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The Remedy That's Killing: CUNY, LaGuardia, and The Fight for Better Math Policy

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Abstract

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Nationwide, there is a crisis in math learning and math achievement at all levels of education. Upwards of 80% of students who enter the City University of New York's community colleges from New York City's Department of Education high schools fail to meet college level math proficiencies and as a result, are funneled into the system's remedial math system. Once placed into pre-college remedial arithmetic, pre-algebra, and elementary algebra courses, students fail at alarming rates and research indicates that students' failure in remedial math has negative ripple effects on their persistence and degree completion. CUNY is not alone in facing and tackling these remedial math issues and the associated outcomes; however, the CUNY system is uniquely positioned by way of resources, scale, and national spotlight to improve and expand its successful remedial reforms. This thesis examines the national remedial math issue, and then delves more deeply into the remedial math situation at CUNY and one of its community colleges, LaGuardia Community College. Utilizing both the university and LaGuardia as case studies, the author interviews key CUNY faculty, administrators, researchers, and policy makers who specialize in math remedial issues, to paint a multi-dimensional picture of CUNY's efforts to address the remedial math "wall." This thesis concludes with policy considerations and recommendations to CUNY leadership on how to consider lessons learned both nationally and at home.

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Introduction

Math education in the United States is in crisis: from early childhood through postsecondary education, American students are trailing those of 29 other developed nations in math outcomes. (Chappell, 2013) Increased pressure from high-stakes standardized testing has only resulted in teaching to test, which, in effect, means less engaging and less meaningful math instruction devoid of explicit or practiced real world application. Furthermore, students develop fears of math learning, as well as convictions that they are "bad at it" and hopeless to become better. Here at the City University of New York (CUNY), colleges are struggling with how to handle students' incoming math deficiencies. The majority of students who enter the system's community colleges fail both the Pre-Algebra and Algebra portions of the CUNY Assessment Test (CAT), the entrance and placement exam for the University, which not only sets them back at least a year in degree progress and completion, but also exhausts their time-limited financial aid. Additionally, the courses' staggering student failure rates contribute to a college environment where students feel like failures upon entry, when what they need is early success. (Cullinane & Treisman, 2010)

Students' struggles with math stem from both bad math instruction and from an ingrained math-averse and math-phobic culture. While quantitative skills and some basic level of math proficiency may be critical to a well-rounded education, imposing demoralizing and often insurmountable test-based barriers to students' degree progress and completion serves minimal – if any – educational ends. The system punishes the victim, requiring that students catch up on years of unlearned math, and do so in a high-pressure environment. The system is anti-educational, asking remedial instructors to rehash the very teach-to-the-test pedagogy that produced deficiency in the first place.

In light of these systemic math remediation problems, this thesis uses CUNY as a laboratory to closely examine remedial math policy in action. My argument will unfold as follows:

1) Understand the extent of the remedial education problem both nationwide and at the CUNY colleges in particular.

2) Explore reform efforts already underway to improve remedial math outcomes, and look at what has worked and what has not, in the realm of math requirements and math remediation, and

3) Address where we find powerful opportunities for more forceful reform within the system. Where is there a need for radical rethink on a university-wide level and what might the rethought policy look like?

Remedial Education: The National Context

Higher education is not what it used to be. Far from being closed off to all but the children of the elite, college is now intended to serve the masses. Indeed, college entry is now accessible to anyone with a high school diploma or a high school equivalency. More students than ever before are graduating from high school (U.S. Department of Education, 2015) and college enrollment has boomed, with a 24% national increase in undergraduate students between 2002 and 2012. ("Fast Facts," 2015) A high school diploma is no longer enough to secure sufficiency wages or a family-sustaining career – indeed, the college premium tells us that the cost of *not* going onto college and earning a degree is significant. (Dewan, 2014) As more students enter college, many arrive only to find out that they are not deemed ready for college-level work. The pathway assigned to these students is called remedial, or developmental, education, and is meant to bring students up to speed and make them more likely to succeed in their college courses. ("Hot Topics in Higher Education Reforming Remedial Education," 2016) Remedial courses generally cost the same as regular credit courses, and are prerequisite for credit-bearing coursework, but they are often worth zero credits and do not contribute to degree progression. Nationwide, nearly two thirds of first year college students are required to enroll in at least one remedial course. At two-year colleges alone, the number is higher, with a full 75% of incoming freshmen place into remedial coursework. The vast majority of these students require remediation in math, which proves to be the subject that creates the greatest roadblock to student success. This under-preparedness has become the status quo in policy and administrative circles, but remains somewhat of a secret to the students themselves, who rarely know about remediation before they arrive at a college campus, and may not understand the stakes of these courses until they feel the impact down the road.

While a high school diploma alone can now guarantee students admission to college, it does not ensure that students will have the opportunity to enroll in college-level courses. This college readiness

gap –the difference between the skills and knowledge that students gain in high school and those that colleges and universities expect at entry – can be attributed in part to the fact that high school exit examinations often measure 8th and 10th grade academic proficiencies instead of college readiness. Because of *No Child Left Behind* and state pressures to graduate students, high schools have found it difficult to increase academic standards while simultaneously improving graduation rates. Further, state, district, and individual high school performances vary vastly across the country, with underfunded schools that serve predominantly poor, minority populations graduating the students who are least prepared, and least likely to be college ready. Even at four-year institutions, where students are required to complete additional college prep coursework in order to qualify for admission, approximately 50% of incoming students do not meet colleges' readiness standards, demonstrating that the gap is evident even for schools and for students who surpass the basic requirements.

If a high school diploma does not qualify a student as college-ready, then what does? To determine students' college course readiness and their remedial needs, colleges generally use test metrics like the ACT or SAT, or, post-admissions, the Accuplacer or Compass. There is little national consensus on how to define "college ready," and thus institutions – and states – vary in their cut-off scores for remedial level and credit level courses, with only one in five colleges using any criteria beyond standardized testing to determine students' course placements. Columbia University's Community College Research Center (CCRC) has found that commonly used test score metrics often fail to adequately place students, finding that up to a third of students who placed into remedial classes could have passed a comparable college level course with a B or better. (Fain, 2012) Compounding these placement issues, CCRC also found that the students who enroll in remedial math are unlikely to have prepared for the placement exam because of misperceptions about the stakes of the exam, misunderstandings about why and how to prepare for the exam, and a deep lack of math confidence. (Fay, Bickerstaff, & Hodara, 2013) Their poor results on these placement tests thus result not just from a lack of math understanding, but also from not understanding the consequences of the tests. Still, their test scores are determining factors for their ability to begin college, and for their chances to complete a degree.

Not surprisingly, the students who place into remedial courses and are most impacted by institutions' placement and remediation systems are also disproportionately socioeconomically and educationally disadvantaged. Nontraditional adult college students – those who have been out of an academic setting for several years – make up a significant proportion of the students with remedial needs. These students are more likely to be attending school while working full-time, caring for children, and dealing with other responsibilities. Low-income Hispanic and African-American students are also more likely to need remediation than their wealthier, white peers, with 29% of Hispanic students and 14% of African-American students meeting math college readiness benchmarks, compared with 52% of white students. Nationwide, only 39% of students who took the ACT in 2014 met the test's college readiness standards in three out of the four subjects of English, reading, math and science. Of these, 49% of white students, 11% of African-Americans, and 23% of Hispanics met the benchmarks in four out of five areas. These percentages have remained relatively stable since 2010. (ACT, 2014) Community college students, who already face greater college success and completion barriers than their four-year college peers are also at a disadvantage when it comes to passing through remediation. Only 40% of community college students in remedial tracks complete them and 70% of community college students never attempt a college-level math course at all. Given the academic opportunity and success gaps between white and minority students that plague our country, it is critical, when examining remedial policy, to keep in mind the dual charges of college access and success for all students.

Math – algebra specifically – is the greatest academic barrier to community college completion. Looking at remedial education by subject, Bailey, Jeong, and Cho found that 59% of new community college students are referred to remedial math, compared to the 33% referred to remedial English. Based on a 2006 student cohort, Achieving the Dream found that 72% of students were referred to remedial math but only 31% of that 72% successfully completed their remedial math requirements after three years. In comparison, approximately 70% of students with remedial writing and reading needs passed their remedial requirements within the same timeframe. Because of the cumulative nature of mathematics, students are often referred to a sequence of remedial math courses of increasing difficulty because their skills have been assessed at more than one level below college math competency. As a

result, completing a remedial sequence can require multiple semesters of zero-credit mathematics courses even when a student passes each consecutive course. The more remedial math courses required of a student, or the greater the skill deficiency, the less likely the student is to complete the sequence. While some research has found that students who enroll in developmental reading may be more likely to earn a degree than if they had not enrolled in the course, research has not shown similar findings for students with remedial math needs. To the contrary, students who enroll in remedial math are found less likely to earn a degree than had they not enrolled in the course at all. (Bailey, 2009) The impact of remedial math on student degree progress and completion in particular is worth serious policy attention, and has indeed, spurred reform and innovation at institutions throughout the country.

Once students make it to their assigned remedial courses, both students and funding agents are faced with additional costs. The number of undergraduates enrolled in remedial courses has increased dramatically over the past ten years, with 2.7 million students enrolled in at least one remedial course in 2011-2012, up from 1.04 million in 1999-2000. Because of the time required to complete remedial coursework, students are using a growing share of their financial aid to pay for these courses, leaving less of their time-limited aid for the college credits required to earn their degrees. The federal government takes a hit in dispersing this aid, too. In 2011-2012, $4.6 billion in Pell grants was awarded to students taking at least one remedial course, compared to $.96 billion in the 1999-2000 academic year. In the same decade, students with remedial needs took on an increasing amount of student debt. Strong American Schools estimates that the combined cost of remedial education to states and students to be around $2.3 billion each year. (Wellman & Vandal, 2011) While students with remedial needs experience an increased financial burden, they also experience a decreased probability of earning a degree. Only 10% of students who enter community college with remedial needs graduate within three years, and only one third of students who enter four-year colleges with remedial needs graduate within six years. (Garland, 2012) In total, only one in four of the students who enter community college with remedial needs ever earns a degree.

