, 1998)

Mayor Giuliani achieved his goal: On January 25, 1999, CUNY's Board of Trustees voted to eliminate basic courses at all 11 senior (four-year) colleges. Given that over 80% of the country's four-year colleges were offering and continue to offer basic courses (National Center for Education Statistics, 1999), many echoed William Crain's reaction that "More fundamental are issues of social justice. Within CUNY, a disproportionately large number of students barred from the four-year colleges will be students of color"

(Crain, 1999). As with any policy issue of this magnitude, there is a wide schism between those advocating basic courses and those opposing them.

Nowadays, to gain admission to a CUNY senior college students need to have one of the following scores: a 510 or higher on the SAT, a 21 or higher on the ACT, or a 75% or higher on the New York State Regents exam. Students who do not meet these criteria must take an aptitude placement test; those who score below the cut-off (see Table 2.3 below) are directed to a CUNY community college where they must take basic courses in math, reading, writing, or all three.

Table 2.3

Proficiency Requirement in Mathematics – CUNY Colleges

College	**SAT**	**ACT**	**NYS Regents**	**COMPASS®** Math1	**COMPASS® Math 2**
Baruch	510	21	75	45	45
Brooklyn	510	21	75	45	45
City	510	21	75	45	45
Hunter	510	21	75	45	45
Lehman	510	21	75	45	45
Online Baccalaureate, SPS	510	21	75	45	45
Queens	510	21	75	45	45
College of Staten Island	500	21	75	35	30
John Jay	500	21	75	35	30
Medgar Evers	500	21	75	36	38
NYC College of Technology	500	21	75	35	30
York	500	21	75	40	35
Borough of Manhattan	480	20	75	30	30
Highland	480	20	75	30	30
Concourse	480	20	75	30	30
Kingsborough	480	20	75	30	30
LaGuardia	480	20	75	30	30
Queensborough	480	20	75	30	30

The Bronx (Concourse and Highland)

According to the most recent U.S. Census bureau figures, in 2008 the Bronx County population was roughly 1.4 million, or about 17% of New York City's population of 8.2 million. The 3.25 million people who view themselves as Hispanic or of Latino origin represent 40% of New York City's population. About 725,000 of the city's Hispanic/Latino residents live in the Bronx, where they constitute nearly 52% of the total population. In the Bronx, the 602,000 people who consider themselves Black (that includes immigrants from Africa and the Caribbean) constitute 43% of the county's population.

The composition of the student population at Highland mirrors that at Concourse. At Highland, the student population is 42% Black and 52% Hispanic, while at Concourse the ratio is 33% Black and 60% Hispanic (OIRA Table: ENRL_0030). Concourse appeals to many Hispanic/Latino students, because some courses are taught in Spanish.

Highland Community College

As in other community colleges, Highland offers specialized training in fields such lab technology, computer science, nursing and allied health professions, and information technology. The 60-credit course of study normally takes two years to complete when pursued full time; however, as mentioned earlier, this period often stretches out to five or six years. At the completion of their studies, most students at Highland end their education with the associate's degree that the school offers, though a few transfer to a four-year college.

The basic math courses at Highland cover the equivalent of two to three years of public schooling in a single academic semester. Some notable differences between public elementary and high school classrooms and basic college courses are as follows: a) Homework, which in math parlance translates to practice—mandatory in school, optional in college; b) Teaching—more student-centered in school, instructor-centered in college; c) Materials and visual aids—user-friendly in school, virtually non-existent in college; d) Cost of textbooks—free in school, expensive in college; e) Teaching pace—slow with many repetitions in school, accelerated, without repetitions in college; f) Textbook language—user-friendly in school, turgid and abstract in college; g) Note-taking skills—less important in school, important in college; h) Calculators—available in school, prohibited in basic math classes in college; and i) Students' level of fatigue—not a factor in school, often widespread in college.

How could a student with a job and a family master in four-and-one-half months math concepts typically covered in three years in middle or high school? Some students at Highland take the same courses several times before they pass them. Many more simply give up and drop out of college. There seems to be little doubt that the above factors influence the graduation rate and time-to-degree.

Making Sense

The evidence assembled in this chapter from CUNY enrollment data shows that 95% of the students enrolled at Highland and Concourse are Black and Hispanic. This percentage representation is by far the highest among all CUNY community colleges. For many, the associate's degree represents a way to escape poverty and join the ranks of the middle class.

What do the low retention and graduation rates of students in the Bronx, combined with an excessive time-to-degree, mean for the formation of human capital in the Bronx, for the ability to fill the jobs in the communities that need them the most, and for this society to reduce disparities in educational attainment among different ethnic and racial groups?

The deficit perspective blames the students' failure to graduate on their previous education, poor study skills, lack of persistence and motivation, bad teaching in middle school and high school, and in general on the students' unpreparedness for academic work. In this dissertation, I counter that perspective by showing not only that most students have the motivation and persistence to succeed academically but that they are also able to fulfill the requirements and receive respectable grades in their major. Where they falter is in the basic math classes. Oddly enough, these courses are often not even a pre-requisite for their major.

This chapter has raised troubling questions. I am reminded of Escalante's frustration at getting his colleagues to believe in his students' potential. In my students I see the image of many of my childhood friends and colleagues, who—disregarded by an indifferent educational system—were weeded out to a life of diminished possibilities. The following chapter, retracing my formation as a math educator and researcher, is meant to cast light on my present stance.

Chapter 3

My Formation as an Urban Math Educator

Invatati, Invatati, Invatati!
Study, Study, Study!
-- Quote from V.I. Lenin emblazoned on the front walls
of the classrooms in my elementary school

Contextual Background

The low graduation rate at public community colleges is attracting increased attention in scholarly journals and the popular press. A central tenet of this research is that quality teaching combined with transformative tools, innovative pedagogical practices, and structural changes will help increase the graduation rate, decrease the time-to-degree, and lower the costs to the taxpayer and other stakeholders. In this chapter I discuss my formation as a basic math teacher and researcher. My stance on education has been influenced by many factors, including dislocations resulting from immigration, exposure to different languages and political systems, and a deep empathy with my students whose struggles mirror my own.

In this chapter I discuss my formation as a basic math teacher and researcher. My stance on education has been influenced by many factors, including dislocations resulting from immigration, exposure to different languages and political systems, and a deep empathy with my students whose struggles mirror my own. In the process of moving from one country to another, I was taught by teachers embodying contrasting ideologies: from socialist to capitalist, from sifting and tracking to inclusion, from glorifying

individual achievements to stressing group work. Ultimately, the twisted path I followed—not entirely by my own choice—toward becoming a teacher and researcher made me the odd–man-out most of the time, but also enabled me to think reflectively on how best to relate to my students and how to try different ways to teach and help them learn elementary math concepts.

Contextual Background

For the last 20 years I have lived in Manhattan, just a few blocks from Metropolitan Hospital in East Harlem. From my living-room window I have an unobstructed view of the Bronx straight to the Yankee Stadium. Based on my observation of the lights there, I know when the Yankees are playing on their home turf. Yet despite this proximity, for many years my visits to the Bronx were limited to the occasional ball game with my brother-in-law, a diehard Yankees fan who was determined to teach me the rules of the game and turn me into an ambulatory baseball statistician as some of my students are.

These were special nights indeed. They started with a ride on the number 4 subway train, an exit at the 156th Street stop, and then a walk uphill toward the Court House. The first time I took this trip I was bemused by my brother-in-law's instructions for getting to the Court Deli, where we had agreed to meet and grab a bite before the game. "Take a copy of *The Bonfire of the Vanities* and follow Wolfe's instructions on page 24," he told me.

In the deli I felt the Bronx atmosphere. Spanish was music to my ears, even though it took many years until I applied myself to learn and master the language. Boom boxes blasted salsa, merengue, cumbia, bachata, and reggaeton, while the pungent aroma of pastrami, mustard, and French fries flooded my nostrils and enticed my taste buds. These

enduring sensory moments are reawakened whenever I pass by the Court House. Arriving early at the stadium, I remember flipping through the pages of *Bonfires* and wondering how many "suits" had season tickets at the stadium but never dreamt of venturing into the south Bronx and mingling with the local population.

Years later, when I became a "suit" on Wall Street, I still looked forward to going to my favorite deli. The cheering crowds at Yankee Stadium brought back fond memories of Bucharest's huge soccer stadium, *Douazeci si trei august* (which means August 23 in Romanian), commemorating the day in 1944 when the Soviet army liberated Romania from its fascist yoke. Much as I enjoyed these outings to Yankee Stadium, to my brother-in-law's disappointment I never did cotton to baseball. The game was simply too slow, putting me to sleep more often than not. The only good thing about the sport is that the spectators appear to know all kinds of statistics about the players.

Sometimes on my way to the stadium, instead of continuing on the subway to 156th Street, I would get off at the 149th Street/Grand Concourse station and walk among the throngs of college students coming out of their classes. Not a word of English was spoken, but I knew they were talking about school. Then I would continue north on Grand Concourse until I reached 159th Street and walk up the hill toward the majestic courthouse. Once I made that turn, I could hear the music and smell the pickles, pastrami, and other tempting aromas. Entering the Court Deli, I would be greeted by our friendly waiter again with his "¿Como le va, señor?' What an embarrassment! After mustering a feeble "Bien, gracias, y usted"? I had to ask sheepishly if he minded switching to English.

My story begins in a different cultural setting in Bucharest, Romania. To this day certain sections of the Bronx remind me of the old neighborhood, where soccer was the

national sport, just as it is in Central and South America. After school I used to play soccer in the street with my friends, watching out for protruding cobblestones. We did not have a real soccer ball but rather a sock stuffed with rags. Two stones served as goal posts, and away we went! When we tired of soccer, we would switch to *tzurca*, our version of stickball.

On Tuesdays I waited in line for hours to buy tickets to the weekend games, and on Sundays my brother and I watched two official soccer games at the stadium. Hoarse from cheering for our favorite teams, *Dinamo* or *Steaua*, at the stadium, we could only whisper on Mondays in school.

Cultural Context

Growing up in communist Romania, I experienced firsthand the conflict between a socialist worldview in school and a capitalist orientation at home. My father used to run a private store, which stigmatized me as having an "unhealthy social origin".

In school we studied Marxism and scientific socialism; at home, my father tried to listen quietly on his Blaupunkt radio to the *Voice of America* and *Radio Free Europe*, anathemas in a socialist society. To avoid conflict my father had the prescience to teach my brothers and me how to navigate the socio-political waters without creating any waves through the approach used by Lessing in the story with the Ring Parable in *Nathan der Weise,* (Lessing, 1868.) Waves were the last thing my father wanted to create in a country that taught children to denounce their parents or, indeed, any relatives suspected of anti-socialist activities.

Elementary School

When I first walked through the gates of Elementary School Number 97 in Bucharest at the tender age of seven, I realized that my life was taking a significant turn. No sooner had I entered my first-grade classroom than I gazed at the stern portraits of the four leaders whose doctrine and teachings were to shape much of my Romanian education: Karl Marx, Frederick Engels, Vladimir Ilyich Ulyanov, better know as Lenin, and Jozef Vissarionovich Dzhugashvili—better known as Stalin. There pictures remained on the wall many years after their passing, The first words I learned to spell were a quote from Lenin, "study, study, study."

Lenin, a progressive educator who advocated the education of preschool children, believed in the elimination of illiteracy and embraced ideas of polytechnical education, similar to the ideas espoused by John Dewey (Spring, 2006). Another influential educator was Jozef Stalin, whose famous statement "man is the most precious capital" was emblazoned on my classroom walls. Stalin was greatly influenced by Anton Semyonovich Makarenko, a strong believer in the ethic and joy of hard work and who in the 1930s introduced centralization and tighter controls on education, resulting in the standardization of curriculum, texts, teaching methods, and teacher manuals (Spring, 2006).

The contradictions inherent in the collective | individual dialectical relationship were mediated in the socialist society by the education I received in school; societal interests had to take precedence over individual interests. Being an exemplary student, I was finally awarded the coveted red tie in third grade and was allowed to march in the national parades on May Day and November 7 (Russian Revolution Day) where I

shouted from the top of my lungs "USSR is the bastion of peace! Long live the international proletariat! Death to the capitalists and their agents!"

The clash between the ideas taught at home and those taught at school caused me great anguish. Twice a week a rabbi came to our home to teach us Hebrew and Judaic studies, subjects that ran counter to our agnostic culture at school, which deplored any overt manifestation of religion or its practice. At home we lived a very comfortable life made possible by Father's private business. In school we were taught that the capitalists were "blood suckers of the masses" and "doomed to extinction." I was a true believer in those days.

As in the Soviet Union and the rest of the Soviet bloc, discipline and good behavior were highly valued in school and stringently enforced. Our uniforms had our school number embroidered on them, reminding us to represent our school with dignity when we were outside of school. Before classes started each morning, we congregated in the schoolyard—uniforms pressed, shoes shined, hair cut to regulation length and style—waiting for the assistant principal to give each of us his nod of approval. Woe to the student whose shoes were scuffed, whose uniform was wrinkled, whose hair exceeded four centimeters! Breaking school rules—for example, not doing homework, talking in class, being disrespectful to adults, talking without permission, not sitting properly at the desk—was severely punished, corporally or with bad grades. When parents came to parent-teacher conferences and learned that their son was not pulling his weight, they typically asked the teacher to administer more corporal punishment. As I attended an all-boys public school, I do not know how discipline was enforced in all-girls schools.

When it came to academics, we received a solid education in math, history, geography, languages, literature, and the arts. In high school we also studied French, Romanian, Latin, and, of course, Russian, Russian, and more Russian. The teacher of Russian language, the wife of a Soviet officer stationed in Bucharest, told us repeatedly that studying Russian was more important than studying math, as evidenced by the fact that we had six hours a week of the subject compared to only five hours of math.

Not to be outdone, our math teacher compensated for this discrepancy by assigning extra homework and slapping us across the face for "negative points" according to his own complex formula. The punishment count was influenced by the gravity of the errors (math thinking vs. calculation). As a result, some students ended up being slapped between 20 and 30 times on each cheek before the class even started. Discipline problems were virtually nonexistent in math class. If we talked without permission, we were banished to the corner of the room and forced to kneel on cracked walnut shells.

Despite the propaganda, rote learning, and at times cruel physical punishments, I had the good fortune of being taught by many inspiring teachers who radiated a love of learning; nurtured our intellect; and inspired us to inquire, think, and question. The American slogan "All children can and will learn" was unheard of Romania. My childhood friend, Constantin C. Constantin, who probably had a learning disorder, was considered to lack native "intellectual endowment" and repeated third grade several times before being dematriculated from school for not acquiring reading skills or mastering his math facts. Constantin later found employment as a dog catcher, rounding up stray dogs in the city.

In addition to math, science, and languages, we also received an excellent liberal arts education, which was much enhanced by frequent trips to the National Museum of Arts, where we viewed masterpieces depicting the Russian revolution and the heroism of the Soviet soldiers during World War II. We sang many patriotic songs, some in Romanian and some in Russian.

Our learning of math in school was constantly reinforced in our daily lives. Every day we listened to radio economic reports to learn, in percentages, which factories were ahead of the provisions of the five-year plan and by how much. We knew how important it was to surpass the capitalists in industrial and agricultural production. As a result of the consistent brainwashing, working with fractions and percentages became second nature to me, to the benefit of my students in basic math classed at Highland, where I've been teaching for the last nine years.

The Virtues of Mental Math

Mental math is the ability to do mental calculations using the human brain without the aid of a calculator, computer, or paper and pen. When we work with any of these devices, or even with a pencil and pen, the objective is to obtain an exact number. By contrast, the first step in mental math is to decide whether we are looking for an exact number or an approximation.

Fiona Ell, a mathematics education researcher at the Faculty of Education, University of Auckland, New Zealand, found that promoting mental calculation methods and delaying written methods until conceptual understanding is established will benefit students in making sense of numbers and problems (Ell, 2001). Elizabeth Fennema and

Thomas Carpenter found mental math strategies are beneficial not only to students but to teachers as well (Fennema & Carpenter, 1996).

Not all children are equally adept at using mental math. It was just the luck of the draw that I came into the world wired for math. The subject always came easily to me; equally important, my teachers and brother instilled good work habits in me at a very young age. The biggest influence in my math development was my elder brother, Joshua, who helped mold my mind through mental math problems. With infinite patience, he instilled in me a love of math as well as an appreciation of its beauty. Puzzles such as "How would you find the heavier of nine identical-looking balls—the other eight are equal weight—by using a balance only twice? were de rigueur at our dinner table.

Not many people had watches when I grew up in Romania. Joshua's watch was the subject of constant irritating questions when he was walking in the street: "Hey, boy, what time is it"? or "Boy, how much time to lunch"? Each one received an appropriate answer: "630 minutes to midnight" or "another 900 seconds." With a grin on my face, I would translate my brother's answer to simple Romanian. I was in second grade.

By the time I was in fourth grade I learned from Joshua how to mentally multiply larger numbers. Example: "Eric, how would you multiply 88 by 7"? Here is a rendering of the answer I was supposed to provide:

We break 88 into 80 and 8.
Therefore, we multiply 7 times 80, then 7 times 8, and then add the results.
Since 7 times 8 equals 56, 7 times 80 will be 10 times larger, or 560.
We add 560 and 56. Final answer is 616.

By the time I entered fifth grade, Joshua expected solving the question using a different

logic:

First the approximate answer. The answer is a bit smaller than 7 times 90, or 630.
Since 88 is closer to 90 than it is to 80, we regard 88 as 90 from which we take away 2.
Therefore, we multiply 7 times 90, then 7 times2, and then subtract the results.
Since 7 times 9 equals 63, 7 times 90 is 630. Now, 7 times 2 is 14.
We take away 14 from 630. Final answer is 616.

As a result, when I took algebra, I was able to understand why $5(3x-4)=15x-20$ By contrast, many college students will distribute only to the first term in parenthesis without comprehending why $5(3x-4)\neq 15x-4$

I have been doing mental math warm ups at the start of each basic arithmetic class at Highland as well with my pre-service teaching students. I drew on my own experiences and the promising research done by Ell and Fennema and Carpenter on the benefit of promoting mental math in children aged 9 to 11. I was happy to observe that in a short time my Highland students were able to perform correctly perform mentally calculation such as $79-\frac{5}{12}=78\frac{7}{12}$ by understanding the pattern and developing mental images.

High school

Following the Soviet model, Romania's minister of education ensured that 80% of the places in high school went to children of a "healthy social origin," that is, the children of workers and peasants. Students not accepted into high school were directed toward vocational schools and became tile layers, masons, carpenters, bricklayers, and plumbers. Those students who were fortunate enough to be allowed to emigrate to the West found their skills much in demand, especially in countries like the United States, which looked down on manual labor and the trades. Social efficiency (Kliebard, 2004) was what the

socialist economic system was all about. The Communist Party preached that the key to overcoming western capitalists in production of industrial and agricultural goods was through professional training and maximum efficiency.

After several blizzards in January or February, we often had the good fortune to be out of school for a few days. We were recruited to perform patriotic work by clearing the roads with shovels. Except in winter, on weekends we would crowd the soccer stadiums to root for our favorite team: *panem et circem* (bread and circus) was the method by which the proud descendants of the Roman emperors kept the masses ignorant but content. During the Cold War, the communist parties of the Eastern bloc countries had their ministries of education devise an elaborate testing and selection system for identifying children talented in math and physics. In ninth grade I earned second place in the nationwide physics Olympiad. As in other communist countries, sports and physical education were serious subjects in Romania. Through systematic testing and training, the country developed its future generation of gymnasts (I was one), weight lifters, boxers, and other athletes.

While living in Romania, I was exposed to the history and culture of other countries, even though the subjects were taught through socialist lenses. We read the classics, and we spoke several languages fluently. The Latin I took in high school facilitated my learning of other Romance languages such as Italian and later Spanish. At home I was taught Judaic principles in secrecy by a rabbi, but in school atheism was the only acceptable religion. Since Christmas was not celebrated, the Christmas tree was called the New Year's tree.

Early Influences

The pedagogical questions I now wrestle with were probably of no concern to the bureaucrats or teachers who worked in the standardized socialist education system. Below are the main characteristics of the Romanian education system I received.

Basic premises

The socialist system was a meritocracy that bestowed many perks on its top performers. The system was based on uniformity: uniform standards, uniform curricula, uniform syllabi, and uniform textbooks. There was a prescribed textbook for grade 4, another textbook for grade 5, and so on. There were also uniform teaching methods and uniform classroom materials. Unlike in the United States today, it was not medicine or finance that commanded the highest respect in Romania but science and engineering. The scientists were the ones who would help the country increase its hydroelectric power and surpass the capitalist countries in heavy industry.

The unstated goal of the Romanian education system was to identify the top students in math and science and to offer them a coveted seat in the schools of science and engineering at the state-supported universities. The Ministry of Education was in charge of setting the curriculum for each subject in each grade. The Ministry decided on milestones for student performance. For example, grade 4 teachers knew exactly what topic to cover by a particular month of the school year. As far as I can remember, no allowances were made for a student's cognitive level of maturity. At the end of each school year, I always acquired the textbooks for the following year. The books were

clearly marked 5th grade math, for example. During the summer I studied the material and completed the assignments before school started in September.

Teaching / pedagogy

My teachers knew their math inside and out, or so it seemed at the time, along with the national curriculum. This is the type of system Kincheloe probably referred to when he spoke of top-down standards (Kincheloe, 2003). I shudder when I recall how my good teachers employed methods comparable to the ones used in rural schools in the U.S. during the 1820s, when "the rod was better, because it involved less risk of injury to the student" (Kaestle, 1983, p.18). The rod was widely used by one of my favorite middle school teachers who tried to persuade me to follow in his footsteps.

Students who did not understand math were called "lazy," "stupid," or "lazy and stupid." Those who did not understand the material had to repeat a grade until they demonstrated their understanding by passing exams. Those who failed to pass year-end exams were weeded out of the system and assigned to either vocational school or relegated to menial jobs. Not everyone was good at math; fortunately, society needed non-math-oriented workers in large numbers. As one of the fortunate few who were well wired for math and had survived the Romanian education system, I was now ready to spread the math education gospel on other continents.

The Big Escape

It was easier to cross the Red Sea of the biblical story than to leave Romania. Nevertheless, my family was finally allowed to leave the country after being denied exit visas for eight years in a row. Applying to emigrate cost my elder brother his seat in

university, where he was already in the last year of study. I had to leave high school in the middle of ninth grade. We spent the year before departing Romania eagerly waiting for our father's return from prison (his crime: possessing a small box of zippers and buttons, which he bought from a government-owned store, in order to resell in his store at a higher price). Together with all the other merchants in Bucharest, he had been sentenced for "economic crimes" in the last sweep of the economic police against private businesses. Naturally our store was confiscated and our family's finances ruined.

Devesh Kapur and John McHale examined the conditions under which prospective emigration takes place. The uncertainty of being granted permission to emigrate notwithstanding, the members of our family were "certain of receiving a higher return on human capital investments should the opportunity to emigrate arise" (Kapur & McHale, 2005, p. 73).

We were finally allowed to leave the country penniless, with a few personal belongings each, a transit pass instead of a passport, and a one-way ticket to Israel for each member of the family. We had to sign an affidavit stating that we were asking to renounce our Romanian citizenship out of our "free will and without coercion." Properly notarized, the affidavit carried stamps in the value of several thousands of Romanian *lei*, which we affixed to it.

Emigration from Romania was the first step in my becoming a global citizen. The move to Israel took us through Tito's Yugoslavia and through Milan, Florence, Rome, and Naples in Italy. Accustomed to seeing long lines for the rationed bread and milk in Bucharest, our eyes opened wide upon discovering the multitude and variety of products available in these cities—peaches, coffee, umbrellas, Levi jeans, Toblerone.

Other Educational Models

In Israel I found a country that was leaning politically to the left. The founding fathers were all immigrants from Poland and Russia, and the governing coalition was composed of the Labor and United Workers parties. Medicine was socialized. Women and men were equal not just in doing menial or professional jobs but also in serving in the army, though not in combat. The *Histadruth* (workers' organization) controlled the industrial production. All workers were unionized, and agriculture revolved around collective farms (*kibbutzim*). If a student wanted to be very well paid, becoming a member of the bus drivers' cooperative, *Egged*, was by far a better option than seeking admission to medical school.

Before entering university, I lived on a *kibbutz* and enjoyed the ideal communist society. There was a common dining room where everybody took turns serving meals and cleaning up. Every morning, a taskmaster assigned us to the job of picking oranges or working in the field. After reaching the age of two, boys and girls lived in children's houses and visited their parents only a few hours a day. A married (or unmarried) couple was assigned a single room in a nice row house. A married couple with children received a one-bedroom apartment. The lawns were lush and green, and everyone appeared to be happy. At night we convened in the communal dining room in pressed pants and shirts and sang patriotic songs in Hebrew or Russian.

Elementary and middle school children were transported to and from the local school in a school bus that served several *kibbutzim.* There, children called their teachers by their first name, and the atmosphere was egalitarian and friendly. School subjects were related to real life. This was the progressive education system at its best. Though I could not

make sense of this at the time, I had gone from the post-Stalinism of the 1950s and 1960s to Leninism and Dewey's education model of the 1920s (Kliebard, 2004).

To gain admission to the math and physics department at the Hebrew University of Jerusalem, I had to complete the equivalent of a GED battery of tests in Hebrew. This meant receiving instruction and taking notes in a language that I was still learning and which used a Semitic alphabet. Having to study in a different language had a lasting effect on me: I do empathize with and understand the difficulties some of my students face when English is not their mother tongue. My Highland students bring to college not only their language but their culture as well. Several years later in my post-graduate studies in Montreal, Quebec, I had to switch languages again, this time from Hebrew to English.

Becoming a Global Citizen

The Canadian education system was definitely Western. Montreal, a French-speaking island in the middle of an English-speaking ocean, is a cosmopolitan city, blending European and North American traditions. McGill University was, however, strictly British in its culture and seriousness toward study. Upon graduation from McGill and after landing my first job in the province of Quebec, I had to switch languages again, this time from English to French. Fortunately, the Quebec government provides many free French classes, making life much easier for those interested in acquiring the language.

I moved once again, this time from Canada to the United States to work in the high-tech industry. The company I joined, Satellite Business Systems, was preparing to launch the first commercial satellite to be used for voice and data transmission as well as for teleconferencing. My master's work on computer communications proved especially

useful. We had some technological successes and some setbacks as well. One of our satellites was supposed to be put in orbit by the space shuttle Challenger; the shuttle disintegrated, leaving millions of people horrifically spellbound. Thousands of children all over the United States watched the live launch broadcast: The first member of the Teacher in Space Project, Christa McAuliffe, disappeared in space 73 seconds after launch.

