Volume 3, Issue 1

The Lighthouse Almanac

A peer-reviewed journal published by the Benjamin Banneker Association, Inc.

Critical Issues in the Mathematics Education of Black Children

About *The Lighthouse Almanac*

… "In an era when books of any kind were a luxury found in a few households, almanacs were common. They included scientific information, such as weather forecasts, tide tables, lunar and solar eclipses, and the times of the rising and setting of the sun and moon; they were also infused with mild poems, proverbs, and bits of general information.

What made Banneker's *Almanacs* innovative – aside from the fact that they were produced by a black man in an age when African Americans were considered incapable of scientific, mathematical or literary accomplishment – was the inclusion of commentaries, literature, and fillers that had a political and humanitarian purpose."

(excerpt from PBS' "Africans in America: Benjamin Banneker's *Almanac*" https://www.pbs.org/wgbh/aia/part2/2h68.html)

Following the tradition of Benjamin Banneker's *Almanacs*, this peer-reviewed journal from the Benjamin Banneker Association, Inc, (BBA) is an inclusive periodical written for and by PK-12 educators and administrators, college/university faculty, community leaders and organizers, parents, and anyone invested in the teaching and learning of mathematics for all children, particularly Black children/children of African ancestry.

The Lighthouse Almanac is a journal that is a compendium of knowledge from the lived experiences of those committed to helping children thrive as learners of mathematics.

Through *The Lighthouse Almanac,* BBA demonstrates our long-standing dedication to advocating for equity and access, as we chronicle the research, practices, and collective actions of many individuals committed to this purpose.

We anticipate you will find *The Lighthouse Almanac* to be a valuable resource for guiding your efforts and hope you will consider sharing your experiences with us in an upcoming edition.

~ Brian Lawler and Brea Ratliff

Brian Lawler
Editor-in-Chief

Brea Ratliff
Founder of *The Lighthouse Almanac*
Executive Editor
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Purpose and Goals of the Association

The purpose of The Benjamin Banneker Association, Inc. are the advancement, stimulation, extension, improvement, and coordination of the learning and teaching of mathematics for *all* students at *all* levels, with special emphasis on students of African ancestry.

The goals of the Association shall be

(a) to serve as advocate for the educational and professional needs of its members,
(b) to serve as advocate for the educational and developmental needs of students of African ancestry, and
(c) to provide educational solutions and policy alternatives to the educational issues which affect the participation and success of students of African ancestry in mathematics learning.

In executing these goals, The Benjamin Banneker Association shall promote and provide opportunities for networking among individuals, institutions, groups, and agencies operating for the betterment of the educational systems of these United States and Territories and promote and provide opportunities for students of African Ancestry to participate and excel in mathematics learning.

Toward this end The Benjamin Banneker Association shall do the following:

- Serve as a resource for The Benjamin Banneker Association membership,
- Develop programs and activities that encourage and support scholarly and professional activities of The Benjamin Banneker Association membership,
- Develop programs and activities that encourage and support participation and excellence in mathematics learning among students of African Ancestry
- Disseminate educational information to The Benjamin Banneker Association membership,
- Identify fiscal and material resources that support The Association's programs and activities and Collaborate with other interest groups when purposeful in seeking the goals of The Association.

Limited Access to Physical and Intellectual Resources and the Perpetuation of Informal Segregation in Mathematics Education in NYC Public Schools: Six Case Studies[1]

Laurel Cooley
Sarah Hannaford-Simpson
Rushna Shahid

In recent years, the National Center for Education Statistics documented that U.S. public schools were majority non-white students (2018a, 2018b). For decades, New York City (NYC) public school demographics have been ahead of these national trends (Kucsera & Orfield, 2014), while NYC private schools are often over 90% White.[2] Home to the largest school district in the country, most of NYC's public schools are high-needs (for definition, see United States Department of Education [USDOE], 2014), serving mainly low-income students of color and ethnic minorities. In 2012, the New York Times reported that half of NYC's 1600-plus public schools were over 90 percent Black and Latinx, and among the most segregated in the country (Fessenden, 2012). Segregated public schools provide a landscape in which policies and resource distribution can have comparatively stronger effects on non-dominant populations, producing under-resourced schools that fail to provide necessary educational opportunities.

In this paper, we present data from six of these typical NYC schools serving a majority of Black and Latinx students, describe systems that track students into these schools, and illustrate the lack of physical and intellectual resources that affects mathematics teaching and learning. The focus on schools that serve both Black and Latinx students is not indicative of an assumption that Black and Latinx students are the same, or that any student is less than unique. In the NYC public school system, however, Black and Latinx students are routed similarly by systemic structures and ultimately share their educational experiences with respect to teacher quality, school resources, coursework offered, support services, etc.

We report on a one-year qualitative examination, drawn from a larger 10-year study. This paper provides a contextual understanding of NYC's high-needs schools and is part of a group of qualitative research papers focused on mathematics teachers trained through the NYC Teaching Fellows, a fast-track selective alternative route program (Cooley, 2019; Cooley et al., 2019, under review). Qualitative case study research methods are employed to examine the following research question:

> *What are some of the structural obstacles present in NYC's public-school system that help to perpetuate informal segregation and impact mathematics instruction and learning opportunities for Black and Latinx students?*

This research question explores the nature of segregated schools in NYC, structures that track Black and Latinx students into under-resourced schools, the type of mathematics teachers serving these students, the mathematics courses offered, and the resources these schools provide or fail to provide. We begin below by presenting the nature of the informal segregation in NYC public schools and some of the structures that keep the segregation in place.

The NYC Context – Segregation Systems in Place

In part to address public school racial segregation, NYC implemented a new process in 2003 by which students could apply to attend up to one dozen high schools. Despite these efforts, high schools remain stubbornly segregated. Those admitted to the most-sought-after schools remained disproportionately upper- and middle-class, White and Asian. Figure 1 illustrates the geographic segregation of NYC's public high schools.

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[1] This research has been partially supported by National Science Foundation awards 0333753, 1535219 and 1535251.
[2] Numbers reflect reported statistics; private schools are not required to report student demographics.

Note that the dark blue zones represent areas in which the high schools have 91–100% Black and Latinx students. These percentages lessen slightly with the lighter shades of blue and light green and the lightest colors represent areas in which schools have a majority of White and Asian students.

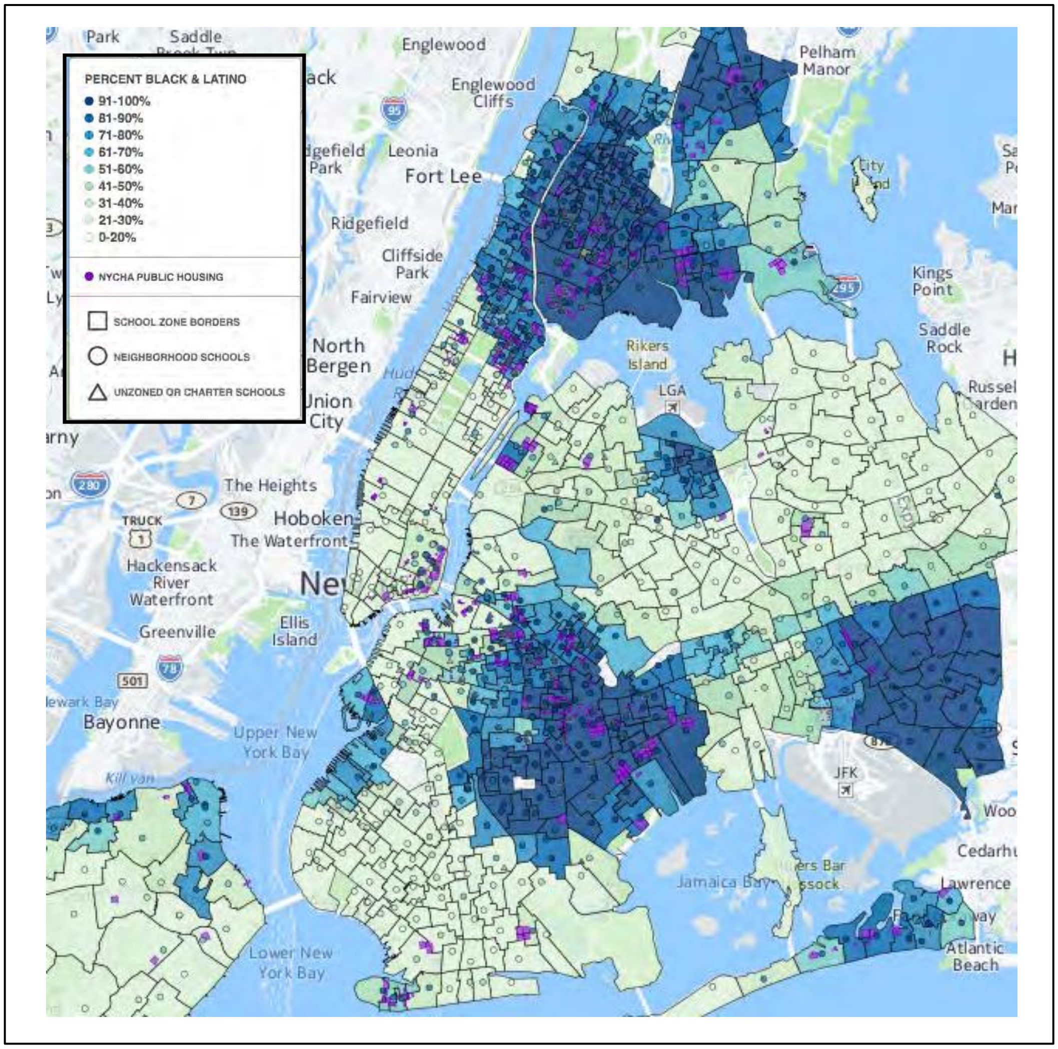

Figure 1: Racial makeup of NYC high school students by school zones.[3]

This persistent segregation is largely because middle schools offering advanced programs provide strong advantages in the high school application process. NYC middle schools in which high percentages of students complete advanced coursework are significantly more likely to serve primarily non-minority and high-income students (Subramanian et al., 2016).

Acceptance into these prestigious middle schools depends on test scores and success in elementary school. This stratifying process begins early; students may be tested for gifted and talented programs for kindergarten. However, only 25 percent of those that apply qualify with the majority from areas serving mostly upper- and middle-class White and Asian students (Wheaton, 2015). Further, while a universal pre-kindergarten program recently instituted in NYC is diverse in its total population, in one-sixth of preschool classrooms more than 90 percent of the first-year students come from the same racial or ethnic group (Potter, 2016). Figure 2 shows the concentration of minority youth in NYC public elementary schools, reflecting a predictive pattern of the high school segregation indicated in Figure 1.

[3] Adapted from Hemphill et al. (2016).