From a government and taxpayer perspective, financial resources are being spent on enrollments for students who never make it to the college finish line. Still, colleges have little financial incentive to

improve their remedial outcomes. While remedial education negatively impacts postsecondary institutions' degree completion and student retention rates, it does not create a significant dent in their operating budgets, and colleges continue to receive federal and state aid money for each student course enrollment, regardless of the cost-effectiveness of remedial coursework. (Berl, 2014) The more semesters a student remains enrolled at college, and the more courses that student attempts, the greater the financial benefits for the college. This perverse incentive does little to push colleges to address the college completion problem.

CUNY and Remedial Education

The City University of New York, or CUNY, is the largest urban public university in the country, an integrated system of colleges, schools, and consortia serving 269,000 degree seeking students and 249,000 adult, continuing, and professional education students at 24 campuses throughout the five boroughs of New York City. ("The Nation's Leading Public Urban University," 2016) CUNY's students are diverse. 40% of CUNY's undergraduates were born outside of the United States, 44% are first-generation Americans, and 20% are the first in their families to attend college. At the CUNY's community colleges, the racial and ethnic makeup is 16% Asian, 29% Black, 39% Hispanic, and 16% white. 26% of students are 25 years old and above, 41% of students attend part-time, and 48% of students speak a primary or native language other than English. Of community college students, 66% are Pell grant recipients, 49% have household incomes of less than $20,000, and 49% are first generation college students. 30% of students work for earnings more than 20 hours per week, and 74% are New York City public school graduates. (CUNY Office of Institutional Research and Assessment, 2015) In sum, the University is uniquely placed to serve New York's population and, indeed, it is charged with doing so.

CUNY's history speaks to its extraordinary expansion – as a set of colleges, and then a University system – and the ways in which it has navigated its dual, and often conflicting, missions of high standards and open access. The evolution of CUNY's admissions policies tells this story, and reflects the University's, the city's, and the country's priorities, through time. It is also important to keep in mind that

college admissions policies tie directly to the issues of remedial education because they determine for whom college is intended, and what an institution sees at its responsibility to its students.

CUNY's mission is rooted in its 1847 origins. Townsend Harris, a champion of public education, called for New York City to create a public higher education academy that would "educate the whole people." Harris's initial fledgling campus called the Free Academy soon became City College, adding the women's Normal School – now Hunter College – 20 years later in 1867. The Free Academy was guided by the principles of access and excellence; the school was to provide an education comparable to one found at an Ivy League to the people of New York City, at no cost. By the early 20th century, the city's immigration boom further increased demand for affordable higher education, spurring the development of Brooklyn, Queens, and Lehman Colleges. For 85 years, from 1847 to 1932, CUNY accepted students based, at least in part, on competitive entrance exam scores. Beginning in 1932, in response to Depression-era demand, "limited matriculation" status was granted to students who were lacking some academic preparation that was previously required. Requirements and entry standards in the admissions process continued to ease, with a "non-matriculated" status established at City College for students not college ready.

With the establishment of the community colleges beginning in the 1950s, senior and community colleges could now track students by aptitude tests and GPAs, funneling the lower-performing students who would have previously enrolled in the senior colleges, into the community colleges. By 1961, New York's state legislature formally established the City University of New York system to unite the then seven colleges into a formally integrated system. CUNY's admissions policies continued to open up higher education to more New York City residents, many of whom had immigrated to the U.S., or came from poorer schools and communities, and often were the first in their families to attend college.

An historic decision, CUNY established the Open Admissions policy in 1970, meaning that community colleges no longer required any specific academic standards beyond high school graduation or a high school equivalency to gain college entry. This decision was prompted by the political activism and student-led protests that began at City College and spread to CUNY's colleges across the five boroughs. In line with the Civil Rights movement of the time and new federal and state policies that

supported increasing educational opportunity for all, students and faculty demanded increased minority representation and racial and ethnic integration at the University's campuses.

For senior colleges, the opening of admissions shifted dramatically student demographics. The implementation of class rank standards meant that students were compared to others from their high schools, not across high schools, thus opening up admissions to more poor and minority students from schools that had not prepared them adequately for college. Similarly, no longer requiring the passing of subject Regents exams nor the specified college prep curriculum made for many more underprepared students entering senior college freshmen classes. Senior colleges also relied on the expansion of the Search for Education, Elevation, and Knowledge (SEEK) program – which admitted underprepared and low socioeconomic students, offering them additional financial and academic supports to ensure their college success – to help deliver on the promise of racial and ethnic student body integration. SEEK's unique and critical position in CUNY admissions at this controversial time meant that it was seen as the impetus for a new group of underprepared students at the senior colleges, and thus also linked increased under-preparedness with the push for racial integration.

Within 17 months of the City College protests that catalyzed open admissions, the University's academic mission was transformed and the size of its freshman class had increased dramatically. With the continued expansion of SEEK and CD and the relaxation of admission standards, diversity was swiftly achieved. With this opening of college doors, came academic deficiencies that CUNY was ill equipped to handle at both the senior and community college levels. The surge of remedial needs left CUNY and the New York City Board of Education (BOE) jockeying over responsibility. Remedial solutions in the mid-1970s included programs that ranged from partnering CUNY colleges and high schools to tutor and remediate students to new approaches to teacher and faculty training.

Facing a citywide fiscal crisis in 1975, CUNY was ultimately forced to address its budgetary problems by implementing student tuition. The mid- to late-1970s also brought on large-scale postsecondary remediation at CUNY. This institutional development was fueled by the deterioration of the New York City K-12 public school system, which was now producing B-average high school graduates who were entering CUNY with significant remedial needs. During this time of upheaval, the University

also suffered a serious decline in enrollment, especially among high achieving students, further incentivizing colleges to enroll the least prepared from the BOE.

In reaction to pressing concerns regarding student standards and grade inflation, CUNY trustees in April 1976 established a certification requirement for students entering the senior colleges from CUNY or non-CUNY community colleges that would provide evidence said students had “attained a level of proficiency in basic learning skills necessary to cope successfully with advanced work in the academic disciplines.” In response to this resolution, a faculty committee recommended testing all incoming freshmen in reading, writing, and mathematics to identify students’ specific skills deficiencies, place them in appropriate remedial courses, and bring them to the standards expected of senior college students. This testing was approved and assessment tests known as the FSATs went into effect for all incoming freshmen in the fall of 1978. At the same time, the SEEK program became a permanent department at senior colleges and charged with compensatory education for those students in need.

Despite the centralized CUNY establishment of a certification process for students to enter CUNY’s senior colleges, which included students coming from within CUNY, the requirements did not bear out in practice. Because of a lack of centralized control or enforcement, not much changed in the way of admissions and not much improved in the way of articulation agreements or smooth transfer through the 1990s. Starting in 1996, however, after the Board of Trustees had ratified a package meant to improve financial efficiency and accommodate repeated budget cuts, CUNY senior colleges were asked to limit their remedial offerings, and thus the admission of students with remedial needs. A major shift in senior college admissions standards followed from this decision, with year-by-year incremental increases in the academic units, GPA, and examinations scores required by entering Bachelor's students. This shift meant a return to pre-open admissions criteria, like college prep courses, and away from class rank, again decreasing senior college admissions chances for economically and educationally disadvantaged students. In 1998, Trustees mandated that senior colleges phase out remedial course instruction entirely over the next three years. The Trustees also established a regulation that prevented students from transferring into a bachelor's or senior college program if they have not passed all three FSATs. (NYC.gov, 1999)

In 2015, CUNY remediation is complex, and remedial course sequences – along with special remediation programs or remedial alternatives – vary from campus to campus. The Testing page on the CUNY website explains that the CUNY Assessment Tests – in Math, Reading, and Writing – are offered as an option, in addition to SATs, ACTs, or New York Regents scores, to meet senior college admissions requirements or to be placed into appropriate courses at a community college. While the remedial course pathways vary across colleges, the standards for passing each CUNY Assessment Test are uniform. Students must score a minimum 70 in Reading, 56 in Writing, 40 in Algebra, and 45 in Pre-Algebra, respectively, to be exempt from remediation in each subject area. The standards change frequently, with the 45 minimum score in Pre-Algebra up from a 35 minimum just a year ago. ("Testing FAQs," 2016) In the fall of 2010, 78.6% of students entering CUNY community college students placed into remedial courses. CCRC found that two years after matriculation, only 38% of students placing into remedial math had completed and passed their course or sequence. Only 26.1 % of CUNY community college students with incoming remedial needs earn a degree within six years, compared to 40.6% of students without remedial needs. In line with these discouraging findings, failure rates in CUNY remedial courses often exceed 50%. (Crook, 2011)

LaGuardia and Remedial Education

While CUNY's community colleges on a whole serve as a vast laboratory for study, I will focus in on math remediation at LaGuardia Community College, the second largest of the system's community colleges. LaGuardia has been highlighted in the media and on a national policy stage as a prime example of the critical role community colleges play in economic mobility and the opportunity for America's underclass to reach the middle class. LaGuardia's president since 2000, Dr. Gail Mellow, has been integral to leading the national charge for investment in community colleges, with several visits to Washington to testify to their importance as an American institution that is a primary engine for economic and social progress on a national scale. Due in large part to her leadership and activism, LaGuardia and its students and faculty have been the subjects of major press in the New York Times and the Atlantic, and have been the recipients of major national public and private grants to continue their important work.