I do not consider these years I worked on Wall Street meaningful to my formation as an educational researcher. There were very long hours of work, fancy titles and business cards, a fancy work office in World Trade Center #2, but no job satisfaction. One of my colleagues best summarized our activities as being "engaged in the business of selling useless investments to people who neither need nor can afford them; by using numbers and statistics, we turn our products from useless to useful."

All that changed after the terrorist attacks of September 11, 2001. Badly shaken from a near-death experience, demoralized by the scandals in the financial services industry, and unable to return to my former place of work downtown, I had an epiphany: I wanted to do something different, something constructive, something personally rewarding. The problem was that I did not know what to do or where to begin.

A few weeks later, the intern who was supposed to start working with me on September 11 and who was at my side when Tower 2 of the World Trade Center collapsed suggested that I try teaching math courses at Highland Community College. My first reaction was, "Is there a community college in the Bronx"? I sent in my résumé, went for an interview, took a math test, and was told I had the qualifications but had to wait until a position opened up, possibly in the summer. A week later, I got a call from

the department chair asking if I could start teaching the next day. Though the compensation was significantly lower than what I was used to, I jumped at the chance to work as a part-time adjunct lecturer in basic math.

Equipped with a syllabus, a textbook, and policy guidelines stating that no calculators are allowed in basic math classes, I headed uptown to teach fractions, percentages, and elementary algebra to students who had failed CUNY's Skill Assessment Test (SKAT), the placement exam administered to incoming students. Little did I know this would be the first step of a journey toward becoming an education researcher.

All the changes, dislocations, and language adjustments I had endured helped me empathize with my Highland students, with their language difficulties, and with the conflict they have to navigate between their upbringing at home and their need to conform to the dominant culture at school. How different was this new world from the one I was used to in downtown Manhattan: Dress: Low-slung jeans and t-shirts versus natty suits and French cuffs; ethnicity: Hispanic and African-American versus predominantly White; education: GED versus MBA; socioeconomic background: Many single mothers, some on public assistance versus high-earning business owners and executives, mostly men.

Coming Full Circle

When reflecting on my formation as a teacher, I begin to understand the role played by a rather unusual sequence of events that contributed to my ability to address contradictions emanating from cultural and social differences and to use my students' and my cultural capital to bridge cultural differences. In her Ph.D. dissertation, Linda Loman attributes her formation as a physics teacher to her extraordinary experience of teaching with the

Peace Corps in Papua New Guinea (Loman, 2005). In my case the biographical narrative helps explain both my unusual trajectory from a communist upbringing in Romania to Highland and the way I situate myself in a community college setting.

In Romania it was assumed that not all children were wired for math. Classrooms were teacher centered, and students were expected to raise themselves to the level of the teacher. The teacher's pedagogical style was never questioned. Highland, offering vocational training to students, reminds me of what the education system in Romania was all about.

Most primary- and secondary-education classrooms in the United States nowadays are student centered. Elementary and middle school teachers are expected to bring their students to a common level of understanding, differences in learning style and ability notwithstanding. Many elementary school classrooms are emblazoned with slogans like "All children can and will learn" and "We are a community of learners." I have noticed that when talking to one another by the water cooler, teachers often refer to certain students as being "smart" or "clever" in math but they generally don't make these statements or use these particular words in public. Instead, struggling students are told that the key to mastery lies in "working hard" and "using your strategy."

Becoming a Teacher

"Why are you teaching math when you can make more money in industry?" "Many teachers in the NYC public school system quit after five years—who can blame them?" "I would never encourage my child to go into teaching." Sadly, these remarks are frequently heard at social gatherings whenever the subject of teaching comes up or whenever someone hears of my desire to enter the profession.

Why is the teaching profession held in such low regard in the United States? Is it because of the low pay; or because of the often miserable working conditions; or because teachers have little say on class size, selection of materials, and methods of evaluation (Rousemaniere, 1997)? Despite these criticisms, parents still want their children to be taught by dedicated, highly qualified teachers. Americans are often surprised to learn that teaching is considered a high-status profession in countries like Japan, Hong Kong, the former countries of the Soviet block, and other countries where 8th graders score higher on literacy and math exams than in the United States.

I did not realize it nine years ago when I entered my first class at Highland, but I had come full circle in my worldview. The communist system I grew up in preached that everyone should produce according to his or her ability but should be compensated according to family needs. By offering vocational training to low-income students, Highland reminded me of some of the nobler principles in the communist education system.

Helping students understand math and make connections to real life, encouraging them to stretch and grow, relating to students as individuals and in their own language—these are just some of the ways I tried to reach my students. bell hooks refers to teaching as a "liberating experience" which is "tantamount to ecstasy" (hooks, 1994, p. 201). That has been my experience, too. In *Teaching to Transgress* hooks states, "The academy is not paradise. But learning is a place where paradise can be created" (hooks, 1994, p. 207). Even though Highland's admissions policy could be described as partly social efficiency and partly social meliorism, for me the attraction was based only on social meliorism (Kliebard, 2004).

Since 40% of students at Highland are African-American, I often wonder whether they prefer to be taught by a teacher of the same race. I still do not have an answer to that question, but I would like to think that the students see beyond race and ethnicity. Teaching at Highland has also opened my eyes to the enormous obstacles my students face in their everyday lives at home. My students are poor, mostly women, and living at the margins of society. Most of them are under-prepared for college work in substantive ways and must take two or more classes in basic math and sometimes in reading and writing as well. Many are single mothers on public assistance. I suspect that more than a few of my students have undetected learning disabilities. At the same time they are active, taking control of their lives, and ready to incorporate new ideas into them. From the perspective of sociocultural theory, the students have agency and are ready to appropriate structures (Sewell, 1992).

My student Zoraida exemplifies Sewell's theory:

September 9. 2009
My name is Zoraida Alvarez, and I'm 25 years old and I'm majoring medical assistance. I take Math 01A- on Mondays and Wednesdays in order to go to the course that I need which is algebra- for my major. Math is my least favorite subject. I'm always confuse on the steps and at times I get it. Its hard for me at times to understand the operations for certain problems and when I do understand it, theres always a new ste that comes for a different problem, and it leads me back to being lost. I want learn and understand math cause I knew we use in in our daily lives. I would like to learn from my mistakes and understand it much clearly on order to be able to pass my classes.

Through my work I have come to see how the gross inequities in the distribution of educational resources across schools in the city are partly responsible for the low achievement among socially disadvantaged students. That disparity exists not only in

math but in science, too. Emdin points out that Black and Latino/Latina students in urban areas take fewer science classes and perform worse on standardized science exams than their peers in the more affluent schools; the Bronx students from the site of Emdin's research (Emdin, 2006) scored 20% lower than their peers in other boroughs on the New York City assessment tests in science.

The reasons for this underachievement are multifaceted and cannot be reduced to a single answer, but here are a few likely structures that might mediate: More inexperienced teachers, lower funding compared to suburban schools, overcrowded classrooms, crumbling facilities, extensive mobility among poor families, less parental involvement, and lower expectations. These disadvantages are sometimes overcome by a student's *ganas*, the determination to succeed. Reflecting on my conversations with students throughout this study, I am reminded that many Hispanic families are characterized by unity and cohesion. The whole family makes tremendous sacrifices to see a child through college; the college graduate, in return, provides for the family and helps younger siblings enter and graduate from college. Poor and minority students are well aware that a college degree has a significant impact on their chances to escape poverty and join the ranks of the middle class. Highland's admission policy proclaims that it opens the "gates to the future"; all over the campus posters remind the students that Highland is "changing lives."

Peering into the eyes of my current students and correcting their homework and exams, I see many of my former classmates from Romania: Constantin, the dog catcher; Octavian, the mason; Gheorghe, our soccer team captain, who probably had ADHD, though it seems to me that no one in Romania knew anything about behavioral disorders

or learning disabilities. In the front of the room in my basic arithmetic class sits Juana, a single mother of two, who is so happy because "it is the first time I understand what math is good for!" Then there is Jorge, begging me to give him a D in basic algebra, which he has already taken three times.

I often wonder what motivates me to go the extra mile to help my students learn math, to befriend them, to speak their language, and to have lunch with them in the cafeteria. What motivates me are the same forces that pushed me to help my friend Constantin, when he tried so hard to learn arithmetic by the flickering light of a gas lamp in his dilapidated house in Bucharest. When inviting me to his house, Constantin always reminded me that if we did good work in math, we'd both receive a gift from his mother. It was always the same gift, a paper-wrapped toffee candy, one for Constantin and one for me. Even though in my capitalistic home we had oranges and home-made pastries, the candies my friend's mother gave us always tasted better!

Unfortunately, my efforts were in vain. After Constantin was thrown out of school for his repeated failures in math, I was shocked to see him working on a do-catching city truck. "Keep up that good work in math, Eric!" he shouted with a grin. I see a Constantin in one of my students, and I have my childhood friend's image in my mind when Melody is telling me that, because of her repeated failures in basic math, she might not ever be able to work in Human Services.

"Oh, no, not again", I thought to myself after my last talk with Melody. I then checked Melody's academic record online: Health: A, Psychology: A-, Political Science: B, Sociology: B, Art: B+, English: A-, and also Arithmetic: F, Arithmetic: R, Arithmetic: F, Arithmetic: D, Elementary Algebra: R, Elementary Algebra: F. Melody is obviously a

bright, very hard-working student who never understood basic math and for whom the pace in this class is much too fast. Does she have to be the victim of the system? Does Constantin's story repeat itself?

Immigrants and Language Issues

Many of my Highland students are new immigrants to the United States. Interestingly, whether my Hispanic/Latino students were born here or not, Spanish is their principal language for interacting with one another. My students speak Spanish to each other during the breaks. They also speak it at home with their families, in church, and in the community.

For foreign-born students, English is difficult since it is not a phonetic language. In addition, in Spanish prose the sophistic tendencies are very pronounced as opposed to English, which tends to be direct and logic-oriented (Villanueva, 1993, p. 85). Students whose first language is not English encounter additional obstacles in math when compared to native speakers. They do not understand expressions in the math textbook, as Sonora Ramos writes below:

SONORA RAMOS	Journal entry #4
This week in class we were reviewing math work. We were using the computer to figure out the answers for many problems. In some of the sections that you gave to us in class on Wednesday to review with for the midterms were some what confusing to me. I had some complications with section 2.12. I could not understand how to solve some of the problems which I believe were subtracting fractions. I had some problems with changes the fractions in order to subtract them. I got stuck in problem #5 on page 71. Also on section 2.5 #9 and # 13 were a bit confusing as well . I would like to see if we can review fractions in class. A side from that everything else in class is going fine.	

Becoming an Educational Researcher

After several semesters of working as an adjunct lecturer at Highland, I started to become preoccupied with the basic math concepts many of my students struggled with despite their diligent efforts to try to pass the course. These are the students who paid for the class, bought the book, did the homework, regularly went to tutoring, and had perfect class attendance.

"Is my teaching the problem?" I wondered. I could not rule that out. I had received no teaching preparation before joining Highland. I did pass the Liberal Arts and Science Test (LAST), Assessment of Teaching Skills-Written (ATS-W), and Content Specialty Tests (CST) in math, but I had no pedagogical preparation and no classroom experience. My ideas on what makes a good teacher were based on instinct and recalling the practices of my teachers in middle and high school.

Even though I was receiving excellent evaluations from my students and the full-time faculty members who observed my classes several times, I knew my teaching should be continuously improved. It helped that I was tutoring outside the college, in many cases working pro bono with elementary and middle school students who were learning the same topics I was teaching at Highland.

To my surprise, when I advanced from teaching basic arithmetic to basic algebra covering the curriculum of grades seven and eight in middle school, I discovered that many algebra students were still making the same mistakes. For example, for them 4 – 2 + 1 was equal to 1, and ½ + ¼ was equal to 2/6 or 1/3. Since in their daily life the students knew the correct answer to these operations perfectly well, whether they dealt

with money or slices of pizza, why were their answers upside down when they faced these operations represented in symbolic notation?

Further, why did I uncover these mathematical issues in the basic algebra course with students who had just advanced from basic arithmetic? How can one explain that students who know very well how much a half dollar and quarter dollar are together make these mistakes when presented with the symbolic notation, even after receiving instruction in operations with fractions every year starting in grade 4? Why are my students still afraid of operations with percentages in symbolic notation but can figure out how much to tip for a manicure or calculate how much they will save when a pair of Nikes are on sale? Why is this happening and what is the remedy?

In the first lesson of each new course, I always ask my students, "Who here hates math"? After virtually all hands go up, I then ask, "Why"? While the answers vary, they generally fall into several categories: a) Too many rules; b) Too much to remember; c) It is the only subject in which I freak out during the test and forget everything; d) Math doesn't make sense to me, and the examples they use are off the wall; e) Most of what we learn here is not necessary or relevant for my future career; and f) They make it impossible for us to pass math; I will not be able to become or work as a nurse (or social worker), and this why I came to college in the first place.

Venus Torres, a liberal arts major, had difficulties with math in high school, since she never understood the concepts. When her husband lost his job, Venus had to find another part-time job. One of my most promising students, Venus got an A+ on the midterm exam but was not able to complete the course.

VENUS TORRES September 10, 2009

Math Autobiography

Ever since I can remember math has been my least favorite subject and one of my academic weaknesses. In high school I dreaded going to math class. It felt like being in a foreign class, and I understood nothing that was going on while others would find the solution of a problem in less than 3 minutes. I wanted to be one of those students but I found that to be impossible. I failed most of my math exams. When a problem was put in front of me it was like seeing it for the first time and I had no idea of what the next step would be to find the solution. Since I never understood math, I think that's why I have grown to hate it so much. Now I believe this has changed. For the first time since attending Math 01A, I am beginning to enjoy math. I feel as though I have achieved some type of greatness. The feeling I get when I am a step ahead of the professor when trying to find the solution to a math problem is amazing. To actually have the right answer and understand what the professor is talking about makes me feel accomplished. I never thought the day would come when I look forward to completing my math homework. I now find myself looking forward and ready to attend math class, and participating in class. I would actually like to thank you for allowing me to understand and enjoy math while you teach. There's something about the way you teach that you make sure the student grasps the concept in order to move on to the next step. So far you have made this subject easier for me to understand and I'm truly grateful for this because math has always held me back in some way. We have always been like oil and water, we just don't mix and I can't say I totally like math but very slowly my feelings towards math are changing as I begin to understand the subject.

Always interested in the way children acquire knowledge, I began reflecting on language skills acquisition. After many years of Spanish instruction—no less than the numbers of years of instruction in fractions received by my college students, my niece was still learning the difference between "soy" and estoy." All she could utter in Spanish was "Yo soy una muchacha" and "¿Como esta usted?' At the store where she works part time, which is visited by many tourists, she sports a name tag announcing the languages

she speaks, English and Spanish. In answer to my questions about the nature of the conversation she has in Spanish with the customers, she answered that all she has to ask in Spanglish is "¿Dinero or credit cardo"? [The correct question in Spanish is "¿Efectivo o tarjeta de credito"?]

Research in MSP

For three years starting in the summer of 2007, I participated in MSP, the Math and Science Partnership in New York City, (MSPinNYC, or in short MSP) a multi-million dollar, five-year research program funded by the National Science Foundation aimed at improving the math and science education in urban schools in New York City. The program catered to several hundred students from Manhattan and the Bronx who had failed, sometimes repeatedly, the New York State Regents exam in math, chemistry, or living environment. This was my lucky day! I would spend the entire summer working with college teachers, high school teachers, and urban students who are a younger version of my students at Highland.

Participants in MSP—college faculty, school teachers, tutors—worked collaboratively in a way reminiscent of the methods of the Mills School in California (Westheimer, 1998). We did collaborative lesson planning and criticized each other's lessons in a reflective, supportive way in order to improve our teaching and student understanding. We started working with the students immediately after the Fourth of July and continued until mid-August.

The typical student day was structured as follows: 9:30 a.m. to 11:30 a.m., a class in which different faculty taught mini-lessons with the students doing work under our close supervision; 11:30 a.m. to 12:30 p.m., lunch–students, faculty, and tutors mixing

together; 12:30 p.m. to 2:30 p.m., small group work in math lab session; 2:30 p.m. to 4:30 p.m., small group tutoring; 4:30 p.m. to 5:00 p.m., board of directors meeting influenced by Tobin's work and research with cogen.

Instead of allowing for a democratic sharing of opinions in which no one's voice is privileged (Tobin & Kincheloe, 2006, p. 24), these meetings were guided by a teacher who posed questions. Nevertheless, the meetings still provided the students and teachers a voice in lauding or criticizing class and lab methods, facilities, food served at lunchtime, or social interactions.

While the students were being tutored, the faculty discussed each student's progress or the specific difficulties he or she was having and recommended follow-up action. We also spent an hour in collaborative work planning lessons for the next day. All sessions were videotaped by doctoral students who received training in educational research, all part of Tobin's research squad. Members of the squad conducted interviews with students and teachers to find what was working and what needed improvement.

On August 16 all students took the official Regents exam in Math A, chemistry, or living environment, depending on the stream in which they participated during the summer. Our success rate speaks for itself. Roughly 70% of our attendees passed the Math A Regents exam compared with only 25-30% achieving similar results of students in regular summer school. The results of the groups who studied chemistry or living environment were even more impressive. Between 90% and 95% of the students passed those Regents exams.

During the school year, some of the faculty participants from the summer program, myself included, participated in full-day pedagogical rotations and development sessions.

In pedagogical rotations, one of us would prepare a lesson plan with the help of a few peers and then deliver the lesson to high school students at Mott Haven Academy and Truman or Columbus High Schools in the Bronx. The lesson was observed by as many as 15 participants: college instructors, high school teachers, principals, and assistant principals. After the class the observers gave constructive feedback to the person who delivered the lesson and then, with the help of several peers, reconstructed the lesson and adapted it to include the colleagues' suggestions. In the afternoon the original presenter delivered the modified lesson to the classroom and received more feedback from colleagues.

A large contributor to MSP's success was the positive emotional climate in the program and the classroom. Based on Collins's sociology of emotions, Tobin explains that good teaching is made out of successful interactions that are charged with positive emotions; bad teaching is made out of unsuccessful interactions that are charged with negative emotions (Tobin, 2006). During successful interactions, there is synchrony between the teacher and the students. A chain of synchronous practices is charged with positive emotional energy and leads to entrainment—instead of copying from the board students anticipate what the teacher will write next on the board. In these moments there is solidarity in the classroom between all participants. The teaching happens without conscious awareness through practices that are anticipatory, timely, and appropriate, that is, fluent (Tobin, 2006.)

Why did the MSP students perform so much better than my basic math students at Highland? Was their improved performance due to the lower student-teacher ratio, the use of technology, and the board of directors meetings? Or was it due to the use of more

engaging learning materials or a more welcoming classroom that involved the students in their own learning? To understand the reasons for the MSP's success and in an attempt to replicate the lessons from MSP into math education in New York City urban teams, I became part of a research team that met each month at Hunter College under the direction of Pamela Mills, a chemistry professor at Hunter College, observing videos from the student interviews and analyzing the program's lesson. The challenge was how to transfer the success of the summer programs to urban high schools in New York City.

The following summer, the MSP program was conducted simultaneously on several college campuses. The Math A Teacher Research Team (TRT) to which I was assigned worked with students at Lehman College. Our students were all Bronx residents from three hub schools: Mott Haven Academy, Truman High School, and Columbus High School. The afternoon lab classes were held at the wonderful computer lab at Lehman College with students working in pairs on complex math problems, using tools such as the Geometer Sketch Pad. That summer experience gave me the chance to practice coteaching and participate in board of directors meetings.

During the summer of 2007, my second one in the MSP, I did joint research on students' mathematical thinking and approaches to problem solving. Through individual interviews with students, we were able to uncover many mathematical misconceptions, and this helped us understand why exclusive reliance on algorithms and mnemonics such as *Please Excuse My Dear Aunt Sally* (PEMDAS), the acronym many teachers are using when explaining the order of operations, hampered students' mathematical development (Fuchs, & Menil, 2008a, 2008b). In MSP the students benefited each day from two hours of math lab.

> It is the first time in my life that math was not boring. Miguel and I examined different ways to pack cans in a container. With the Geometer Sketchpad, and the calculation we realized why a six-pack is the optimal way to package cans of soda or beer. It was a lot of fun!
>
> (Maurice Ruiz, MSP student, 2006)

The MSP students told me in interviews that doing math in the lab was the most exciting part of the summer program. Working in pairs at their own pace and using computers was, as Maurice noted above, "a lot of fun." While it is difficult to ascertain quantitatively the relative contribution of the math lab to the high success rate on the Regents exams, it is clear that technology introduced new, exciting ways for the students to learn math. My students at Highland, who constitute the focus of this study, had 40% of their classes in the computer lab. Details of that part of the study are provided in Chapter 6.

Changing My Perspective

To gain a theoretical understanding of pedagogy and to learn the methodology of education research, in the fall of 2006 I enrolled in the Ph.D. program in urban education at the CUNY Graduate Center. I found it very challenging to work in an area of educational research espoused by my advisor, Kenneth Tobin, in whose seminar I participated earlier as part of the MSP program. I was excited about doing mathematical educational research grounded in sociocultural theory, such as that which Tobin and his science education research squad undertook at City High in Philadelphia (Tobin, 2005). Besides benefiting immensely from the studies in urban education, the applicability of which are discussed later on in this study, I decided to undertake studies in the use of interactive technology in pedagogy as well.

When I joined the Graduate Center, I had great plans for reforming math education in the United States through the use of Singapore Math and by helping students master mathematical concepts at a young age, as they do in Asian and Eastern European countries. These great plans were first shaken in the History of Education class, when I learned from David Tyack and Larry Cuban about the need for an "accurate and appropriate historical map" (Tyack & Cuban, 1995, p. 6). I further learned that whatever great ideas I had for reforming the system had probably already been tried and that the most I could hope for was to tinker with utopia.

My initial admiration for the math rigor of my childhood disappeared after I studied Kincheloe's book, *Teachers as Researchers*, which suggests that teachers research their students (Kincheloe, 2003). Good teachers, Kincheloe suggests, have to understand the complexity of the educational process, the social role of schooling, and the ideological inscriptions of the curriculum. They also have to question the perceived role of teachers as automatons responsible for making information palatable to students.

Teaching Future Educators

Teaching urban students in community college is immensely satisfying: Graduating students can become productive members of the society, and their lives as well as their families' lives can change much for the better. A similar, but different type of satisfaction exists in working with future teachers. Teachers in training display an unmatched enthusiasm and desire to change the lives of hundreds of students. When working with future teachers, I feel that my efforts are multiplied several times. I was fortunate to work for two years with Aspiring Teachers (ATs) at Hunter College Teacher Academy and two additional years with student teachers at Queens College.

Teacher Academy

Using critical pedagogy lenses helped in my observations and supervision of two cohorts, each comprised of 20 ATs, at Hunter College Teacher Academy. Every Wednesday morning during the first year, together with several ATs, I observed classes taught by three different teachers in grades 6, 7, and 8 at Manhattan East Middle School in Harlem. While in class, the ATs were interacting with the classroom students during the *Do Now*s—in-class problems to be solved by each student—and during other class assignments. Toward the end of each semester, each AT prepared a lesson plan, and then one of the other ATs or I video recorded the presentation to the classroom students. Back at the college in the seminar, I cotaught with another instructor and the class discussed pedagogy, watched selected vignettes from the video recordings, analyzed and constructively criticized the lesson's presentation. Being in the field gave me the opportunity to observe directly the curriculum, pedagogy, and students' struggles with math concepts.

During the second year at Teacher Academy working with another student cohort, I observed grade 9-12 classes in math, physics, chemistry, and living environment at Fashion Industries High School and Manhattan Hunter Science High School. The lesson plans my students presented in chemistry and living environment sometimes went over my head, but in math and physics—my two main areas of study—I enjoyed observing the different pedagogical approaches of some of the teachers. In particular, I was impressed with the extensive use of technology in geometry, physics, and pre-calculus classes at Manhattan Hunter Science High School. Back at Highland, I started using some of the methods I learned from the teachers I observed at the Teacher Academy.

Future elementary school teachers

For pre-services teachers to improve math instruction, as they must, they need an atmosphere in which *they* gain a number sense, learn mental math, and learn how to help students translate word problems into symbolic notation. The similarities to learning a new language—or any new skill—have become strikingly obvious to me: one must progress through different stages until fluency, or competence, is acquired. There are no short cuts.

With this in mind I decided to use the full arsenal of methodology and methods I learned at the Graduate Center, at Teacher Academy, and in the MSP in the classes I had with future elementary school teachers at a senior CUNY school. These techniques include coteaching, cogen, videorecording classes and observing vignettes from the digital files, letting students take charge of the class, and a weekly sharing of student reflections with other students. The students do their assigned readings one week in advance and then discuss the readings and their practicum in class conversations.

My students and I have set multiple objectives for that class: a) Learning how to foster an atmosphere of cordiality, equality, motivation, and solidarity in their future classrooms; b) Mastering the math concepts required for their future practice; c) Learning and experimenting with multiple pedagogies for each topic and concept; d) Learning to observe and understand their students' work; e) Learning how to interview students to understand their mathematical thinking; and f) Using technology to foster students' understandings of mathematical concepts at their own pace.

A Complex Problem

For years, while teaching one basic math class after another, I could not grasp the complexity of or reasons for Highland's low graduation rates. I felt like a person caught in a complex maze, looking for the way out. It was only when I decided to take an aerial view and look at the whole system at the macro level, in addition to examining the interactions in my classroom at the micro and meso level, that the picture came into sharper focus. Being the odd man out has definite advantages: It provides a different perspective from the group norm.

My examination has been much enriched by my exposure to different education systems, along with my work with colleagues and students of different grades and age groups. My work with future teachers in math methods classes was extremely valuable, since it illuminated the cultural transmission in the teaching of math. I realized that most student teachers would teach an elementary level math class the way they were taught the course content in elementary school.

Chapter 4 probes CUNY and Highland graduation rates to better understand the role basic math classes play in preventing the students from finishing their associate's degrees.

Chapter 4

The Truth in the Data: Locking the Gates

> There are worse crimes than burning books.
> One of them is not reading them.
> (Joseph Alexandrovitch Brodsky, Russian-American poet)

It is a steamy day in late August 2008, and I am on the Major Deegan Expressway looking forward to the start of another semester at Highland Community College. Traffic is at a standstill at Exit 7. A long queue of trucks is waiting to cross the George Washington Bridge.

Some drivers keep their hands on the horn, as if that will help. I feel a headache coming on. I turn off the air conditioning so my 10-year-old Nissan does not overheat again. That is one problem I do not need on the first day of school. The class I am supposed to teach starts in 45 minutes, but what can I do? I lean back, take a swig from my water bottle, and turn up the volume of the radio, hoping the traffic clears soon.

There is an interesting interview on public radio with a CUNY spokesperson. "[We] will soon launch a new alternative, experimental community college prototype called the New Community College initiative…[which] will be located in Manhattan." I sit up in my seat: What am I hearing? CUNY is opening a new community college in Manhattan for around 5,000 students? The spokesperson talks about the low graduation rates in community colleges and about the new school where students will be provided with extensive counseling and academic support so they can graduate in three years.