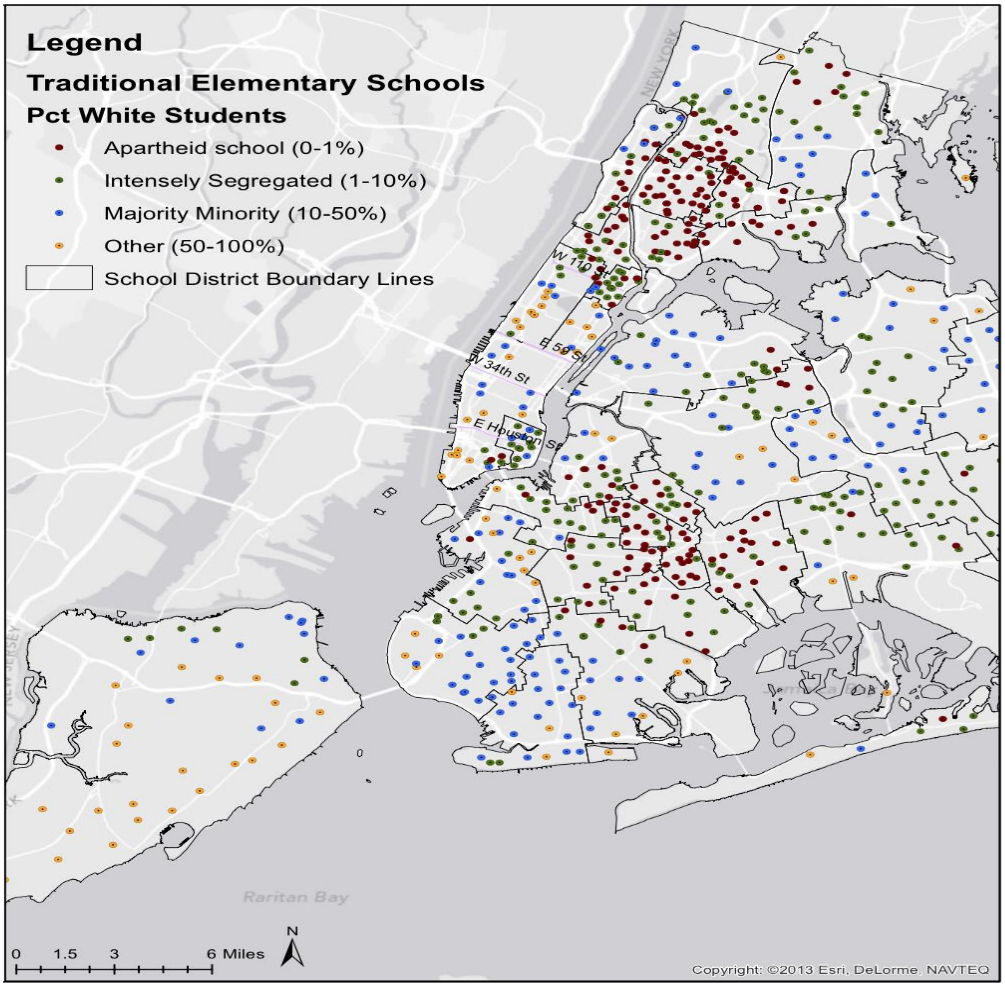

Figure 2: Minority concentration of traditional elementary schools in NYC, 2010–2011.[4]

Note that the dark brown and green regions in Figure 2 represent highly segregated schools in the same geographic areas as Figure 1. Hence, it is no exaggeration to say that students, predominantly Black and Latinx, tracked into segregated, under-resourced schools in kindergarten, are set on a path to segregated, under-resourced middle and high schools.

Such stratification can have particularly strong effects on non-dominant populations in access to mathematics opportunities. In New York State (NYS), 69 percent of middle schools offer Algebra I, an important benchmark on the path to completing calculus in high school (Sadler & Sonnert, 2018). However, as Figure 3 shows, Black and Latinx students are three to four times more likely to attend a middle school that does not offer algebra (New York Equity Coalition, 2018). Sixty-eight percent of NYS high schools offer some form of calculus. However, Black and Latinx students are five to seven times more likely to attend a school without calculus. Black and Latinx students are also two to three times more likely to attend high schools that offer no mathematics or science Advanced Placement (AP) or International Baccalaureate (IB) classes at all.[5]

In 2014, just 18 percent of students starting NYC public high schools four years earlier earned Advanced Regents diplomas, considered the college-preparatory diploma. This is in large part because 39 percent of NYC's high schools do not even offer a standard college-prep mathematics curriculum. More than half do not offer any AP mathematics (Hemphill et al., 2015).

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4 Adapted from Kucsera and Orfield (2014).

5 AP and IB are programs by which students may earn college credits in some high schools, if the programs are offered.

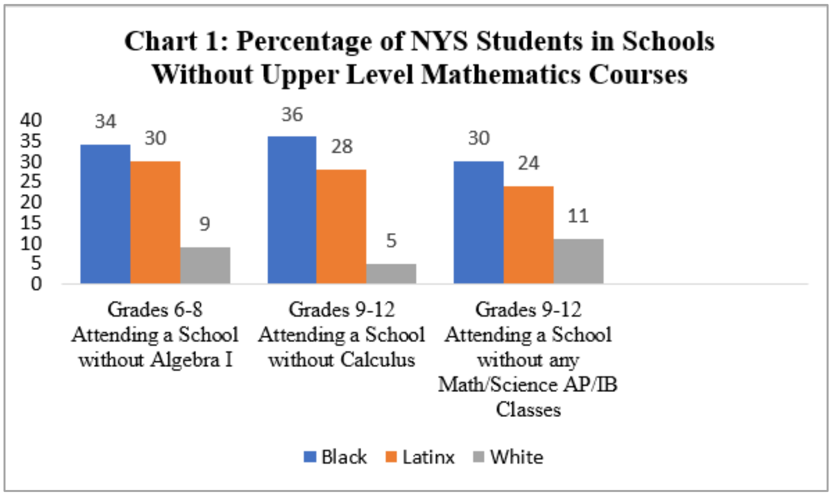

Figure 3: Percentage of NYS students in schools without upper level mathematics courses.

A consequence of limiting college-preparation mathematics courses to only some schools is that many Black and Latinx students are effectively "low-tracked" automatically by the school they attend. As a result of these and other institutional obstacles, Black and Latinx students currently remain as segregated by high school as they are in elementary school. Indeed, as explained by the New York Equity Coalition (2018),

> If Latino and Black students had access to these important classes at the same rate as all students in the schools with the greatest access across New York State, the additional number of course completions for Latino and Black students would be 34,126 in Algebra I in middle school, 29,570 in Calculus, 61,386 in Physics, and 143,542 in all AP and IB classes. (p. 3)

Thus, tracking by school becomes an institutionalized way of stratifying opportunity to learn mathematics. In NYC, this stratification is predominantly along racial lines, paving the way for the reproduction of inequality and segregation.

Methods

To design the study, collect data, and analyze the dataset, we employed qualitative, case study research methods (Merriam, 1998; Stake, 1995). The data set, teacher selection for this case study, and methods of analysis are described next.

The Data Set

The data analyzed are drawn from a larger data set; from 2006–08, members of the original research team visited the schools of nine mathematics teachers enrolled in the NYC Teaching Fellows (NYCTF) program. These teachers were being licensed for secondary mathematics and in their first or second year of teaching. In this paper, we highlight the school year 2006–07 and the schools in which the mathematics teaching fellows began their careers, with the exception of one, who was already in his second school.

In the original project, the research team visited each school to observe and videotape a mathematics class 15–20 times. They collected extensive discursive data in the form of reflections and interviews, with the teachers appraising school characteristics and how these affected their mathematics classrooms and instruction. The teachers' discursive data came from: (1) two in-depth audio-recorded semi-structured interviews conducted at the beginning and after the first year of classroom observations (2006 and 2007), (2) an in-depth semi-structured oral history interview (McMahan & Rogers, 1994) conducted in 2015–17, and (3) 15–20 audio-recorded and written post-observation reflections and follow-up interviews collected 2006–08.

To provide school site context for the teacher data, we drew upon school descriptions in the researchers' field notes; an audio-recorded semi-structured interview with each site mathematics coach or department chairperson; and the School Report Cards published annually by the NYCDOE which provided information about student performance, demographics, teacher backgrounds, and other measures.

The NYCTF (2010) program, a fast-track, selective alternative route program (SARP), was implemented in 2000 to address "the most severe teacher shortage in NY's public-school system in decades" (p. 1). The shortage pertained to certified teachers; large districts like NYC had relied on uncertified teachers for years in hard-to-staff subjects like mathematics. NYCTF was designed to replace large numbers of uncertified teachers with alternatively certified teachers in high-needs schools. Indeed, since 2000, upwards of 25,000 SARP teachers have entered the NYC public school system, including *more than 70 percent* of all new secondary mathematics teachers (NYCTF, 2014; TFA, 2018).

Case Study Selection

Data collection began in nine distinct schools located in four of NYC's boroughs (Staten Island was not included) with nine collaborating NYCTF mathematics teachers. Although the original research focus was on the teachers, we quickly realized that the different schools provided a unique opportunity to examine the context in which NYCTF teachers generally began teaching mathematics. To understand this better, we expanded the data collection to include school data, as described previously.

Six of the nine schools, two high schools and four middle schools, closely reflected the demographic imbalances that are typical of NYC's segregated public schools. Therefore, in order to study effects of informal segregation on mathematics instruction and learning opportunities for Black and Latinx students in particular, we chose these six schools as case studies for this paper. Figure 4 shows the demographics of each school using the collaborating NYCTF math teacher's name[6] as compared to the average demographics of all NYC public middle and high schools in 2005–2006. Although the data collection began in 2006, NYCDOE stopped publishing the comparison to all NYC high schools and middle schools after 2005–2006, along with other school data. While the percentages may have been slightly different, we do not expect large changes from one year to the next.

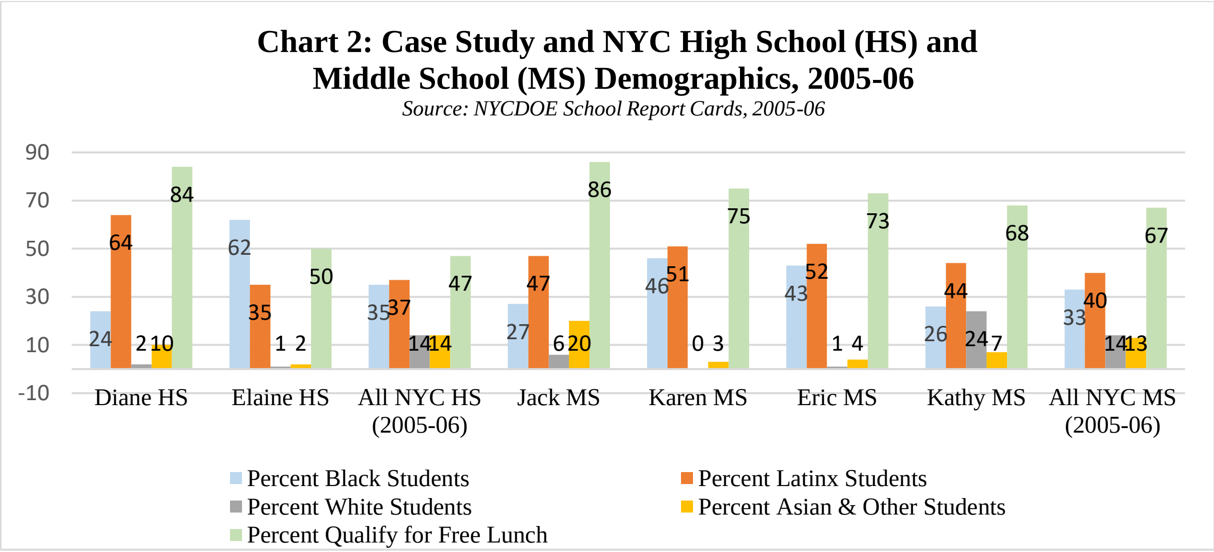

Figure 4: Case study school demographics, along with NYC high school (HS) and middle school (MS) demographics (NYCDOE, 2006). Percentages are rounded to the nearest digit.

[6] All names are pseudonyms.

Data Analysis

We drew upon the teacher and site data to focus on how these six highly segregated schools functioned in 2006–07. Using field notes, discursive data from teachers, and interviews with math coaches and department chairs, we open coded to find any common trends among the six schools' characteristics, noting any similarities in levels of resources. Based on this initial analysis, we then used NVivo software to code for specific examples of how the identified resource deficiencies affected mathematics teaching and learning, further sub-coding intellectual and physical deficiencies. Using NVivo's crosstab function, we examined the data by case and attribute, creating a case study of each school, highlighting systemic obstacles. It became evident that there were several commonalities among the schools: teacher experience level, teacher absenteeism, lack of available mathematics courses, and other deficient resources. We detail these commonalities next

Findings

In this section, we report the results analyzing the school contexts of six early career NYCTF teachers to identify structural obstacles that may perpetuate informal segregation and impact mathematics instruction and learning opportunities for Black and Latinx students. The obstacles identified in these six schools included three types of shortcomings: lack of an experienced, stable mathematics teaching force; lack of mathematics courses considered necessary to prepare for college; and lack of basic educational resources, affecting the teachers' ability to teach and the students' opportunities to learn mathematics.