Queens County, or the borough of Queens – from which the college draws most of its students – is one of the most racially and ethnically diverse counties in the country and in the world. As of April 2014, Queens's demographics were 27.6% white, 17.7% Black, .3% American Indian, 22.8% Asian, 27.5% Hispanic, and 4% other. (Narula, 2014) In 2011, immigrants accounted for 48.5% of the borough's overall population, with the top immigrant countries of origin being China, Guyana, Ecuador, Mexico, Dominican Republic, Colombia, Korea, Bangladesh, India, and Jamaica. (Bockmann, 2014) LaGuardia's students reflect the diversity of the county, with a Spring 2015 enrollment of more than 20,000 matriculated college students that comprised 11% White, 22% Black, .5% American Indian, 23% Asian, and 43% Hispanic students, in all coming from 150 countries and speaking over 111 languages.

In fall 2014, the proportion of new LaGuardia students who tested into basic remedial math increased to a high of 87%. Meanwhile, basic Reading and Writing needs remained much lower, at 19% and 14% of all testers, respectively. Remedial placement data across the CUNY community and comprehensive colleges (those colleges that accept students with remedial needs) are similar, and thus high remedial placement and low exit rates are a concern. (Dickmeyer, 2015) As the following chapter will demonstrate, both LaGuardia Community College – its leadership and mathematics faculty – and CUNY at large have made reforming math remediation pathways, processes, and curriculum a priority.

CUNY and LaGuardia Remedial Math Reform

The faculty and administration at the CUNY Central office and at the CUNY community colleges are well aware of the ways in which remedial courses, as they are currently structured, are "killing off students" and they know that something has to change. Reform has been coming incrementally, in fits and starts, and often piecemeal. CUNY community colleges have developed and initiated their own alternative models to traditional remedial math. At LaGuardia, leadership and faculty have introduced new math courses and opportunities that serve students who have remedial placements from the Compass assessment exam and address many of the shortfalls of the current remedial math structure: intentional and improved pedagogy, acceleration of content, reform of content, credit make-up, and brush-up second chances. Concurrently, the CUNY Central Office has continued to expand the two primary remedial and

student success programs that it funds: CUNY Start and Accelerated Study in Associate Programs (ASAP).

The relationship between the Central Office and the campuses is critical to understanding the path of remedial reform at the University and some of the rocky road therewith. As former Executive Vice Chancellor Alexandra Logue outlined in her 2010 Inside Higher Ed piece, "The Power of the System," there are both advantages and disadvantages to CUNY's colleges' status as members of a University system. With regard to the issue of remedial education reform, one benefit of the system is that individual colleges, often in partnership with the central office, can experiment with a new way of doing something – i.e. remedial math reform – to get a better sense of what is working and not have to worry about mass-scale buy-in before disseminating it system-wide. As Logue put it, "to the degree that these innovations do succeed, the strategy of starting with just a few colleges will build support for expanding innovations to other colleges; if they do not succeed, CUNY can move forward without having changed practices across the board." (Logue, 2010) Further, it can benefit students to be a part of a system like CUNY, where one can advance educationally from community college to bachelor's degree to masters to doctorate with clear articulation agreements and smooth transfer processes. In the same vein, having uniform remedial entry and exit criteria across the community college system can standardize the system for students moving between institutions (not to mention the New York City Department of Education, which sends many of its high school graduates directly onto CUNY institutions). Additionally, faculty in given disciplines, and academic departments, can benefit from the system because they have a community across campuses and can learn from one another and collaborate on academic standards, curriculum, research, and pedagogy. With remediation issues, data can be housing centrally and outcomes shared across campuses and across innovative practices but with "like" students. Logue also mentioned a "healthy competition" between colleges for being the best or ahead of the pack on various achievements and metrics. Community colleges are racing to be the first to "fixing" the remedial math problem, to out-innovate each other. Finally, it benefits the colleges to have the central office capacity to conduct large-scale research both internally and externally and utilize best practice findings to fund and support such programming.

Still, there are challenges and frustrations inherent in being a member of a system. Friendly competition between colleges can turn unfriendly, a central office can be an extra layer of bureaucracy that gets in the way of efficient and impactful change at the campus-level, community colleges can feel the brunt of over-enrollment that pushes the flow of students "down the chain." Such enrollment surges at the community college level have exacerbated remedial education issues because colleges have to address the academic deficiencies of more and more students while trying to maintain overall quality and resources for all enrolled students. Often, colleges want to do their own thing and are stunted by the system-level requirement that certain policies or processes must be standard across colleges. This system affect impacts remedial policy in a major way. Some community colleges are confident they have a better way of doing remedial math, for example, and find it counter to faculty and student success to abide by system norms, while other colleges do not want to act on reform at all – and are being pushed by central administration to do so. Colleges can also feel as though the central office administrators are out of touch – or at the very least, less in touch – with what is occurring, working, and not working at the campus level. This speaks to a power struggle around autonomy – to what extent should a college president need to bend to the will of the system? Logue references the sentiments of Mark Yudof, the president of the University of California system, in saying that "systems usually provide more benefit for colleges that have not reached their full potential." Indeed, colleges on both ends of the success spectrum can be resistant to mandates or urging from a central administration and central can lack understanding of what is happening on the ground on the campus. And beyond the inter-campus competition, there can be friendly and less friendly competition between colleges and central as well.

The central office has been able to utilize both its research capacity and central positioning to initiate and sustain the Task Force on Remediation. Led by Executive Vice Chancellor Vita Rabinowitz and David Crook, University Dean for Institutional Research and Assessment, the mission of the task force is to examine and address CUNY's major remedial issues. Its members include Central Office administrators and faculty fellows, campus provosts, the head of math discipline council, the head of the writing/reading discipline council, and the Central Office Enrollment Manager, among other key instructional and administrative staff across Central and the campuses. The group meets monthly and

discusses the primary remediation issues: the high stakes nature of the exit exam, accelerated models or alternative pathways to substitute for or supplement the traditional remedial models and remedial placement procedures. As of early 2016, the Task Force is developing a list of policy recommendations – primarily centered around remedial placement procedures – while concurrently working with stakeholders, CUNY policy makers, and Board Members on implementation procedures to ensure that the recommendations can and will lead to substantive policy change. While the task force is not an innovation in and of itself, it is important to understand the central office's ongoing role in remediation policy across the University.

Reform in Action: Content, Assessment, and Delivery

This chapter will look at both the LaGuardia and the centrally-led remedial math reform efforts currently under way in the areas of content, assessment, and delivery. The final reform recommendations chapter will again focus on these issues but with a roadmap for how to move forward.

1. What are the fundamental math content, skills, and competencies that community college students are required to master?

Over the past decade, CUNY has tested out, implemented, and significantly expanded some of its remedial math reforms, but none of these forms have expressly challenged the math content or mathematical learning objectives at stake. The bold reforms thus far – namely CUNY Start and ASAP – which will be explored later in this chapter – have addressed the form, structure, and delivery of the content. They have made wraparound support services and intensive academic and personal advisement critical to student success, increased the time on task, accelerated the learning model, mandated tutoring and heavy academic supports, provided additional student financial support, and addressed teaching methods by employing innovative pedagogy. But not until recently have colleges, and indeed the nation, begun to push the major content assumption: Do students need to take a full semester, demonstrate competency, and pass a high stakes test in a full range of elementary algebra topics? Is passing this course and understanding these topics a critical pre-requisite to being successful in college math, in

college altogether, in one's academic major or chosen career pathway, and in life as a productive citizen of the city, the country and the world? Or better yet, is there a good argument that without demonstrating these algebra competencies on a standardized test, students will be set up for failure in subsequent college math courses, in their college degree, and as a citizen of the world?

Under the leadership of President Gail Mellow, LaGuardia charged ahead in rethinking remedial math to promote student learning and student success. In January 2013, LaGuardia joined the Carnegie Foundation's Community College Pathways program, an innovative project organized around two mathematics pathways that works to address the remedial loop that many students throughout the country get stuck in as a result of remedial math placement at college entry. Specifically, the pathways - Statway and Quantway – "aim to accelerate students' progress through their developmental mathematics sequence and a college-level course for credit." The pathways "reduce time required to earn college credit while improving content and pedagogy of developmental mathematics." In developmental math content, the curricula include engaging, relevant, and useful mathematics concepts that students can use in their daily lives." ("Pathways Improvement Communities," 2016) Milena Cuellar, Assistant Professor of Mathematics at LaGuardia and one of the leads on the project, described Carnegie's Pathways as "a network improvement community" that grew out of University of Texas-Austin's Dana Center's New Mathways Project and its integration of holistic student success approaches and strategies to teaching math. (Cuellar, 2016)

LaGuardia chose to adopt and implement the Statway model, which traditionally covers 12 modules over two semesters, covering mathematics content through college level elementary statistics. Thus, unlike the traditional elementary algebra content, Statway "is focused on statistics, data analysis, and causal reasoning," and "is designed to teach mathematics skills that are essential for a growing number of occupations and are needed for decision making under conditions of uncertainty." Because the course is geared towards non-STEM students with remedial math needs, LaGuardia has had more latitude to think differently – with Carnegie – about the math content and skills its students need to master. However, the limits on allowing this kind of alternative for STEM majors are grounded, at present, in CUNY policy, not necessarily the skills that STEM majors absolutely need. Cuellar and the rest of

LaGuardia's Carnegie math faculty team went through three or four iterations of the Statway course in order to best adapt it for the LaGuardia remedial structure and student needs. They ultimately compressed it into one semester to enable students who place into LaGuardia's second level remedial math course, 096 Elementary Algebra, to accelerate through algebra and satisfy their college elementary statistics in half the traditional time. In order to accommodate the increased content, heightened academic intensity and accelerated timeline, the course is 7 hours a week instead of the typical 3 or 4, ostensibly granting students 3 credits for the 'non-remedial' portion of the class and no credits for the additional 'remedial' hours.