In my seven years of teaching basic math at Highland, I have seen hundreds of students come and go, but I must confess that I never gave much thought to what

happened to them after they left my classroom. I just assumed they eventually graduated. The traffic clearing, I switch gears and drive off. Ten minutes later, I park the car at Highland.

When I get to class, I am still thinking about the comments of the CUNY spokesperson on this morning's talk show. Little do I know that today's traffic jam would be a turning point in my academic life. I was about to start my third year at the CUNY Graduate Center and I was still trying to formulate my theoretical stance and research interests. My curiosity piqued by the gloomy graduation statistics, I decided to find out about Highland's graduation rate and how it compares to the community colleges' national average of 16% in three years mentioned on this morning's talk show.

All CUNY data were right there on the website. All I had to do was read them. And indeed, if Highland's data is not any better than the national average—i.e. only 16% of students graduate in three years—could I figure out the reasons? Wasn't I for years just an instrument in reproducing a culture of failure at the expense of my students? Did I really believe that in a one-semester *lecture* I would get better results than middle school teachers get in three years of *classes*? Something is rotten in the state of Denmark: I found the puzzle piece I didn't know was missing. The puzzle piece was teaching and pedagogy in basic math classes. For years, I was guilty of the crime Joseph Brodsky refers to in the quote above.

The extent to which basic math classes serve their purpose has been the topic of several studies. Peter Bahr of Wayne University conducted a large-scale evaluation of data covering over 85,000 students enrolled at over 100 community colleges. The study concluded that students who completed a basic math sequence performed as well in

credit-bearing math classes as those who placed out of the basic classes. Bahr concluded that "remedial [basic] basic math programs are highly effective at resolving skill deficiencies" (Bahr, 2008).

At the same time, based on research at the Carnegie Foundation, Anthony Bryk, president of the Carnegie Foundation for the Advancement of Teaching, and Uri Treisman, a senior partner with Carnegie, argue that "while successful intervention strategies exist at many community colleges, they tend to be costly add-ons and extra courses and therefore can have an impact on only a small number of students" (Bryk & Treisman, 2010). Bryk and Treisman assert that *"*Remedial math has become an insurmountable barrier for many students, ending their aspirations for higher education" and that "between 60 and 70 percent of students placed into remedial math either do not successfully complete the sequence of required courses or avoid taking math altogether and therefore never graduate" (Bryk & Treisman, 2010). With a goal of dramatically decreasing the time-to-degree, Carnegie is sponsoring research aimed at replacing basic math courses with an alternative statistics-based pathway to be completed in one year. The Carnegie Foundation foresees expanding the project to cover over 100 community colleges in the next two to three years.

After investigating dozens of investments in the field of education, the Bill and Melinda Gates Foundation concluded that the pathway to opportunity now runs from high school graduation, through college enrollment, and finally to college completion (Gates, 2010*).* Calling the traditional basic courses an "afterthought," Melinda Gates identified remedial programs as the biggest obstacle students must overcome in their pursuit of a college degree: only about 25% of all students who take these courses earn a degree

within eight years of enrolling. Pointing out that the basic classes taught in community colleges cost the students, colleges, and taxpayers about $2 billion a year, Gates urged the audience of community college presidents to pursue new models that "yield dramatically better results for a fraction of the cost." (Gates, 2010). Through their $110 million initiative, the Gates Foundation is doing research on changing the structure of basic education, math as well as English. According to Hilary Pennington, Director of Education, Postsecondary Success and Special Initiatives at the Gates Foundation,

> Academic catch up should be a launching point for students, not a roadblock…when students feel as though their academic catch up is not a waste of time and money they will stay motivated, and we'll begin to see improved retention and completion.
>
> (Pennington, 2010)

Effect on My Students

In class now, I look up at the 25 faces staring at me, eager to learn math or, more accurately perhaps, to get it over with. Checking the students' bursar receipts, I see that all of them are full-time students taking four or five classes this term. Most are freshmen, but for some this is not their first year in college. They appear to be determined, hardworking people. If they take classes over the summer, they probably expect to graduate in three years or less despite having to take basic classes in addition to the 60 credits required for the associate's degree.

Only 16% will graduate in three years? Since I have 25 students in the class, that means only 4 will finish in 2011. I look intensively at their faces trying to figure out who these four students are. It's time to start my lesson; however, I cannot get that 16% figure out of my mind. It is evening. I am home eating dinner. Still perturbed by those numbers, I get up from the table to check the college graduation data on CUNY's official website.

All the numbers are right there in the OIRA tables. I can even go back to cohorts that started eight or ten years ago. It turns out I was wrong in my calculations: the figures for Highland's students are worse than I thought. Fewer than 8% of students graduate in three years, and the numbers seem to decrease in more recent cohorts. I remember the students' faces and many of their names. Only two?

I am trying to understand the data for the 1,100 or so full-time Highland freshmen who started in the fall of 2003. After three years, only 7% graduated, and only a quarter were still enrolled. That explains why I never bump into many of my former students on campus. I thought they might have graduated. In reality, they probably dropped out. How about the remaining 25%? Will these students ever graduate? To answer that question, I look at the data for the fall 2000 full-time freshmen. Even after seven years, only one-fifth of the original cohort has graduated. I leave the numbers for a moment and think about my morning class and all those eager, smiling faces. Even after six years only five students will graduate. Stated differently, of the ten students in the nursing program, only two will become nurses six or perhaps eight years from now. Does it *really* take longer to become a nursing assistant than a medical doctor?

I wonder about the costs that these numbers imply for the students, their families, and the taxpayers. What about the students' hopes for a better life? After lingering in school for several years, do eight out of ten return to their former jobs, if they had one? What do they do? Where do they go? Clearly, we have a problem at Highland. Some may argue that the low graduation rate can be partly attributed to large numbers of students who transfer out, move to a different borough, leave school because it wasn't for them, fail too many courses, or run out of money.

These explanations do not pass muster, for I know my previous students and how much that degree meant to them. Many, especially those who are the first in their family to attend college, spoke of the sacrifices they made to attend Highland. To be sure, high aspirations alone do not translate into realities. Problems of academic preparedness, which are rooted in demographic trends and disparities in educational outcomes related to family income, parental education, and other factors stand in the way of students finishing their education and is cause for serious concern.

I am aware that many of our students are unprepared in English, math, or both, but that alone cannot account for the high failure rate. Against this sobering backdrop, it is important to consider that the fault may lie with my colleagues and I, the instructors, and the way we forge ahead teaching a time-driven curriculum that covers far too many topics in too short a period of time. Or maybe the problem is a curriculum that makes little sense to the students or their major. I had a hunch that basic math classes might be a major contributor to the high failure rate. I decide to speak with some of my colleagues.

"Have you ever wondered what happens to the students who fail our remedial classes"? I ask Martin Kaminski, a colleague, over lunch. "You can't help everyone," he mutters while dabbing some mustard from his lip with his napkin. "The students have to help themselves. If we make a difference in the life of one student, then we've done our job." Miranda Genes, a faculty member has this to say, "Think of the level of education [the students] come to us with." She shakes her head and shrugs her shoulders, then shuffles over to her desk and begins stapling some papers. She must notice the look of surprise on my face. "Eric, lighten up!" she snaps.

I wonder if this is what Hillel Ha-Zaken (the Elder), the famed religious leader and teacher born in Babylon, meant when he said, "to save a life is to save the entire world." But we are not saving lives at Highland, I thought, at least not in the literal sense. The school's mission promises to "transform lives." Transforming the lives of only two students in my classroom strikes me as woefully inadequate. What about the other 23 students?

It is mid-September. I know all my students now, and I know quite a bit about their personal lives. Surely I cannot fix the students' previous education in elementary, middle, and high school, but I can do a better job of relating math to real life and relating the math problems to the students' future vocations. After all, these are CUNY's most vulnerable students: the ones who cannot afford to buy the textbooks; the ones who have to juggle classes, job, and family; the ones who are the least academically prepared in the CUNY hierarchy.

There is Xianna Huertas, a single mother of a four-year-old with autism; Rafael Castro, who falls asleep in my 8:00 am class after working the night shift at Albert Einstein Hospital; and Cesar Peralta, who missed two classes while helping his family move to a new shelter. I decide therefore to delve deeper into the causes of the low graduation rate and understand the relationship between basic math classes and the low retention and graduation rates and the long time-to-degree. That traffic jam in August was my epiphany.

Data Collection and Data Analysis

The quantitative data in this chapter indicate that there is a relationship between the placement in basic math classes and the high drop-out rate. While basic reading and

writing classes might also contribute to students' failure in college, their impact is not nearly as great as that of basic math classes. I conclude that instead of helping students graduate, the basic math classes do the opposite. My observations jibe with the conclusions reached by the Carnegie Foundation and by the Gates Foundation.

In this section I used multiple data sets, some quantitative and some qualitative. The quantitative data consisted of the following: a) CUNY's OIRA—specifically, information on enrollment, demographics, graduation rates, retention rates, and time-to degree (The tables contain data for the entire university, senior colleges as a group, community colleges as a group, and individual community colleges.); b) Highland's Office of Institutional Research—data on pass/fail rates on the COMPASS tests in math, reading, and writing; repeat rates in basic classes in math and reading; the relationship between students' grades in remedial classes and student retention and graduation rates; and c) transcriptual data from Highland's registrar for several hundred of my students who took my remedial classes between 2002 and now. The information included enrollment data, class grades and scores on the COMPASS placement tests and assessment tests.

This section also compares CUNY OIRA figures for Highland with corresponding CUNY OIRA figures for Concourse, since that school serves similar student population as Highland. In addition, the students from the two schools are known to take courses at each other's campus. In interpreting the data, I considered only full-time, first-time freshmen. That way, I can answer the questions of those who might attribute the low retention and graduations rate to the students' lack of seriousness about their academic studies or not taking enough classes each semester. To better understand the effect math

education classes have on different groups of students, I separated students in a cohort by full-time freshmen and full-time transfers.

I also collected and reviewed extensive qualitative data sets that included student-produced artifacts, questionnaires, and interviews (all described above). I gathered additional data from examining the classroom and lab videorecordings and notes taken while viewing the video files recorded during classes, cogen, and labs.

Graduation Rates from CUNY Community Colleges

In a feature article of *CUNY Matters* entitled "2010: Year of the Community College," Chancellor Goldstein talks about the importance of community colleges and their role in filling job openings with those who need the jobs the most. In CUNY community colleges "three out of five students are women…46% say their native language is not English…and three-quarters come from families earning $40,000 or less" (Goldstein, 2010, p. 2).

The significant growth in CUNY's enrollment has happened in the community colleges, where the numbers have increased by an "astounding 45%" over the last decade. The Chancellor alludes to a national norm of three years for time-to-degree, pointing out that nationwide that goal is achieved by only 16% of the students in urban community colleges. While acknowledging that "poorer students and students of color are not only underrepresented in higher education nationally, but are also less likely to graduate with a degree," the Chancellor notes that "congressional approval is far from assured" for President Obama's American Education Initiative, which has a goal of five million additional graduates from community colleges by 2020 (White House, 2009).

Graduation Rates in the Bronx

Tables 4.1 and 4.2 below provide the cold statistics for the retention rate, graduation rate, and time-to-degree of full-time, first-time freshmen enrolled in associate's degree programs at Highland and Concourse for the fall 2000 cohort. I chose this cohort because it provides longitudinal data spanning eight years.

OIRA's definition of *Retention Rates* and *Graduation Rates* are as follows (OIRA, Table: RTGI_0001): *Retention Rates* are calculated as the percentage of students still enrolled at the college of entry in the subsequent fall term(s) who have not earned the degree pursued. *Graduation Rates* are calculated as the percentage earning a degree at the college of entry any time prior to the start of the subsequent fall terms.

The data show that, as mentioned before, after three years only a quarter of the students are still enrolled and less than 8% have earned their associate's degrees. After eight years only one-fifth of the full-time freshmen of the fall 2000 cohort—the cohort of Sandra Brown discussed in Chapter I—have earned their degrees.

Table 4.1

Retention and Graduation Rates from Highland Community College

Cohort of Fall 2000: Full-time, First-time Freshmen Enrolled in Associate Programs

Total = 979	1 year	2 years	3 years	4 years	5 years	6 years	8 years
Still enrolled	62%	42%	25%	12%	6%	4%	2%
Awarded Associate		1%	7%	15%	19%	21%	22%

Based on CUNY Office of Institutional Research and Assessment Table: RTGI_0001

Table 4.2

Retention and Graduation Rates from Concourse Community College
Cohort of Fall 2000: Full-time, First-time Freshmen Enrolled in Associate Programs

Total = 598	1 year	2 years	3 years	4 years	5 years	6 years	8 years
Still enrolled	60%	42%	26%	13%	7%	3%	2%
Awarded Associate		1%	7%	13%	17%	18%	20%

Based on CUNY Office of Institutional Research and Assessment Table: RTGI_0001

To summarize the freshmen's story: after three years (the lofty objective referred to by President Obama, Chancellor Goldstein, and Melinda Gates) about 7% of full-time, first-time freshmen at CUNY community colleges in the Bronx graduate. Even after 8 years only about 20% of the participants in community college earn a 2-year associate's degree.

Proficiency in Math and Language

As CUNY's website explains, students can demonstrate their skills proficiency based on their scores in SAT, ACT, or NY Regents exams. Students who fail to document satisfactory grades will have to take "the appropriate CUNY Assessment Test offered at the testing center at CUNY colleges." Appendix H provides CUNY criteria for determining math and language proficiency.

The COMPASS Test

To better understand the test format and content, I have taken the COMPASS test several times in arithmetic and algebra. The fall semester was not even over, and I was leading

all 25 of my basic math students to the testing room to take the M1. On the way some students discussed their trepidations in revisiting the placement test that many took on August 19 of that year. All 25 students had failed both the M1 and M2 tests; otherwise, they would not have been assigned to my class.

Now they had to pass both my course and eventually basic algebra. I overheard some students telling of friends who had passed basic arithmetic, then took basic algebra, failed it again and again, and eventually withdrew from college.

My students were well prepared for what would happen while taking the test. They understood why in August their screen went blank after answering only five or six questions. I explained to them that taking a multiple-choice, computer-adaptive test is like climbing a slippery road, the slope of which gets higher and higher as you answer more questions. The first question is of average difficulty; subsequent questions become increasingly difficult. The computer program knows at every moment where a student is on the slope. An incorrect answer moves the student down the slope. Several consecutive slippages on easier questions take the student to the bottom of the hill.

We also repeatedly discussed test-taking strategies, such as eliminating answers that do not make sense. “This is a multiple-choice exam—do not get bogged down in calculations; the correct answer is already given. Eliminate the answers that don’t make sense. And please, please, read every word carefully. The test is in English, but don’t get confused by the words!”

We went upstairs. Every student was assigned a computer. The proctor read the instructions out loud: “No calculators, no telephones, no electronics. There is a calculator on the screen, but you cannot use it, since it was disabled.” Why, again, I asked myself,

are students prohibited from using the calculator when the test developer's website states that it is up to individual schools to decide whether to allow or forbid using the calculators?

I told the proctor I would be roaming around the room for about 20 minutes before taking the M1 and M2. "I hope you do better than your students," the proctor said with a smile. "We'll see," I replied and started moving around the room and looking over my students' shoulders. Most of them were very tense. It was obvious they were struggling. Of course, I could not help them. Some students were adding numbers vertically 9+9+9+9+9+9, etc., counting on their fingers 6 times. I wished I had had more time in the class to review the math facts. After 15 minutes I sat down and took the tests, first the M1 and then the M2.

After the 12th question, I knew that more than 90% of my arithmetic class would never reach that part of the test, since it was geared toward students scoring 60 or above. Once I completed the M1 test, I continued straight to M2. The more advanced part of M2 contained questions on rationalizing the denominator using complex conjugates and questions on conic functions, which were not part of the syllabus of the basic algebra courses I had taught in previous years. The COMPASS provides an immediate score and percentile ranking of all the students taking that test, similar to lining up students in elementary school by height.

Since there is no time limit, when I finished my tests I saw that some of my students were still working on their M1 test. As I walked outside the testing room, anxious faces were staring at me. "We have to wait for Carla and Julio to finish the test," I said. Julio Mendez came out first, then Carla Rojas. I went inside and asked the proctor for the

results. “The good news is that you have proven that one can score 99 in each of these tests.” “Big deal,” I answered, “How did my students do”? Looking at the printout, I saw that 60% had failed: they obtained scores of between 22 and 29, but not 30. Even worse, some nursing students passed with scores between 30 and 34, not high enough for the nursing department. There were a few surprises: One student scored 48, another one 53. Even though I gave the scores individually to each student, like students everywhere, they all shared their results with each other.

I later met 6 of the 15 students who had failed the COMPASS in a seven-day workshop I taught the following January; by that time 3 more students had passed the test. While much relieved from their initial worry, the students who passed knew that a bigger hurdle awaited them: the basic algebra course. I cannot think of a single test that influences the students’ destiny as significantly as Highland’s math placement exam. Highland’s math department guidelines state the following:

> Students in MTH [Math] remediation have opportunities to retest until they achieve proficiency (30 or more in both M1 and M2). However, **retests are not used for “re-placement.”** [emphasis in the original]

As a consequence of this guideline, students get stuck in basic math classes. Their hopes for a better life will be put on hold until they pass both basic arithmetic and basic algebra courses. About 90% of first-time full-time freshmen need to take basic algebra; more than half of these students have to take basic arithmetic as well. Other major tests, Regents, SAT, ACT, GRE, can be retaken when students try to improve their score; not so the math placement test at Highland. It is as if the students step on a trap door that snaps open and then snaps firmly shut. Once in, it’s almost impossible to get out.

Placing out of Basic Courses

On the average, 55% of new enrollees at Highland do not place out of the basic arithmetic course. For example, 1,680 students, or 55% of the fall 2009 cohort comprising 3,049 students, received a score of less than 30 on the M1. For most students, passing the algebra placement rest is harder than passing the arithmetic placement test. In the fall 2009 cohort at Highland, 2,837 students, or 93%, were unable to pass that cut-off and were directed to take the basic algebra course.

How do freshmen compare to transfer students? As might be expected, the latter fare better than the former, since they might have taken basic math classes elsewhere. This is evident from Table 4.3 below, which is based on the M2 and M1 tests scores of 2,949 students in the fall 2009 cohort at Highland.

Table 4.3

Highland, Fall 2009:

Arithmetic and algebra cutoffs

Students tested		Freshmen		Transfers		Totals	
Arithmetic	Non-exempt	1287	58%	393	45%	1680	55%
	Exempt	886	42%	483	55%	1369	45%
	Total	2173	100%	876	100%	3049	100%
Algebra	Non-exempt	2078	96%	759	87%	2837	93%
	Exempt	93	4%	109	13%	202	7%
	Total	2171	100%	868	100%	3039	100%

Calculators and Basic Math

In the COMPASS test the calculator, while present on the screen, is disabled. In basic math classes, use of calculators is prohibited in quizzes or final exams in basic courses at Highland as well as at Concourse. Most math departments in CUNY are split on their position on the no-calculator policy; irrespective of which camp is right (I favor the use of calculators), the students are penalized by the incongruity between CUNY's calculator policies and those of the New York State Department of Education. While in the community colleges in the Bronx the no-calculator policy is enforced for all examinations, all students advancing to an intermediate algebra basic course at Highland are instructed to purchase and use a TI-83 calculator in that course.

A typical student from a public middle and high school in New York State has been using a calculator since fifth or sixth grade. When taking standardized tests in middle school, the teachers must distribute a calculator to each student before class starts. In tenth grade, every math teacher distributes a model TI-83 graphic calculator. The calculators must be distributed to every student taking the Regents exam in New York State, in accordance with the instructions of the New York State Education Department. Naturally, the students become so accustomed to using calculators that they use them even for simple operations.

Breaking Old Habits

Vanessa Angelis is a fifth grader I tutor for acceleration and enrichment. She attends a highly ranked public school in Manhattan and has a solid understanding of basic math concepts. Last year she correctly answered all questions on my basic arithmetic test,

which I give to all my students, whether fifth graders, Highland students, or pre-service teachers. "Hey, Mom, I can do the order of operations!" Vanessa shrieked after solving correctly the following exercise without the use of a pencil or paper,

$$24 - 3 + 2(7 - 2 \times 3) - 2\sqrt{25} - (-3)(-2)$$

Because Vanessa was busy with extra-curricular activities, we had to stop working together for several months. When we resumed our sessions three weeks ago, to refresh her memory I asked her to solve the following simple question as a warm-up:

$$(8 - 2 + 1) \times (8 : 4 \times 2)$$

Instead of solving the problem using mental math, as she would have done last year, she took a pencil and wrote the word PEMDAS in her notebook. Then she calculated the partial answer for the first parenthesis, then the second parenthesis. She then multiplied the two results and said that the answer is *5* (the correct answer is *28*). Obviously, by following the acronym PEMDAS, Vanessa performed the following operations: Since the letter A precedes the letter S, and the letter M precedes the letter D, Vanessa made two errors in that simple example.

Upon realizing what happened, I asked her the answer to *4 – 2 + 1*. Vanessa came to the erroneous conclusion that, while in "real life" the answer is *3*, in math the answer is *1*, because the order of operations are determined by PEMDAS. Unlike harmless mnemonics such as "Thirty days hath September, April, June and November," the ill effects of a mnemonic like hinder the learning of algebra, where students reach the erroneous conclusion that $8x - 3x + 5x$ is equal to $4x$ (instead of $10x$). Over-reliance on mnemonics or algorithms has been found to be detrimental to children's mathematical development (Rubenstein, Reta, Thompson & Denisse, 2002).

4 – 2 + 1 = ?	
EF: Still, what is the answer?	
EF: Are you sure?	
EF: What is that?	
EF: So, is the answer 1 or 3?	
EF: We cannot have two different answers to this silly question. Let's take a vote.	
EF: Let's see. If you have four dollars in the bank and you spent two, you are left with two dollars, right? Now, if you add a dollar, you should have three. Right?	
	Student$_1$: This is an algebra class!
	Several students: The answer is obviously 3!
	Student$_6$: I remember now, I learned it in grade 10, in Mr. Kaplan's class, is called PEMDAS.
	It's the order of operations: The letter A comes before the letter S, addition before subtraction, therefore the answer is 1.
	Several students: It is 1. *Other students: It is 3.*
	Student$_{12}$: You guys are wrong, it cannot be done. You need parentheses.
	Student$_6$. That might be true in banking, not in math. In math, the order of operations is done according to PEMDAS! I learned it in Mr. Gallager's class.

First day of the basic algebra class. Most of the students had already completed a basic arithmetic course at Highland. None of my students had attended a basic arithmetic class with me in the past; all are new faces. The discussion above is about the order of operations. I am telling the students that since we have in the syllabus two hours for review of arithmetic topics, we'll start with the order of operations. I write on the board the question *4 – 2 + 1 = ?* Below is a rendering of a class discussion.

Like Vanessa, students in the class accept the existence of a double standard: one used in banking, where *4 – 2 + 1* equals to *3*, and a different standard used to be used in mathematics where *4 – 2 + 1* is equal to *1*.

Failure in Basic Math

The role of math as a gatekeeper to graduation is best manifested when students fail a certain basic math course, sometimes repeatedly. A good example is the fall 2003 cohort comprising 1153 first-time, full-time freshmen. After six years, 21%, of the students graduated. Who were these 242 students? Were they the ones who attended basic arithmetic classes?

The answer is provided by a closer examination of Table 4.4 below. The 1153 original students could be divided into subgroups: a) 595 students, or 52%, passed the M1 COMPASS placement test in 2003; the remaining 558, or 48%, failed the test. For the 595 students who did not have to take basic arithmetic the graduation rate after six years was over 31%. By comparison, the group that was placed in basic arithmetic saw a much smaller graduation rate, 56 students, representing only 10%. Therefore, the 21% graduation rate after six-years, as low as that percentage may appear, is still overly optimistic for roughly half the incoming full-time freshmen.

Table 4.4

Six-Year Highland graduation rates by basic algebra attempt category, Fall 2003: First-time, full-time students

	Not Graduated as of Summer 2009	Graduated as of Summer 2009	Total
No Attempts	595 76%	186 24%	781 100%
One Attempt	255 84%	49 16%	304 100%
Two or More Attempts	61 90%	7 10%	68 100%

Total	911 79%	242 21%	1153 100%

Based on the above table's data, I could predict that in my class, in which no student had passed the M1 test, fewer than three students would graduate after six years and only one of the ten nursing candidates would get the degree after six years. I conclude that failure in math COMPASS leads to failure in math remedial classes, in turn affecting the graduation rate. The basic math program sequence does not help students obtain their associate's degree; instead it is a hostile gatekeeper to graduation.

It is much costlier for students, the college, and the taxpayers to place a failing student in the basic math sequence than to allow that student take the COMPASS test. The data show that only a small percentage of students placed in basic math courses ever graduate. Therefore, wouldn't failing students be better served by being allowed to attend one of the many one-week workshops available at Highland—and then retest? If the students then pass the COMPASS, thereby eliminating the need to take basic math sequence, wouldn't the graduation rate increase as a result? Other community colleges around the country are experimenting with innovative new models, such as cooperation with the high schools or providing basic training in intensive workshops, before college studies begin.

Language Skills

A legitimate question is whether the language skills programs share the responsibility for substandard graduation rates with the math programs. Based on my investigations, I conclude that, while poor reading skills could pose a high barrier to college completion,

nowhere is that barrier as formidable as the math barrier. This explains why the course catalogue at Highland for the last semester had listed less than 10 sections of basic reading and less than 20 sections of intermediate basic reading classes compared to about 100 basic math classes in the campus. Considerably fewer students are placed in basic reading classes than basic math classes.

Poor English skills would mediate a student's math performance, especially in tests requiring comprehension of word problems. Compared to other academic subjects, though, success in math is probably less affected by poor English reading skills, since math has a language of its own. Indeed my students who are English Language Learners have to master some math terminology they are familiar with in Spanish; they are able, however, to understand the language of a math exam better than the language of a sociology exam. In math they can answer questions using only formulae and algebraic expressions.

Other Factors

Although basic math education has been identified as an obstacle to college graduation, there is no doubt that other factors, such as family obligations, financial constraints, lack of preparedness for college work, or language difficulties, influence a student's decision to drop out of college. What is apparent in reviewing the literature is the scarcity of studies on the reasons for postsecondary education attrition.

In *Tinto's Theory*, Vincent Tinto identified three main reasons for students' departure from college: academic difficulties, the inability of students to resolve their educational and occupational goals, and the failure of students to become or remain involved in the intellectual and social life of the institution. According to Tinto, to persist in college,

students need to integrate into academic systems and social systems, both formal and informal (Tinto, 1993).