Mathematics Teachers

Inexperienced Teachers. The collaborating NYCTF mathematics teachers in this study were, by definition, lacking in experience; they were all in their first or second year of teaching during school data collection and concurrently completing a subsidized master's degree in education (see Table 1).

Table 1
Demographics of Collaborating NYCTF Mathematics Teaching Fellows (MTFs)

	Diane	**Jack**	**Karen**	**Elaine**	**Eric**	**Laura**	**MTFs entering summer 2006–07**
Race/Ethnicity	White	White	White	Black	White	White	57.3% White
Age	21	24	24	24	55	33	70.1% $\leq$ 26 yrs. old
Gender	F	M	F	F	M	F	54.1% female
Social Class: identified as middle or upper-middle-class	Yes	Yes	Yes	No	Yes	Yes	55%
HS in NYC	No	No	No	Yes	No	No	72.2% outside NYC
College Major	All non-STEM[7] majors. Eric completed a math minor.						67.4% non-STEM

It is important to note that three of the six, Diane, Karen and Elaine, left for more prestigious schools that served higher percentages of White and Asian students after one or two years; Jack left for a similarly constituted school after four years. Only Laura remained at her first school which was newly opened and in a quickly gentrifying neighborhood. Eric was originally observed at his second school; he had taught for one year prior to the study and was excessed[8]. Eric remained at this school for 10 years and retired.

[7] STEM is an abbreviation for Science, Technology, Engineering, or Mathematics.
[8] Teachers are "excessed" when they have the least seniority and a school needs to reduce its teaching force, usually for budgetary reasons

Figure 5 provides data about teacher experience at the two high school sites in comparison to averages across all NYC high schools. The two high schools had less than the NYC average percentage of teachers with two-plus years teaching in the specific school, likewise with five or more years of *any* teaching experience. The latter metric is considerably lower, with 25 and 28 percent of teachers in this category as compared to 57 percent of teachers city-wide.

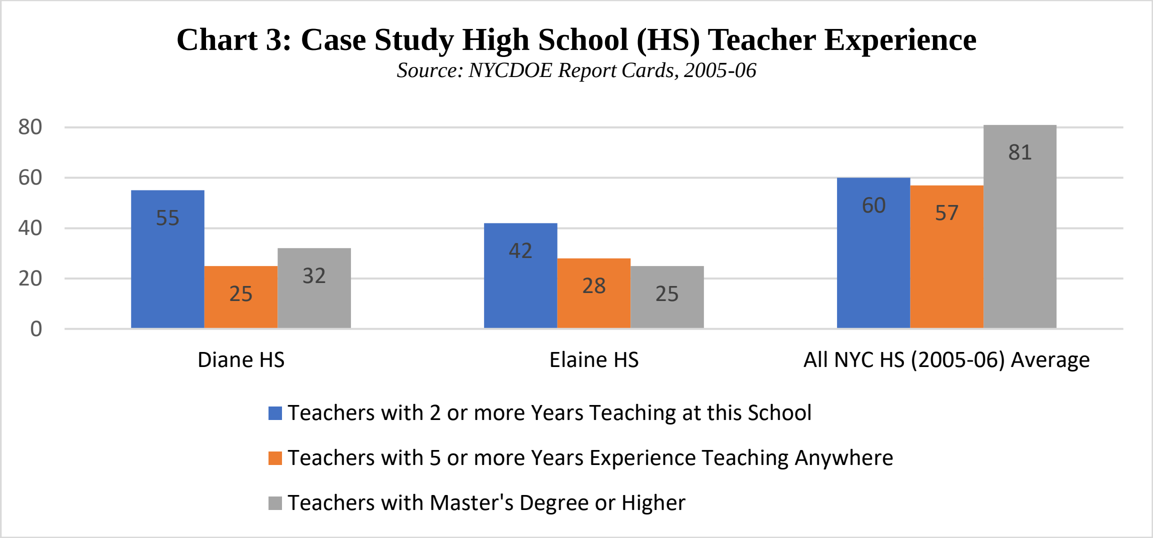

Figure 5: Case study high school (HS) teacher experience, along with all NYC high school teacher experience (NYCDOE, 2006).

Both high schools also had substantially fewer teachers with at least a master's degree comparatively. NYS requires that all middle and high school teachers earn a master's degree as part of the process for permanent certification. Compared to the city-wide 81-percent average, at 32 and 25 percent, we may deduce that most teachers in these high schools were early-career, with less-than-average experience.

Figure 6 gives similar teacher experience data for the four middle schools. Jack's school was slightly above average in teacher experience. Karen's school was about average in teachers who had taught at the school for two-plus years, but below average for those with five-plus years general teaching. Eric's and Laura's schools were quite a bit below average for both categories. However, Laura's school had opened only two years prior, an obvious correlation for lower teacher experience.

Analyzing percentage of teachers with at least a master's degree, we found that Jack's middle school was average (78 percent) compared to the city-wide 77 percent, but the other three were significantly lower (26, 29 and 57 percent), demonstrating relative teacher inexperience. The interestingly high number of master's degree holders at Laura's school may be explained by the high number of Teaching Fellows hired, candidates who had earned the master's degree but lacked experience.

In our interviews, the teachers reflected on the experience and stability of teachers in their respective schools. Importantly, all of the teachers discussed high turnover and great reliance on NYCTF for mathematics staffing, demonstrating the program's particular impact on highly segregated schools such as these. As mentioned previously, NYCTF and other SARPs have provided over 70 percent of all new NYC mathematics teachers since 2000; therefore, using them as an exemplar of new math teachers in NYC is appropriate.

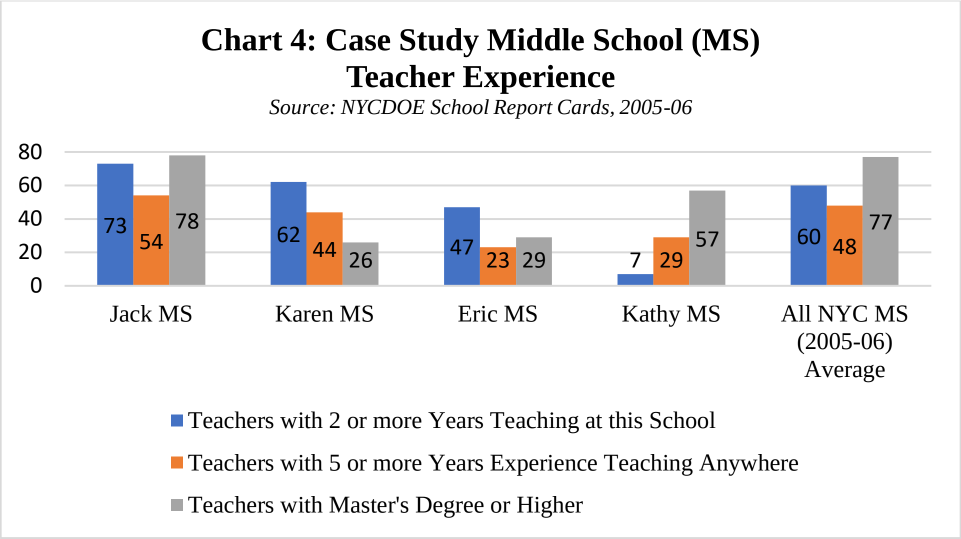

Figure 6: Case study middle school (MS) teacher experience, along with all NYC middle school teacher experience (NYCDOE, 2006).

All six discussed the large numbers of Teaching Fellows in their schools. In the excerpts below, Jack, Elaine and Laura described this high reliance and how it affected teacher turnover.

> *The middle school that I ended up teaching at – this just goes to show how badly they were hurting for teachers. They hired, in the math department alone, there were five of us that were first-year Teaching Fellows…. I think the last of them has left…. But those weren't the only Teaching Fellows in that school. There were easily a handful in the English department…. a couple in science…. There was a revolving door.* (Jack, 2015 interview)

Elaine described the mathematics Teaching Fellows in her first school and how few remained:

> *As I left, many of the other Fellows…. went to other schools…. I think there are only four people there now that were there when I was... And the department was pretty large. It was about 25 [Teaching Fellows]…. There's only four that are still there…. There were a ton of Fellows.* (Elaine, 2017 interview).

Demonstrating how gentrification can impact a school, we note that Laura's school has changed dramatically since she arrived; according to the 2017–18 School Report Card, it currently serves 55% White, 9% Asian, 20% Latinx, 11% Black, and 5% multi-racial students. Twenty-one percent currently qualify for free lunch. Along with the gentrification, teacher turnover has waned:

> *There was really high turnover my first couple of years because everyone was new and a lot of people were Teaching Fellows and.... left. And we hired a lot of new people. This year, we only hired one person.* (Laura, 2016 interview)

The six teachers in this study had little to no prior experience teaching mathematics. Four of the six expressed hesitation about having sufficient mathematical knowledge, as Jack explained:

> *Q: "Do you think you were prepared to teach math?"*
>
> *I remember thinking towards the end of the summer session…. "I am not well-equipped to teach math. There's no way that I have the skill set."… I remember a good majority of that boot camp was preparing to take the certification exam. That was the math that I learned that summer.* (Jack, 2016 interview)

Diane reflected on how her teaching techniques had improved after having two years of teaching experience as compared to her first year:

> *I think going through a year of teaching and focusing mainly on surviving as opposed to preparing and looking at the curriculum as a whole…. Now I've had experience to see how everything comes together. I think it's important because you can make the experience for the students much better.* (Diane, 2007 interview)

Karen also reflected on the skills that an experienced math teacher possesses and how these impact the learning experience. She compared her beginning year to later years:

> *I just had a lot more systems and structures in places. I spent a lot more time on each problem as a teacher…. I would know strategically what problems to pick so that half my class would…. make that mistake so that everybody could learn from it…. Those things I didn't have a clue…. I didn't know any of that savviness that you know later.* (Karen, 2016 interview)

An inexperienced teacher workforce allowed school leadership to set demanding norms, as Laura explained:

> *Q: "Would you consider your school a high-needs or hard-to-staff school?"*
>
> *Hard-to-staff? Seventy-five percent of the teachers are Teaching Fellows, so if they tried to get like real teachers would they be able to? I have no idea…. Everyone is new and no one is tenured. That's why they're able to demand so much from everybody…. But I guess my main problem with the Math Department and…. the reason that our school works, is because everybody is really motivated and really energetic and young…. willing to take on so much crap.* (Laura, 2007 interview)

The teachers in this study identified the stresses of these first schools in which they were employed added to their desire to move to better-resourced schools.

> *[My friend] was the one who said to me, "You know, there are other schools out there. You don't need to change this one to enjoy what you're doing."…. So, I went [to interview] and I fell in love with [the school]. I was like, "This is awesome. This is exactly the kind of school environment that I feel like teachers can thrive in, students can thrive in."* (Jack, 2016 interview)

All new teachers struggle. However, many of these schools' mathematics teachers left after a few years, replaced by other new teachers, thus depriving students of a stable teaching force improving with time.

In summary, the data demonstrate that five of the six schools had teachers with comparatively less experience than NYC's average. Indeed, three of the teachers themselves left after one or two years (one left after four); the school at which one remains had gentrified greatly, serving a much whiter and more affluent student body. All six schools were highly dependent on NYCTF staffing, particularly for mathematics. While new teachers can bring in a certain energy and enthusiasm, the schools also suffered from high turnover rates, with teachers gaining experience but then leaving for more prestigious schools.