This initial Statway cohort produced strong outcomes, with 68% of students passing the course. In comparison to the outcomes for the two sequenced courses Statway has been a trial substitution for – the traditional remedial elementary algebra course has a 40% pass rate and the college statistics course has a 70% pass rate – the Statway outcomes are significant. First, the 28% gap between the 40% and 68% pass rates for students with the same initial 096 remedial algebra placement have several implications for student learning, student progress towards degree, and student retention in community college. Second, the 70% pass rate for statistics is only out of those winnowed 40% of remedial passers from elementary algebra who have made it through to the next course in the sequence, at which point the college has either permanently lost the other 60% to dropouts, or students have failed or withdrawn from the course, meaning they are forced to retake the course (which they are again statistically likely to fail). Meanwhile, the 68% of Statway passers includes the entire 096-placed student group, many of whom would never have made it through algebra or onto college statistics. These data force us to reconsider the use of a zero credit elementary algebra pre-requisite course when it neither produces student success nor significantly improves success in the subsequent sequenced math course for those few who do make it through. Put another way, the overall elementary algebra-college statistics sequence has a pass rate of approximately 28% of the initial algebra-placed students, compared to the 68% pass rate outcomes of the accelerated one semester Statway course. After the fall 2013 pilot, Cuellar and her colleagues revised the curriculum to make it more cohesive and less like a cobbled together version of elementary algebra plus college statistics.

Making the Statway curriculum more cohesive meant removing selected elementary algebra topics altogether. (Karr, 2016) This decision to remove specific algebra topics is one of the key controversial issues in remedial math debates at CUNY and nationwide, because it questions whether algebra is a necessary part of general education requirements. Andrew Hacker, Political Science and Quantitative reasoning Professor at Queens College (CUNY) and author of "The Math Myth and Other STEM Delusions," argues that much of the algebra we require is not necessary for adult life for 95% of career fields, including those in STEM. Instead, he argues for teaching facility with arithmetic, statistics, analytical and quantitative thinking, and "vigorous computation." In line with Hacker's thinking, Cuellar explained that Statway does not cover quadratic equations or factoring because they are not topics that prepare a student to succeed in statistics. Students attained these strong pass rate outcomes even without some of the elementary algebra content that has been deemed necessary for their college success. Will missing out on algebra hurt the students down the road, either in their subsequent college math courses or in their future occupations? Increasingly, there is evidence and growing belief to suggest that the answer is no, that new approaches to math will support students' success in a myriad of ways.

Even though the course has demonstrated student success, CUNY's Math Discipline Council still has concerns. How can we be confident that students exiting Statway have the same skills as those exiting the college level statistics course at the college? In part to address this concern, LaGuardia has implemented assessments that can compare learning outcomes for students who exit Statway, or Mat 119, and those who exit traditional college statistics, or Mat 120. As of the writing of this paper, Statway is only enrolling students whose only degree math requirement is Mat 120 – thus excluding Science, Math, Business, and other Majors with more extensive quantitative majors – but Cuellar hopes that with a more rigorous comparison assessment they can gain the trust of both the Math Discipline Council and ultimately other discipline departments that challenge the academic rigor of the Statway course. Cuellar also points out that because the pedagogical and content approach to a course like Statway is so untraditional, it is difficult to assess students' learning in conventional ways. Since the Carnegie method is not one geared towards the same algebra content or the same methods of learning the content, the current CUNY-wide standardized remedial algebra exit assessment, called the CUNY Elementary

Algebra Final Exam (CEAFE) – which is designed to capture traditional algebra learning – would not serve in assessing the learning of students who have been learning and expressing their learning in an entirely different way.

The critical question at stake here is if a student who is enrolled in Statway decides to switch their major to a STEM field, will he or she be ready or have shown enough algebra competence to take Mat 115, the college algebra course in a subsequent semester? Without passing the CEAFE, how can we be sure? Cuellar expressed confidence that students would be ready for Mat 115, and in fact, from the small sample size of students who have already passed Statway and switched to STEM majors, only one failed Mat 115. Further, it is conceivable that students who may not have otherwise had enough math confidence to change to a STEM major (or made it this far in their college career at all) have – due to Statway – now seen and approached math in a new and confident way. Indeed they will have persisted through and succeeded in quite a rigorous semester of algebra and statistics. Cuellar said that future math – and one could argue, any academic - success is not just about "what you know on the list" of topics, but how you approach learning. But the Math Discipline Council, a CUNY-wide committee comprise of the Math Department Chairs, requires more proof, and is not fully in favor of LaGuardia's ability to waive the CEAFE requirement. According to Cuellar, the Discipline Council may have suspected that LaGuardia was avoiding CEAFE implementation because they feared their Statway students would not be able to perform well on it. The reasons to waive the CEAFE for alternative pathways like Statway is because Statway does not have the same elementary algebra learning objectives that the CEAFE tests and because a high stakes test like the CEAFE does not align with the pedagogical and teaching and learning practices of Carnegie's pathways models. Still, to the algebra traditionalists, making special assessment exceptions or workarounds is suspect.

Other remedial math reforms that touch on content are underway at CUNY. Borough of Manhattan Community College (BMCC) has also partnered with Carnegie to adopt their other math pathways course, Quantway, which has the same approach as Statway, but is directed and structured for students who place into the lowest level arithmetic/pre-algebra course. Students are able to accelerate their sequence from two semesters to one, while learning mathematics material that focuses on

proportional reasoning, some algebra topics, and quantitative literacy in a meaningful and real world applied way. Like Statway, Quantway outcomes relative to traditional remedial course sequence outcomes have been impressive. (George & Milm, 2014) At BMCC, only 30 percent of students in the traditional version of remedial math pass the course the first time around, but about 60 percent of the students who take the Quantway course instead pass on first try. (Baron, 2015)

In November 2015, Mari Watanabe-Rose, Director of Undergraduate Education Initiatives and Research at the CUNY Central Office, and a member of the Remedial Task Force, along with faculty from BMCC, Guttman Community College, and Hostos Community College were awarded a $300,000 Teagle Foundation grant in Teaching and Learning, Faculty Planning and Curricular Coherence. The grant enables three professors – one math, one natural science, one social science – at each campus to work together to examine syllabi and align curricula based on the needs in each discipline's major requirements and sequenced coursework. The project, called Project for Relevant and Improved Math Education (PRIME) will utilize empirical findings – rather than the traditional application of intuition – to compare syllabi across departments and ask questions like: Which topics of elementary algebra are needed to be successful in college algebra? What statistics is needed for success in a psychology course? Which college algebra topics are needed to succeed in a biology or chemistry course? According to an outline on the Teagle website, faculty will then "implement a placement policy and curricular streamlining strategy for developmental mathematics that is grounded in empirical evidence and in students' aspiration," as well as "revise and align their remedial and introductory qualitative courses" with the added goal of "reducing contact hours while increasing pass rates and levels of proficiency. ("Teaching and Learning: Faculty Planning and Curricular Coherence," 2015) This kind of work promises to use curricular research and data to support, from a different angle, the positive outcomes that have resulted from the implementation of Statway and Quantway at CUNY. Such work can broaden the base of support for these alternative pathways, support their expansions and proliferation, and sustain the argument that CUNY can and should adjust content, structure, and pedagogy across its remedial math systems.

2. How does CUNY assess content or skill levels – at college entry and post remedial intervention?

ACT recently announced that effective November 2016, the company would be discontinuing the COMPASS exam and all of its associated products. ACT's website notes that in the time since the Compass exam began in 1983, "course placement needs among students and the institutions who serve them have shifted significantly" and "a thorough analysis of customer feedback, empirical evidence, and postsecondary trends led us to conclude that the ACT Compass is not contributing to student placement and success as it has in the past." ("The Future of the ACT Compass," 2016) In addition to the Compass phase out, the other placement-serving assessments external to CUNY – the SATs and Regents – are making significant changes.

Until fall 2012, CUNY used ACT's Compass exam both as the entry assessment test for all incoming CUNY students (except those whose SAT or Regents exams exempted them from testing) and the as exit remediation exam. The COMPASS exam is an "untimed, multiple- choice, computer-based test designed to measure students' knowledge of a number of topics in mathematics. The test draws questions from four sections: numerical skills/pre-algebra, algebra, college algebra, and trigonometry." ("COMPASS Test," n.d.) The test is also adaptive, moving up or down in difficulty level depending on your correct or incorrect responses to each question. Students are placed into CUNY's lowest level numerical/pre-algebra course if they score less than a 45 in numerical/pre-algebra section of the COMPASS. These students are required to take the entire pre-algebra and algebra remedial sequence, which is at least two courses over two semesters, depending on the college. Students who score less than a 40 on the elementary algebra but above a 45 on the pre-algebra, place into the higher-level elementary algebra remedial course.

Beginning in fall 2012, CUNY kept the COMPASS as the entrance CUNY assessment test, but changed the remedial exit exam to a homegrown CUNY Elementary Final Exam (CEAFE). G. Michael Guy, member of CUNY's Remedial Task Force, professor of mathematics at Queensborough Community College (CUNY), and co-developer of the CEAFE, explained that the development of a new exit exam grew out of the faculty's desire to re-evaluate what students should know before beginning college level math coursework. (Guy, 2016) The work on CEAFE development and piloting began in 2010 with

examining key learning objectives for remedial math. As of the Spring 2016 semester, the CEAFE is administered to upwards of 10,000 students each semester. Beyond honing the learning objectives for remedial math CUNY-wide, the CEAFE implementation reformed remedial math assessment in three additional ways. First, it lowered the high-stakes nature of the exam by requiring the exam score to be at least 35% of final course grade, where the remaining 65% could be determined by homework, participation, other quiz and test grades. The condition was that all students must have a 74% course average to pass out of remediation. Second, the transition from Compass to CEAFE meant that there would no longer be a required exit exam for the lower level arithmetic/pre-algebra course. Thus, campuses could develop their own arithmetic exit exam or assessment system if they wanted. The removal of the arithmetic exit mandate also left room for colleges to adjust course or intervention structure and as they saw fit, so long as the CEAFE was used as part of the final exit criteria. Third, the CEAFE committee structured it into policy that departments could offer a short, intensive second chance workshop for students who fell within a specific number of points of passing the CEAFE and exiting the remedial sequence. Still, the initial implementation of the CEAFE outlined clear and limiting guidelines that all community colleges and math departments were required to follow.