Based on Tinto's theory as theoretical framework, Lutkowski, Robbins and Noeth (2004) conducted a meta-analysis (a quantitative synthesis of different empirical studies) entitled *The Role of Academic and Non-Academic Factors in Improving College Retention* of the factors responsible for student attrition (Lutkowski et al, 2004). The academic factors are rated in the placement exam and high school grade point average. The nonacademic factors include goals, motivation, self-confidence, institutional commitment, race, social support and social involvement, while the other factors include socioeconomic status.

As discussed in Chapter 5, CUNY's new ASAP program shows promise in helping students finish their degree within three years. The program's elements, identified as essential to improving graduation rates are as follows: financial incentives, full-time study, consolidated course schedule, small class size, cohort grouping by majors, comprehensive advisement and academic and career development services (ASAP, 2009).

There is much scholarly discussion on basic math education, but much of it centers primarily on different pedagogical methods for teaching basic math at community colleges, improving student preparation before entering college, and institutional interventions (tutoring, counseling services, academic support) for struggling students. Investigating the additional factors contributing to college attrition is outside the scope of this research. Based on the finding associated with the role of basic math education in Highland's low graduation rate, I concur with the findings of Gates Foundation:

> …improving remediation is the single most important thing community colleges can do to increase the number of students who graduate with a certificate or a degree. These low-quality programs that are supposed to help students catch up academically are actually the biggest obstacles students must overcome in their pursuit of a college degree.
>
> (Gates Foundation, 2010)

Making Sense

Chancellor Goldstein proclaimed 2010 as the year of the community college. Through its open admissions policy, Highland has met the extrinsic part of CUNY's mission by providing access to post-secondary education for thousands of students in the Bronx. New construction is taking place to accommodate the growth in enrollment, and for the first time in the college's history there is a wait list. With this record number of new students come a record number of basic math classes. As the data in this chapter show, these basic math classes are a hostile gatekeeper to graduation even for those students who have completed all or most of their coursework in their major. Chapter 5 pulls together the threads of my analysis by examining Highland's basic math classes hermeneutically from different perspectives—curricula and syllabi, policies and procedures, pedagogy and teaching, and students' background and culture.

Chapter 5

What's Happening in Basic Math Courses?

> Insanity is repeating the same action over and over again, expecting different results
>
> (Alcoholics Anonymous)

Quality teaching is crucial to learning not only in elementary, middle school, and high school but also in community colleges, which have been shouldering the burden of educating students who arrive with serious academic deficiencies, especially in math. This is particularly true in the Bronx, where students have been ill served by their previous education and as a result are placed in non credit-bearing courses in math and English.

To be sure, academic success depends not just on quality teaching but also on a student's prior education and preparation as well as effort and persistence. In this dissertation I argue that Highland and schools like it need to make associate's degree attainment a top priority, especially for students with the lowest entering credentials. The goal of helping more students complete their degrees in a timely fashion will be more than worth the required effort.

In previous chapter I identify the math courses as gatekeepers for graduation. Most students who enter CUNY community colleges are placed in basic courses in reading, writing, and math, with the group placed in basic math classes outnumbering the other two groups by a ratio of 3:1. Rather than being gate openers to academic work, the basic math courses have become places where students linger, often taking the same classes semester after semester until, in considerable frustration, they drop out of college.

In this chapter I take a broad look at basic math classes at Highland through two different lenses: a policy lens to understand whether existing policies, teaching, and pedagogical practices help or hinder the graduation rate and a math content lens to illuminate the math knowledge students have when entering Highland, the math knowledge they acquire in basic classes, the relevance of that knowledge to their majors, and the effect of having to take those courses on the retention and graduation rate.

Scope and Lenses

Some pertinent questions to ask at this point are the following: What makes basic math classes insurmountable hurdles for so many Highland students? To what extent and in what ways are basic math curricula and syllabi relevant to the students' vocational interests or career fields? What counseling and tutoring services are available to help students master basic math concepts and improve their grades? How motivated are the students to master the curricula and syllabi of the basic math courses? What changes should Highland consider to help CUNY meet its graduation goals?

There may be controversy about the answers to some of these questions. One answer to the first question is that Highland's basic math curriculum has to provide a solid foundation from which to advance to college-level work. Another answer is that there is only so much the college can do and that the problem resides with the students. Yet another answer is that under-prepared students are demoralizing to faculty and, if students cannot pass the basic courses, they have no business being in college. In other words, there may be a widely held assumption, conscious or unconscious, that this is the way things are.

Let me state at the outset that my proposals for raising the graduation rate are neither to dilute academic standards nor to grant students an undeserved passing grade. I am certainly not advocating turning community colleges into diploma mills on par with certain universities advertised on the Internet where an applicant can, for a fee, acquire an instant degree—from associate's to a doctorate—based on life experience. While I believe it is my duty as a teacher to exact academic performance for an academic grade, I also believe it is my duty as a teacher-researcher to investigate not only my own practice but also my college's curricula, syllabi, teaching practices, and policies to understand better the reasons for my students' mathematical difficulties.

As a cultural activity, teaching is not just produced but reproduced and transformed in the classroom. Teachers are not automata following a syllabus and delivering lectures from a textbook. Every teacher adds his or her own interpretations, experience, and personality while interacting with students and groups of students in and outside of class. This is especially true in community colleges, where class sizes are small and intimate compared to the impersonal lecture halls of many four-year institutions.

I argue that it is wrong-headed to attribute students' weak mathematical content knowledge, weak mathematical thinking, and inability to connect math to the real world solely to poor teaching. It is no less wrong to blame the students for not having studied hard enough or not having practiced enough. Most math teachers teach the way they were taught; therefore, they should not be faulted for reproducing a teaching culture in which algorithms, rules, and repetition constitute the fabric of the system. Having observed multiple teaching styles of in-service teachers and pre-service teachers, I venture to say

that most teachers probably replicate the pedagogical style of one or two of their favorite teachers.

In community college the distance between the student and the teacher is larger than the one students encountered in their earlier years of schooling. The class is called a *lecture*; the lecturer is called *professor*. There is a gulf in knowledge and academic achievement, yet in a small class there is much opportunity for rapport between teacher and students.

Vygotsky defined the zone of proximal development, also referred to as the ZPD, as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers*"* (Vygotsky, 1978, p. 86). The ZPD constitutes the part of the gap that should be closed by the end of a course not through students' efforts alone but through the active help of the teacher. Through sound pedagogy an instructor can decrease that gap or cause it to disappear.

When two trains—a slow one symbolizing the student and a fast one symbolizing the teacher—are on opposite ends of the same track, the distance between them decreases more rapidly if the faster train moves rather than remains stationery. Likewise, when instructors stand on a podium, lecture to a chalkboard, and fail to check students' understandings (except for verifying whether they got a correct or an incorrect answer to a word problem or a calculation), the fast train is not moving, and at the end of the course the gap between the lecturer and student is about the same as when the course started.

My Major Turning Points

After wrestling with a problem over a period of time, people often reach a moment of

clarity during activities that can range from the most mundane to the most profound: while swimming laps in a pool, listening to a sublime piece of music, or dodging a bullet. I reached a turning point while listening to the radio while stuck in traffic on the Major Deegan Expressway. That is when I decided to delve into Highland's graduation rates and to consider if my teaching during the previous seven years might have contributed to that low rate. These findings, coupled with an analysis of CUNY's enrollment trends and the findings of both the Carnegie and the Gates Foundations, provided an opportunity for me to look through bigger lenses in order to understand the main source of Highland's low graduation rates. I also started reflecting on the implications of the low graduation rates for the individuals and the community and the wasted opportunities these rates represent.

Despite teaching at Highland several days a week and being very familiar with the students and faculty, I had no inkling that the ASAP pilot program, scientifically divided into a control group and an experimental group, was fully operational at Highland and the other five community colleges within CUNY. I never imagined that early ASAP findings would validate my two years of preoccupation with graduation rates and my research on that topic. I felt as if I had just discovered a long-lost sibling who had been living across the street from me for the last 20 years. Having taught basic math classes to regular freshmen during numerous fall and spring semesters and to College Discovery students during school breaks, I wrongly assumed that ASAP was outside my sphere of interest, since—so I thought—it is a program intended for students who place out of basic courses.

I remember reading a description of ASAP by CUNY Administrator Frances Gottfried, stating "No one's taking remedial work in this program" (Village Voice, 2008). What I did not understand is that Gottfried was referring to students in the pilot program. It was only recently that I came across some graduation figures which on first blush did not seem to add up: I encountered an 11% two-year average graduation rate for a large group of first-time, full-time freshmen in the 2006 CUNY cohort, that is, among students distributed among all six CUNY community colleges. Until then, the number I was working with for the two-year rate for the 2006 cohort was only 2%, almost 5 times smaller.

After more probing into the significance of these numbers, I examined in detail the *Early Outcomes Report for City University of New York (CUNY) Accelerated Study in Associate Programs (ASAP)* (CUNY, 2009*),* prepared by CUNY in November 2009. That led me to several important realizations: a) Through the ASAP program, CUNY is attacking with full-force the low graduations rate in community colleges; b) The program is well planned and its early results are promising; c) My efforts during the last two years were consistent with CUNY's plan; and d) I saw in ASAP's initial findings a validation of my own hypothesis, that basic math classes do not help students graduate but rather constitute the biggest obstacle to graduation from CUNY community colleges. The rationale for these realizations is provided in the section below.

Graduating in Three Years or Less

The ASAP program, which was started in the fall of 2007 in all six CUNY community colleges, was developed with the goal of helping "community-college students graduate in a timely way" (Goldstein, 2010). Intended primarily for motivated students from low-

income families, the program's goal of having at least half of the students graduate within three years has been exceeded. The ASAP students receive tuition waivers, block scheduling of classes, academic advisement, support and career counseling, and free monthly MetroCards and textbooks, (CUNY Website). As of 2010, some 60% of the students in the pilot group are expected to graduate within the three-year norm.

The new alternative, experimental, community college prototype called the New Community College initiative, mentioned in Chapter 4, will be located in Manhattan. The college will open its gates to 5,000 students who have a good chance of finishing their degrees in three years or less and will be modeled on ASAP.

Early ASAP outcomes

The information in this section is based on CUNY's report summarizing the first two years of the ASAP program (CUNY, 2009). To eliminate the confounding statistical effect caused by some students taking basic courses in math or English, all 2,900 participants in the first phase of the program were exempt from or had placed out of all basic courses.

The control group, referred to as the comparison group, consisted of 1,791 students, or roughly 10% of the 17,000 full-time, first-time freshmen of the 2007 cohort. The experimental group, which in statistical studies is also referred to as the treatment group, consisted of 1,132 participants, or roughly 6% of the 2007 full-time, first-time freshmen. The experimental group comprised those students fortunate enough to be accepted in the ASAP program. To ensure that none of the students in the experimental group have to take basic courses, the program administration granted full acceptance to 319 students

who initially did not place out of all the basic courses (about 28% of the ASAP group) only upon their completing the basic course requirements in the summer of 2007.

The two groups were of a similar socioeconomic status and ethnic/racial composition. Two years later, 30% of students from the experimental group had graduated, compared to only 11% from the control group. The difference between the two groups is expected to further increase by September 2010 when an additional 300 ASAP students are expected to graduate, thus bringing the three-year graduation rate for the ASAP students to an impressive 60%.

Next steps for ASAP

Based on the early outcomes of the program, it is evident that ASAP was more than successful with a group of students exempt from taking any basic courses. A new phase in ASAP will open in the fall of 2010 when the only students accepted into the program will be those who need to take either one or two basic courses. It remains to be seen how effective the ASAP treatment will prove to be for the new students placed in basic math courses in the fall of 2010.

Assuming that the graduation rate of the future ASAP treatment group increases substantially, the question of the cost effectiveness of the treatment arises; in other words, what is the average per-student cost of direct and indirect support to the funding bodies to reduce the gate-closing effect of basic math courses?

Implications for this research

The beneficial effect of the intervention in ASAP was well demonstrated in the experimental group. I was surprised, however, when I examined the data for the control

group. It appears that placing out of basic math classes is an advantage that translates to a many fold increase in the graduation rate and a significant shortening of the time-to-degree. In theory, one would expect the students taking basic math classes to take longer to graduate, perhaps by two or even three additional semesters. For students placed in basic math courses, the time-to degree increased by many years while the retention rate dropped drastically, thus producing a low graduation rate. The purported gate-opening role of the basic math courses turned out to be an obstacle to rather than a facilitator of graduation.

The differences in academic support received by the two groups cannot explain why time-to-degree stretches out to seven years, and nowhere can those differences explain why only 20% to 25% of non-ASAP students ever graduate. Comparing the graduation rate of ASAP control group with that of regular students is valid, since both groups attended similar high schools, have a similar socioeconomic background, and have similar motivation to graduate. Given that non-ASAP students have to take additional basic courses, it is not unreasonable to expect that their average time-to-degree would be extended by one or two semesters but that their graduation rate would be similar to that of other ASAP students.

Even if ASAP's findings show, as I hope, that providing the same degree of support as received by the treatment group will greatly benefit the most vulnerable students, it remains to be seen whether it will be feasible to make the program available on a wider scale. In this dissertation I consider less costly alternatives to achieving equally salutary results. These alternatives imply changes in curricula, syllabi, teaching and pedagogy, and institutional policies.

Understandably, many people are skeptical of the notion that improvements in education can be accomplished at a lower cost. The underlying assumption is that beneficial changes always cost more, not less. The societal implications (and the cost to the taxpayer) of producing one allied health professional, instead of educating an additional four who enroll in the program and invest time and effort but fail to earn a degree for a waiting job, are considerable.

I believe therefore that increasing both the retention and graduation rates and reducing the time-to-degree should be part of CUNY's explicit mission policy. and that directive needs to filter down to college presidents and department chairs.

Basic Math at Highland

The bad economy has brought an influx of new students to CUNY community colleges in the Bronx. With this increased enrollment the number of basic math classes offered is bound to increase. The quantity of these sections eclipses the number of sections taught in many other areas of the college combined. A cursory look at the fall 2009 *Registration Guide and Schedule of Classes* reveals a list of about 120 sections of basic math courses, 40 sections of credit-bearing math courses, and 5 sections of credit-bearing computer science courses.

During both the winter and the spring breaks and in June as well, students who failed basic math are allowed to attend a ten-day workshop in order to obtain a passing score in the subject. No tests or quizzes are given in these workshops—a misnomer, actually, since all workshop sessions I observed informally were talk-and-chalk lectures. The workshop concludes with a final exam on which a score of 70 or above translates to the grade P, or pass; a score below 70 translates to the grade of F, or fail.

Additional basic math sections are taught over a six-week period in the summer. During the school year, accelerated weekend sections are offered 6 hours a day, with a 30-minute break for lunch. Furthermore, there are also preparatory classes for the COMPASS test, some sections for M1, some for M2, and others for M1 and M2 together. Thus, a tally of all the basic math sections in a given year could easily exceed 300. With an average class size of between 25 and 30 students, basic math classes enroll a considerable percentage of Highland students at any given time. During each school semester, thousands of students are enrolled in one type of basic math course or another.

With a tight syllabus to cover, most Highland instructors resort to the traditional lecture format, which enables them to cover the entire curriculum. Such efficiency, however, comes at the expense of student understanding. Research in educational psychology has shown that the lecture format is the least effective teaching method, producing a much lower average retention rate than demonstrations, discussion groups, or experiential learning (Sousa, 2001).

Research also shows that 38% of an 80-minute class consists of down time, during which the students' span of attention is minimal. Moreover, during the remaining 62% of the time, students' attention spans vary in intensity. To make matters worse, the prime-time and down-time blocks alternate, occurring as many as four times during an 80-minute class (Sousa, 2001). While the above data apply to 80-minute classes, as some of Highland's basic algebra classes are 180 minutes long, student learning there is most likely affected even more.

Students missing classes because of work or domestic responsibilities end up missing a considerable amount of material, especially if they are enrolled in a section that meets

for three hours at a time. Probably in order to reduce the impact of absenteeism, basic math classes at sister school Concourse meet four times a week—three times in the class with the instructor and one time with a tutor in the computer lab, where students use Math XL, a computer program consisting of self-paced exercises.

The Math Faculty

At Highland a large number of instructors teach approximately 300 basic math classes each calendar year. The teachers belong to two groups: full-time faculty (consisting of professors, lecturers and substitute lecturers) and part-time adjunct lecturers, who for brevity's sake are referred as adjuncts. Full-time faculty teaches most of the credit-bearing sections. Some faculty instructors teach one credit-bearing course in addition to two basic courses. A few faculty instructors elect to teach only basic courses.

Most basic math courses are taught by adjuncts whose work is governed by the contract between the Professional Staff Congress (PSC/CUNY) and CUNY. The "adjunctification" of CUNY is well documented; in light of current budget constraints, an increasing number of classes are being taught by adjuncts. With little job security, adjuncts can be terminated at the end of the semester for "any reason, or no reason at all" (FACE, 2009). As a result, according to Glenn Peterson, chair of the department of sociology and anthropology at Baruch College, "adjuncts are never, ever in a position to take risks… Yet half our courses are being taught by people who don't have, and will never have, the kind of [academic] freedom we say is so fundamental. What does this mean for students' education"? (FACE, 2009)

An examination of Highland's website shows that 90% of the full-time faculty received their Ph.D. in pure mathematics, a curriculum that does not generally include

courses in pedagogy. A basic math student struggling with fractions and percentages may be reluctant to seek the advice of a faculty member whose stated research interests include topics such as submanifolds, potential theory, large cardinals, moduli and Teichmuller spaces, contact/symplectic topology, mathematical physics, automorphic forms, infinite abelian group theory, but very seldom math education.

Teaching and Pedagogy

Highland instructors strongly favor an approach to the classroom which is teacher-centered: The instructor typically stands at a podium and delivers a lecture while students take notes. Such a teaching approach offers little interactive pedagogy. My conversations with faculty members and students, coupled with observations from the doorway during my nine years of work at Highland and my students' math autobiographies and reflections provide strong evidence for this bias toward lectures. I wonder if this is a result of cultural reproduction and the training the instructors received during their graduate education.

Instructivism vs. constructivism

The lecture format is an embodiment of the instructivist learning theory that reinforces a view that reality, or knowledge, is external to the learner. Instructivists favor a model where teaching objectives exist apart from the learner (Reeves & Reeves, 1997). Stated differently, the students are responsible for understanding the concepts taught by the teacher, who is responsible for delivering a clear, organized lecture. Because the lecture method has prevailed in classrooms, especially in post-secondary institutions, for centuries, it is understandable why many instructors favor this style: They are replicating

their own training. Because the lecture format allows little interaction between teacher and students, many math instructors have difficulty understanding *why* their students fail to grasp simple concepts; they attribute the students' difficulties to not working hard enough or not doing enough practice exercises.

By contrast, the constructivist learning theory takes the view that a learner builds, or constructs, new knowledge by analyzing new information and relating it to prior experience and learning. Constuctivists view a teacher's role as helping guide learners to solve a problem or learn a new skill or topic. As opposed to being passive recipients, students are actively involved in their own learning. In this vision, the teacher engages students in critical, in-depth, higher order thinking about the content through the use of manipulatives, technology, cooperative learning and other pedagogy that enable students to construct mathematics concepts on their own by reasoning, verifying, comparing, synthesizing, interpreting, using different strategies of investigating or solving problems, making connections, and communicating ideas and constructing arguments (NCTM, 2000).

The view that students learn by reflecting on their physical and mental actions is mostly derived from Jean Piaget's descriptive theory of developmental stages and Jerome Bruner's prescriptive theory of modes of representational thought (Bruner, 1966). Many researchers view the constructivist approach as the best way to teach elementary math and algebra concepts (Dienes, 1971; Davis, 1988).

Math content

The syllabus of the basic arithmetic and algebra courses at Highland makes it clear that most exercises and examples done in classes are essentially calculations of one form or another. A basic arithmetic class may include operations involving fractions, decimals, or percentages. The basic algebra classes include lessons in evaluating algebraic expressions, finding the slope of a line between two points, plotting a function without a calculator, solving absolute value inequalities, or finding the vertex of a parabola and its intercepts with the axes. With classes composed of students for a variety of majors and with a tight syllabus to cover, the exercises in basic math classes are not related to the students' career areas or vocational interests. The students try to remember the procedure for solving a problem of a certain type rather than understanding concepts and making logical connections.

Using technology

For several semesters I have been experimenting with the use of technology in basic math classes. Students' reactions, as described in Chapter 6, were extremely favorable. The reaction from CUNY Central Office, the IME (Improving Mathematics Education) initiative, was favorable as well, as demonstrated by the approval for the funding of a proposal that Violeta Menil and I made for research on the use of technology in basic math education. I was puzzled by what appeared to be the conservative approach to teaching by the rest of the faculty. After all, Highland has a well-equipped math lab in the department; is it being used, however, for teaching any of the 300 basic classes? The lab technician confirmed my suspicion that, while the lab is currently being used in computer

science classes, no other instructors are taking advantage of the facility for teaching basic math classes. Maybe these classes are being taught in other facilities, I asked myself: After all, we have several wonderfully-equipped smart rooms in the campus. E-mails I sent to the entire faculty, enquiring whether any faculty member in the department had experience in teaching with technology, bore no fruit. The reaction I received was that such so-called experimentation (i.e., using technology in basic math classes) might contradict the existing policy against the use of calculators and/or other electronic devices in basic math classes at Highland.

Curricula and Syllabi

On closer scrutiny of the curricula and syllabi of the basic arithmetic at Highland, I conclude that the main purpose is mastering of algorithms, that is, gaining skill in doing calculations manually using paper and pencil. Shown below is a sample of a typical final example in basic arithmetic, which consists of 20 questions worth 5 points each.

Typical Math 01A Final Exam Questions

Question 1:

Evaluate: 635,344 – 189,377

Question 2:

Evaluate: 85,217 ÷ 23

Question 3:

Evaluate: $\frac{4}{15}+\frac{5}{6}$

Question 4:

The temperatures on five different days were: 62.1º, 57.3º, 59º, 62.6º, and 64.7º. What was the average temperature? Round the answer to nearest tenth of a degree.

Question 5:

Convert 3 5/8 into a percent and into a decimal rounded to the nearest hundredth.

Question 6:

Write 47,808,007,086 in words.

Question 7:

Find 58.3% of 340

Question 8:

Question 9:

Find the product of 859 and 46.

Question 10:

Write "six billion, twelve million, fifty five thousand, seventy two" in numerals. Round the result to the nearest *hundred.*

Question 11:

Evaluate: 55.1 ÷ 0.19

In the basic algebra course students are expected to find the equation of the line—perpendicular to another line in the plane—that passes through a certain point, to find the coordinates of the vertex of a quadratic function, to solve a quadratic equation using the quadratic formula, to plot graphically an absolute value inequality, and to complete the

square of an algebraic expression.

Some faculty may disagree with my questioning the arithmetic and algebra curriculum. After all, aren't students supposed to know basic arithmetic concepts such as fractions, decimals and percentages, and aren't they supposed to know basic algebra in order to study college level subjects? The faculty members are probably correct when referring to students enrolled in four-year colleges or to students intending to transfer to a four-year college upon obtaining the associate's degree. These students, however, are not the focus of my research, and they are not the students to whom President Obama was referring in July 2009, when he unveiled the American Graduation Initiative, mentioned in Chapter 1. Neither were these students the ones to whom Melinda Gates referred in her speech this year to the annual meeting of the American Association of Community Colleges.

From discussions with my students, it became apparent to me that when students see the relevance of the syllabus to their interest and future careers they are more motivated to study. In the words of Alexa Cordoba, a student in my basic algebra class:

> My aunt's a nurse at Metropolitan Hospital. When I showed her my workbook, she said she never needs to find the intersection between a parabola and a line perpendicular to a second line passing through a given point. Why do we need to know this stuff?

A comparison of graduation requirements reveals significant differences among CUNY's community colleges. While Highland offers *Survey of Math, a* course offering topics such as mathematical logic and set theory, other colleges offer more contextualized instruction, as indicated by course titles such as A*lgebra & Math for Health Science*, A*lgebra & Math for Respiratory Systems,* and *Algebra & Math of Medical Dosages.*

Textbooks

The *Developmental Mathematics* textbook (Johnston, Willis & Hughes, 2006) used in basic arithmetic classes at Highland uses abstract terminology—hard to understand for many of my students—and provides *rules* and *methods* to do long calculations by hand. Below are examples of some typical homework exercises:

Page 12, exercise 19: Add 75,386 + 77+ 105,706,035 + 880,775,009 + 28,388,406
Page 12, exercise 23: Add 885,209,734 + 42,076+ 68 + 7,090,300 + 9,004
Page 19, exercise 29: Multiply 75,009 by 30,007
Page 19, exercise 30: Multiply 820,040 by 90,007
Page 28, exercise 35: Divide 5,248,749 ÷ 583
Page 28, exercise 36: Divide 2,087,490 ÷ 298

By strictly following the algorithms, the students end up doing strenuous exercises, and the chances are they are going to obtain incorrect answers. The textbook focuses only on the first step (understanding the problem) and the third (doing the calculations) out of George Polya's four-step strategy to math problem solving, explained in his book *How to Solve It* (Polya, 1945). Left out is the second step, that of considering different strategies to solving the problem and devising a plan. Also left out is the fourth step, which involves looking back, reflecting on the problem and the strategy used, judging whether the answer makes sense, considering and evaluating alternative strategies, and ultimately reflecting on the lesson to be drawn from the problem just solved.