Teacher Absenteeism

Not only were the schools under-resourced without an experienced and stable workforce, teachers were frequently absent. The six collaborating teachers expressed frustration with absenteeism causing extra work. For example, Diane discussed the number of coverages,[9] "I averaged about four coverages a week on top of what I'm supposed to teach…. People were out all the time" (Diance, 2007 interview).

Karen was also regularly saddled with covering for absent teachers. She recounted a typical week during her first year, "Monday I taught a class, a first period and a seventh and eighth. The rest of my day, the five periods in between, I had at least two to three coverages, depending on how many people were out that day" (Karen, 2007 interview). Jack wondered if the high number of coverages he was assigned was punitive, "As of late I've been getting a lot of [coverages]…. I wonder that sometimes…. if it's a punishment" (Jack, 2006 post-observation interview).

Laura described the stress and chaos coverages can induce:

> *Those are the times that are really hard—when I have an impossible amount of stuff to do and there's no help available and the pressure is too much. After the coverage fifth period, no one came to relieve me and I was supposed to have my lunch break and I was so annoyed and exhausted and hungry and stressed about having to write stuff on the board for my next class.* (Laura, 2006 post-observation reflection)

Altogether, high teacher absenteeism answers to stressful working conditions within schools and how it can affect teacher morale. Novice teachers in under-resourced schools are further stretched within their working environments, denied time and resources to plan lessons and other class-related activities. These new Teaching Fellows faced inordinate demands, affecting their ability to provide reflective, focused and prepared mathematics classes.

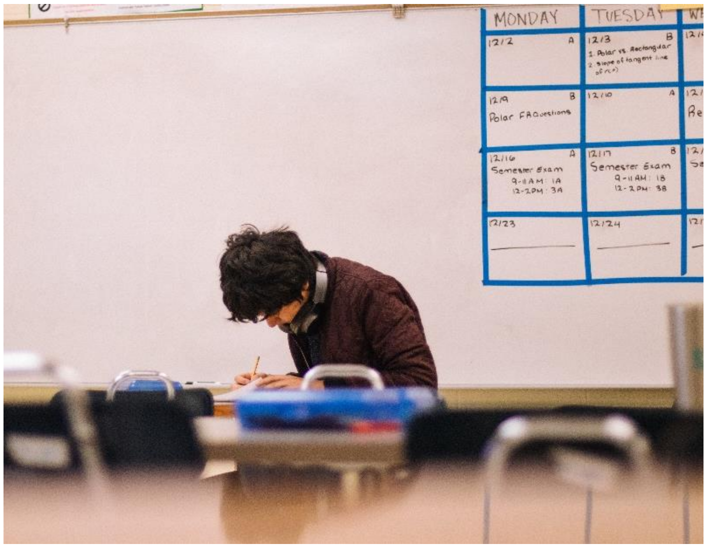

Photo by Jeswin Thomas from Pexels

Lack of College-Track Mathematics Classes

This section demonstrates a lack of college-preparatory mathematics classes at these schools. Sadler and Sonnert, (2018) found that students need to complete Algebra I by eighth grade in order to complete calculus by graduation. However, of the four middle schools, only Laura's quickly gentrifying school offered algebra. Neither of the high schools offered precalculus or calculus (Table 2).

Table 2

Case study high school (HS) and middle school (MS) upper-level mathematics courses offered.

	Diane	Elaine	*Average*	Jack	Karen	Eric	Laura	*Average*
School type	HS	HS		MS	MS	MS	MS	
Offer HS precalc/calc *or* MS algebra	No	No	*59% of NYC HS offer no AP math*	No	No	No	Yes	*40% of NYC MS offer no Algebra 1*

[9] "Coverages" are needed when a teacher misses work, and someone needs to cover the teacher's classes.

Diane's case provided a particularly illustrative example of how under-resourced schools can affect students' academic paths. Her school only began to offer Math B, a course required to receive a college-prep *Advanced Regents* diploma, the year Diane started. Prior to that, they had offered only Math A, the minimum mathematics requirement for graduation. In the excerpt below, Diane's Math Coach explained the transition:

> *When I first came to this school, they never had anything beyond Math A…. And I fought for Math B, because I felt that the students would not be prepared for college…. So, they started teaching Math B. "Okay, we'll do this as an experiment."… It was kind of like a watered-down version…. Although we did get Math B here, the reality is a lot of students still can't handle Math B…. The kids had enough math to get outta high school, but they did not have enough mathematics to survive in college.* (Diane, 2007 interview).

According to the Math Coach, the students in this school had not been sufficiently prepared, demonstrating the long reach of year-over-year, elementary to high school, tracking by school.

Elaine provided an example of how new teachers could positively impact mathematics education by advocating for students. Her high school mathematics department was entirely NYCTF-staffed. This school was unique among the case studies in that the mathematics teachers were almost all Black, along with 62 percent of the student body. Although the school offered Math B, very few students were enrolled. Elaine described how she and fellow teachers were concerned the students were not being sufficiently challenged:

> *[My math teacher colleagues and I] still spent a lot of time just talking about how to fix [the school]…. We all had the same idea…. We saw what was happening…. and said, "This is unbelievable. They have 10 kids taking the Math B exam when all of these other kids should be learning and doing the same thing."… I was in a process before I left, just getting a proposal together for [the math chair].* (Elaine, 2007 interview)

Unfortunately, Elaine and several of her colleagues left the school shortly afterward without being able to implement the changes.

Lack of Basic Educational Resources in Segregated Schools

In addition to lacking college-preparatory mathematics courses, these schools also lacked other resources, impacting teacher ability to teach and student opportunities to learn. Here we highlight fundamental structural imbalances that affected mathematics classroom teaching and learning.

Classrooms and Teaching Resources. Firstly, all of the schools lacked space including sufficient classroom space. When asked what changes she would like to see, Diane responded, "I would like classes that are smaller. All of my classes have over 30 students…. I only have 29 desks in my room" (Diane, 2007 post-observation interview). In her recent interview, Diane reflected again on the impact of constrained space:

> *The school that I taught at the first couple of years, [the collaborative learning model] was a physical impossibility…. I had a classroom where kids sat in chairs with clipboards because there weren't desks*. (Diane, 2016 interview)

Eric's school lacked space to the extent that he could not have his own classroom. Having one's own classroom allows cohesiveness, e.g., putting preparatory notes on the board and organizing time/resources. Eric had to push a cart between classrooms. As noted by his observer, "[Eric] is a traveling teacher this year – a somewhat frustrating situation…. He has had to use more overheads than the previous year, as he can't put things on the board ahead of time" (2007 observer field notes).

Karen discussed how her school's lack of resources affected her ability to teach mathematics:

> *My chalkboard, you couldn't write on because it was covered in wax so the chalk didn't stick to the board. The overhead light bulb, the overhead died, so did the second one. So, the…. only thing I had to write on was that chart paper, which was ridiculous writing on chart paper and moving chart paper around. I mean it was hysterical the fact that the only thing a teacher had to write on was chart paper. And then what do you do when they ran out of chart paper? So, I started writing on the back of old charts 'cause I had nothing else to write on.* (Karen, 2007 interview)

The picture that Karen painted demonstrates how easily mathematics teaching and learning opportunities can be derailed by a lack of basic resources.

All of the new teachers resorted to buying supplies for their mathematics classrooms, in some cases spending significant money. For example, in Elaine's school, there was a Smartboard; however, there was no teacher laptop. The observer noted: "[Elaine] bought a laptop so that she was able to have access to a Smartboard" (2006 observation field notes).

In summary, all six schools were significantly under-resourced in basic educational materials. However, efforts to reconcile the budget struggles further contributed to job stress, and a desire to move on to better-resourced schools, perpetuating the "revolving door."

Mathematics Textbooks. Another basic need for student success is access to, and learning how to read, mathematics textbooks. None of the six schools had a complete set of textbooks that students could take home to read and complete homework or enable parents or tutors to provide outside help.

An additional consequence of a lack of textbooks meant that the teachers had to expend extreme effort to get homework problems to students. This was done either by making copies (often not possible), developing worksheets, or having students copy problems into their notebooks. Not only did these students miss out on learning how to read and consult math textbooks on their own, significant class time and effort was consumed making up for this missing resource. Demonstrating this added burden, Jack explained his method of getting students to copy homework problems into their notebooks:

> *They begin the "do now" and once they've done that, then the other thing that I ask them to do is take out their homework notebook to copy down the homework problems and then to open up to last night's homework and leave it on the corner of their desk.* (Jack, 2006 post-observation interview)

The teachers themselves often had limited book resources. Eric reflected on how time-consuming this was, "I spent a lot of time creating materials. If I'd had a good textbook, I would have used that time to give feedback, but…. I was always creating new materials" (Eric, 2016 interview).

Laura described the combination of a lack of books and copy resources:

> *The next unit we're doing, data, we don't have a book. All we have is this [holding up a teacher edition textbook]. So, we're basing everything on this which is a pain in the ass because we don't even have a copy machine we can use for worksheets and it's just ridiculous. So, now we're going to have to resort to this kind of thing [holds up chart paper with handwritten notes]. Just ridiculous.* (Laura, 2007 post-observation interview)

In summary, resource deficiencies, e.g. adequate desks and a math textbook at home, have long-term effects on students' identities as learners, effectively altering educational paths (Martin, 2006; Nasir & McKinney de Royston, 2013; Spencer, 2009). The students in these schools were not only blocked from college-preparatory mathematics courses, the schools were unable to provide basic tools needed for student success.

Discussion

To answer our research question, *What are some of the structural obstacles present in NYC's public school system that help to perpetuate informal segregation and impact mathematics instruction and learning opportunities for Black and Latinx students?* We first described systems in place that support the elementary to high school stratification structures that allow for a systematic lack of resources and opportunities for Black and Latinx students. As noted earlier, this is important since extremely segregated schools afford a context in which inexperienced teachers and a lack of mathematics course offerings and other basic resources can have a comparatively strong impact on the quality of education for non-dominant populations. Although the school year focus is on 2006–2007, there is a slow violence (Nixon, 2011) to the formation of racialized structures in (mathematics) education that become calcified and normalized over time. Indeed, the current context of NYC's public schools demonstrates that, rather than improving in diversity and resources, segregation and lack of equitable resource distribution have persisted and increased.

We then provided a qualitative case study analysis, focusing in on six typical, highly-segregated NYC public middle and high schools through the lens of mathematics resources and opportunities. The analyses demonstrated a scarcity of resources both physical (e.g., desks, chalkboards, textbooks) and intellectual (e.g., experienced, stable mathematics teacher work forces and robust and rigorous, college-preparatory mathematics courses) that support the informal yet systemic segregation of Black and Latinx students in mathematics education. These mostly Black and Latinx students are part of the demographic that is regularly systemically blocked from achieving mathematics credentials (Bullock, 2017; Diversity in Mathematics Education Center for Learning and Teaching, 2007; Jorgensen et al., 2014; Larnell, 2016; Martin, 2012, 2013; Martin et al., 2010; USDOE, 2014) which is why an open and transparent dialogue is so important.

In 2017, the NYCDOE published its plan to diversify public schools (Office of the Mayor, 2017) in an attempt to improve systemic equity. This plan, however, has been criticized for lack of ambition with very low-set target goals. In fact, the current demographic trends are actually sufficient to satisfy its unambitious agenda, thus resulting in minimal changes to the system as a whole. Critics note that,

> Indeed, if recent demographic shifts that have occurred in [NYC] schools merely continue apace for the next five years, the DOE will be able to meet these diversity goals without implementing a single one of the dozen policies they recommend in their new plan. (Mader & Sant'Anna Costa, 2017, p. 1)

To address these inequities, Mader and Sant'Anna Costa recommend, among other initiatives, setting the range of "racially representative" around the actual citywide share of Black and Hispanic students (67% in 2016–17 schoolyear).