Since implementation the Math Discipline Council has agreed to adjust CEAFE policy in the following ways: 1) relax the narrow definition of what it means for students to be nearly passing, so that now colleges have full autonomy to determine what almost passing looks like and what kind of subsequent intervention they think is best to offer students to get them over the remedial finish line; 2) temporarily allow for remedial alternatives or experimental offerings to waive the CEAFE as a mandatory exit requirement for their students; and 3) lower the minimum passing course score to a 70% average, down from 74%. The CEAFE also continues to undergo revisions and improvements each semester, as faculty understand what questions best get at the math competencies students need to have.

Still, even with the relaxation of the CEAFE's restrictions and continuous improvements and revisions, it still tests elementary algebra competencies and its learning objectives are aligned with the elementary algebra topics. Thus, it assumes this content model, as well assuming that the best way to assess for math knowledge and skills is through a high stakes test. The controversy comes to a head in a

program like Statway, when LaGuardia's faculty confront CUNY's University-wide Math Discipline Council, a committee comprised of the Math Department Chairs of the CUNY colleges that are asked to consider and come to some consensus on issues including "the alignment of introductory curricula with expectations for skills and competencies." In other words, the Math Discipline Council is supposed to agree upon what is remedial and what is not, what math students need to learn and prove competent in before advancing to credit-bearing coursework. Because Statway does not fit the mold and was assessed as an innovative, alternative model, Statway sections were given a temporary 'CEAFE waiver' and have been able to hold onto that waiver to date, while they continue to analyze their outcomes data. Cuellar explained that given this exemption, the Discipline Council wants assurance from LaGuardia that students' algebra content knowledge is not being sacrificed and that they will be able to demonstrate and apply the necessary math knowledge in subsequent community college courses, at bachelor's colleges, and in the world.

3. How do CUNY institutions deliver the math content and skills we deem necessary for major courses and graduation?

This question can be best answered by addressing two critical parts of teaching and learning success, namely: a) the structure of the remedial math intervention or alternative and b) instructor methods and approaches to content and skill delivery, otherwise known as pedagogy.

A. Remedial Math Intervention Structure

As I have noted, the first initiative to boldly rethink remedial education at CUNY is a program called CUNY Start that started in fall 2009 "with the goal of helping students reduce their remedial needs and become better prepared to take college-level courses." Since its beginning, CUNY Start has expanded from one CUNY campus to nine CUNY campuses, and is now serving more than 4,000 students annually. CUNY Start enrolls students whose entering CUNY Assessment Test scores demonstrate that they have significant remedial needs, and provides them with intensive reading, writing, and/or math coursework, in addition to a college success seminar, in order to help them become remedial free before they enter college. CUNY Start is a post-admissions but pre-college program, meaning that

students who enroll in CUNY Start temporarily delay the start of their degrees to participate in the semester-long program. The program's structural innovations are: 1) serving students pre-college matriculation so that students can avoid using their time-limited financial aid, 2) providing a more accelerated, intensive course model that allows students to tackle all of their remedial needs – with more time on task in each subject – in a single semester, and 3) offering students two opportunities to re-take the CUNY Assessment Tests post-intervention, once after their first 12 to 14 week Session One and a second time after their 4-6 week Session Two. CUNY Start's continued expansion has been due to its impressive outcomes. In fall 2014, 68% of full-time CUNY Start students entered having failed all three CAT subjects – math, reading and writing – and 32% came in having failed two of three subjects. By the end of the program, 51% of students were proficient in all three areas, 30% were proficient in two areas, and 14% were proficient in one area. After one semester, 53% of CUNY Start students with remedial math needs gained proficiency, compared 10.2% of a comparison group of similar students who did not enroll in the program. (City University of New York, 2015)

The CUNY ASAP program, while not primarily focused on students with the most remedial needs, accepts students with up to two remedial needs at entry, and requires that these students fulfill their remedial requirements immediately upon college matriculation. ASAP also requires that students in remedial courses attend regular and intensive tutoring sessions to help them pass these courses in their first attempts. While ASAP does not touch the instruction or the remedial math course model itself, it does structure timing and intensity with which students focus on their remedial coursework. By creating this structure, ASAP has improved remedial math outcomes for their students.

Guy and his colleagues at Queensborough Community College (QCC) also adjusted the structure of their remedial math intervention. They took advantage of the new clarity of the learning objectives developed alongside the CEAFE development to successfully lobby at QCC to accelerate the remedial pathway by eliminating the lower level arithmetic/pre-algebra course and integrating the needed arithmetic into their elementary algebra course. They were able to do this without weakening the course content or algebra learning objectives. Guy, Karan Puri, and Jonathan Cornick were able to advocate for this acceleration college wide by showing that students who enrolled in the initially piloted accelerated

one-semester course had statistically significant higher completion rates than those who were placed into the traditional two-semester course sequence. (Puri, Cornick, & Guy, 2014)

As noted above, one of the main goals of Carnegie's Statway and Quantway pathways is to accelerate remedial math education, either by combining a traditionally two-course remedial math sequence into one single-semester course, or by merging a higher level remedial math course with an introductory college math course to create a one semester course that can grant successful students some credit. This acceleration in and of itself is a critical component of most successful remedial math alternatives because it minimizes the possible exit points for students and thus avoids semester breaks at which students often have the "opportunity" to either fail or withdraw from the course, and sometimes withdraw from college altogether. (Jaggars, Edgecombe, & Stacey, 2014)

In addition to the Statway course, LaGuardia has two other remedial math alternative pathways in various pilot and development stages. Both courses are more straightforward acceleration models that have been developed or are being developed in house, rather than adopted from outside models like Statway. Mat 90 will combine pre-algebra and algebra and serve the students who now place into 095, or the lowest math remedial placement. Instead of needing a minimum of two remedial math semesters (095 and 096), these students will be able to take a course that will satisfy their remedial math needs in one semester. The other course is Mat 117, a course parallel to the Statway course but more traditional in its approach and more comprehensive in its content. Jeanne Funk, Assistant Professor of Math at LaGuardia Community College has been leading the development and implementation of MAT 117, an accelerated course that, like Statway (or MAT 119) enrolls students with elementary algebra placement, but serves STEM majors instead of non-STEM majors. In describing the impetus for the course's development, Funk echoed the exit point literature, discussing how "the more classes you have to get from one point to another, the more places you have to lose people – frequently called exit points – so the idea is, these times between classes are places where students can… fail and then have to repeat or leave or they can pass and they just don't register for the next course in the sequence, so even the students who pass – you lose some of them." To address this problem and eliminate these opportunities for exit, LaGuardia has been merging two sequenced courses into one and utilizing learning objectives

that align closely with that of the more advanced course. In the case of MAT 117, the department merged the remedial elementary algebra course and the college level credit-bearing algebra and trigonometry course. This course mirrors Statway further in that in one semester, it provides college credits to students who complete it.

B. Pedagogy and Approaches to Teaching

Both CUNY Start and Statway have also significantly altered the pedagogical approaches to remedial math instruction. At CUNY Start, instructors and transitions advisors are hired from outside the colleges, vetted for an interest in teaching and learning new methods (in addition to teaching and content experience), and trained for a full semester as a "Cooperating" teacher or advisor with a "Lead" teacher or advisor before leading their own classroom or advising a full caseload of students. The math curriculum and math teacher training focuses on student-centered instruction, meaningful questioning, developing real understanding, and emphasizing "student talk" over "teacher talk" in every class. These practices and, the philosophy surrounding inquiry-based learning, require that students, rather than teachers, "are given great responsibility for developing, testing, explaining and assessing mathematical ideas and answers." As a result, students build math confidence and deepen their own fundamental understanding of algebra.

Cuellar described the Statway approach as not just the accelerated content, but also - and notably - the classroom interventions necessary to support student success, and particularly success in math for students with poor math preparedness and math confidence. Cuellar referenced UT's David Yeager and Gregory Walton's work on the use of social-psychological interventions that address barriers to learning, including the teaching of the growth mindset - or the belief that people can learn and change - in instructional settings, as central to the Carnegie/Statway approach. She continued, "It's not just about that the students cannot learn, but they have these barriers that we have to break, and especially in urban environments, maybe stereotype threat, belonging, mindset, anxiety, performance under stress, all these things." This research, and more, informed Carnegie's development of what they call "productive persistence," which Cuellar defined as a unique component integral to students' academic success.

In this vein, the Statway course curriculum begins with a module called “Starting Strong,” where instructors spend the first four weeks of the term facilitating interventions in the classroom students’ mindsets and attitudes. These interventions aim to develop a cohort community model and culture so students see one another as resources and as accountable to and for one another’s success. They also challenge the traditional professor-students dynamic by including the professor in the learning community. In other words, the whole class rises and falls together. Another key component of Starting Strong is reading, learning and coming to believe the Growth Mindset (developed and popularized by Carol Dweck), the idea that when you try hard and struggle with academic material, the neurons and connections in your brain expand and you become smarter. Professors use these interventions both to emphasize that this course and this learning is a difficult journey that it is going to challenge and frustrate them, and to emphasize that every student in the class is capable of success. This academic frustration is the kind that often causes students to drop out of remedial math coursework, give up on their own abilities to learn or do math. So preparing them psychologically for that frustration and struggle, naming and normalizing it, and identifying it as the process by which they actually learn and grow their brains is critical to retain students in an accelerated and intensive course like Statway. Beyond the content of the interventions, the instructor also practices pedagogy that allows and requires students to experience struggle early on in the course. Rather than lecturing “the answers,” the instructor primarily facilitates students’ coming to their own understanding of the academic material.