Research shows that in U.S. elementary and middle schools, many teachers see their job as showing students how to solve a typical problem (Schmidt, 2005). This same method is the purview of the textbooks we use in basic arithmetic courses, par excellence. For example, on page 69 of the *Developmental Mathematics* textbook (Johnston, Willis & Hughes, 2006), the students learn how to subtract mixed numbers:

"Method I: One way to subtract numbers is to convert each mixed number to an improper fraction, then perform the subtraction. If the final answer is an improper fraction, convert it to a mixed number":

That involves the steps shown in the box on page 64:

1. *Find the LCD.*
2. *Convert each fraction to an equivalent fraction having the LCD as a denominator.*
3. *Subtract the like fractions as before.*
4. *Reduce the resulting fractions to lowest terms.*
5. *Any improper fraction found in step 4 is usually changed to a mixed number.*

To find the LCD (step 1 above), the student has to follow the steps in the box on page 63*:*

1. *Write the proper factorization of each denominator. Repeated factors should be expressed as powers.*
2. *Write down each different factor that appears.*
3. *Raise each factor to the highest power to which it occurs in any denominator.*
4. *The LCD is the product of all the powers found in step 3.*

The proper factorization (step 1 above), is completed by following the steps explained under *Method for Finding the Prime Factorization*, given on page 55:

> The smallest prime is 2; the next smallest is 3; the next smallest is 5, and so on. To find the prime factorization of 24, first try to divide 24 by the smallest prime

> number, 2. Two does divide 24 and gives a quotient of 12. Next try to divide 12 by the smallest prime, 2. Two does divide 12 and gives a quotient of 6. Next try to divide 6 by the smallest prime, 2. Two does divide 6 and gives a quotient of 3. This process ends here because the final quotient 3 is itself a prime. The work of finding the prime factorization of a number can be conveniently arranged as follows…

This procedure becomes very difficult to follow, especially when the numbers are larger, such as in exercise 20, on Page 71: $234\frac{5}{14} - 157\frac{3}{7}$

This is how Lamar, a student coteacher, explained on the board how such a question could be solved more elegantly:

Step 1. $234 - 157 = 77$

Step 2. $\frac{5}{14} - \frac{3}{7} = \frac{1}{14}$

Step 3. $77 - \frac{1}{14} = 76\frac{13}{14}$

The example below, from page 102 of the *Developmental Mathematics* textbook (Johnston, Willis & Hughes, 2006), illustrates the difficulties faced by a student trying to understand division of decimals:

1. *Place a caret (^) to the right of the last nonzero digit of the divisor.*
2. *Count the number of places between the decimal point and the caret in the divisor.*
3. *Place a caret in the dividend the same number of places to the right (or left) of its decimal point counted in step 2. Attach zeros to the dividend when needed.*
4. *Place a decimal point in the quotient directly above the caret in the dividend.*
5. *Divide the numbers the same way you divide whole numbers.*

While accurate mathematically, the textbook masks basic concepts behind abstract terminology. On pages 12 and 13 students learn that 9 – 4 = 5 because 5 + 4 = 9 and that *subtrahend* + *difference* = *minuend.*

Curriculum Changes

Recent changes in Highland's course offerings, curricula, and syllabi have major implications for the students, the teaching staff, and for CUNY and the graduation rate; this section describes the changes and their far-reaching effect on many Highland students.

Until the fall of 2009, the basic math courses at Highland were taught in a series of courses, numbered (all pseudonyms) Math 01A (three hours a week), Math 03A (four hours a week), Math 04A (four hours a week), Math 05A (six hours a week) and Math 06A (six hours a week). Students were placed in a particular sequence based on the results of their placement tests and their career areas. This structure had been in place for over 10 years. Starting in the spring of 2010, the math department consolidated the curricula of the basic courses. The lower level algebra classes, Math 03A and Math 04A, were eliminated, while the curriculum for the basic arithmetic course, Math 01A, was expanded.

The modified course—I refer to it as the basic arithmetic/pre-algebra course, Math 01B is being taught in two weekly sessions of two hours each for a total of four hours a week compared to only three hours a week for Math 01A. The syllabus has also changed: the new Math 01B covers pre-algebra concepts, such as working with signed numbers, evaluating algebraic expressions, and solving simple linear equations. The rationale behind the changes: simplicity, uniformity, and convenience, by allowing

students an easier way to change their major without having to take other basic classes. There is a downside to the new system, though. In particular, three groups are affected: students caught in the transition, new and future students having to take Math 01B followed by Math 05B, and future students placing out of Math 01B but not placing out of Math 05B.

The first group consists of hundreds of students who had passed Math 01A and expected to continue to Math 03A, followed by Math 04A, or expected simply to complete Math 03A only. For a nursing student, for example, Math 03A was the highest level of math course required for graduation. With the elimination of Math 03A, these students are advanced into Math 05B, where they face a syllabus that assumes they have met all the required prerequisites – concepts which were taught in the now-eliminated Math 03A course. The three hours of review in the first class of Math 05B are insufficient for learning the algebra topics not included in the previous Math 01A course. Possibly, as a result, their graduation rate of these students will suffer.

The second group of students affected by the recent curriculum changes are new and future students who in order to graduate were previously supposed to complete Math 01A (three hours a week) followed by an introductory algebra course, Math 03A (four hours a week). These students will now have to complete the basic arithmetic/pre-algebra course Math 01B (four hours a week) and a more advanced algebra course, Math 05B (six hours a week). Besides spending $220 on textbooks, the students will have to learn additional topics in a more accelerated fashion.

The third group of students affected by the curriculum changes includes future students placing out of Math 01B but not out of Math 05B. These students would

previously have completed their math requirements for graduation simply by passing only Math 03A or by passing Math 03A followed by Math 04A, depending on their major. They will now have to complete a more advanced algebra course, Math 05B (six hours a week). Besides having to purchase an additional, more expensive textbook, these students will also have to master a more concentrated and accelerated course syllabus. Following this year's curriculum changes, some students, particularly those who had completed most requirements in their major—and now enrolled part-time while waiting to pass the basic math classes—will encounter additional tuition fees. Melody, mentioned in Chapter 1, for example, had to pay $600 for the Math 05B class.

College/Departmental Policies and Support

Tania's story below illustrates many a student's predicament. Understanding Tania's plight requires first examining Math 06A, Highland's most advanced basic math course, which is a pre-requisite for pre-calculus and statistics, both credit-bearing courses. To place of or to pass Math 06A is a degree requirement for business, radiology, computer science, and other technology students.

The curriculum of Math 06A, which consists of intermediate algebra and trigonometry, was unaffected by the recent changes in the math department curricula. Most freshmen at Highland did not pass the old Math A Regents exam in high school—let alone the Math B Regents—and have had virtually no exposure to trigonometry. In contrast to the Regents exam, where students receive sheets containing all basic formulae (sine, cosine, and tangent of sum and of differences of two angles; formulae for half angles; the trigonometric form of the Pythagorean identity; and other trigonometric identities), Math 06A allows no formulae sheets in the final exam.

At Highland trigonometry occupies only one-third of the MATH 06A syllabus; the first two-thirds of the course cover intermediate algebra. Thus, in a four-week period, students have to learn trigonometry from A to Z: The right triangle trigonometry, the trigonometry of the unit circle, trigonometric identities, trigonometric functions and their graphs. This timeframe does not allow review time for the Math 06A final exam. As a teacher, I was often caught between two bad alternatives: rushing through the trigonometry topics, thereby forfeiting the chance for a more thorough review before the final exam, or skipping some topics in the syllabus entirely. I felt I was doing a disservice to my students in either case. Most teachers I know try to review all topics, explaining everything on the board (or to the board) in a rush to cover the syllabus in its entirety. Less than a week after classes end, students take the final exam. As the grades on the math department's bulletin board show, half the students fail the test. For those who get a passing score, D is the most prevalent grade. With their weak background in algebra and trigonometry, they fail the pre-calculus course, sometimes repeatedly.

Tania's story

It is the fall of 2007 on the first day of Math 06. After collecting and examining the students' forms, I see that about half are repeating the course; Math 06 lives up to its reputation as the toughest class in the math department. Suddenly, a student named Tania approaches me and asks if we can chat. Not wanting to hold up the class, I suggest that we meet after class. Tania thanks me and to my surprise leaves the room. Two hours later, I find her waiting for me in the corridor. Here is a rendition of our conversation:

> Tania (visibly upset and talking rapidly*): I can't graduate from this college. I've been here seven years, and the only thing I need to pass is pre-calculus.*

EF*: I don't understand. This is Math 06, intermediate algebra and trigonometry, not pre-calculus.*

Tania: *I know, I know.* I just took pre-calculus for the second time and failed it again, so I can't graduate.

EF*: So what's next?*

Tania (slowing down considerably): *I started in college seven years ago, in Brooklyn. I liked math in high school. In community college I studied computers for two years. Then my husband left. I have a child, so had to move to the Bronx to be closer to my mom. That's when I decided to enroll at Highland.*

EF*: To study computers?*

Tania: *No, no, no. People told me that all programming is outsourced. If you want to make a living, they said, study business. So I did! I'm a business major. Based on the placement test, I was told I had to take a basic math class, Math 06. I got a C-.*

EF: *You passed the test; that's good!*

Tania: *Not so great. My advisor told me I could have continued to pre-calculus, which would have fulfilled my math requirements.*

EF: *Did you do it?*

Tania: *No, my advisor said I had plenty of time to take pre-calculus and that I should first take all my business classes.*
That was almost five years ago. I cut hair. I want to get a business degree and work in a real company. I finished all my classes, in my business major - as I said - except pre-calculus. Then I failed pre-calc.

EF: *Did you repeat the course?*

Tania: *Yes, but I failed it again, so I was put on academic probation; for six months I can't register for the course.*

EF: *I'm not familiar with academic probation.*

Tania: *Waiting six months will make them worse. I told my advisor I'll have to drop out of college after seven years of hard work! No matter how many times I take pre-calc, I'll continue failing.*

EF: *So, what's the solution?*

Tania (continuing, this time much faster): *My problem is not pre-calc; it's Math 06. Pre-calc is based on Math 06.I forgot all my trigonometry and I'm rusty in advanced algebra: exponential functions, logarithms and inequalities, graphing parabolas, that kind of stuff. Trigonometry is killing me.*

I haven't taken any math class in five years. And then boom! Pre-calculus is impossible to understand. What I need to do is [in a loud voice***I is to take Math 06 one more time.*** *Then I'll know everything I need for pre-calc.*

EF: *If that's the only solution...*

Tania (visibly excited): *Unfortunately, it is. I don't want to cut hair for the rest of my life. Plus I already work part-time in accounting. I never see my son; he is with my mom most of the time. I need to take Math 06 just one more time.*

EF: *So did you register for my class? I didn't see your name on the roster.*

Tania: *Of course not. They won't let me even though I am prepared to pay for the course. They say since I already passed Math 06, I can't repeat the course. I'm prepared to pay for Math 06A, but they still won't let me to take it.*

EF: *This is what we're going to do. Come to all my classes and take all the tests and quizzes and do all the homework. Participate in class like all the other students. Just don't show up for the final.*

Tania: *I can't thank you enough.*

EF: *No need. I'll be happy when you get your diploma.*

Fortunately, this story had a happy ending: Tania marched on graduation day a year later. There are at least two lessons to be learned from Tania's predicament. First, Highland's academic counselors, who have to understand the implications of having students interrupt their math education for five years in a row, need better training. The college's policy on academic probation and courses that students are and are not allowed to enroll in requires review. Without these simple steps Tania and many others will drop out as they approach the finish line.

Calculator Policy

It is puzzling why calculators are not permitted in basic arithmetic or algebra classes, when their use is mandated in New York City middle and high schools. Calculators are still prohibited in Highland's restructured Math 01B and Math 05B courses.

In a position paper called *The Use of Technology in the Learning and Teaching of Mathematics*, National Council of Teachers of Mathematics (NCTM)—a organization representing over 90,000 math educators—recommended that "every school mathematics program should provide students and teachers with access to tools and instructional technology, including appropriate calculators, computers and mathematical software, Internet connectivity, handheld data-collection devices, and sensing probes" (NCTM, 2003).

In New York public schools the use of calculators is governed by the policies of the New York State Education Department (SED) / The University of the State of New York. Stressing that "integration of technology in the classroom is a powerful motivator" and that "the usage of calculators helps students visualize concepts," SED issued a policy on the use of calculators in classrooms and on the State Assessment in mathematics (SED, 2007). Accordingly, four-function calculators may be used in the classroom for instructional purposes, starting in grade 3; however, no calculators are permitted in the State Assessment of Mathematics for grades 3 through 6. The scientific calculator is used in classroom instruction in grades 7 and 8 and in parts the State Assessment. In grades 10 above students use a graphic calculator, typically the Texas Instruments model TI 83 or TI84.

When calculators were used in college math instruction and testing, students' operational and problem-solving skills improved. Use of calculators did not hinder the development of mathematical skills (Ellington, 2003). The conclusion of a meta-analysis of 42 research studies on the use of graphic calculators in middle and high school mathematics, as well as in college courses through the first semester of calculus, was that when calculators were used in testing and instruction, the procedural, conceptual, and overall achievement skills of students improved (Ellington, 2006).

Where Do We Go from Here?

The findings of this chapter are easier to state than to act upon. Seen through social-efficiency lenses, if Highland were a business—an unpopular model in education circles—its prospects for remaining solvent would be very bleak. Without providing a decent rate of return on their investment now or in the foreseeable future, Highland's sponsors would discontinue the cash flow.

The problem is not Highland's products (its graduates): There is a good market for them locally in the Bronx, especially in allied health and related services. The problem is that for each graduate Highland produces, the sponsors (taxpayers) have to finance the course of study of four other students who drop out. Considering that the college receives approximately $5,000 for each student (full-time equivalent) from New York state and approximately $4,000 from the City of New York (FPI, 2009), a time-to-degree of six years or more of that single graduate, the cost to the taxpayers for each allied health professional is in excess of $150,000. Carrying the business analogy further, an outside consultant would try to identify the inefficiencies in the production process. As this chapter concludes, these inefficiencies point to the basic math classes. With

approximately 300 classes being taught at Highland every year by approximately 100 instructors, the basic math classes are the main barrier to degree completion.

The high failure rates in basic math classes demonstrate that something is wrong with the curriculum, with pedagogy, or with both. Many students complete the basic math sequence without understanding fundamental concepts such as operations with fractions, percentages, or signed numbers; instead, they rely on mnemonics and formulaic ways of doing calculations, the benefits of which elude them entirely. The majority of the students, however, are unable to complete their prescribed basic math sequence and drop out of college even after completing most, if not all, of the coursework in their majors.

CUNY's efforts to improve graduation rates have been bearing fruit: Preliminary findings from the ASAP program prove that graduation within three years is an achievable goal. Innovative programs for improving retention and increasing graduation rates instituted in many community colleges across the country show promising results. Based on future ASAP findings and additional research, CUNY will no doubt redesign the production process, replace obsolete production lines with innovative pedagogy and teaching, and adapt its model to satisfy the requirements of its main constituents, the students, as well as its sponsors and the marketplace.

Many community colleges now offer promising new models of basic math education. El Paso Community College, in collaboration with local school districts and partnering with University of Texas at El Paso, eliminated the need for basic courses, resulting in an increased graduation rates. Monterey Institute for Technology and Education will fund the development of basic math courses using interactive technology that will be made available for free to colleges.

In the words of Melinda Gates:

> Either [community colleges] can keep doing what you've been doing, in which case you will gradually find yourself able to meet fewer and fewer of your students' needs, or you can innovate," she said. "You can educate your students according to new models that yield dramatically better results for a fraction of the cost.
>
> (Melinda Gates, 2010)

For the last nine years I have been working in the trenches as an adjunct lecturer at Highland, but change is in the air. Being closer to the ground, I hear the roar of the approaching steamroller. To quote Nicholas Negroponte: "if you're not part of the steamroller, you're part of the road." (Brand, 1987).

Chapter 6

Making the Difference

> If you don't like the way the world is, you change it. You have an obligation to change it. You just do it one step at a time.
>
> (Marian Wright Edelman, president and founder of Children's Defense Fund)

The previous five chapters shed light on the relationship between the COMPASS math placement test, the basic math sequence, and the low retention and graduation rates at Highland. The research also examined community college structures such as policies, curriculum, and pedagogy, which potentially mediate the graduation rate. Through this study I argue that changes in the manner and methods of teaching and the institution of structural changes will increase the retention rate, improve the graduation rate, and shorten the time-to-degree without diluting the quality of academic content.

Basic Math and College Graduation

Basic math courses are not a pre-requisite for many courses in students' majors at Highland. As a result, students complete most, if not all, of their curriculum requirements *before* they successfully navigate the basic math sequence; their graduation thus becomes contingent only on completing the basic math courses, in which they become mired. In frustration, most of those students drop out of college without graduating. It might be assumed that if the human services department considered the content knowledge of the basic math classes essential for a career in nursing or human services, it would require completion of all basic math courses in the sequence *before* allowing students to take

courses in their major. In that respect basic math courses would be considered as essential as the biology course is for a nursing major or the health course is for a human services major. I question the purpose of much of the math content in basic arithmetic or algebra for those students seeking an associate's degree in allied health professions, human services, education, or liberal arts. Has completion of the basic math sequence become an end in itself?

Not all classes students take in college are geared toward developing skills directly related to students' future employment. Through college attendance students learn how to think logically and analytically, organize their work, analyze data, and devise strategies to solve complex problems; learning math is instrumental in developing all these skills. Ultimately, students enroll in college—especially in a community college—with one objective in mind: to obtain the college diploma necessary to enter their chosen profession. When the placement in basic math courses and the basic math classes that follow have the effect of diminishing students' chances to graduate rather than of helping students get their associate's degrees,, it is reasonable to question curricula and syllabi, teaching practices, and institutional policies.

Naturally, all the content of the basic courses is highly regarded by people who value mathematical knowledge and logical thinking, but do equally practitioners in allied health professions, human services, education, or liberal arts agree? If the research of the Carnegie Foundation and the Gates Foundation is any indication, alternatives to the basic math courses might be more relevant to the students' majors and help raise the graduation rates.

Given my own mathematical training and love of math, I, too, believed for many years—including during my first years at Highland—that students failing basic math classes should not be awarded a degree. It was only during the last four years, influenced by my research and teaching, that I started questioning whether the content knowledge of the basic math classes became the equivalent of *una lingua muerta.* As much as I love Latin and believe that it helps the study of medicine, I question whether a medical student should be prevented from obtaining the medical license because of a failure in an intermediate Latin class.

City College, one of CUNY senior colleges, offers a program leading to an M.D. degree geared towards liberal arts students. In comparison to students with a science background, participants in this program received less math training in high school, but, through their ability to do well in other subjects, they are deemed as capable to be good medical doctors as students graduating from a science curriculum. Does the analogy not hold for students enrolled in allied health professions programs at Highland?

It is not within the scope of this dissertation even to try to make policy recommendations to either the Highland or CUNY administrations. It is my hope however, that policy makers—guided by their desire to increase graduation rates at Highland—will address some of the questions I have raised throughout this dissertation. At the institutional level, the administration might want to look into the role of the placement exam and question whether students should be allowed to take that test for placement purposes more than once. Administration policy-makers might consider the function of math basic courses in students' acquiring essential mathematical knowledge for their professions and the role played by those courses in helping students graduate or

in hampering their academic achievement. The administration might look into the support provided to students with the goal of increasing retention by emulating practices that proved successful in ASAP and in several community colleges experimenting with different methodologies. Ultimately, the administration might want to look into curricula, syllabi and textbooks, teaching and pedagogy, existing policies and their relationship to student graduation, as well as the use of technology to enhance student learning of math concepts. Changes do not come easily, and it is hard to change a culture that places so much value on a placement test and on a sequence of basic math courses. I am optimistic that the waves of change will reach Highland for the benefit of the students and the benefit of the community in the Bronx.

Changes do take time to implement, and cultural changes at the macro level take even longer. In *Tinkering with Utopia*, David Tyack and Larry Cuban assert that, historically, efforts to revolutionize the education system are doomed to fail and that the best educators can hope for is to make one small change at a time (Tyack & Cuban, 1995). At the meso and micro level, teachers can always implement changes in their respective classrooms. A major tenet of this study is that quality teaching can increase student understanding of mathematical concepts and can mediate the graduation rate, other obstacles at the macro level notwithstanding. In this vein I describe some promising pedagogical approaches I enacted in a basic arithmetic class (Math 01A) at Highland in the fall of 2009. My goals were modest: By making small improvements in the quality of my lessons and interactions with and among my students, I hoped to arrive at a better model for other courses in the basic math sequence. As a side benefit, I wanted to effect

long-term improvements in the students' mathematical learning, thereby increasing their chances of graduating and in as short a time as possible.

What Does Good Teaching Mean?

Escalante achieved exceptional results in his classrooms—in spite of institutional opposition from colleagues and administration—not only by clear explanation of mathematical concepts and principles but also by motivating the students and creating an atmosphere of camaraderie and support in the classroom. As Hargreaves points out, teaching is an emotional practice, a form of emotional labor that involves emotional understanding (Hargreaves, 1998). Based on Collins's sociology of emotions, Tobin explains that good teaching is made out of successful interactions that are charged with positive emotions; bad teaching is often associated with unsuccessful interactions charged with negative emotions. During successful interactions, there is synchrony between the teacher and the students. A chain of synchronous practices is charged with positive emotional energy and leads to entrainment (instead of copying from the board, for example, my students anticipate what I will write next on the board). In these moments there is solidarity in the classroom between all participants. The teaching happens without conscious awareness through practices, which are anticipatory, timely and appropriate, i.e., fluent (Tobin, 2006).

Teaching as a Cultural Activity

My exposure to a variety of educational systems and studies in urban education make me the odd man out at Highland's math department. I venture to say that most of the faculty members are content with current practices and see no reason to change them. Were that

not the case, I would have expected more of a discussion at department meetings about how to improve student learning. I would have expected acknowledgement of and a response to the appalling graduation rates. At the very least, I would have expected significant changes in the classroom structures and in pedagogy and pedagogical development sessions for all faculty members, including both full-timers and adjuncts.

The prevailing teaching culture in Highland's math department reproduces the existing culture in the department and the methods most instructors learned from their own teachers. In other words, the reproduction of culture preserves past practices, in this case teaching practices. These practices might work well for students who are strong in math, but they fail miserably when applied to the most vulnerable urban students, as the evidence shows. With Highland's average class ranging from 25 to 30 students, why is the preferred method of instruction a lecture format? Do the instructors believe they can adequately compress several years of schooling into one semester? Would it not be better to cover less material more thoroughly? Should the math instruction not be contextualized to give students opportunities to learn, practice, and apply these skills to their lives and career areas? Is it not time to revisit the no-calculator policy?

Guided by these questions, I decided four years ago to redesign my teaching methods to address the social and cultural aspects of teaching and learning. My intent was to enact collective responsibility for learning basic arithmetic. I began by gradually shifting the focus of my classes from impersonal teacher-centered lectures to student-centered practices, where volunteers are invited to the board to explain or demonstrate how they arrived at a solution to a given problem. Breaking with tradition, I now encourage the

students to use calculators to check their homework and to bring to class problems that they had difficulty in solving.

Following two summers' work in MSP (see Chapter 3), I co-authored with Anthony Durante, a chemistry professor at Highland, an essay titled "What the College Teachers Learned from High School Teachers in MSP," in which we describe how our classroom format had changed through planning and re-evaluating the course material from the learners' perspectives:

> First, we write out and state the objectives for each lesson; second, we create exercises or questions to assess whether the students grasped the background necessary to understand the new skills or topics stated in the objectives; and finally, we design a lesson plan clearly describing the new topics and concepts. In the end, the plan contains a mix of presentations, demonstrations, discussions, questions and answers, problem solving techniques, inquiries and scavenger hunts ... all pointed toward meeting the objectives, which we share with students at the beginning of the lesson. Our expectations on student achievement are thus clearly conveyed to the class.
>
> (Durante & Fuchs, 2007, p. 1)

Inspired by Escalante and hooks, I interact with students outside the classroom, having coffee with them and learning about what stands between them and mathematical learning. Sometimes we chat informally while eating breakfast or lunch in the cafeteria. Very often, when students tell me about the difficulties they are having, I direct them to tutoring sessions and check with the tutoring director about their attendance and progress. I also review my students' homework and provide feedback to them.

In the classroom I divide the students into small groups. Graybeal and Stodolsky found peer work groups very effective in encouraging student participation and improving the learning of both more capable and less capable students (Graybeal & Stodolsky, 1985). I also offer suggestions on how the students can teach elementary

math, such as math facts and mental math, to their children. If my students' evaluations of my classes are an indication, they are pleased with my efforts to enhance teaching and learning. I have received very favorable evaluations—produced anonymously at the end of each course and returned to me by the department after the grades were distributed—with comments such as "you made math interesting," "in this class, things made sense," "thank you for caring about us as a person," "thank you for helping me teach my son the multiplication facts."

According to sociocultural theory knowledge does not belong exclusively to the individual teacher; rather, it is distributed within the collective. Both teachers and students are agentic, meaning they have the power to act; they appropriate structures and as a result culture is enacted. After receiving IRB approval, I decided to infuse my Math 01A class with additional student-centered practices grounded in sociocultural theory: cogen and coteaching. Video recording in the classroom and in the lab, followed by group discussions on vignettes from the recorded data, are important parts of successful cogen and coteaching practices. Both cogen and coteaching are forms of praxis, or cultural enactments.

The teaching practice consists of an infinite string of singularities (praxis), or events that happen (Sewell, 1992). The praxis is an unconscious move by a teacher that exists in a dialectical relationship with the conscious moves. Learning—as a cultural activity—is partly productive, partly reproductive, and partly transformative. To achieve fluency in the classroom, teachers' reactions have to be timely, anticipatory, and appropriate. In a community college, teaching and learning take place in the classroom, a field without defined boundaries, which intersects with other fields (college, students homes and

family). Students bring their culture into the classroom rather than checking it at the door. Sewell develops this concept from Bourdieu's work.

A community college structure consists of human resources (teachers, administration), material resources (classrooms, computers), and schemas (rules, ideologies). Sewell defines the relationship schemas | resources: "resources are the effect of schemas and … schemas are the effect of resources" (Sewell, 1992). The Sheffer stroke (the vertical line between the words) is used to symbolize the dialectical relationship, a relationship between two elements in which each presupposes the other; that is, neither entity can exist without the other. Structure coexists in a dialectical relationship with agency, symbolized by agency | structure. In my classroom students are agentic, they have the power to act and appropriate structures as they learn new things. Contradictions exist in a dialectical relationship between the elements of the relationship, as in individual | collective. Cogen constitutes a methodology to solve dialectical contradictions. As Tobin and Kincheloe explain,

> We regard cogenerative dialogues as a professional development activity in which teachers and students can accept shared responsibility of the quality of teaching and learning, and by regularly meeting they can learn to interact successfully with each other. (Tobin and Kincheloe, 2006, p. 24)

There are no privileged voices in cogen; the teacher is just one of the participants. There is no time limit imposed on a speaker. Through cogen the participants arrive at collectively agreed-upon solutions to problems pertinent to the teaching and learning in the classroom.

In coteaching, the two participants (teacher/teacher, teacher/student, or student/student) act as copilots of an airplane adopting "complementary roles…the

coordination of the step forward, step backward routine is important" (Tobin & Roth, 2006, p. 25). Coteaching differs from team teaching, where participants divide teaching tasks according to competency and inclination. One advantage of coteaching is that the second coteacher can seize on a teaching moment and take over from the first coteacher at any time, the same as a copilot could seize on a pilot's weakness and take control of the plane. Rather than limiting myself to a single coteacher, in our class we had four coteachers: I was one of them; two other coteachers, Lamar and Jaime, were chosen because of their mastery of math concepts and their ability to explain them clearly to their peers. The fourth coteacher, Destiny Villa, excels in her computer skills and was instrumental in helping students less familiar with the technology.

My Basic Arithmetic Test

Realizing that Highland's exit exams in basic math are based primarily on calculations, I have developed my own test, which I administer to my arithmetic students at the beginning and end of the course. My purpose is to assess understanding of mathematical concepts. I also administer this test to my algebra students at the beginning of the course as a baseline for their grasp of arithmetic concepts necessary for the algebra study.