We argue that detailed attention to the issues presented in this paper need to be considered in the public discourse about mathematics education. There is currently little mainstream debate about the need to ensure that NYC's segregated schools serving mostly Black and Latinx students offer high quality classrooms and resources, experienced teachers, and access to challenging, engaging, and college preparatory mathematics classes. As pointed out by the National Council of Supervisors of Mathematics and TODOS: Mathematics for All (2016) in their joint position statement:

> Incremental approaches to address urgent calls for action have made little difference in how many children experience mathematics in our nation's schools. This is repeatedly documented by the disparities in learning opportunities and outcomes in mathematics education based on race, class, culture, language, and gender. Immediate and transformative change is necessary. These changes must occur in multiple settings and at multiple levels including classrooms, district offices, school boards, universities, legislatures, and communities. Three components are needed…. There must be acknowledgment of the unjust system of mathematics education, its legacy in segregation and other forms of institutional systems of oppression, and the hard work needed to change it. (p. 1)

Recommendations Related to Access and Diversity

There are several groups that advocate for NYC's Black and Latinx students and whose reports and recommendations are thoughtful, realistic and address segregation and resource allocation (see, in particular, Hemphill et al., 2015, 2016, 2019; Kucsera & Orfield, 2014; Mader & Sant'Anna Costa, 2017; Nauer et al., 2015; New York Equity Coalition, 2018; The Education Trust – New York, 2017). We note some of these recommendations here that are specifically related to this paper's themes but encourage readers to see the original reports for a full understanding of their recommendations.

Hemphill et al. (2019) from The Center for New York City Affairs recommend, among other things, that NYC's screened schools, i.e., those schools that rely on records from previous schools, remove or modify unreasonable school screening while replicating or expanding the enrollment of successful schools, both screened and unscreened, that have far more applicants than seats. The authors observed that schools admitting children from all five boroughs (i.e., citywide) have the potential to be racially and economically diverse. Another important recommendation is to eliminate ranking of applicants at screened schools that puts students on a strict comparative competition. Instead, it is proposed to set a threshold for admission, such as certain cutoff school grades, and have a lottery among students who meet that threshold. In addition to changing admissions, the authors propose "the City should also take steps to avoid internal tracking, which effectively segregates students by ability within a school building. All schools should be welcoming to students of different races and ethnicities. They should hire more teachers of color and make the curriculum more responsive to students of different cultural backgrounds" (p. 20).

Kucsera and Orfield (2014) from The Civil Rights Project/Proyecto Derechos Civiles, document the extreme segregation in NYC's thirty-two Community School Districts. Among other recommendations, the authors suggest that the state and local education agencies need to develop policies (e.g., controlled school choice) focusing on reducing racial isolation, promoting diverse schools, and ensuring an equal distribution of resources. They also believe that magnet schools, or any choice program for that matter, must demonstrate a commitment towards increasing racial and economic integration, recruit actively to create a diverse student body, provide transportation for students, and have no academic screening mechanisms.

Among the recommendations of The New York Equity Coalition (2018) is to increase student support for access to information in order to pursue rigorous college and career-preparatory pathways, with expansion of access to school counselors and other resources. The report also recommends expanded access to AP, IB, dual-enrollment courses, and employer-based internships and other connections to colleges and employers. The goal is to provide every student the opportunity to gain college credit or participate in work-based learning opportunities before graduating from high school.

The Education Trust – New York (2017) proposes broad strategies identified as essential in improving achievement and success for students in New York. These include the provision of high-quality early care and education for all children, specifically through the significant expansion of access to pre-kindergarten for three and four-year-old's. Another crucial area of concern is the provision of support and resources needed for teachers to be successful, the need for a diverse teacher and school leader workforce, the quality of preparation programs, and ongoing professional development. The report also calls for implementing a school funding formula that achieves the goal of providing adequate and equitable resources for all schools—especially those that serve low-income students and students of color.

We end this paper with vigorous support of these institutions, their recommendations and their continuing efforts for equity in mathematics education in New York City and beyond.

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Laurel Cooley is an Associate Professor in the Mathematics Department, Brooklyn College – City University of New York (CUNY). Her current research project (NSF grant award 1535219) examines the sociological and political aspects of racialized systemic violence in mathematics education, using NYC public schools and the NYC Teaching Fellows as context. Prof. Cooley has been a member of the CUNY faculty since 1994, when she began her career at York College – CUNY, after finishing her PhD at New York University. While she retains interest in the research of college mathematics cognition and has published in this area, her many years teaching mathematics in NYC's public university system have influenced how she thinks about mathematics education. In particular, Prof. Cooley has come to understand that racism and racist structures play powerful roles in the persistence of systemic inequity in mathematics education.

Sarah Hannaford-Simpson, PhD in Sociology, completed her graduate work at Queen's University in Northern Ireland. Her research includes a theoretical examination of youth risk behaviors. It was in this research that she came to understand the important role that education and access to education play in the stratification of opportunities for youth. Her expertise was a significant contribution to this paper while she served as a senior research associate on this project. Dr. Simpson is currently pursuing a second professional career in teaching.

Rushna Shahid, M.S., completed her master's degree in Political Science at New York University. A true global citizen, she has studied and worked in Germany and Pakistan as well as the USA. Ms. Shahid has extensive program management, research and teaching experiences ranging from conducting policy studies for the Pakistani Parliament Committee of Foreign Affairs and campaigning for local U.S. political candidates, to teaching and mentoring undergraduate students. Her current position as research associate on the National Science Foundation grant number 1535219, housed at Brooklyn College – City University of New York, has allowed her to gain a deeper understanding the socio-political effects of racism and systemic violence in mathematics education.

Leveling the playing field in the mathematics education of Black students through collaboration, mastery, and peer interaction

Maila Brucal-Hallare
Anne Fernando

Across the nation and throughout almost all kinds of educational institutions, mathematics professors who teach freshman-level pre-calculus and calculus courses encounter an academic issue that seems to unify all of us: students do not have sufficient academic preparation for college-level mathematics (Mulvey, 2009). At Norfolk State University (NSU) in particular, we observe that our Black students come under-prepared in their mathematics background. For example, some students in our freshman calculus level courses demonstrate poor algebraic factorization skills while some students in the freshman pre-calculus level show a lack of mastery in basic arithmetic skills. Moreover, we also observe that many of our students do not know how to study, do not know how to be successful in their mathematics courses, and find it difficult to balance the mismatch between their high school experiences and college expectations. Indeed, we have various anecdotes from college freshmen who claim that in high school, mastering the material was not the goal as much as good behavior, showing up for class, and keeping a passive albeit successful-enough position as a student. They also shared that they have not had Black teachers as role models and they have not encountered the frustration and struggle of studying and learning mathematics and subsequently, they have not experienced the joy of learning that results from such frustrations and struggles. A consequence, STEM majors often postpone enrolling in higher-level mathematics courses due to their inability to demonstrate mastery of prerequisite mathematics skills.

While we do not claim to offer solutions to these mathematics education issues in our university, this report highlights two projects at the NSU Department of Mathematics that aim to "level the mathematics playing field" for STEM students while they pursue their mathematics training. As a mid-size Historically Black College/University (HBCU), we have a mostly-homogeneous group of students in the cultural sense but not necessarily in the mathematics-playing-field sense. Differences in the amount and speed of learning mathematics skills and concepts are apparent during the first week of classes.

The two National Science Foundation (NSF) funded projects that we report here are called SUMMIT-P and TIP, both of which have a general aim to help our STEM students become successful in their mathematics courses. In Synergistic Undergraduate Mathematics via Multi-institutional Interdisciplinary Teaching Partnerships (SUMMIT-P), a national consortium of ten universities nationwide, NSU is the only HBCU member institution. In Targeted Infusion Project (TIP), NSU is one of many HBCU members across the nation. While NSU-SUMMIT-P's driving force is improving the calculus curriculum by developing partnership and colleagueship between the mathematics and engineering departments, NSU-TIP's main thrust is improving the quality of learning in the STEM classroom through mastery and peer interaction.

In this paper, we first report on the program structures of SUMMIT-P, followed by a report on the those of TIP. Then we present an analysis and summary of recommendations of structural and pedagogical strategies that we found to be effective in addressing some cultural contexts of mathematics learning at NSU.

Improving Mathematics Learning by Collaboration

The SUMMIT-P consortium (http://www.summit-p.com) consists of ten universities around the nation that maintain constant communication and close collaboration with a general goal of revising and improving the curriculum for lower division undergraduate mathematics courses. The collaboration happens in two levels: an inter-collaboration among member institutions and an intra-collaboration between selected departments within each member institution. At NSU, SUMMIT-P is implemented through a collaboration between the Department of Mathematics and the Department of Engineering. The leadership team consists of Dr. Shahrooz Moosavizadeh, Dr. Deo Makarand, and Dr. Maila Brucal-Hallare. As an example of an inter-collaboration activity in SUMMIT-P, faculty from Virginia Commonwealth University, Embry-Riddle Aeronautical University, and Appalachian State University conducted a site visit at NSU in April 2019, where ideas, resources, and stories were shared and support systems and solutions to identified issues were offered (see Figure 1). Guests attended SUMMIT-P pilot section classes, had conversations with university administrators, conducted dialogues with faculty from the departments of mathematics and engineering, and interviewed students taking the SUMMIT-P courses. The consortium is multi-cultural as some institutions are predominantly white and NSU is the only HBCU. From the NSU perspective as the only HBCU member, this collaboration across institutions brings awareness of what competing environments with purportedly better-prepared students are doing with their students. Such awareness helps us understand what our STEM students will face upon graduation, whether they attend a graduate school or join the workforce. The collaboration also invites idea exchange for teaching and learning projects and for innovations in teaching pedagogies. This site visit in spring 2019 was particularly illuminating as other professors experienced our academic environment at NSU and based on that experience, they were able to help the NSU SUMMIT-P team find areas where we can improve and meet our students' needs in creative ways.

Figure 1. NSU welcomes the faculty visitors from the other SUMMIT-P member institutions.

It is well-documented that an active learning experience in mathematics is one of the most effective ways to address both the learning issue and the diversity issue in a mathematics classroom (Herzig, 2005; Ross, 2014). In an HBCU mathematics classroom specifically, students learn best when they have the chance to engage socially with their peers, their mentors, and their professors. Thus, the NSU SUMMIT-P team designed a program wherein students enrolled in a calculus course have direct significant contact throughout the semester with upper-level engineering students, engineering graduate students, and engineering professors. This is in contrast with the traditional calculus classroom where the students learn from the professor only. The first step to make this learning community successful is to create a special section of calculus, called Calculus I for Engineering Majors, wherein registration is limited to engineering students only. In this way, the faculty of this section is able to recalibrate the common calculus syllabus and specialize the calculus examples to specific engineering applications. It is important to note that this was possible at NSU because of the small number of students taking calculus as a freshman. In this special calculus section, upper-level engineering students serve as peer tutors and role models, engineering professors team-teach with the calculus professor, and engineering graduate students provide necessary support during engineering laboratory visits.