Cuellar pointed out that even as strong and research-backed as the Carnegie curricular approach is, the course’s student outcomes are only as strong as the professor’s skill in implementing the intended approach. “The new way of teaching is about how good you are at teaching Stats but you have to learn about productive persistence and how to implement that, and the learning opportunities, delivered practice, and something called the learning cycle,” Cuellar explained. To address this teacher training need, Cuellar and the other leads on this project went to several Carnegie workshops and then a core group of five instructors began teaching the first five sections in fall 2013.

With these new curricular revisions and a track record of success with the pilot semesters, LaGuardia planned to dramatically expand to 40 sections of Statway for fall 2015. To prepare for a

successful expansion, Cuellar worked with a team to develop an intensive professional development program in order to get enough faculty – both full-time and adjunct – trained, compensated for their time, and on board for fall. Again, this training was not to address content instruction in mathematical topics, but rather how to support students' productive persistence in the course, developmental mathematics, and ultimately in their college journey. Many instructors resisted the new approach because it was asking them to shift their teaching paradigm, what they understand and know college-level teaching to be. It is relinquishing a kind of control and egocentric view of the role of instructor, whereby you are not in front of the classroom as expert, feeding expert information to a receptive group of students but rather, standing back and saying "Ok, let's be confused and see what happens," as Cuellar put it. Students do a lot of group work, supporting each other in these mathematical discoveries. In the training programs, faculty also learned how to manage and support student group work, how to mentor and support one another in their practice. Prospective Statway faculty completed in-person training, modeling, and workshops, and a summer intensive online course to better understand the context and rationale for productive persistence.

In fall 2015, Statway instructors met together two or three times to share and gain feedback from another, and support each other's teaching. Cuellar emphasized how difficult it is to teach this course in general, and particularly for the first time. Instructors are all at once teaching a new curriculum, completely upending their teaching methods and approaches, and spending a lot more time each week in the classroom with students, the vast majority of whom have a lot of anxiety around math. Oftentimes, math struggle – a byproduct of the productive persistence approach – is a serious emotional trigger for students that can result in disruptive behavior. Cuellar mentioned that Campus Security had to be called to a Statway classroom on more than one occasion in fall 2015 to address verbally or physically violent student behavior. Overall, however, the professional development institute and expansion of Statway was extremely successful, and resulted in similarly strong outcomes as when the course was just a five section pilot. The course is also cleared for transfer to Bachelor's programs, so students will have no trouble carrying their credits with them beyond LaGuardia to satisfy either quantitative reasoning or statistics requirements. Given LaGuardia's impressive success with their Statway expansion, Carnegie is now utilizing LaGuardia's professional development scheme to help other colleges around the country

who are attempting the same kind of scale that Cuellar and her LaGuardia team has achieved. The professional development work at LaGuardia has been led and championed by President Mellow, who has recently launched a Pedagogy Matters! campaign to take college teaching seriously by investing in "quality teaching and professional development." ("Gail O. Mellow, President," n.d.). Investing in teaching is critical to solving the remedial math problem.

Remedial Math Reform Recommendations for the City University of New York

As an Adult and Higher Education Administrator, I use and "do" math every day, and am confident that my strong math background and confidence in my quantitative skills make me better at my job, and at understanding the many quantitative aspects my life. Community college, and four-year college graduates, should have some basic mathematical or quantitative math competencies. On this, everyone agrees. But what has become clear in my conversations with CUNY experts and in my research on CUNY remedial issues and solutions, as well as those nationwide, is that the choices we make about competencies and their delivery is a complex matter. Further, because the ways in which these issues can be understood and addressed is so varied, it is critical that CUNY Central office policy allow for the CUNY colleges and departments to do a great deal of their own exploring, experimentation, and implementation of solutions that work for them. This means ensuring policies are not restrictive, and indeed CUNY has started down the path of relaxing restrictions in these areas. Many of the colleges and departments at CUNY have run with the relaxation of limitations and have begun to offer their own innovative and successful remedial alternative offerings. However, some have been resistant to change altogether, despite the overwhelming evidence that change is needed. It is critical that CUNY's Central Office facilitate remedial math mentorships, peer-to-peer best practice and innovation sharing to encourage ground up change within every institution, supporting the faculty members who feel isolated and stuck because their leadership is unwilling to approach remedial math in new ways.

Guy proposed that college readiness should be evaluated by asking the question "How ready is a student to succeed in his or her college or Major courses?" and if he or she is not ready to succeed, "What support(s) would best improve the student's chances of success in said college course(s)?" The

clear problem, Guy said, is that the remedy we currently have is damaging student progress: “The idea of remediation is that we give a student a placement test, and this placement test along with other indicators says ‘I don’t think you can be successful in this course. It’s just not fair, you’re not going to be successful. And the remedy that we offer currently is a remedial course that a student takes before that course. So, unfortunately, that remedy often kills many of the patients, partly because that remedy is often very one-size-fits-all and there are opportunities to improve it but nevertheless it’s the remedy that’s harming students.” Remedial math courses at CUNY are the primary contributing factor to CUNY community college students dropping out of college. If the purpose of a remedial math course has been to give students foundational mathematical knowledge that they must know to succeed in their future Major courses, and to ensure students’ well-rounded education and engaged citizenry, the remedial course itself has fallen seriously short of serving any of these purposes. It is a relic of the past, a math tradition, and a stumbling block for students that math departments have held onto tightly, because this is how it has been done. We have lost sight of the purpose of remedial courses and they have instead become a holding place for students who need the greatest academic and psychological boost.

According to Watanabe-Rose, remedial policy changes will likely happen soon in one or two areas. Due to the testing company, ACT’s, phase out of the current CUNY math assessment test, the Compass, in November 2016, CUNY will need to - and fortunately has the opportunity to - rethink its course placement of incoming students. (Watanabe-Rose, 2016) Effective for the Spring 2017 starting college cohort, the Accuplacer will serve as the available placement test, and the University is working to incorporate multiple measures instead of just the traditional single test score measure into determining students’ course placements. These measures may include Accuplacer scores, SAT scores, Regents scores, and/or GPA. The goal is to determine which of students’ academic record components best predict their likelihood to succeed or the extent to which they will succeed in a given remedial or college level math course. It is a difficult question to answer. For example, GPA cannot be used or weighted equally across different high schools because a given GPA can mean very different things depending on the rigor and grading scale of the school. Thus, the predictive power of grades varies widely. While it is promising that these CUNY-wide reforms are in the works, CUNY leadership needs to be forceful in

continuing to push comprehensive reform. This chapter will evaluate three angles to remedial math reform: 1) what math competencies, content knowledge, and skills should community college students be required to have and demonstrate mastery of, 2) how should we assess these skills, both at college entry and at remedial exit point(s), and 3) how should delivery the necessary mathematics, both in terms of remediation structure and in terms of pedagogy and approaches to teaching. Further, how do we achieve all of this while ensuring that student learning outcomes, degree progress and persistence, and degree attainment are at the forefront of institutional priorities?

1. What are the fundamental math content, skills, and competencies that community college students *should be* required to master?

The short and complicated answer is that it depends on a student's major and degree requirements. Individual colleges and academic departments within the college need to ask what quantitative skills an English Major, or Psychology Major, or Biology Major needs at graduation, and then work backwards to evaluate how best to support students in achieving such learning objectives. In other words, these policy decisions should not be made by either the CUNY Central Office for the entirety of the community college system, or by a college's Math Department on a given campus. As G. Michael Guy pointed out, each college and major has a general education quantitative requirement that is not determined by the Math Department. "If a student can be successful in that course, and meet the standards that are defined in that course, through whatever background gets them there, we should celebrate and acknowledge that success," Guy argued. Guy's view is that if a student can take their degree-required quantitative course and be successful in it – through any means – that is what ultimately matters. An associate degree typically requires the student to earn 60 credits, and none of these credits are remedial "credits," of course, because remedial courses carry no credit. Thus, if a student can earn that degree without those zero credit courses, the degree still stands as legitimate, full, and valuable as it otherwise would.

There is a need for a paradigm shift, both he and Cuellar indicated, that views student learning and progress with an eye and a push towards success and achievement rather than failure and obstacle.

And this shift needs to happen not just within the remedial structures that currently exist, but importantly, outside of them, so that we can create the structures that will support the learning and success of our students. What math competencies are actually useful for a student's future? Algebra has become a controversial word but algebra and algebraic thinking is not necessarily the problem. It is rather the way in which we teach it, and the way in which we expect students to regurgitate without meaning or context. When we think about what school has given us, the skills we have acquired are almost universally more important and useful than the content itself. We tend to forget the content; what remains years later is how to apply the problem solving skills to new situations and scenarios. That is the purpose of education after all – to expand our brains and our thinking capacity, to enable us to understand more and solve more.

Cuellar, too, defended algebra and addressed the misconception that "algebra" as a mathematical area is the problem. She believes that you need to know the algebra because "it's kind of like a civic right. You need to know this because everybody should be able to learn this. It's nothing that is rocket science." Cuellar did not argue that students need every topic, but did contend that students should know the basics: what a variable is, what inequalities are, and how to think abstractly in the ways that learning basic algebra requires. And it is true, that for the students who place into the lowest level of remedial math on the Compass exam, Guy pointed out, it may appear that they are entering college without the very basics of math. But these same students have all had experience with this math in prior schooling. They have seen this arithmetic material before, and in order to make it to college, have demonstrated some sort of minimal proficiency in it that they were not also able to demonstrate on the Compass entrance exam.

Cuellar and Guy agreed that some degree of elementary algebra content and skills are important for students to understand to continue in a STEM track major and to take and succeed in courses like college algebra and pre-calculus. And both also felt that students do not need all of what CUNY has defined as the elementary algebra course content to be successful in a subsequent quantitative reasoning or statistics course. As mathematics scholars who have earned doctorates in math and dedicated their professional lives to math research and teaching, both professors were careful not to

denigrate the value of a math education. Rather, they saw that the dismal assessment results – both at the college entry and remedial exit points – do not reflect the learning or the potential of our students. Guy, Cuellar, and Funk all have greater confidence in their students' ability to do and learn math than do the one-time high stakes testing tools we have used to asses them, and the instructors have witnessed the student learning and achievement in their own classrooms that bears out their confidence. The powerful outcomes of the alternative pathways and reforms at CUNY have thus far provided further evidence that our status quo remedial math system is not reflective of what is possible for students' learning and professors' teaching.