With so many tests available, why develop another one? The answer is that I needed a test that would assess understanding of concepts rather than checking for correct answers to calculations. Knowing that new teachers reproduce the teaching culture they learned from their teachers, I developed my arithmetic test while working with aspiring teachers (ATs) for grades K-6 on one hand and with elementary school children (grades 4-5) on the other. To understand the difference between the test below and a multiple-choice test, it suffices to look at questions 4 and 5. Most ATs solve question 4 correctly, but only

those who understand fractions concepts would solve question 5, identical to question 4 except for the numbers. Solving question 4 by finding the common denominator (36) is totally divorced from the way we would solve that problem in everyday life (in a pizza parlor, no one cuts 9 pies into 36 quarters when a client orders a quarter of a pie).

Through many years of tutoring elementary-level math, I have found that children who have a conceptual understanding of fractions retain that understanding. Children who are taught using a *how to* approach tend to confuse *rules* or forget how to apply them and end up being taught the same rules year after year, with no effect. This explains why I encounter algebra or pre-calculus students who still cannot work with fractions even after completing two basic math classes at Highland.

I use my arithmetic test as an assessment tool and work with my class with virtual manipulatives with the goal of allowing students gain, at their own pace, a conceptual understanding of basic arithmetic.

My Basic Arithmetic Test

Question 1:

8 – 2 + 1

Correct answer: **7**
Expected student answer: 5

*[*Reason*: reliance on PEMDAS, without understanding order of operations]*

Question 2:

7 ÷ 0

Correct answer: **undefined**
Expected student answer: 0

[Reason: confusion between 0 ÷ 7 and 7 ÷ 0]

Question 3:

$$\frac{1}{2}+\frac{3}{4}$$

Correct answer: 1¼

Expected student solution: $\frac{1}{2}+\frac{3}{4}=\frac{1+3}{2+4}=\frac{4}{6}=\frac{1}{3}$

[Reason: confusion between fraction multiplication and fraction additional and failure to examine an answer that does not make sense]

Question 4:

9 – 1/4

Correct answer: **8 ¾**

[Observation: Could be arrived at by observation and understanding]

Expected student solution: $\frac{9}{1}-\frac{1}{4}=\frac{4\times 9}{4\times 1}-\frac{1}{4}=\frac{36}{4}-\frac{1}{4}=\frac{35}{4}=8\frac{3}{4}$

[Reason: reliance on converting to improper fractions even when a more logical solution is available]

Question 5:

9 – 4 $^{63}/_{68}$

Correct answer: **4 $^{5}/_{68}$**

[Observation: Could be arrived at by observation and understanding]

Expected student solution: Without understanding fraction concept, Highland basic math students are unable to solve this question.

Question 6:

6 ÷ 1/3

Correct answer: **18**

Expected student answer: 2

[Reason: confusion between division by 3 and division into thirds]

Question 7:

Find **3/4** of **5/6**

Correct answer: 1/4 of 5/6 is equal to 5/24. Therefore, 3/4 of 5/6 is 15/24, or 5/8.
Alternative correct answer:

$$\frac{3}{4}\times\frac{5}{6}=\frac{3\times 5}{4\times 6}=\frac{5}{4\times 2}=\frac{5}{8}$$

Expected student solution:

$$\frac{3}{4}\times\frac{5}{6}=\frac{3\times 3}{4\times 3}\times\frac{5\times 2}{6\times 2}=\frac{9}{12}\times\frac{10}{12}=\frac{90}{144}$$

[Reason: students tend to find common denominators even in fraction multiplication]

Question 8:

Sonia made $23,000 last year. This year, she received a 5% increase. What's Sonia's new salary?

Correct answer: **$24,150**
Rationale: 10% of $23,000 is $2,300. Since 5% represents half of 10%, we have: 23,000+1,150=$24,150

Expected student answer: 23,000 x .05, and then add the result to 23,000

[Reason: I've seen many different answers, including answers exceeding $11,500,000, since 23,000 x 500 = 11,500,000 (student confusing 5% with 500)]

Question 9:

What is the perimeter of the rectangle with length of 4 foot and width of 6 inches?

Correct answer: **9 ft**
Rationale: length is 4 feet; width is 6 inches, or ½ foot. Perimeter is 4 +½ + 4 +½ = 9 ft

Expected student answer: varies

[Reason: not paying attention to units, thus adding 6+4+6+4, yielding 20, or adding just 6 and 4, thus obtaining 10 ft. Other students confuse perimeter with area and multiply 4 by 6. They get the correct answer of 24 but fail to understand that this is not the perimeter of a rectangle.]

Question 10:

6 ½ ÷ 3 ¼

Correct answer: **2**
Rationale: Observe that 6 is twice as large as 3, and ½ is twice as large than ¼

Expected student answer: varies.

[Observation: Students who get the correct answer typically convert mixed numbers to improper fractions, multiply the first fraction by the reciprocal of the second and simplify the result.

Question 11:

8 ÷ 2 x **4**
Correct answer: **16**

Expected student answer: 1
[Reason: reliance on the mnemonic PEMDAS. The student multiplies 2 x 4 first, since the letter D comes before the letter A.]

Question 12:

.02 x **1.5**
Correct answer: **.03**

Expected student answer: varies.
[Reason: difficulty understanding and working with decimals]

Question 13:

You paid $20 for a shirt when the sign says SALE 20% off. How much did you save?

Correct answer: $**5**
Rationale: Since you saved 20%, you paid only 80% of the original price. The original price was $25. You saved 20%, or $5.

Expected student answer: $4
[Reason: Students will calculate 20% of the $20, even though that was the reduced, not the original price.]

Question 14:

You just had a hair cut costing $15, and decided to tip the hair stylist 20%. How much change would you get from $20?

Correct answer: $**2.00**
Rationale: The tip is 20% of $15.00, or $3.00 The total is $15.00 + 3.00 = $18.00.
The change is $20.00 - $18.00 = $2.00

Expected student answer: varies

Question 15:

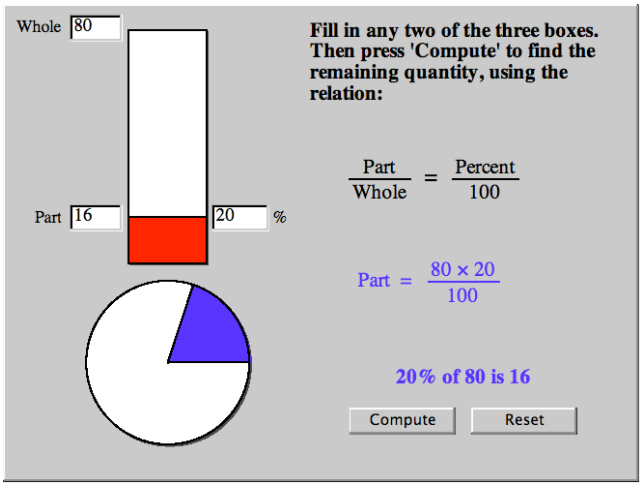
– 4 – 2

Correct answer**: – 6**

Expected student answers: 8, 2 or 6.

[Reason: confusion between adding signed numbers and multiplication of signed numbers: "two negatives make a positive"]

Learning Mathematics with Virtual Manipulatives

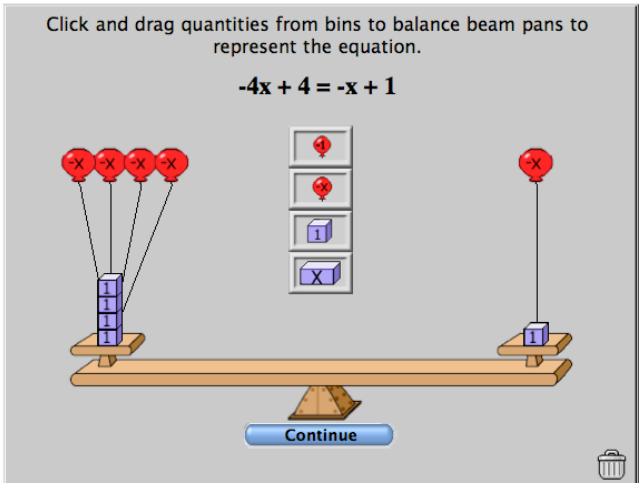


As mentioned earlier, Violeta Menil and I were the recipients of a CUNY grant to use virtual manipulatives in the teaching of arithmetic and algebra concepts in basic math classes. The software we used is called the National Library of Virtual Manipulatives (NLVM) and was developed by researchers at Utah State University. It is the same software my students used in the Math 01A class in the fall of 2009. I had had extensive experience with the software before starting the class through my tutoring and my teaching ATs at a CUNY senior college.

Appendix I gives an excerpt of the proposal we submitted when bidding for the grant on improving undergraduate math education through the use of virtual manipulatives. It explains the role manipulatives play in the development of math concepts in children and the difference between physical manipulatives and virtual manipulatives:

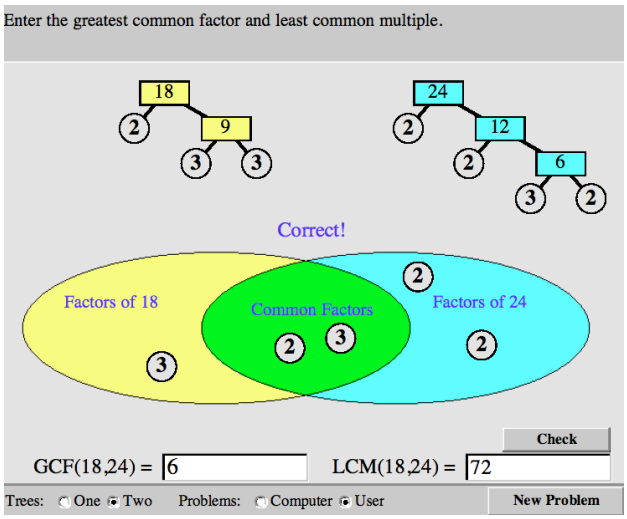
> Whereas hands-on manipulatives are tactile and visual, virtual manipulatives are only visual; on the other hand, virtual manipulatives are interactive: that is, the learner can manipulate the same objects and create the same mental representations of the objects using the computer mouse. In today's technology-enriched environment, it is even more appealing for college professors and college students to use computers rather than hands-on manipulatives.

Understanding fractions and percentages poses a significant challenge for many students. It is relatively hard to emulate the problem on this page using physical manipulatives. Students are trying to find out the savings associated with purchasing an $80 pair of sneakers bought during a sale; the sale sign in the store states “20% off.” With the virtual



manipulatives the students obtain a visual representation, and they can try different discounts, 59%, 25%, 19%, 20% and so on until they understand the pattern.

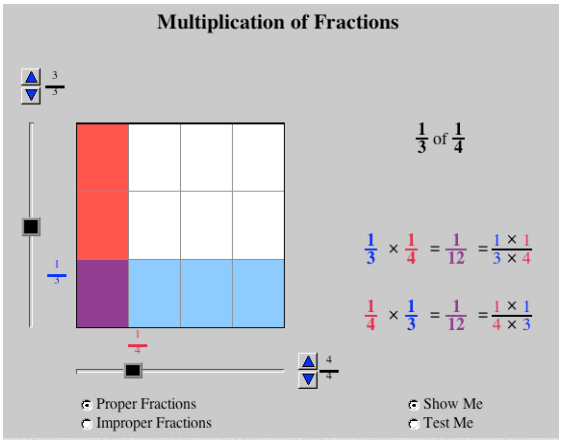
The screen shot on the left represents a graphic display of a linear equation with negative coefficients and unknowns on both sides. The students can experiment by subtracting, adding, multiplying or dividing both sides of the equation. The weight and balloons appear and disappear according to the operation students elect to perform. In pursuing their solution, the students constantly obtain both an iconic and abstract representation on the screen.



The picture of the computer screen to the left shows an exercise students perform in the lab during a lesson on prime factorization. The assignment is to find the prime factorization of 18 and 24. After constructing the factors tree, the students drag the common prime

factors (2 and 3) to the intersect area highlighted in green; the factors that are not in common are dragged to the yellow and blue part of the Venn diagram respectively. The students then determine the greatest common factor 6, as the product of 2 and 3.
Then they find the least common multiple (LCM), 72, either by multiplying 18 (the product of the prime numbers in the yellow and green ellipse) by 4 or by multiplying 24 (the product of the prime numbers of the blue and green ellipse) by 3.The assignment also helps students learn to work with Venn diagrams and understand the concepts of intersection and conjunction of sets.

The screen shot on the right illustrates the use of virtual manipulatives to teach fraction multiplication. By dragging the horizontal and vertical cursors, the students perform a variety of exercises, starting from ½ of ½ to more difficult exercises dealing with improper fractions. Below is a reflection written by Yolanda Perez on learning fraction multiplication and prime factorization with virtual manipulatives:



From Yolanda Perez
Homework#5 Virtual Manipulatives

One of the exercises that i enjoyed is called "Fractions-Rectangle multiplications." I learned about how to multiply fractions, and learned the steps of how to do it. i worked with proper fractions, and improper fractions. It was a fun exercise . I also work with the exercise called "Factor Tree." i enjoy it a lot, and i could figure the factor of a number in my head. i compare it to the computer and got the exact answers.

These are the exercises i work with..

1.Proper fractions.

1/3 of 1/3 = 1/3 x 1/3= 1/9

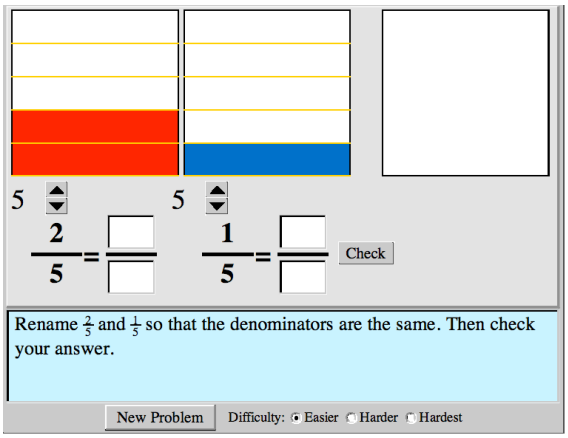
1/3 of 1/4 = 1/3 x 1/4= 1/12

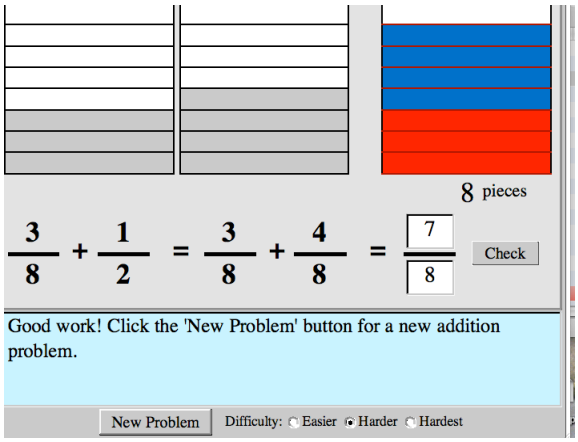
2.Factor Tree.

```
     16          40
     / \         / \
    4   4       4  10
   /\   /\      /\  /\
  2 2  2 2     2 2  5 2
```

Naturally not all students advance at the same pace. While some students like Yolanda were playing with fraction multiplications and with prime factorization, other students were trying to understand the concepts of basic fraction addition:

Starting with addition of fractions with the same denominators, students progress at their own pace to fractions of different denominators, as shown in the screen shots above.





Here is what Flavio had to say about learning math in the lab:

National Library of Virtual Manipulative
10/05/09

The National Library of Virtual Manipulative is a very fun website it's a great way for students to learn and understand mathematics, at every level in a fun way. The

website has every type of problem on it and it can be use by any one because it is so easy to use, any student who can use a computer and knows how to work with the internet can use this website and have fun on it no matter the age of the student or the grade. Not only students but parents could also use this website to teach theirs kid mathematics in a fun way I definitely recommend it for any parent who is determine to teach their kids something good and fun…

I couldn't stop until I was done, there are a lot more exercises like this one. I also did a lot of adding and subtracting but that wasn't as much fun because I could do all that in my head. I also like how the website has an index and you can choose whatever problem you desire, how everything is divide the Numbers & Operations, Algebra, Geometry, Measurement and Data Analysis & Probability, You can also change the language to Spanish or French if is more helpful in that way….

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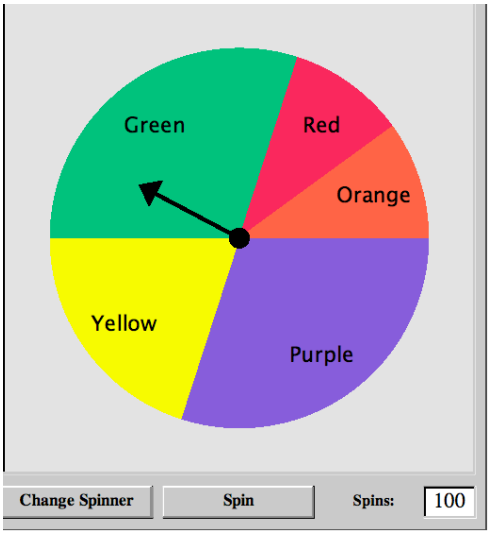


Flavio enjoyed the games immensely as his words above indicate. I observed Flavio assigning different probabilities to the different colors, associating colors with names of his colleagues, spinning the electronic spinner hundreds and hundreds of times, and observing the plotted bar chart. He explained to his colleague, Ana that he was trying to prove that in the long run "theoretical probability and experimental probability run neck and neck, therefore people should give up smoking and always wear seatbelts when driving."

A Different Class

In my practicum in the basic arithmetic class in the fall of 2009, I experimented with innovative pedagogy grounded in sociocultural theory and also used elements from the

sociology of emotions and educational psychology. The major assumptions guiding my work in that class were as follows:

a) My Highland students bring to the college a mathematics culture that has been formed over many years of schooling in elementary, middle, and high school. It is a culture that treats mathematical problems as calculations, the purpose of which is to obtain a number as a result. An algorithm, or a procedure, is required in order obtain the right answer. The equality (=) sign is not treated as a comparison of two quantities, similar to the inequality signs (> or <) but as an imperative to perform a calculation in order to obtain an answer;

b) Students who erroneously add fractions—represented in abstract notation, such as in 1 /2 + 1 /4—by adding the numerators and the denominators can add *one half and one quarter* in money or pizza pies correctly;

c) The reason why students have difficulty with simple fractions operations after being taught repeatedly these concepts for many years is that the methods used to teach the concepts were not conducive to student learning;

d) Four months of teaching elementary math in college in a lecture format would not bear more fruit than teaching the same concepts for several years in middle school and high school in a lesson format;

e) Students learn at their own pace how to operate a computer, swim, or ride the bike; learning math ought to be no different;

f) Students are very familiar with technology. In comparison with many adults who learn serially, contemporary students are capable of figuring out how gadgets work (example, a young child experimenting with a complicated digital watch); therefore, the

students should be more prone to figuring out fractions, decimals, and percentages with a computer than on a blackboard or in a notebook; and

g) Students learn better working in pairs in a lab than by listening to a teacher's lecture or a tutor's explanation.

Some of the above ideas, grounded in constructivism and educational psychology, are widely used in middle schools and high schools. I have experimented with them with moderate success in my basic math classes over the years. The major difference between those earlier classes and the class of the fall of 2009 was the addition of teaching practices grounded in sociocultural theory and of socio-affective practices grounded in the sociology of emotions, combined with a significant infusion of technology promoting differentiated instruction. Thus, the class of the fall of 2009 benefited from the complete arsenal of methodologies at my disposal, as discussed in the rest of this chapter.

Basic Arithmetic – Fall 2009

The use of the historical present in the following sections is intended to convey a sense of immediacy and have readers see certain events from different points of view, including those of the students.

It is Monday, August 31, 2009. The time is 10:00 a.m. Twenty-six students show up for the first day of class in my Math 01A section. The class meets on Mondays and Wednesdays from 10:00 to 11:15. I am pleased with the assignment—no classes on Friday. Friday classes translate into higher absenteeism, and a 10:00 a.m. start is sufficiently late to give students time to drop off their children at the daycare center and get to class on time. I decide to explain my research project to the students during our next meeting after the roster has stabilized.

After introducing myself, I ask the students to introduce themselves and state their majors. The students take turns trying to recite the names of their classmates and their majors. We repeat the exercise several times until most of the students know each other's names. I write my name, e-mail address, and cell phone number on the board and pronounce my name. I ask the students to send me an introductory, one-sentence e-mail with their preferred e-mail address. I then circulate a sign-up sheet and ask the students to record their names, e-mail addresses, and phone numbers.

The next order of business is asking the students to buy an inexpensive, basic-function calculator (TI-34 Solar model) on which to check their answers. The math department's policy prohibits the use of calculators on class quizzes or exams, but I see no harm in having the students use the calculator as a learning aid. Only a few students have the textbook, which costs $70. A few are waiting for financial aid, so I suggest that they pair up with a student who has the textbook.

It is time to take my basic arithmetic test, described earlier in this chapter. It does not surprise me that most of the students in Math 01A fail this test; it proves that they are in the right class. I am glad I chose the basic arithmetic class for my research. At least I will not be pressured by time constraints nor have to cope with large learning gaps among the students. In the evening I check my students' answers to my basic arithmetic test. Through an examination of their work, and by asking probing questions in class, I conclude that my students are not different from students from my previous arithmetic classes. It is always the same topics that cause difficulty: fractions and operations with fractions, percentages, order of operations, and operations with integers. Students also confuse area and perimeter, lack a number sense, and stumble over mental math.

The second class

It is Wednesday, September 2, 2009. The time is 10:00 a.m. Iris Diaz and Sandra Aguirre join the class, which now numbers 28 students. They introduce themselves to the class. Now that the roster is complete, the students take turns reciting the names of the class members and their majors

> Ana Gomez-nursing; Iris Diaz-education associate; Ariel Rojas-animal care and management; Destiny Villa-liberal arts; Liya Williams-liberal arts; Hector Acevedo-liberal arts; Manuela Vidal-media technology; Jaime Rodriguez-digital arts and graphics; Lamar Jackson-criminal justice; Charlotte Mallette-nursing; Sanon Isaaka-nursing; Tania Lopez-liberal arts; Sandra Aguirre-nursing; Emily Leon-nursing; Anthony Colon-liberal arts; Carmen Fernandez-nursing; Miranda Cadalzo-education associate; Genesis Madera-liberal arts, Mirabel Lobos-medical office assistant; Davonte Arzu-radiologic technology; Venus Torres-liberal arts; Yolanda Perez-computer information systems; Margaret Del Farro-nursing; Flavio Sanchez-accounting; Daisy Flores-human services; Xiomara Espejo-liberal arts/psychology; Julissa Delgado-nursing; Zoraida Alvarez-nursing.

Everybody claps and cheers when Lamar is the first to recite correctly the names of all the students in the class and their majors. “How did you do it?” asks Genesis. Lamar shrugs his shoulders and answers, “Dunno; I just did it.” Sandra and Zoraida soon follow in Lamar’s footsteps. I tell the rest of students not to worry—tonight they will receive an e-mail from me listing the names of all the students.

We talk about what makes this class different from other classes they might have taken at Highland. Attendance and punctuality will matter greatly in their building on previously learned concepts. I require active class participation by all. The students’ rewards for their diligence will be increased understanding and possible enjoyment of math. I tell them that mastering basic arithmetic concepts will probably help them pass the COMPASS test, if their major requires this for graduation; however, passing the COMPASS test is not the main objective of this course.

Students who are parents are excited about the prospect of being able to use their new math knowledge to help their own children. As Julissa Delgado says, "I don't want my daughter to sit in this chair 12 years from now." After explaining that my research aims at improving my teaching in this and future classes, I distribute the IRB-approved consent form to each student. Since all students are over 18, no parental or guardian-approved consent forms are required.

Teacher-student interactions

It is September 7, 2009. This is our third class. We discuss the methods by which we will communicate with each other: students with teacher, teacher with students, students with students. I could build an on-line discussion board relatively quickly and have a synchronous on-line communication such as chat. The students did not like the idea, given the constraints on their time; a large number of students are already juggling school, work, and domestic responsibilities. We agree to use e-mails instead. Students will send me their e-mails to which I will respond individually. To communicate to the entire class, I form a group. The students may also communicate with the entire class or only with their individual buddy.

I explain the principles of cogen, coteaching, and peer working groups. We decide to hold half the classes (one day a week) in the computer lab, where students will work in pairs. They are not prepared to participate in cogen outside of class. We decide therefore to conduct short cogen sessions in the lab.

To help me get a sense of my students' previous education in math, I recommend that they send me an e-mail with a mathematical autobiography describing their previous math courses and attitude toward math, teachers and teaching methods, learning math

outside the classroom (such as from family members and friends), and optional information on their family and upbringing (including learning English as a second language and current employment). This information will help germinate ideas on how to adapt my teaching to the students' needs.

Only 24 of the 28 students submit a math autobiography. I also suggest that students send me periodic reflections on the class activities; they can use the reflections to identify areas in which they need help. As the semester draws to a close, the number of weekly reflections starts to diminish. I attribute the decrease to a lack of time because of year-end assignments and a waning of the students' initial enthusiasm for communicating with me in an asynchronous mode.

The classroom sessions

The class of September 7, mentioned above, is the last class before the lab sessions. It is time to play some mathematical games and to stimulate the students' interest. The first topic is the order of operations, described earlier in this chapter. My question on the board is 4 – 2 + 1. Initial reaction: "You must be kidding!" The class votes on the correct answer: the favorite choice is 1, but Hector and Mirabel Lobos argue that the correct answer is 3. They all rely on PEMDAS, but interpret the mnemonic differently.

Not surprisingly, they all understand that if I had $4 in the bank and spent $2, the balance now is $2. I deposit $1; the balance now is $3. I deposit $4 more; the balance now is $7; I spend $2, the balance now is $5; I spend $3; the balance now is $2. I spend $4; I am overdrawn $2, and so on.

The students discover how their overreliance on rules could produce unexpected results in simple questions. We discuss different ways of understanding the number

system, the relationship between numbers, and why the order in which we perform operations has to make logical sense. The next topic is comparisons: larger, smaller, equal. "What's larger ½ or ¼?" I ask. "Obviously ½ is bigger," says Emily Leon. "Always?" I ask. "Yes, always," reply Anthony, Genesis Madera, and Emily, in unison. I love this moment. "Would you rather have half of my salary or a quarter of Bill Gates salary?" I ask. "Ah, that's totally different," opines Julissa. We discuss the meaning of one half *of what*, as opposed to simply one half, 25% *of what.*

Ana and Manuela volunteer to solve on the board, independent of each other, the addition of ½ and ¼. The class laughs upon realizing that the two results, 2/6 and 1/3 respectively, are smaller than ½, based on an excellent drawing of a pizza and its slices, courtesy of Hector Acevedo. Lastly, we do some mental math exercises to help the students see the importance of understanding the relationship between numbers and the order of magnitude. "You mean we have to know the answer, more or less, before we solve the problem?" asks Hector.