The NSU SUMMIT-P team make particular efforts to create team-teaching opportunities between the mathematics and the engineering faculty; this collaborative teaching community is the essence of the NSU SUMMIT-P program. While the actual team-teaching session in the classroom, or sometimes in the laboratory, is the fun part of the program, a lot of planning and preparation happen behind the scenes. Two years before the first team-teaching session was delivered to the classroom, the team organized meetings where the mathematics and engineering faculty talked about the specific needs of engineering students. Conversations brought forth curricular alignment tasks, where questions such as "How deep should we go into the discussion of the Mean Value Theorem?" were discussed. Then, the team organized a special event in a speed-dating format: five mathematics faculty stay seated at the same table while five engineering faculty moved from table to table and spoke about their specific engineering projects, research, and grants for about 10 minutes. At the end of the speed-dating session, coupled with a better knowledge of the intellectual resources from the engineering department, a mathematics faculty then paired with an engineering faculty. This two-person team was tasked to create a team-teaching calculus module with a hands-on laboratory component related to the engineering faculty's specialization. The mathematics faculty ensured that the module was accessible to calculus students and that the module fit appropriately in the calculus syllabus. The pair were given a few weeks to write up a lesson plan, a slide presentation, and an engineering laboratory primer related to the presentation. Once completed, they visited and delivered their application module to the special calculus section.

As in any collaborative scholarship, communication was a key to success. The students reported that seeing an engineering professor and engineering graduate students in a calculus class provided vital curricular coherence between mathematics and engineering courses. Aside from the novelty of having another professor deliver lecture materials, the students also appreciated that the mathematics and engineering faculty were modeling collaboration and classroom communication. Some of the engineering faculty invited the calculus students for a campus field trip to the electronics laboratory where they learned, with upper-level engineering students, how to manipulate circuits via software. In Figure 2, the calculus class was held in an engineering laboratory, where an engineering graduate student assisted the engineering professor in explaining circuits. It is important to note that the calculus students were not graded on their understanding of circuits at this point of their academic career. The goal of the activity was to introduce engineering concepts early, in an active and tactile way, while students were in their calculus course.

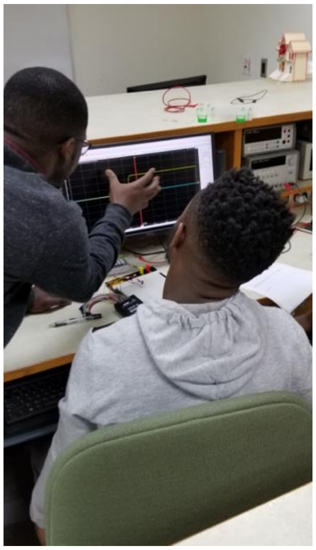


Figure 2. Peer tutoring: a calculus student listens as an engineering graduate student explains circuits.

Finally, the students watched videos for their calculus final exam review created by upper-level engineering students (see Figure 3), an example of peer learning. The videos were specially prepared, not by strangers from the internet, but by their NSU peers, with whom they share classes in their general education requirements. Such familiarity creates a stronger Black university community. We ensure that students cheer each other on and celebrate their successes.

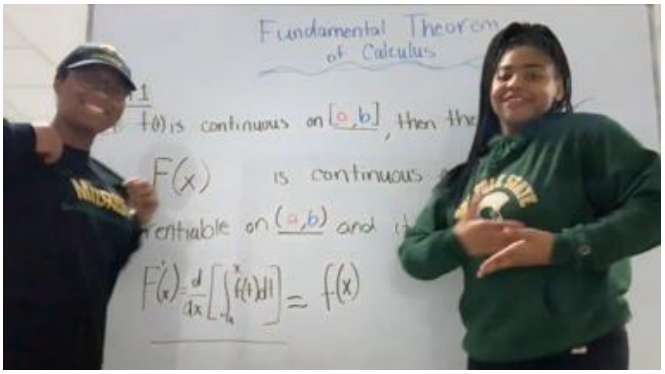


Figure 3. Peer learning: a screenshot of a video created by upper-level students for freshman

The NSU SUMMIT-P program during the Spring 2019 semester was quite successful in motivating our students to appreciate and experience calculus, in creating an opportunity to communicate directly with their future engineering faculty, and in providing teaching and inspirational support to our students. As a small HBCU, we strive to maintain a strong collegial bond that is rooted in applicable mathematics, where students and faculty from different departments are united by a shared vision of strengthening the mathematics education of our students at NSU. Figure 4 reports some of the positive feedback from our students.

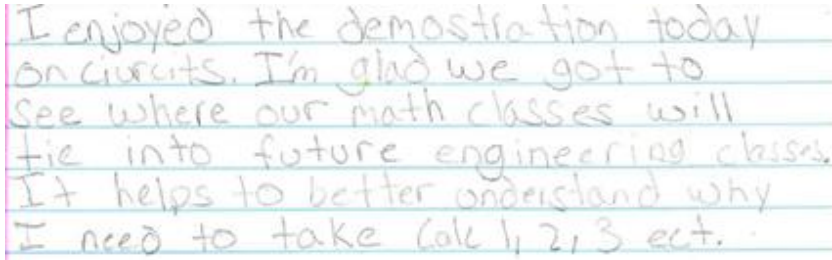
During the Fall 2019 semester, the SUMMIT-P calculus class welcomed four engineering faculty professors who presented concrete applications of mathematics in various areas of engineering, namely, graphical analysis in biomedical engineering, optimization in deep learning, parameter analysis in thin films and optic devices, and reduced-order models in wireless power transfers. It is important to note that these engineering topics do not appear as calculus textbook examples. These engineering applications modules were carefully integrated into the calculus curriculum so that students see that a calculus class does not consist of drill-based instruction focusing on basic computational skills but a powerful opportunity to use mathematics thinking to solve real-life actual engineering problems. By the end of the semester, two students from the class have initiated long-term research projects with the visiting engineering faculty professors. Indeed, we believe that one success of SUMMIT-P at NSU was that we were able to initiate an early connection between first-year engineering students and their engineering professors. Our HBCU students respond positively to this early research collaboration between professors and students. The research output may not go too far due to the still-developing mathematics background of the freshman student, but the academic connection and relationship has started and will hopefully advance looking forward.

As part of the SUMMIT-P consortium, NSU contributes to social justice and leveling the playing field:

(1) by offering our Black students high-quality mathematics instruction and training that are comparable to what their peers receive in other institutions;

(2) by increasing awareness of the challenges and issues that students and professors encounter in an HBCU; and

(3) in NSU specifically, by providing a special, close connection between the students and faculty of the Mathematics and Engineering departments.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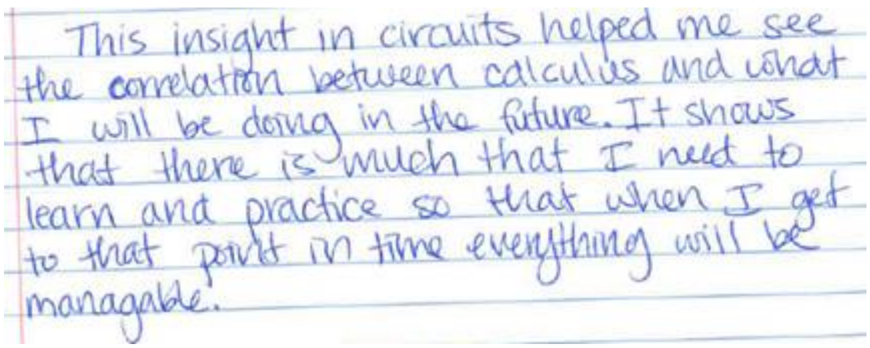
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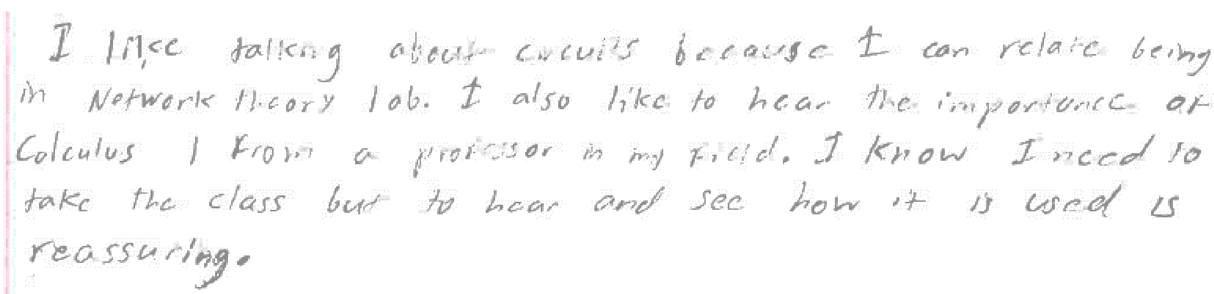
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Figure 4. Student feedback on faculty presentations through the NSU-SUMMIT-P program.

Improving Mathematics Learning by Mastery and Peer Interaction

The TIP grant is one of the tracks in the National Science Foundation's HBCU-Undergraduate Program and at NSU it is called, Targeted Infusion Project: Engaging Students for Higher Retention and Building Stronger Foundations in Pre-Calculus Using the Flipped Model. The leadership team consists of Dr. Rhonda Fitzgerald and Dr. Anne Fernando. The TIP grant addresses leveling the playing field by providing a supportive learning experience to the Black student, with an overall goal of achieving mastery of concepts through the flipped approach to teaching. The flipped approach adapts to many aspects of the Black student's culture. It has been shown that social interaction when learning is critical for Black students in particular (Alting & Walser, 2006; Pashler et al., 2008). Unlike Asian students, who may thrive in lecture environments and may work better individually, Black students may be better suited to a flipped approach where there is less emphasis on lecture and there are more opportunities for group work, discussion, and peer interaction (Ross, 2014). This social interaction and its benefits for learning extend beyond peer group work. Role model mentoring by supplemental instructors (SIs) in the classroom demonstrate math knowledge and college success habits for the younger students through conversations with working groups and one-on-one interactions (Arendale, 1994). The SIs are STEM upper-level undergraduate students who also act as mentors by sharing strategies on how to be successful in college courses (Novak et al., 1999). Flipped learning allows for a metacognitive approach where students are exposed to many facets of learning leading to discernment, analysis, and better learning. The self-paced, low-pressure, high-accountability learning environment allows mastery of concepts in a comfortable and engaging approach for students of all backgrounds.

The following outline details the daily implementation phases of this endeavor. During the first few weeks of the semester, the instructor must adhere to the program until the students learn its cyclic nature and reap some of the academic benefits.

(1) ***Pre-Class Implementation.*** Prior to class, students are provided with links to videos that feature mini-lectures to enhance procedural knowledge. The sample video screen shot in Figure 5 is an example of tailoring the mathematics content for greater effectiveness. We have created videos for most of the mathematics topics in pre-calculus. With the Learning Glass, the student can see the work and the instructor's image explaining through a topic much like in a traditional classroom setting, but with the advantage of watching, pausing, rewinding, taking notes in the comfortable environment of choice for each student. This is a less threatening way to deliver content ensuring higher probability that the student will study outside of class.

(2) ***In-Class Implementation.*** Class begins with an exercise drawn from the video lectures, where students can ask questions for clarification or to gain further insight. Then, students form groups to work on additional problems. The classroom includes a mastery check-point station, an actual physical location in the classroom, where additional practice worksheets are available to those who have not mastered the concept and to those who are ready for more challenging problems. The instructor may form small groups of students using a variety of criteria, including forming groups by levels of understanding. Solutions to practice worksheets are available online and in a solutions folder in the mastery check-point station. The course instructor and SIs circulate the room to query and assist any of the groups. During the worksheet phase of the meeting, group formations may be adjusted. Daily tracking of individual and team group performance, along with periodic team member ratings of one another help to keep all students accountable for productivity during class time. In Figure 6, the students work in groups with some of them using white boards, which is less committal than pencil and paper. The active nature of the in-class setting is crucial to student mastery as the more delicate part of the learning process is taking place.

(3) ***Post-Class Implementation.*** Online homework assignments are administered through the software provided with the textbook. Figure 7 shows the after-class interaction between instructor and students. Students are highly encouraged to meet with their instructors outside of classroom time to complete mastery before an exam.

The close interaction between the students and their SIs is a critical component of our program. Our SIs facilitate the message that high achievement in STEM by Black students is believable and possible. Through their work with SIs, we hope that the student conveys, “You did it, I can, too.” The sense of support is critical for our Black community, as many are first-generation college students and may not have the belief that they can actually accomplish their academic goals.