"When we [Guy, Jonathan Cornick, and Karan Puri] do our experiments and we use our methods in teaching students, the success rates are far higher than the other sections, so, I believe there is an opportunity to improve our students within elementary algebra," Guy explained, "I just don't think they should all have to." What both Guy and Cuellar, and the several other CUNY Math and non-Math faculty and administrators, and I, are making an informed plea for is, above all, a flexibility in thinking and an openness to ask questions. Such questions do not have a single right answer, but the hardline system that has been in force to date has not served students in any positive way, and so we see that that is, indeed, a wrong answer. A central tenet of academia and higher education is to keep asking questions and to make advances, and push one another's thinking. Guy, Cuellar, and math remedial outcome data have thus far shown that it's in the students' best interest to keep asking the hard questions. According to Guy, the argument between CUNY camps over the need for full elementary algebra is "really religious… I think the argument's almost always "I believe.."" Still, Guy went on to affirm that the evidence lies primarily with the "pro-alternative" side in that a mountain of evidence – both at CUNY and nationally – has shown that students have been successful without the pre-requisite elementary algebra package some so vehemently defend.

2. How *should* CUNY assess content or skill levels – at college entry and post remedial intervention?

As I have noted, CUNY is moving to the Accuplacer exam as the universal first-year entry assessment test effective in the Spring 2017 semester. According to Watanabe-Rose, CUNY is in the process of piloting the Accuplacer exam and will evaluate these placement outcomes against the Compass placement results. Cuellar mentioned that this test would be more appropriate for the four year colleges because of the higher-level topics tested, but is unsure how it will work with community colleges.

The thoughtful development and implementation of the CEAFE – and the accompanying relaxation of some of its stringent guidelines since 2012 – has been a major step in the right direction for CUNY and its students with remedial math needs. One of the current debates around the CEAFE as of early 2016 is to what extent CEAFE exceptions or waivers should be granted for remedial alternatives. In part, this debate centers back on the algebra-only versus alternative math pathways camps, or "religions." As Guy pointed out, it is not that faculty and administrators want to allow CEAFE exceptions because students are not passing the CEAFE in high numbers – or because they fear students will have low pass rates, nor is it that Cuellar and her colleagues want to avoid the CEAFE to ensure students have an easier time passing the course. It is rather a question of whether this assessment makes sense for evaluating the student learning objectives associated with the remedial alternatives in question.

While Milena Cuellar believes that CUNY graduates need algebra thinking and skills, she is not convinced that an exit exam like the CEAFE is the appropriate tool to assess these skills, nor that any high stakes test should be a central determining factor for student progress toward degree. Watanabe-Rose also mentioned that very few other colleges or universities across the country have developed or implemented remediation exit exams comparable to the CEAFE, and so it has been difficult for CUNY to assess the validity or effectiveness of this test. As I have argued, CUNY should continue to examine the entry math placement standards and measure students' math proficiencies via multiple metrics. Not only will this sweeping reform more accurately place students according to skill level, it will more appropriately account for students' ability to succeed in future courses. Similarly, CUNY should continue to examine the CEAFE as the exit test and consider closely if a) the weight the test is given in determining students' exit from remediation is necessary; and b) if the CEAFE's use is necessarily universal across the community colleges, or better suited as a learning metric for traditional elementary algebra courses.

3. How *should* CUNY institutions deliver the math content and skills we deem necessary for major courses and graduation?

A. Remedial Math Intervention Structure

At present, the majority of incoming CUNY community college students take the CUNY Assessment Test and then learn they have failed one or both of math portions (and possibly the reading or writing portions as well). In other words, CUNY has assessed these students with a "projected poor prognosis" of passing a college level mathematics course, and up until this point, the only real "remedy" offered is a separate remedial course. (Guy, 2016) This type of response is normal and natural for academics, who think in terms of courses and semesters because of the traditional structure of higher education institutions. And yet, as we have seen – both at CUNY and nationally – colleges, states, foundations, and independent pedagogical institutes like Carnegie and the Dana Center have begun to see evidence demonstrating that a traditional course is not the only or even the best way to conceptualize and implement a remedial math "remedy." Other options that have demonstrated some success are a co-requisite workshop or course, supplemental course tutoring, and supplemental growth mindset and productive persistence curriculum.

What we have seen is that students who cannot pass out of elementary algebra return to it for semester after semester until they can longer bear it and drop out of college altogether. If they are luckier, they drop out before having sunk hours, semesters, years and financial aid or tuition into their college education but if they are less fortunate, they do not encounter the remedial math wall until they have neared the end of their associate's degree requirements. Is this is a fair system? Does it align with the mission of CUNY and its community colleges? The fact that students in this kind of situation have persisted and succeeded in every other academic requirement but remedial math should speak volumes, not just about students' math deficiencies, but rather about the deficiencies of a system that allows for such a scenario.

In response to the evidence that a pre-requisite isolated remedial math course has not been effective in supporting student retention or academic success CUNY-wide, CUNY's Office of Academic

Affairs has been exploring remedial structure reforms that include: accelerated and alternative pathways, differentiated pathways, mainstreaming, and co-requisite remediation. In the area of alternative (or differentiated) pathways, along with Carnegie's Statway model and LaGuardia's thus-far successful adaptation, implementation, and expansion of the course, both Cuellar and Watanabe-Rose discussed the Dana Center's New Mathways Project (NMP). With NMP, there are three possible pathways for students, depending on a student's major and career goals. The three general pathways are for STEM majors, students with pathways requiring a statistics focus, and students who require general quantitative reasoning. These pathways are applicable even if a student does not have remedial needs, but if they do have remedial needs, they go through a remedial semester in their given pathway, rather than the traditional elementary algebra is generally disconnected from or not meaningfully connected to a student's college and career goals. Additionally, NMP was developed to be scalable for implementation at colleges around the country, and indeed, more and more institutions have been utilizing the curriculum as an integral piece of their own remediation reform efforts. To be scalable, the Project and its materials include the structure, sequence, pedagogy and curricular parts of implementation, and also the managerial and policy piece regarding faculty buy-in and institutional change.

The next promising model is called mainstreaming, or co-requisite remediation. In 2013, Mari Watanabe-Rose, with then Executive Vice Chancellor Alexandra Logue, ran a research study with students LaGuardia Community College, Hostos Community College, and Borough of Manhattan Community College, where students with elementary algebra remedial placements were randomly assigned into one of three conditions: 1) the control group, elementary algebra, 2) elementary algebra with an accompanying 2-hour weekly academic support workshop, or 3) the mainstreaming condition, college level introductory statistics with an accompanying 2-hour weekly academic support workshop. The findings were that 37% of the control group passed elementary algebra; 45% of the second group, who had the additional workshop, passed; and 56% of students in the mainstream group passed the course. In some ways, these results mimic the outcomes that LaGuardia has found with Statway, where it appears that incoming students with remedial algebra placements will do better – on average – when placed directly into a statistics course rather than directly into a remedial algebra course. The critique, of

course, is again that the results would possibly be far weaker if a study were to compare remedial algebra outcomes with college level algebra outcomes, instead of remedial algebra with college level statistics. And thus, this kind of mainstreaming could not work for STEM majors. Nevertheless, for those students whose degrees never require college level algebra, it may be a moot point.

Watanabe-Rose has continued to track these students and ask: How fast does the mainstreaming group (compared to the control groups) move through college? How many more credits do they accumulate? In the two years since the study began, the mainstreamed statistics students have accumulated more college credits and much closer to graduation, and retention rate between the groups has stayed relatively the same. Likely the most important outcome of the study thus far is that one year after the completion of the experiment, 57% of the mainstreamed group had completed a college level quantitative course, and only 17% of the elementary algebra students had completed a college level quantitative course. These results indicate that mainstreaming works and can be a very effective solution for students with remedial algebra placements who are non-STEM majors. As in the Statway model, the problems also remain that first, what kind of remedial math reform is needed for algebra and STEM major math sequences, and second, what if students go through mainstreaming or a differentiated statistics-based algebra and then change their major to a STEM-field? Further, there is some evidence to show that students like math more after Statway or Statistics, and therefore might actually be more likely to switch into a quantitative field than they would have been previously. There is an assumption, of course, by many math faculty members, that it would be absurd to run a similar experiment with the variable group being mainstreamed into college level algebra instead of college level statistics. How could students possibly go straight into a credit-bearing course for a subject in which they had just tested at remedial levels? And there is a fear, perhaps, that if those students can be more successful without the remedial class, then why have we been wasting student, faculty, and institutional resources? Based on conversations with Cuellar and Watanabe-Rose, neither of whom is entirely convinced that students need a full semester of remedial algebra before taking a credit algebra course, it seems worth an experiment.

B. Pedagogy and Approaches to Teaching

As part of Guy and his QCC colleagues' work to reform remedial math at their college, they also wrote an open source textbook that emphasizes innovative pedagogy, including new and meaningful, real-life based approaches to teaching math. Part of Guy's point is one that Milena Cuellar expressed as well – that students need to know how to be students, and that the need for academic success skills can perhaps be seen most clearly in math because the content area is one that students have such bad educational experiences in and fear learning the most. The Statway model implemented at LaGuardia is designed with this need in mind, and there are several other remedies that holistically support student success. The State University of New York (SUNY) has also recognized the value of and successes in implementing Carnegie's Statway model and has begun running the program at all of its community colleges.