The students are fascinated when I tell them that all calculations leading to the building of the Brooklyn Bridge and the New York City subway system were performed by engineers who, equipped with slide rules as opposed to computers and calculators, could never obtain the exact answer to a simple division such as 83,728 divided by 413. The students' math autobiographies and reflections written during the break reflect students' enthusiasm to learn math, to understand why, and to think outside the box.

The homework for the next week: complete the questionnaire on confidence in doing math and attitude towards math learning. The questionnaire (see Appendix G) is based on two subscales of a revised version of the Fennema-Sherman Mathematics Attitude Scales

(Hackett & Betz, 1989). I also suggest that they check Singapore math online. I give them the website and suggest that they start from the lower grades. They think that the assignment is ridiculous but promise to do it. I remind my students that in the long run the turtle, not the rabbit, will always win the race. In the last ten minutes of the class, we take a tour of the campus and visit the math lab where the real learning will take place.

In future weeks we continue to meet in the classroom once a week to consolidate math concepts and solve problems on the board or in small groups. The students' reflections on the classes help me adjust my teaching. Here is one of Ana's reflections following the lesson on power and roots:

Ana Gomez
Math01A 10-8-09
Journal entry #4

This week we learned about power and roots. Power and roots was one of the best topics that I loved when I was in high school. Remembering till this day that a lot of my class mates had problems doing it. I don't know why because power and root is one of the easiest topics. I looked up the definitions and it means and says the same thing we learned in class.

Tania Lopez added the autobiographical notes to her first classroom reflection:

Hi. My Name Is Tania Lopez From Your Math 01A Class. First Of All i Would Like To Say I am Not Good At Math At All... Obviously! But i Am Willing To Try And Give it My All. I Am a Very Serious Person But At The Same Time i Know How To Have Fun. I Play Softball And Also Ran Track. Im Trying To Make it In The Criminal Justice Field And Become A Correctional Officer Or Maybe Even a Cop. Im Not Going To Ask You For Much But Just For One Thing To Teach Me Some Of Your Knowledge So That i Can Understand Math Better Because i Never Had a Problem With Math Until i Got Into Middle School. I Dont Know How And Why But it All Just Seemed Harder. i Guess i Just Need Someone To Explain it In a Way i Would Be able To Understand Because Now it All Seems Boring To Me. But Hopefully i Would Learn alot From What You Teach Me And Hopefully Be Successful Enough To Move On To the Next Level in Math. Thank You

Subject: Reflection --Sent: Mon October 22, 2009
Last Week In Class Was Very Fun. Learned How To Add And Subtract Fractions.The Only Problem I Have Trouble With Computer I Have A Computer At Home But My Older Brother Doesn't Really Let Me Use It So That's Why I Cannot Communicate Or Play The Games You Want Us To Play On The Computer. But Hopefully I Get The Chance To. Thank You!

Below is Sonora's reflection on the class lesson in prime factorization, a topic we also learn in the lab, as seen from Yolanda's comments earlier on.

SONORA RAMOS Journal entry #3

This week in class , october 5, 2009 we learned about the factor tree and the factor of certain numbers. We also learned about the gcf 's and lcm's of a number. I also learned the difference between prime numbers and composite numbers. I found this weeks classes to also be interesting because I actually understood the lesson. In highschool I never really understood these topics..

P.s. sorry I sent the journals so late I haven't been able to have internet access for a while.

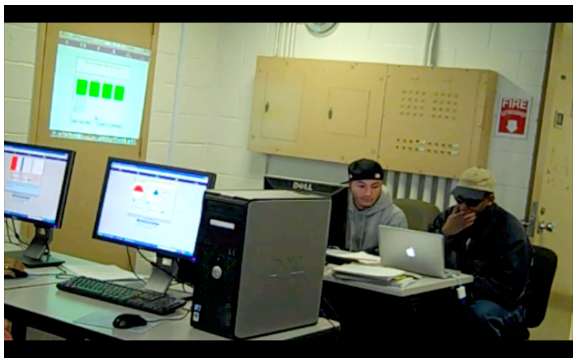
As interesting as the class sessions might be, however, the lab is where the exciting learning happens in our class.

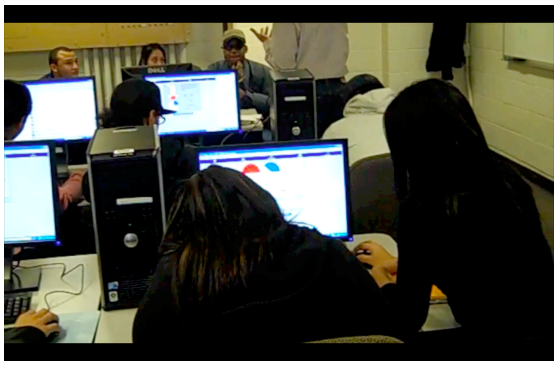
The lab sessions

Even though we practice coteaching in the classroom sessions, record the classroom activities on video, and watch and discuss selected vignettes, it is in the lab where we enact the most significant changes in my pedagogy. About half of our classes are held in the lab, where students work in pairs on 15 computers. The students choose their work partners. I ask each pair to exchange phone numbers and to call each other before class to encourage full attendance and punctuality. I joke with the students that their grade will

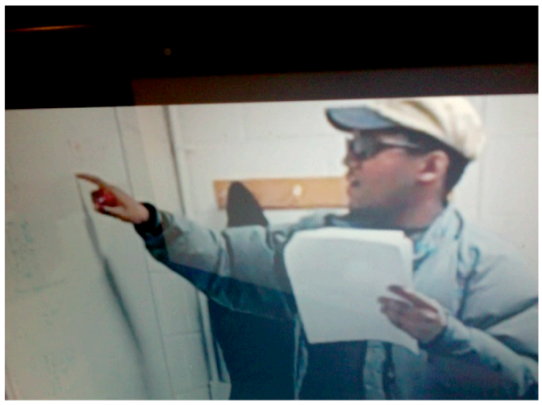
suffer if their buddy does not show up for class. Everyone gets the message and class attendance this semester is at an all-time high. Reviewing the attendance sheets, I see that the students avoid missing a lab session; if they have to miss a class, they choose to miss the classroom session instead.

Before each lab session I meet with the three student coteachers: Lamar, Jaime, and Destiny. They master the concepts and make sure they are able to model the applications from the three computers facing the classroom: That way they will be able to project their solutions on the large display seen by the entire class. In the pictures below, Jaime and Lamar are analyzing the upcoming exercises (below, left); Jaime, Destiny, and Lamar facing the classroom from their stations (below right).

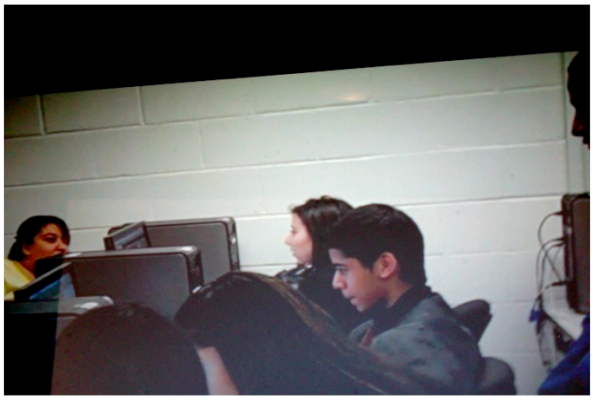




One coteacher always sits a computer controlling the large display, while Destiny roams around the room helping with the software. The students work on a series of the assignments explained by the coteachers. The lesson is on fractions, but each pair progresses at its own pace.

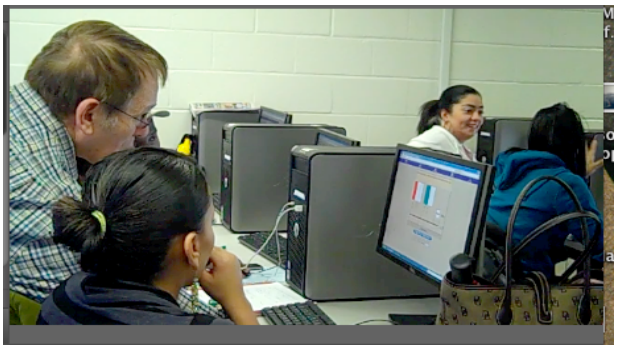


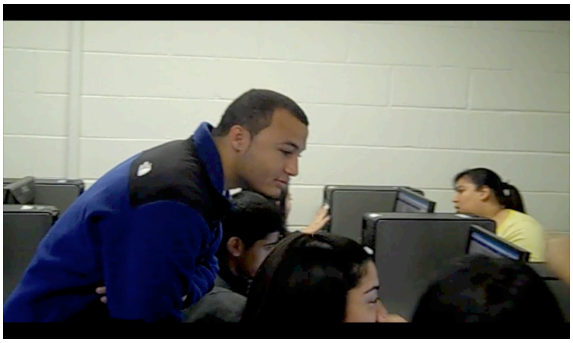
Lamar models selected problems on the board: addition of fractions, solving proportions, calculating percentages. Occasionally, he joins a pair of students and asks questions to assess their understanding. He is more comfortable explaining to the entire class on the board. Occasionally, he joins a pair of students and asks questions to assess their understanding. He is more comfortable explaining to the entire class on the board or modeling on the computer to the entire class. In the class sessions Lamar is constantly volunteering to explain at the board, and I have sometimes to curb his enthusiasm by telling him: "Lamar, you're not the only one in this class who wants to be a math teacher. Give a chance to someone else, as well."



Hector, the shy student who declined to be a coteacher but who amazed everyone with his 74 score on the COMPASS exit exam, is shown above (right) focusing with great intensity on a more difficult problem. Looking over Hector's shoulder his shoulder is Jaime, only partially shown, who is trying to learn something from Hector. Maybe one day Hector will gather the courage to share his knowledge and understanding with others.

With Lamar in control and Destiny helping students, Jamie and I are free to go from student to student, asking probing questions and challenging them.





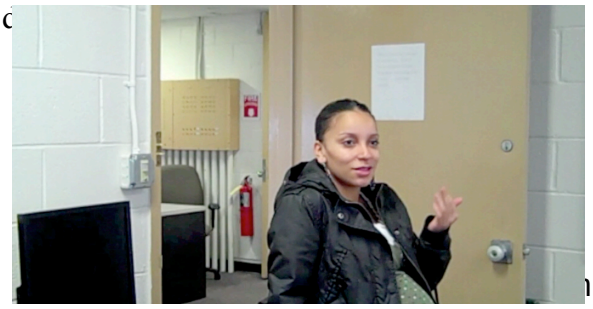
Each pair of students solves a series of progressively more difficult problems at its own pace. With four coteachers at the ready, help is always a few seconds away. This is in contrast to a teacher-centered math lecture, in which students are passive agents in their own learning; they spend their energy copying from the board and trying to keep up. With computer lab exercises that are self-paced, no student feels the pressure to keep up with the rest of the class.

Cogen affords us the chance to argue, express frustration, and solve contradictions.

Below is a rendering of a discussion between several students about purchasing textbooks.

Davonte (visibly upset): I cannot afford a $70 textbook.	Jaime: Why do you need a textbook?
Sanon (in a very loud voice): Wait, wait – who is talking? I can't pay for the book either.	Anthony: I have the book, but I hardly opened it. I tried to understand fractions. The book doesn't help. It's easier in the lab.
Lamar: I don't find the book useful either. Probably someone just wants us to buy books.	Ana: Come on guys! No need to fight. I am a nursing student. I do have the book. There is not one exercise about nursing. *Nada.* So I do the work in the lab, and at home.
Mirabel (standing in the corner): Lucky you, some people here have jobs, families. Or they're expecting a baby…	Destiny (scratching her head): Who has laptops here?
[Some hands go up]	Destiny (firmly): You can do all the assignments in the bus, on the way to school. Maybe you could use your iPhone.
Flavio: Provided you have a seat…	

The cogen solution that did not even cross my mind: To do the assignments while traveling on the bus, using a laptop, or even a smart phone. In the cogen pictures below, on the left we see Sanon (with a white hat), Hector (with a red sweater), Lamar (his face does not show), Ana (bottom right), and Tania (with glasses). Mirabel appears in the



previous page's picture at the bottom right. Destiny and Davonte do not appear in the picture.

To a Better Classroom

We hold the cogen in the back of the lab, where we have a projector screen. Sandy (a pseudonym), the lab technician, is always on hand to make sure that the computers are in working order and that we have all the equipment we need. Sandy installs an icon in the shape of a tree, the tree of knowledge, with a link straight to the NLVM website. Since we do not have the budget, we can not purchase the worksheets and the lesson plans from eNLVM. Therefore, I compose my own lesson plans (see Appendix C) and worksheets. Cogen provides the most exciting time in the lab: live discussions, laughter, and more laughter. We see first Davonte cracking a joke about the darkness in the projection room. Liya and Davonte get ready to watch the vignettes (left picture). Students want Lamar's explanation in the vignette (right picture).

Davonte (smiling widely): Why is it so dark in here; can we have some light? I cannot see myself!

Hector: Wait till you to see yourself in the movie.

Ana: That's right. Here is Lamar at the board. Isn't he handsome?

Sanon: It's our turn!

[Everybody laughs]

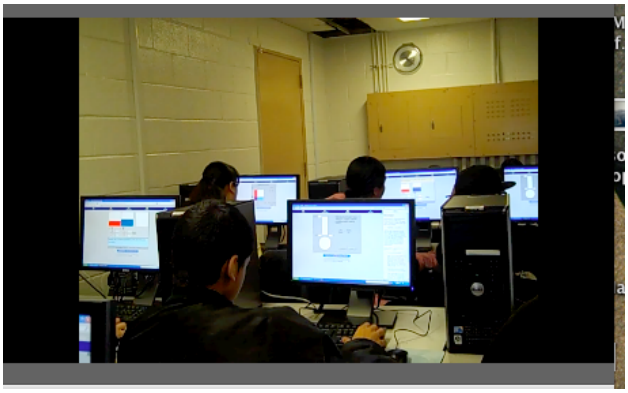
Lamar: If you want to be in the movies, You'd better be a co-teacher!

[Laughter, and more laughter]

[Laughter, and more laughter]

Students laugh seeing the funny shot at left—from back to front we see Jaime, Yolanda, Davonte and Lamar (bent down). Emily Leon is in the back. In the picture on the right, I participate in watching a vignette with some students: we see Sanon, Ana, Ariel and Tania.

At left, in the picture above, students watch a vignette depicting their work with in the lab. At the right they share a laugh during cogen (see exchange in the textboxes above).



Grades and Scores

The class started at the end of August 2009 with 28 students. One student, Andel, withdrew before the midterm exam. Three additional students (Manuela, Julyssa and Tania) withdrew with the grade W (withdrawal) before the course withdrawal period ended in mid-November. Three other students (Carmen Fernandez, Margaret Del Faro and Xiomara Espejo) withdrew later on and obtained a grade F (fail) as a result. Both Venus—whose husband lost the job, and Mirabel—who was expecting a baby—did not show up for the final exam and obtained a grade INC (incomplete). Consequently, only 19 students showed up for the final exam.

The final class grades breakdown for those 19 students were: one A+ (Hector), two A (Charlotte and Flavio), three A- (Ariel, Liya and Lamar), three B+ (Sanon, Jaime and Davonte), one B (Yolanda), three C (Ana, Destiny and Emily), three D+ (Iris, Anthony and Miranda Caldazo), two D (Zoraida and Sandra) and one R (Genesis Madera). Appendix K provides students' grades (midterm and final), scores in the basic arithmetic

test (pretest and post-test), and scores in the M1 COMPASS exam (placement and post-test) for all the students in the class.

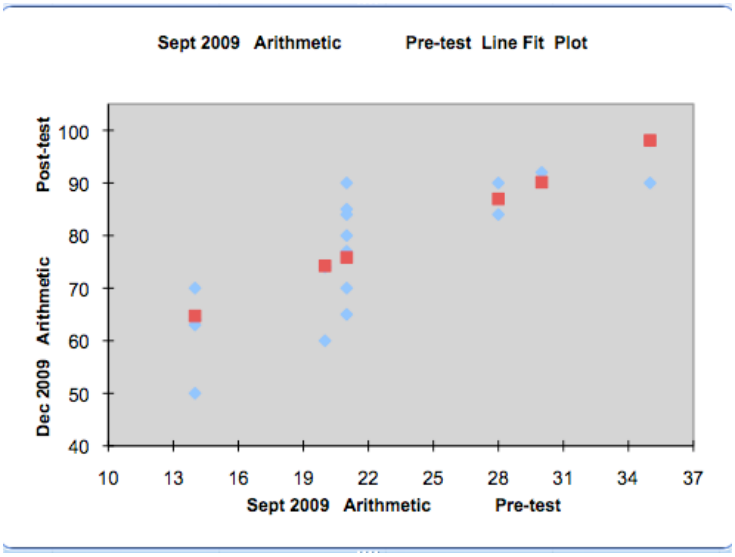
Scores in the Basic Arithmetic Test

To compare students' mastering of basic arithmetic concepts, in the last week of school I administered my basic arithmetic test to the entire class: 19 students took the test. The test questions were based on the test I administered in September, when starting the class, except for changes in numbers. The statistics of the scores show an overall considerable improvement from the September data: the mean jumped from 22 to 78 while the median jumped from 21 to 80. However, where the September scores were clustered around the mean (with a standard deviation of 6), the December scores showed a larger dispersion, with a standard deviation of 13.

Hector and Flavio Sanchez, the two students who obtained the highest scores in September (35), showed the largest improvement to 98 and 90 respectively. Based on the September scores, I grouped the data into four distinct groups. The average of the lowest scorers in September (4 students) improved from 14 to 62, the second group's (11 students) average improved from 21 to 77, the third group's (2 students) average improved from 28 to 93, while the highest group's (3 students) average improved from 33 to 93.

Graph 6.1

Pre-test and Post-Test Scores in the Basic Arithmetic Test



In the Graph 6.1 above, the x-y coordinates corresponding to each student provide the September (pretest) score and the December (post-test) score. The large correlation coefficient, 0.79, indicates that the better-prepared students showed the highest improvement in their mastering of basic math concepts. The slope of the regression line (1.59) was highly significant.

Scores in the Compass Exam

At the beginning of December, all students were instructed to take the COMPASS exit test. It should be noted that the departmental policy changed in subsequent semesters. Starting in January 2010, only students scoring a grade of C or above in mid-term are allowed to take the COMPASS exit test at the end of the class.

Since the focus in the class was primarily on understanding—and mastering—basic math concepts, I did not devote any time preparing students for the COMPASS test. Consequently, the results obtained by my students in the December COMPASS exit test

were lower than the results obtained by other students who participated in COMPASS-preparation workshops I conducted over the years.

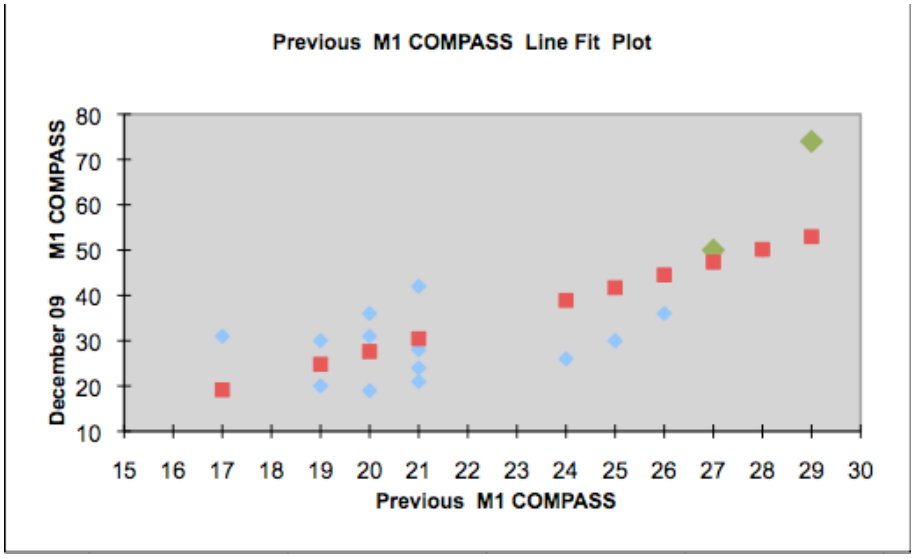
To everyone's amazement, Hector scored a very high 74. Flavio and Ariel, both with 50, joined Hector in receiving their classmates' prolonged round of applause. Other students passing the COMPASS were: Charlotte with 42, Liya with 36, Yolanda with 36, Mirabel with 31, Sanon with 31, Jaime with 30, and Ana with 30.

Compared to the previous placement COMPASS scores, the data in the December test show an increase in the mean from 22 to 34 and an increase from 21 to 31 in the median, indicating that over 50% of the students being tested passed the test. Similarly to the basic arithmetic test, the data show a considerable increase in the dispersion of the scores, with the standard deviation increasing from 3.5 to 13.

Based on the placement test scores, I grouped the data into four distinct groups. The average of the lowest scorers improved from in 18 to 27; the second group's average improved from 21 to 29, one point shy of the passing score. The third group's average improved from 25 to 31, while the highest group's (3 students) average improved from 28 to 58.

Graph 6.2

COMPASS test– Placement and exit scores



In the Graph 6.2 above, for each student the x-coordinate shows the COMPASS placement (previous) test score, while the y-coordinate shows the December (exit) score. On the surface the large correlation coefficient, 0.72, seems to indicate that the better-prepared students showed the highest improvement in their mastering of basic math concepts. However, the slope of the regression is pulled upward by the scores of Hector, Flavio, and Ariel. Without these students' data the slope of regression does not differ significantly from zero.

Looking Ahead

The semester seemed to come to an end much too quickly. In the first week of December all the students had to take the exit test, even though in many majors that is not required for graduation. Here are the scores of the students who passed (the result on their

entrance placement test is shown in parentheses): Hector –74 (29); Ariel –50 (28); Flavio –50 (27); Charlotte –42 (21); Liya –36 (26); Sanon –31 (17); Jaime –30 (25). The top three scores were higher than those of any of my past students; the class average was higher as well.

Naturally, I was disappointed that Lamar, who claims to be a "bad test-taker," Yolanda, Genesis, Miranda, and Davonte, did not pass (the passing score is 30). We were all happy for the ones who passed and commiserated with the ones who did not. I tried to tell the students that our class is not a COMPASS preparation workshop and that the main objective is to master the math concepts—which they did; with a little bit of preparation (one week of intensive work) they would easily pass the test, as many of my workshop students did in the past. This explanation did not seem to console the ones who had failed, however.

In mid-December, the students took the final exam, the grade of which constitutes 30% of the final grade. The other 70% of the grade is based on class tests, quizzes, and class participation. Before the final, I re-administered my basic arithmetic test and asked the students to complete (in class, without names) the questionnaire on attitude toward math and confidence in math (see Appendix G). The results were very encouraging: There were significant improvements in the scores on my basic math test, both at individual level (several students obtained a perfect score) and at the class level. By examining students' work I was able to find, to my satisfaction, that overall, both mental math ability and understanding of concepts leaped significantly. I know that my students finally understand fractions, proportions, percentages, and order of magnitude,

knowledge they will cherish forever. Their increased confidence in doing math and better attitude towards math were well reflected in the answers to the questionnaire.

Mirabel said "I will help my baby in math", while Hector added "If I can jump from 29 to 74 in six months, it means I can do math now." During the last class we shared several pizza pies and cans of Sprite. Ariel joked "Now, we deserve the pizza; finally we understand the fractions." Sanon made me blush, stating, "We couldn't have done without you," while everyone clapped. It was an emotional parting from my most wonderful class. My *adios* words were: "Remember and believe it: you will pass algebra, you will graduate from Highland, and you'll be successful in your career and life—it all depends on you."

Parting Thoughts

In my arithmetic class of fall 2009 I experimented with novel pedagogy, and with socio-affective practices grounded in sociocultural theory and the sociology of emotions. By experiencing novel learning methodologies—cogen and coteaching—by working in pairs and learning from each other, and by using technology in their learning of mathematics, my students mastered at their own pace math concepts that eluded them for years, while having fun in the process.

My students afforded me the opportunity to conduct a research that meets the three authenticity criteria: ontological, catalytical, and tactical (Guba & Lincoln, 1989). It is my sincere hope, that the research and its results will influence other community college teachers who are willing to depart from the chalk-and-talk lecture toward a type of class that is rewarding, satisfying and produces better results.

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Appendix A: Students' Reflections on Class Teaching

You can observe a lot just by looking around

(Yogi Berra, Yogi Berra was a Major League Baseball (MLB) player)

SONORA RAMOS Journal entry #2

In This week's class, Septembr 30, 2009 we reviewed addition and subtraction of whole numbers. we also learned how to solve the same problems using a program in the computer. Before today I hadn't known that it was possible to use a computer to solve math problems. It has actually been made our math class interesting. I really enjoy this clas

From Yolanda Perez
Homework#5 Virtual Manipulatives

One of the exercises that i enjoyed is called "Fractions-Rectangle multiplications." I learned about how to multiply fractions, and learned the steps of how to do it. i worked with proper fractions, and improper fractions. It was a fun exercise . I also work with the exercise called "Factor Tree." i enjoy it a lot, and i could figure the factor of a number in my head. i compare it to the computer and got the exact answers.

These are the exercises i work with..

1.Proper fractions.

1/3 of 1/3 = 1/3 x 1/3= 1/9

1/3 of 1/4 = 1/3 x 1/4= 1/12

2.Factor Tree.

```
     16          40
     / \         / \
    4   4       4  10
   /\   /\     /\  /\
  2 2  2 2     2 2  5 2
```

SONORA RAMOS Journal entry #5

This week in class we were reviewing math work. We were using the computer to figure out the answers for many problems. In some of the sections that you gave to us in class on Wednesday to review with for the midterms were some what confusing to me. I had some complications with section 2.12 . I could not understand how to solve some of the problems which I believe were subtracting fractions. I had some problems with changes the fractions in order to subtract them. I got stuck in problem #5 on page 71. Also on section 2.5 #9 and # 13 were a bit confusing as well . I would like to see if we can review fractions in class. A side from that everything else in class is going fine.

From: Flavio Sanchez

National Library of Virtual Manipulative
10/05/09

The National Library of Virtual Manipulative is a very fun website it's a great way for students to learn and understand mathematics, at every level in a fun way. The website has every type of problem on it and it can be use by any one because it is so easy to use, any student who can use a computer and knows how to work with the internet can use this website and have fun on it no matter the age of the student or the grade. Not only students but parents could also use this website to teach theirs kid mathematics in a fun way I definitely recommend it for any parent who is determine to teach their kids something good and fun.