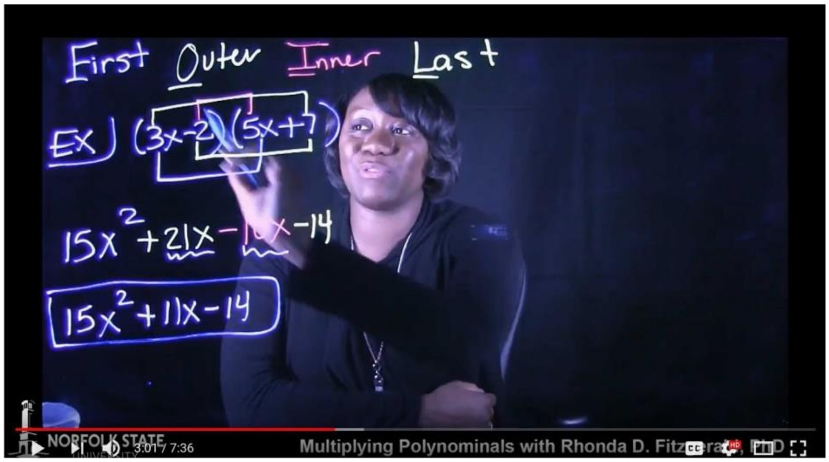

Figure 5. Flipped learning: screenshot of video created by Dr. Rhonda Fitzgerald that students must watch before coming into class.

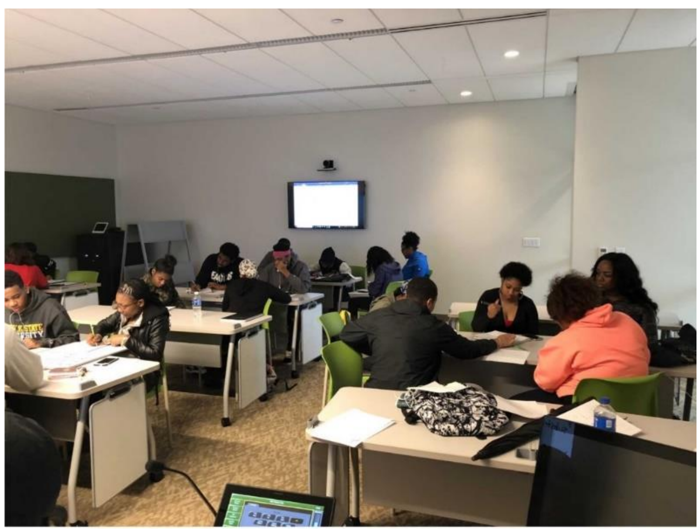

Figure 6. Active learning: students at NSU enjoy solving problems in small groups.

The TIP does not only benefit the students registered in the class. It also provides valuable professional experience to our SIs as teachers and as leaders, growing from a passive role of student to an active role in the center of the classroom or as group facilitators. For the mathematics major SI, in particular, the professional growth afforded by TIP is a crucial part of how this grant encourages leveling the playing field for the Black mathematics major. Even before the mathematics major graduates, our SIs in the TIP gain significant experience on managing a mathematics classroom and dealing with various day-to-day classroom issues.

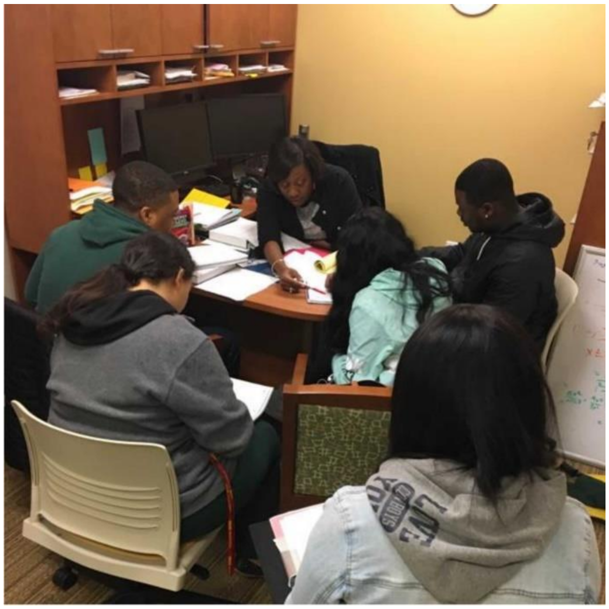

Figure 7. Personal touch: Dr. Fitzgerald continuing to guide active learning during her office hours.

A Work in Progress

While initiatives like SUMMIT-P and TIP at Norfolk State University do well in addressing some critical issues of the mathematics education of Black students, there are many areas to be explored about the Black culture and mathematics learning.

The NSU SUMMIT-P's efforts on establishing collaboration between the mathematics and engineering departments produced discipline-specific applications that were presented in a team-teaching manner. Such efforts create opportunities for our Black STEM students to engage in critical thinking, beyond busy computational drills. In our SUMMIT-P calculus classes, problem-solving and analytical thinking are now emphasized, encouraged, and demonstrated through engineering applications. Moreover, the team-teaching approach creates a stronger sense of academic community, with our freshmen engineering students embracing the opportunity to make strong connections with their engineering mentors as early as their first semester in the university.

The NSU TIP's efforts through the flipped-learning model caters to cooperative learning in the classroom and one-on-one teaching with the faculty outside classroom hours. For our Black students, learning and working in groups have fulfilled their desires to interact and have helped them develop teamwork skills that will be helpful when they graduate, while, one-on-one teaching with highly accessible faculty provides the support that they need to maneuver a rigorous curriculum. Related to the faculty's willingness to be accessible is our positive conception of our Black students. Our students know that we believe in their capabilities to succeed, wherever they are coming from, because we view the mathematics learning process as dynamic and organic.

One needs to acknowledge some background from which many Black students have forged their relationship with mathematics and mathematics classrooms. As faculty of an HBCU, we have this golden opportunity to understand and listen to their stories. Some academics have argued that insufficient mathematics training comes from a discontinuity that exists between the Black student's home language and the precision of mathematics and mathematical language (Orr, 1987), while some have argued that the mathematics content is presented in a way that is neither applicable nor relatable to a Black student's daily life (Tate, 1994). As for our Black students, what they tell us is that their experience in high school mathematics classes vary from "We spent half of the time taking roll and dealing with classroom management," to "Our teacher did not really know what she was talking about."

The NSU academic culture consists of many Black students who may arrive under-prepared and un-motivated, but we believe that they are able to perform at high levels of competence when opportunities to demonstrate competence and mastery and opportunities to experience mathematical applications to engineering are available and accessible to them. We aim to increase higher-order cognitive skills like problem-solving and critical-thinking but also wish to develop skills in teamwork, collaboration, and communication.

Seeking innovative teaching approaches which appeal to the Black students' style of learning and to the Black student' culture is essential to leveling the playing field in mathematics education. Participating in the NSF SUMMIT-P and NSF-TIP grants has allowed us to tailor our freshman pre-calculus and calculus courses through professional collaboration, flipped-learning, and peer instruction, but there is still much work to do in terms of recruitment and retention for both students and faculty.

Mathematics is more than a set of skills; it is a culture. An HBCU is more than a set of Black students, it is a culture. We are fortunate that in our HBCU, we have the opportunity to bring these two cultures in a beautiful synergy that will hopefully lead to success in mathematics classes for our Black students.

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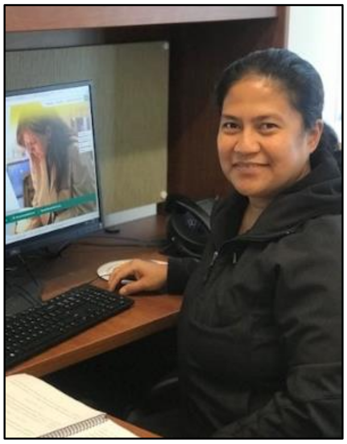


Dr. Maila Brucal-Hallare is fondly called Doc H by her students, where H may mean “humorless” or “hortative”, depending on the students’ moods. She holds a BS from the University of the Philippines, an MS from the National University of Singapore, a Diploma from the International Center of Theoretical Physics in Italy, and a PhD from the University of Kansas – all degrees are in Mathematics. She is currently an Assistant Professor of Mathematics at Norfolk State University and serves as a co-principal investigator for the NSF SUMMIT-P grant, Synergistic Undergraduate Mathematics via Multi-institutional Interdisciplinary Teaching Partnerships ($157,920). She believes that to be more effective with Black students, a professor must perceive them to be fully human, possessing enormous intellectual capacity. Outside the university, the H in Doc H means Homeschooling mom to her three children.

Dr. Anne Fernando is an Associate Professor of Mathematics at Norfolk State University. Her work focuses on the development and analysis of numerical methods for aero acoustics and risk benefit models. Prof. Fernando is very active in mentoring undergraduate students and advising undergraduate research projects. She has been awarded five ORISE Fellowships with the Food & Drug Administration in the Risk-Benefit Research group and was awarded two STARS grants at NSU. She has investigated active and collaborative learning methods in calculus I, and college algebra courses. Prof. Fernando has more than ten years of experience teaching and revising the course materials and curriculum for college algebra and pre-calculus courses at the university level and five years of experience on the community college level. Prof. Fernando holds a BS in Computer Science from University of Virginia, MS in Statistics and MS in Applied Math both from Georgia Institute of Technology and a PhD in Computational and Applied Mathematics from Old Dominion University. Prof. Fernando is a Co-Principal Investigator for an NSF grant, Targeted Infusion Project: Engaging Students for Higher Retention and Building Stronger Foundations in Pre-Calculus Using the Flipped Model ($396,412) in its 4th and final year. She is also involved in University service having served on the University Faculty Senate as Secretary for two years, and now as President.

The Impact of Implementing A Social Justice Task in Middle School Mathematics Classrooms

Kendra Nwosu
Kristopher Childs
Natalie Holliman
Tanishia Pride

> *I believe that education is the civil rights issue of our generation. And if you care about promoting opportunity and reducing inequality, the classroom is the place to start. Great teaching is about so much more than education; it is a daily fight for social justice. – Secretary Arne Duncan (United States Department of Education, 2009b, p. 6)*

Change the Perspective

In the past 50 years the academic achievement gap between the haves and have nots has persisted (Hanushek et al., 2019). Collectively educational leaders in the mathematics community ask, "How might we, the mathematics education community, make a difference in the teaching and learning of mathematics 'that promote rich, rigorous, and relevant mathematical experiences' for all students?" (National Council of Teachers of Mathematics [NCTM], 2014, p. 2). The mathematics community, as a collective, is committed to improving educational environments to impact all student learners, not just the privileged. As one advocates for better approaches that benefit every student, a social justice approach to mathematics instruction should be considered. In order for teachers to embed teaching mathematics for social justice into their mathematics lessons they must be equipped with the tools to locate and/or create lessons and develop resources by crafting their practice through a three-lens approach that includes lesson planning about social justice, with social justice, and for social justice (Benjamin Banneker Association [BBA], 2017). For the purpose of this article we will focus on teaching *about* social justice through a mathematics lesson.

What is Social Justice Mathematics Teaching?

Educators who lesson plan to teach "about social justice" must realize that these "practices are founded on the belief that mathematics is the tool to be used to challenge the status quo that is adversely impacted by the lack of social justice" (BBA, 2017, p. 1). The National Council of Supervisors of Mathematics and TODOS: Mathematics for all (2016) defines teaching mathematics for social justice as:

> A systemic approach that includes fair and equitable teaching practices, high expectations for all students, access to rich, rigorous, and relevant mathematics, and strong family/community relationships to promote positive mathematics learning and achievement. Equally important, a social justice stance interrogates and challenges the roles power, privilege, and oppression play in the current unjust system of mathematics education—and in society as a whole. (p.1)

Teaching about social justice through mathematics empowers all students to go beyond what society tells them they can achieve and creates change in an inequitable system (Bell, 2007). In the classroom this plan can be supported through the use of high cognitive demand tasks, with a focus on social justice. The purpose of this paper is to describe *how* one group of researchers implemented a social justice focused mathematics task in middle school mathematics classrooms, reflect on the experience, and provide implications for future use.