As we know, doctoral degrees do not require pedagogy or teacher training courses, nor do colleges or universities train their faculty or adjuncts how to teach effectively. But it is evident from recent national research and the results of professional development at LaGuardia that an investment in instructor support and pedagogical training is critical to successful delivery of remedial math content and skills and thus is critical to attaining strong student learning outcomes. In the recent research published by faculty from Washington State University and Carleton College – through faculty professional development and iterative teaching and student learning assessments and processes at their colleges – researchers found that even for instructors who were unwilling participants in teaching improvement, they improved at teaching over time. (Flaherty, 2016) Guy noted that most full- and part-time faculty want to be effective instructors in remedial math topics and otherwise but have never had the training or support to aid them in their classroom teaching strategies. Further, Guy pointed to the particular difficulty in teaching students with remedial math needs. Not only do instructors need to learn how to teach topics in more meaningful contexts, with more explicit and dissected methods, and to reach learners who may take longer and have less academic background to aid them in learning concepts, but they also need to correct years of prior wrong math learning that students have accumulated. Community college students are not learning arithmetic or algebra topics for the first time, but as evidenced in their remedial course placement, the vast majority have learned these topics either weakly, or worse, with understandings that

are faulty and misinformed. It is a very difficult task for any instructor or content specialist to successfully address such misconceptions and to help students unlearn something wrong, without any instruction in how to do so. Without an awareness of what is different about one's students and their particular math experiences and barriers, an instructor is missing an important angle on how to best instruct his or her students.

Guy discussed that one of the pedagogical strategies he has discovered in his reading and research and implemented successfully in his remedial math courses is to teach students something new with each topic. In other words, he brings a new method or approach to a problem that both illuminates a mathematically meaningful truth about a problem, and provides students with an opportunity to learn something disconnected from any prior false knowledge they bring with them. As an example, the textbook Guy and his colleagues wrote teaches equations by considering them as a balance where two sides require equal weight. Often, students are told to do the same thing to one side as you do to the other, but without understanding why or what those mathematical decisions really need.

The CUNY Central Office is uniquely positioned to play a pivotal and powerful in role in developing a professional development program that reaches across the campuses by taking advantage of the math teaching experts already leading in this area at their campuses. To address the need for pedagogical training at its root, with the doctoral students who often begin teaching at CUNY colleges early in their degrees without any support or training, the CUNY Graduate Center founded, in 2015, its own Teaching and Learning Center (TLC). Particularly as the University moves forward with supporting campuses in implementing or expanding alternative pathways and content, it is absolutely critical that the time and financial investment necessary to train and develop faculty in the particular classroom practices integral to the success of said reforms is made. Ideally, math instructors would be financially compensated for attending such professional development opportunities and in other ways incentivized to do so. The new TLC at the Graduate Center is already charged with connecting and networking out to the CUNY colleges' Teaching Centers, and it would be timely for the Center to make developmental math teaching a priority strand.

Still, a shift in remedial math learning and success opportunities for community college students across CUNY colleges requires that all of the colleges experience a culture change. LaGuardia is ahead of the curve in this shift, with President Mellow's priority centering on her local and national campaign around Teaching Matters. Other colleges, however, have a way to go. In the world of academia and in faculty circles across American higher education, research is – and has historically been – king. Tenure opportunities have become far less common, and the few available tenure around faculty's published research. So even while research shows the importance in teaching, and the particular need for this emphasis at community colleges, research is prioritized. Some math departments at CUNY community college still view their role as solely or primarily to produce research. "Right now, if you [as a professor] care about teaching, you're almost considered a loser," said Watanabe-Rose. Teaching can be viewed as light, subjective, or self-explanatory. Not the serious work of PhDs. CUNY needs to create or expand on hiring and tenure incentive structures that reward teaching practice at least as highly as research in order to show substantive support for the leadership and faculty who are investing in better pedagogy, as well as to create a University-wide culture that values teaching.

Conclusion

At the writing of this thesis, many remedial math reform pilots are in various stages of implementation across CUNY's campuses, with some colleges – like LaGuardia – ahead of the curve, and others resistant to any kind of change. LaGuardia's Statway, for example, was initially a pilot but has now been approved as an official course offering. The role of the central office has been and should continue to be to relax the limits and increase the incentives for colleges to offer alternative pathways for their remedial math need students. The alternative pathways are working. Nearly three quarters of undergraduates across CUNY are non-STEM majors, and at present, all of them are required to pass elementary algebra. This is not a useful or helpful requirement for their college careers. Indeed, this requirement diminishes degree attainment. Further, changing placement procedures will work toward better student outcomes by using more than one measure to more accurately place students into initial math coursework. But it is not the subject matter alone that makes remedial math the nearly impenetrable

wall that it has become. As Watanabe-Rose points out, algebra is not rocket science. The same students who enter CUNY's community colleges without the demonstrated algebra competencies we expect to them to have, have seen and taken and maybe learned some of algebra in middle school, high school, and/or in preparing for the high school equivalency exam. Further, we know from growth mindset literature that students' neural connections and capacity grow and expand as they struggle with difficult material and their belief that they can learn will enable them to learn. Community college students are capable of learning algebraic content, concepts, and skills. But there is something about the way our elementary algebra is taught, or not taught, and accompanying disconnect between these difficult concepts and the meaning they have in students' lives or future career worlds that, naturally, creates a significant obstacle in their learning. There is a confluence of negative factors that work together to decrease students' chances at success: the disconnected and decontextualized pedagogy and content, the naming of it as a remedial pre-college course, the proliferation of fixed mindsets around math. Solutions that only tackle one part of the problem, for example, addressing content by removing some elementary algebra topics and centering the curriculum on meaningful statistics and quantitative analyses, will only go so far if professional development around teaching methods and approaches do not accompany the curricular change.

Another issue that comes to bear is how to communicate best practices in remedial math reform. Not only will communication minimize the need for reinventing the wheel or starting from scratch with innovations, but it will also help build momentum around a common reform agenda. It is safe to assume that most math faculty are aware of the reform debate around remedial math, but it is less clear that they are aware of all that is going on right here at CUNY. This communication problem may seem straightforward to address, but it is not. Having worked at CUNY in both the central office and at LaGuardia, as well as been a graduate student at CUNY, throughout the past five years, I have learned that getting critical information to all of the important actors in the CUNY system can seem like a losing battle. The production of new programs and initiatives, new rules and policies, new procedures and logistics is constant, as is the change in staff and faculty and students, many of whom are part-time and less immersed in the system. And so, as difficult as it is to keep track of all these moving pieces in the

stream of communication, it is all the more important to work to do so. These efforts might be best captured on the CUNY Math Blog, if a single staff member were tasked with documentation and updating of 'Developmental Math at CUNY' section, complete with information on all pilots, outcomes data, and subcategories that look at reform in assessment, content, and delivery (much like this thesis) at CUNY to date.

One of the toughest parts to institutional reform is changing the key hold-outs, many of whom hold positions of power. As Watanabe-Rose put it, "There are roughly two kinds of beliefs, right, 'Everyone needs algebra,' 'Not everyone needs algebra." Many of the Math Department Chairs throughout CUNY are in the former camp. And yet, there is hope. In November of 2015, the majority of the 20 math chairs were against eliminating elementary algebra, and since that point – as more and more evidence of alternative pathway success has come to bear – that ratio has started to shift. And perhaps the point is that it does not have to be a 'for/against' paradigm, but instead a topic-by-topic examination of what algebra is necessary for college and for life. According to Watanabe-Rose, the evidence for dismantling the current elementary algebra requirement is in place, but the challenge remains of how and when to package the evidence in a way that invites those in power – Board Members and Math Chairs, for example – to join the reform agenda.

"We have this mission as a CUNY community that – OK, here's a student, he or she is working hard for his or her degree but why do we put these blocks in front of them?" asked Watanabe-Rose. This is the question we need to interrogate deeply and without regard to academic tradition or biases. The recent and major publicity in *The New York Times*, on NPR, in *The Washington Post*, and more around the algebra obstacle, has been supporting this interrogation effort and aiding CUNY in its transition to more sensible remedial math policy and reform. Additionally, the evidence and the response to the evidence is building nationwide, with different college systems and states across the country trying to new reform efforts.

Beyond reform recommendations, there are several avenues for further research:

1) The issue of what to do for, or how to now quantitatively short change, STEM majors has been a theme central to the push back around remedial math reforms at CUNY, but it is still

unclear how many STEM majors would be impacted negatively by any of these reforms. In other words, how many students placed into remedial math are STEM majors, and of those students, how many actually pass remedial math and math into the required quantitative STEM courses? And if the rates of both are abysmal, how can we make wise policy decisions around a group that is not succeeding. Relatedly, what is the rate of STEM students with remedial needs switching to non-STEM majors, and the rate of students in alternative pathways switching into STEM? If there are indeed many alternative pathways students switching into STEM, that trend would tell us something positive about the relationship between these quantitative classes. The next wave of advocacy should be over how to push the same alternative pathways to be applicable for non-STEM and STEM majors so the menu of course and major options throughout the CUNY system can simplify rather than proliferate. To do this, we need to sharpen our understanding of the math topics STEM majors do and do not need for their future careers.

2) We need to build our body of quantitative research around what is happening with students who exit both remedial math and the alternative pathways. Leaving can mean withdrawing, failing, or re-enrolling. We should survey these students more broadly to better understand similarities or differences between traditional and alternative pathways in response to questions such as: What caused your exit from the course? How did you feel about math at the beginning of the course? And at your exit point? What was effective in supporting your learning in the class and outside of it? What was not effective in supporting your learning in the class and outside of it? Collecting data from students on these issues will help to shed more light on what happens inside of the classroom and how we can shape our reforms.
3) Finally, given that remedial placement is the first time our students interact with remedial math and the first point at which we assess our incoming students' math needs, and given that this is current big frontier for change CUNY-wide, we need to better understand how to place students appropriately. Further, in addition to placement criteria and measurements, it will be critical to research further what each placement measurement or score should mean

in terms of students' best remedial math pathway. How do these align with students' prospective majors, and to what extent can we count on majors to remain unchanged?

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