I will definitely recommend this website to any one that wants to learn mathematics in a fun way or any one that wants to teach some math, the National Library of Virtual Manipulative is a very helpful website and it should be use if you're trying to learn in a fun way.

Appendix B: Students' Reflections on President Obama's Speech

Every soldier carries a marshal's baton in his knapsack.

(Napoleon Bonaparte, 1789-1821, Emperor of the French)

Sample Student Narratives:

Margaret Del Faro

Obama's speech was about education. He speaks about it maybe being the first day of school for many students and maybe even the first day in a new school, like myself. He spoke about how even if we have the best teacher and the best schools it depends on us, students, in putting the hard work into having a successful education. We are the ones held responsible. He said that every single one of us is good at something, we just have to find it. Anything you want in life you need a good education. You have to train, work, and learn for your career. He spoke about how challenges that can make you struggle in school work and make you lose your focus. He even spoke about him haven't that problem at one time when he was younger. He said the circumstances in your life is not an excuse for neglecting a good education. He said he's calling on each of us to set our own goals for our education and meeting them, even if it's as simple as doing your homework everyday, or paying attention in class. I liked the speech because he persuades students into wanting a better education to lead to a better future. I liked the fact that he spoke about him struggling at one point in his life, and wasn't doing as good as he should have been doing yet he overcame the slackness and distraction. The conclusions I draw to myself from this speech is that its true education is very important to one's life. It's everything. He made me realized that no matter how unfocused some circumstances may make me, it shouldn't affect my work and learning.

From: Flavio Sanchez
Obama's Speech on Education
09/22/09

First of all I want to start by saying I like the way Obama talks and greet his audience with energy and sense of humor otherwise it would've been a boring speech to the students because that's how it should be done when the crowd is mostly young students. Obama made a lot of important points and examples to the students to keep them motivated on going to school and making a bright future for them self, letting them know that parents and teachers have responsibilities to help them with their education but that is the student responsibility to try by going to school, doing their homework, paying attention in class, etc.

I think Obama gave a great speech to those fellow students, teaching them and telling them that they need education and that they will be so much better in the future if they go to school and graduate, for example I like when he said "You cannot drop out of school and just drop into a good job, you need to have training for it and work for it and learn for it" that's a great way to tell students not to drop out of school and show them they won't be as successful as they can be if they continue with their studies . I also like when he told them that the future of America depends on them that if they quit on school they're not jus quitting on them self they quitting on their country and that twenty years from now they going to be the next doctors, inventors, teachers, police officers, etc., but they will not be successful if they don't complete their education, he told them that every little knowledge they learning in class will be needed to create and help the future.

President Obama gave a lot of example with students who faced and are still facing hard challenge who didn't give up on their studies and set goals for them self including himself and his wife Michelle Obama, the first lady. He explain that having no adult influence, having no money, living in a bad neighborhood, etc. shouldn't be used as an excuse for neglecting their homework, cutting class or miss behaving in class, that where they are today doesn't have to determine where they'll end up in the future. I like when he said "asking for help isn't a sign of weakness is a sign of strength" he ends the speech by telling them to get serious, to put their best effort to everything they do, to not let their families down nor their country down but most important to not let them self down.

This speech gave me the motivation to continue my studies it showed me that all those excuse I used for messing up in high school was all crap, maybe if Obama was the president four years ago I would've graduate from high school but any who I decide to get my GED and now I'm in college and will graduate in a couple of years with a profession I don't know which one yet but am going to do it, I won't let my family or myself down like Obama said.

Lamar Jackson

09/21/09

Analysis of President Obama's Education Speech

On Tuesday September 8, 2009 president Obama addressed the nation about the value of education. For me this speech was a message to students, parents, educators and all those responsible for growing up children.

In his speech he stated what was possible for children to make achievements. He encouraged students and parents to rise above the politics that exist in Washington for a long time. He told them to be brave and try new ideas until they find one that is suitable to give students a chance in life. President Obama did not say success was easy. He made a connection to himself and his wife that poverty did not prevent them from getting a world class education and that any child can do the same.

Obama's speech also stated the opportunities students can have in order to make success in life. For example, scholarships voluntary services etc. He said good jobs can be located anywhere there is an internet connection. Also, the most valuable skill you can sell is your knowledge. He also urged students to get educated so other countries will not out- compete them for jobs. Obama said "We are a nation that our future depends on the education of our children. ''This means the success of our country depends on the ability students have when they graduate.

People critize the activity he set for students in his speech but I think that is normal because we live in a country with free speech. My opinion on the speech is positive. My only concern is will he and those responsible, carry out the promise mentioned to make things work? Or will they vote him out of office before the job can be?

Appendix C: Sample Lesson Plans Using Virtual Manipulatives

Topic: Multiplication of Fractions

Aim: Using virtual manipulatives students to will understand the principles associated with multiplication of fractions.

Step 1: Review of the meaning of the conjunction "of" (i.e. multiplication)

Step 2: Through use of Virtual Manipulatives demonstrate how to represent fractions of the whole. Note: Computer is connected to the digital overhead projector.

Step 3: Student coteacher writes on the board the problem to be solved:

1/2 of 3/4

Step 4: Student coteacher keys in into the computer the same problem. The student drags the horizontal cursor to obtain representation of three quarters (3/4) of the whole and drags the vertical cursor to obtain representation of one half (1/2) of the whole.

Step 4: Using Virtual Manipulatives, the student obtains the answer:

1/2 of 3/4 = 3/8

Step 5: Teacher explain how the priciples of commutativity and associativity apply in the case of fractions multiplication.

Step 6: Using Virtual Manipulatives, students work in groups and solve the following problems on their computers and checking the results with paper and pencil:

2/3 of 1/2
1/4 of 2/3
2/3 of 4/5
3/4 of 2/5
1/3 of 2/5

Step 7: Teacher and student coteachers work with students answering questions and helping with math difficulties.

Step 8: Homework: Assignments from syllabus. Students will solve questions using both Virtual Manipulatives and paper and pencil and compare results. Use Virtual Manipulatives to find errors and check answers.

Topic: Solving Linear Equations

Aim: Using virtual manipulatives the students will understand the principles associated with solving linear equations

Step 1: Equation / balance scale comparison

Step 2: Through use of Virtual Manipulatives demonstrate that to keep equation in balance, one might: add / subtract / multiply / divide both sides of equation by same quantity. Note: Computer is connected to the digital overhead projector.

Step 3: Student coteacher writes on the board the equation to solve

$$4x - 2 = -x + 3$$

Step 4: Student coteacher keys in into the computer the same equation. The student clicks and drags quantities from bins (square and baloons) to balnce beam pans to represent the equation. (See picture on following page).

Step 5: Using Virtual Manipulatives, the student coteacher the equation. All steps below are recorded and seen by all students on the overhead projector as well as on the board.

$$\begin{array}{r} 4x - 2 = -x + 3 \\ +2 \qquad\quad +2 \\ \hline 4x \quad = -x + 5 \\ +x \quad = \quad x + 5 \\ \hline 5x \quad = \qquad 5 \end{array}$$

$$\begin{array}{r} \frac{5x}{5} = \frac{5}{5} \\ x = 1 \end{array}$$

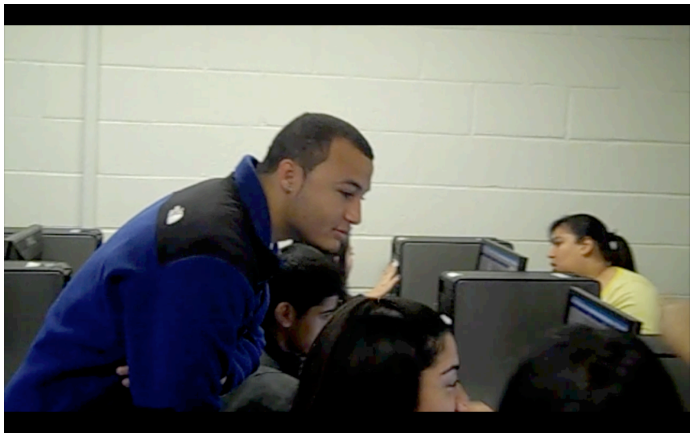
Step 6: Using Virtual Manipulatives, students work in groups solve the following equations on their computers and checking the results with paper and pencil:

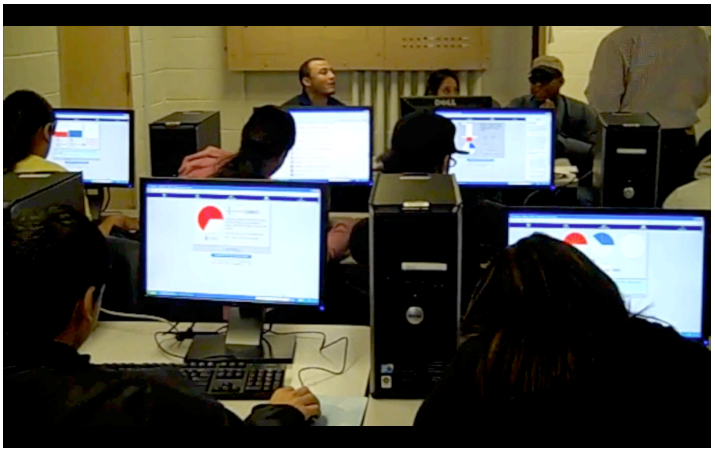
$$4x + 2 = 2x + 4$$
$$-2x + 3 = -x - 1$$
$$-3x + 5 = x - 3$$
$$3x - 4 = -x + 8$$

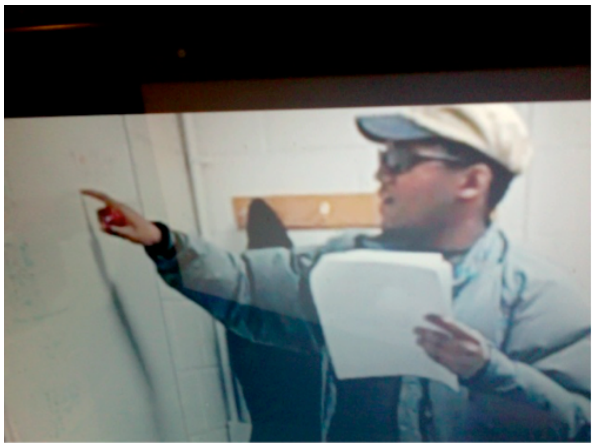
Step 6: Teacher and student coteachers work with students answering questions and helping with math difficulties.

Step 7: Homework: Assignments from syllabus. Students will solve equations using both Virtual Manipulatives and paper and pencil and compare results. Use Virtual Manipulatives to find errors and check answers.

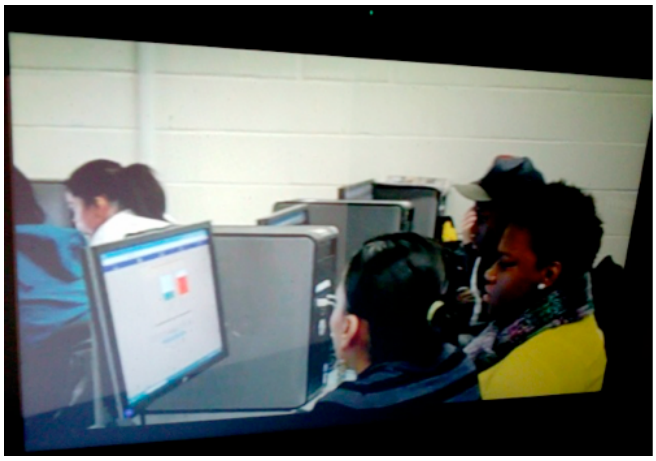
Appendix D: Images of Coteaching in the Lab Sessions

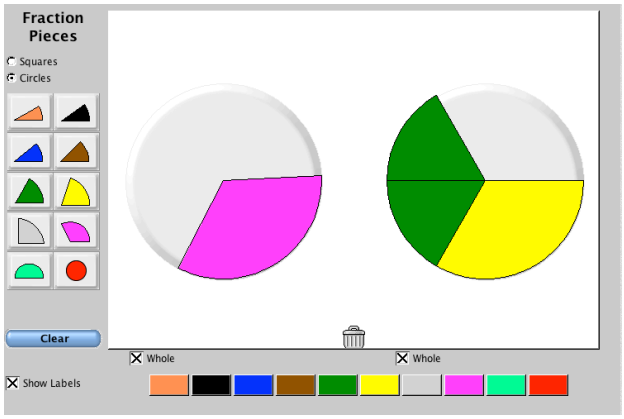


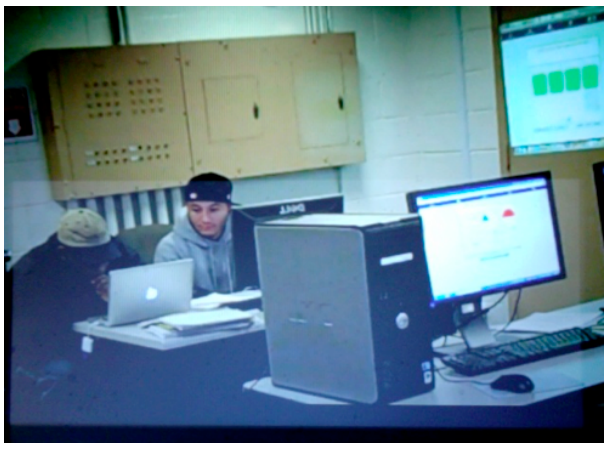


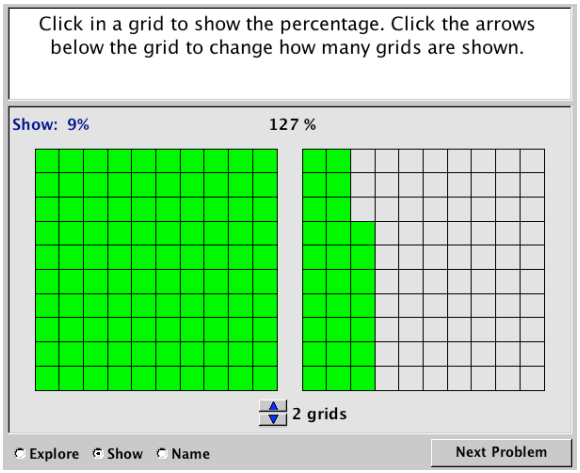


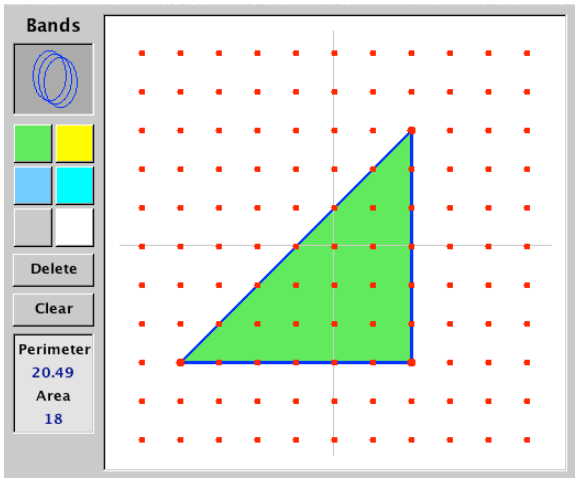
Appendix E: Learning Math with Virtual Manipulatives

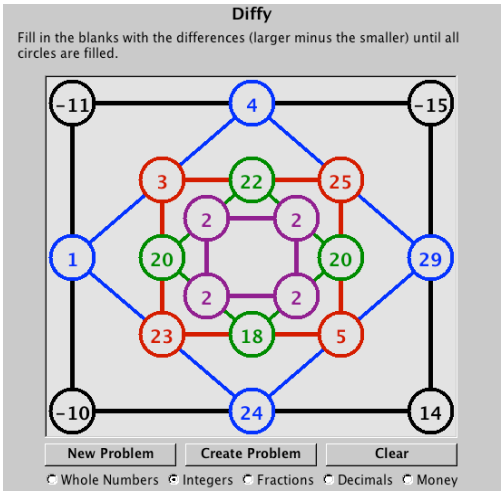




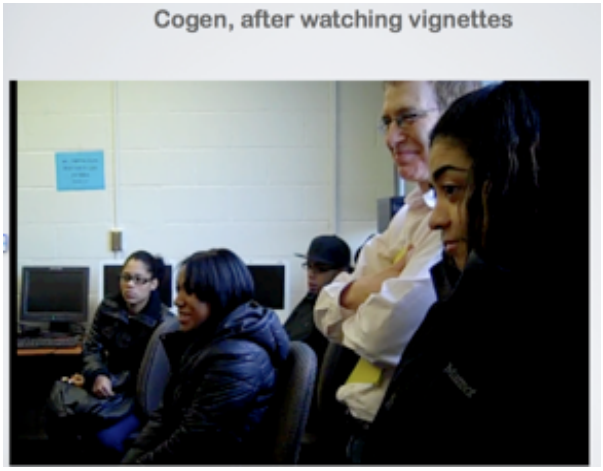








Appendix F: Images of Cogen Sessions



Appendix G: Sample Questionnaire – Attitude and Confidence in Math

I. Biographic Information

1. Gender: Male _____Female ____

2. The group I use to describe myself is: (Check one)

African-American __ Dominican___ Puerto-Rican ___Caucasian ___Other___

3. The language spoken most at home is: (Check one)

English_____Spanish_____Other_____

II. Questionnaire: Circle the number that reflects your present attitude

1. Generally I have felt confident about attempting mathematics.

Strongly Disagree *Disagree* *Undecided* *Agree* *Strongly Agree*

2. I am sure I could do advanced work in mathematics.

SAME SELECTIONS ARE REPEATED IN ALL QUESTIONS

3. I am sure I can learn mathematics.

4. I think I can handle more difficult mathematics.

5. I can get good grades in mathematics.

6. I have a lot of self confidence when it comes to mathematics.

7. I am no good at math.

8. I do not think I could do advanced mathematics.

9. I am not the type to do well in mathematics.

10. For some reason, even though I study, math seems unusually hard for me.

11. Most subjects I can handle OK, but I have a knack of mucking up math.

12. Math has always been my worse subject.

13. Math does not scare me at all.

14. It would not bother me at all to take more math courses.

15. I haven't usually worried about being able to solve math problems.

16. I almost never have got nervous during a math test.

17. I usually have been at ease during math tests.

18. I usually have been at ease during math classes.

19. Mathematics usually makes me feel uncomfortable and nervous.

20. Math makes me feel uncomfortable, restless, irritable and impatient.

21. I get a sinking feeling when I think of trying math problems.

22. My mind goes blank and I am unable to think clearly when working mathematics.

23. A math test would scare me.

24. Mathematics makes me feel uneasy and confused

Appendix H: CUNY Criteria for Math and Language Proficiency

Math proficiency

The proficiency requirements in math differ from college to college within CUNY, as shown in Table 1.3 in Chapter 1. The typical requirements in SAT are 510 for the senior colleges and 480 for the community colleges; the typical requirements in ACT are 21 for senior colleges and 20 for community colleges; the typical requirements in Math A Regents are 75 for both; the typical requirements in M1[1] and M2[2] COMPASS scores are 45 for senior colleges and 30 for the community colleges.

Most students seeking admission to community colleges do not meet these requirements. Having worked for three years in MSP with urban high schools students from the Bronx, I can state emphatically that it was the rare student who scored a 75 or above in Math A Regents at the end of the six-week intensive summer program. To obtain the Regents diploma, the new required score is 65 (it was only 55 in the past). The CUNY SAT and ACT proficiency requirements do not seem any less lofty to the typical student seeking to earn an associate's degree from a community college in the Bronx. The net result is that almost every freshman entering the gates of Highland or Concourse must take the math placement exams that were discussed earlier in this study.

[1] M1 is the arithmetic part of the COMPASS test.
[2] M2 is the algebra part of the COMPASS test.

Language Skills Proficiency

CUNY's website indicates that there are identical requirements for demonstrated proficiency in language skills, irrespective of whether a student applies to a senior or a community college. Proficiency can be demonstrated by documenting one of the following: a) SAT I verbal score ≥ 480, or b) critical reading ≥ 480, or c) ACT English ≥ 20, or d) N.Y. State English Regents ≥ 75, or d) CUNY Assessment Test: reading test ≥ 70 and writing test ≥ 7. Based on the above requirements, it is generally easier for an applicant to a CUNY community college in the Bronx to be deemed English-proficient than math-proficient.

Being deemed English-proficient or math-proficient based on these scores should not be interpreted as a universally accepted statement of students' readiness for academic work. Each college and university has its own definition of proficiency.

Appendix I: Excerpts from Proposal on Virtual Manipulatives

The purpose of the study is to determine the effectiveness of the use of virtual manipulatives in the learning of pre-algebra and algebra concepts by community college students. The development of a plethora of hands-on (Borenson, 1986; Picciotto, 1990) and virtual (Bradford; 1996; http://nlvm.usu.edu, 2008) manipulatives to teach algebra concepts has flourished in the market and on the Internet. Except for a few dissertations (Gningue, 2000; Sobol, 1997), however, very limited research in the implementation of the teaching techniques that accompany the materials and of the cognitive issues related to their use has been conducted, especially at the college remedial level. This proposal will test the effectiveness of using virtual manipulatives when teaching pre-algebra and algebra concepts to community college remedial students.

This research proposes a comparative study designed to investigate the impact of virtual manipulatives on attitudes and achievement factors in the learning of pre-algebra and algebra concepts by community college students. The development of a plethora of hands-on (Borenson, 1986; Picciotto, 1990) and virtual (Bradford; 1996; http://nlvm.usu.edu, 2008) manipulatives to teach mathematics concepts has flourished in the market and on the Internet. Unfortunately, however, very limited research in the implementation of the teaching techniques that accompany the materials and of the cognitive issues related to their use has been conducted, especially at the college remedial level. This proposal will test the effectiveness of using virtual manipulatives when teaching basic pre-algebra and algebra concepts to community college remedial students.

Whereas hands-on manipulatives are tactile and visual, virtual manipulatives are only visual; on the other hand, virtual manipulatives are interactive: that is, the learner can manipulate the same objects and create the same mental representations of the objects using the computer mouse. In today's technology-enriched environment, it is even more appealing for college professors and college students to use computers rather than hands-on manipulatives.

This research hypothesizes that students in the experimental group (use of technology-virtual manipulatives) will demonstrate improvement on tests of confidence in mathematical ability, on their attitudes toward mathematics and on tests of pre-algebra and algebraic skills.

Appendix J: Protecting Students' Anonymity

After distributing the consent forms, I made sure that the students read them and I answered any questions they may have had. I pointed out that if they were agreeing to be videotaped, audio taped, or both, they had to specifically check the respective boxes in the form. I also explained that even though their participation in the research was voluntary, they could drop out of the research at any time. I recommended that the students take the forms home, read them again, and, if they agreed to participate in the research, return the forms at the next class. re that the students read them and I answered any questions they may have had. I pointed out that if they were agreeing to be videotaped, audio taped, or both, they had to specifically check the respective boxes in the form. I also explained that even though their participation in the research was voluntary, they could drop out of the research at any time. I recommended that the students take the forms home, read them again, and, if they agreed to participate in the research, return the forms at the next class.

During the following class, I asked one student to collect all the consent forms and count them, since I did not want to single out students refusing to participate in the research. The student who collected the forms informed the class that all students had signed the consent form and all had agreed to be videotaped. The forms were returned to me in a sealed envelope. Had some students elected not to participate in the research, I would have had the sealed envelope with the forms delivered to the department for safekeeping until all grades in the class were distributed. That would have avoided the apparent conflict of a student being concerned that refusal to participate in the research might have a bearing on the final grade.

I asked myself whether any students felt pressured to participate in research out of concern for their grades, my assurances that the grade would not be affected notwithstanding. Even though I told the class that should some students decline to participate in the research, their identity would be unknown to me before final grades were distributed, I presumed that lack of trust is prevalent in a classroom composed of students who, after encountering so many systemic adversities in their lives, have grown skeptical of what might turn out to be empty promises.

Since all the students agreed to participate in the research, I made copies of the forms and handed the individual copy to each student during the next class, when I also reminded students that they could drop out of the research at any time without penalty. During that class I also recommended that they not only write reflections on the material learned and their difficulties with topics but also provide suggestions on how the class should be run differently.

All my students agreed to participate in my research, even though the priority of their objectives was the reverse of mine. Whereas I was more interested in improving my pedagogy for the benefit of future students, they wanted to finish their degree as quickly as possible.

For the research with my Math 01 basic arithmetic class, I infused additional student-centered practices grounded in socio-cultural theory: use of cogen, coteaching, and technology to promote peer learning. This was consistent with the approval of my research proposal as part of my doctoral studies and with the IRB approval, which I had obtained before starting my study. By the second class, I had given the students my basic arithmetic test mentioned earlier in this chapter.

Appendix K: Students' Scores and Grades – Basic Arithmetic, Fall 2009

Count	Pseudonym	Final Class Grade	Dec 2009 Arithmetic Post-test	Sept 2009 Arithmetic Pre-test	December 09 M1 COMPASS	Previous M1 COMPASS	Midterm Grade
1	Gomez, Ana	C	74	20	30	19	B
2	Diaz, Iris	D+	65	21	19	20	D+
3	Alvarez, Zoraida	D	60	20	20	19	D+
4	Rojas, Ariel	A-	92	30	50	28	B+
5	Villa, Destiny	C	70	21	21	21	C
6	Williams, Liya	A-	84	28	36	26	A+
7	Acevedo, Hector	A+	98	35	74	29	D+
8	Rodriguez, Jaime	B+	85	21	30	25	C+
9	Jackson, Lamar	A-	90	28	26	24	A-
10	Mallette, Charlotte	A	90	21	42	21	A-
11	Isaaka, Sanon	B+	77	21	31	17	B-
12	Aguirre, Sandra	D	63	14	-	27	D
13	Leon, Emily	C	80	21	-	-	B+
14	Colon, Anthony	D+	70	14	24	21	D+
15	Arzu, Davonte	B+	84	21	28	21	D+
16	Perez, Yolanda	B	80	21	36	20	D+
17	Sanchez, Flavio	A	90	35	50	27	A+
18	Cadalzo, Miranda	D+	64	14	28	21	C
19	Lobos, Mirabel	INC	Incomplete	21	31	20	A-
20	Torres, Venus	INC	Incomplete	28	-	-	A+
21	Madera, Genesis	R	50	14	28	-	D
22	Vidal, Manuela	W	Withdrew	7	-	17	W
23	Delgado, Julyssa	W	Withdrew	14	-	17	W
24	Lopez, Tania	W	Withdrew	14	-	-	D
25	Castillo, Andel	W	Withdrew	7	-	18	-
26	Fernandez, Carmen	F	Withdrew	7	-	27	D+
27	Del Faro, Margaret	F	Withdrew	14	-	25	B+
28	Espejo, Xiomara	F	Withdrew	14	-	19	B-