Why social justice teaching?

According to Gutstein (2003), social justice pedagogy has three main goals: “helping students develop sociopolitical consciousness, a sense of agency, and positive social and cultural identities” (p. 3). Social justice teaching through mathematics requires fair and equitable teaching practices, unrestricted access to mathematical support, and relevant subject matter. It has been well documented that students in schools that are predominantly Black/Brown and/or poor, experience inferior opportunities to learn mathematics (Berry et al., 2014). Critical mathematics pedagogy attempts to address this injustice. This pedagogy includes the theories and practices of critical teaching and social justice but uses mathematics as a tool to identify and take action against social injustices (Gutiérrez, 2013; Stinson et al., 2007). The essential characteristics of a critical mathematics pedagogy approach are to develop a sense of political awareness in students and motivate them to take action (Gutiérrez, 2013). If students are aware of their position in society and in history, they can push for changes of unjust practices. In mathematics, this looks like students having the ability to analyze and use real-world data to advocate for just practices (Gutiérrez, 2013). When the scenario is relevant to students’ lived experiences, then content retention is increased.

Creating relevant scenarios builds upon teaching via problem solving. This pedagogical approach embodies building upon the experiences students bring into the classroom setting, allows students the opportunity to engage in mathematics tasks through multiple pathways, and allows students to engage in authentic discourse (Carpenter, et al., 1989; NCTM, 2014; Schroeder & Lester, 1989, Smith & Stein, 2011). In order to simplify the experience for the teacher-researchers facilitating the tasks, we identified six stages of effective mathematics instruction to be used as a lesson planning tool to guide instruction: standard, student learning outcome, task selection, task implementation, task discourse, assessment (Figure 1).

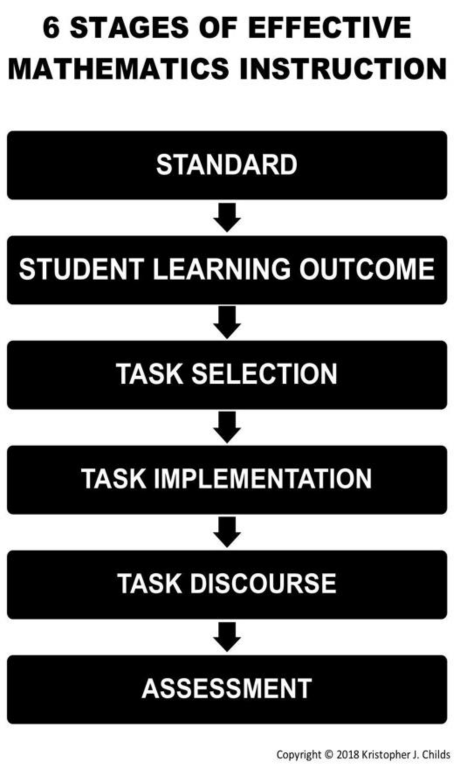


Figure 1. Six stages of effective mathematics instruction.

The six stages of effective mathematics instruction focus on key elements of mathematics instruction as defined by the NCTM (2014) and uses Smith and Stein's (2011) framework for discourse engagement.

Stage 1 – Standards define what students should understand and be able to do in their study of mathematics.

Stage 2 – Student learning outcome ensures that the discussion will be productive; teachers must have clear learning goals for what they are trying to accomplish in the lesson.

Stage 3 – Task selection defines a mathematical task as a mathematical problem or set of problems that address a related mathematical idea or concept. (Stein et al., 2000).

Stage 4 – Task implementation focuses on the implementation of instructional tasks (i.e. how tasks are enacted during instruction) has the most significant impact on students' learning. (Boston, 2012).

Stage 5 – Task discourse focuses on engaging in a mathematical discussion following their work on an instructional task influences students' opportunity to engage in high-level thinking and reasoning. (Boston, 2012).

Stage 6 – Assessment is a process whose primary purpose is to gather data that supports the teaching and learning of mathematics. (NCTM, 2014).

Let's explore a naturally embedded social justice task in the context of a traditional mathematics lesson.

Social Justice Task – Setting the Stage

A standards-aligned social justice mathematics task was selected to be implemented in a middle school setting. Two middle school mathematics educators, Vanessa and Shonda (all names and school names are pseudonyms), were selected to implement a social justice task with their respective student populations and also were researchers on this project; we refer to them as teacher-researchers. Vanessa and Shonda were both instructional facilitators in different regions of the United States and were published authors and leaders in their field. Vanessa's implementation of this project's research and data collection phase occurred while mathematics teachers were absent, and students were supervised by substitute teachers. Shonda collaborated with Olivia, an after-school teacher during their schools extended day program.

South Middle School. Vanessa is a middle age Black female who has been an educator for seventeen years, primarily at the middle school level. Ten of those years have been dedicated to educational leadership working with diverse student populations in suburban middle school environments. Vanessa works at South Middle School, a Gifted and Talented International Studies Magnet School located in the South Central region of the United States. This school had a total population of 535 students consisting of 46% girls and 54% boys. Ninety-three percent of students identified as students of color and all students at the school received free school lunch.

Vanessa engaged forty-one students at in the *Welcome to Orlando* social justice task; 37% girls and 63% boys. Ninety-four percent of these students identified as students of color with approximately eighty percent representing students from an African diaspora background. Four groups of students engaged in this research project, including two 6th-grade gifted mathematics classes, one 8th-grade intervention mathematics class, and one 8th-grade math enrichment pull-out accelerated group. The majority of the students (78%) who engaged in this social justice task had been identified as gifted learners and participated in an accelerated learning pathway for mathematics. The remaining students (22%) participated in a regular mathematics pathway and were enrolled in an additional mathematics class as an intervention course that involves technology-assisted learning as a supplemental aspect of their curriculum.

This task required a major shift from the common pedagogy that students were accustomed to in their mathematics learning environments. The gifted and accelerated students at South Middle School adhered to a textbook-based curriculum supplemented by standards-based learning activities. They were never presented with an activity that focused on social justice in their own communities. South Middle School intervention students spent half of their class time in a small group scripted, teacher-led, guided practice assignment, and the other half on a computer-assisted mathematics program as their curricular delivery mechanism. Vanessa stated, "this technology-enriched mechanism involves several interesting global international issues of social justice, but none that are addressed within our students communities and neighborhoods."

East Middle School. Shonda is a millennial Black female and has been in education for over 10 years. In this capacity she has worked in the areas of curriculum and instruction, professional development, and educational leadership. She worked as an instructional facilitator with Olivia, a Black middle-age teacher that worked in the after-school program with a passion for student learning. East Middle School, located in the Northeastern part of the United States, was among the most diverse middle schools in the state, and was the second site to participate in this research study. East Middle School was an urban school, located in an underserved neighborhood of one of the larger cities in the U.S. The student-to-teacher ratio was 15:1, with approximately 700 students enrolled in this institution, 43% girls and 57% boys. This school reported 100% of its students to have free or reduced lunch, and the median household annual income was $24,000. All of the students identified as students of color with 55% representing students of African ancestry. Eleven students in the school's extended day program participated in completing the task; 56% girls and 45% boys.

The afterschool program, funded by the Department of Human Services, had been in operation for eight years and managed to maintain steady enrollment to secure funding every year. Students in the afterschool program have embarked on "Money Making Mondays" where they learn and dialogue about financial stability, entrepreneurship, and how to make money work for the investor. Shonda mentioned at East Middle School there was not much of a shift in the curricular aspect of this task for students and teachers. She mentioned, "my teachers do 'Money Making Monday;' we did this on a Monday, so they are accustomed to an hour session of doing something, learning about something, learning about something impactful, whether it be about budgeting, couponing, or how to balance a checkbook."

Task Introduction

Vanessa and Shonda wanted to implement a social justice mathematics task that proved to connect their students to a socioeconomic reality that impacted their real-world. Understanding that the majority of the targeted students identified as African American or Black, it was imperative for Vanessa and Shonda to select a task that not only provided an interesting mathematical experience, but one that engaged students in rigor, relevancy, and empowerment. The educators selected the task *Welcome to Orlando* (Figure 2) which included corresponding Teacher Notes to review prior to implementation of the task. The *Welcome to Orlando* materials included identification of the associated mathematical standard, student learning outcome, task, questions, and guiding thoughts.

Welcome to Orlando

Please complete the following two scenarios and answer the questions below. Show your work. Be prepared to explain and justify.

Scenario A (Pine Hills Home*)

After paying the mortgage you have 3/4 of your monthly budget left. If you spend 2/15 of the leftover budget on utilities, what fraction of your whole budget is spent on utilities?

Scenario B (Windermere Home*)

After paying the mortgage you have 3/4 of your monthly budget left. If you spend 2/75 of the leftover budget on utilities, what fraction of your whole budget is spent on utilities?

Questions

1. What percent of Scenario A's budget is spent on utilities?
2. What percent of Scenario B's budget is spent on utilities?
3. Does Scenario A or B spend more of their monthly budget on utilities?
4. How do you know?
5. Why? (FYI - homes are the same size; both are families of 4; utility usage is the same)

**Community names changed to match actual community names located within the school community*

Figure 2. Welcome to Orlando student directions.

Collectively the researchers discussed modifying the task to align with their respective communities. The *Welcome to Orlando* task focused on two communities in Orlando, Florida: Windermere and Pine Hills. In Pine Hills, a predominantly low-income community, 10% of household income was spent on utilities (Sabol, 2016). However, in Windermere, a predominantly affluent community, 2% of household income was spent on utilities. Based upon this data the researchers were able to ascertain similar inequities in Vanessa and Shonda's communities in which the task would be implemented.

The researchers prepared for implementation of the social justice task by working through the task individually to predict potential student experiences, misconceptions, and outcomes. As a goal, the researchers sought to use this task to enhance mathematics programs at their school site to look critically at significant and provocative issues (BBA, 2017), and to embrace the NCTM (2014) position that "effective curriculum incorporates problems in contexts from everyday life and other subjects whenever possible" (p. 4). The task was designed to highlight two communities (one from which the targeted students resided and another in a different school zone) and the inequities in energy efficient homes and accessible renewable energy. Given the varying geographical locations, the researchers were required to examine the data associated with their own communities using local energy statistics and average energy consumption corresponding to each neighborhood and city subdivision. To ensure the task context matched the community referenced, average annual salaries were computed to ensure the fractions within the task matched a true economical representation for each community. Likewise, the fractional representations provided within each task scenario needed to be adjusted to align to the communities being examined at the South and East Middle School sites. To ensure that students were able to connect meaningfully to the task the researchers modified the *Welcome to Orlando* context to ensure all students were familiar with city and community names and identifiers. However, a key element of the *Welcome to Orlando* task was the fact that it was rooted in the mathematics standards. Thus, students had the opportunity to experience a high cognitive demand task and simultaneously make sense of a real-world economic issue that their families faced.

Task Implementation

The implementation of the task focused on the use of mathematics that could in turn reveal that inequities exist among neighboring communities within the same city. The essential components of social justice education provided by Gutstein (2006) was utilized as a reference point while planning for the use of this task. Specifically, the components content mastery, action/social change, and awareness of multicultural group dynamics were focal points during the researcher's planning and collaboration. Ensuring these three topics remained at the forefront of instructional planning allowed opportunities for deeper discussions and critical analysis of authentic experiences to take place (Welton et al.,2015). This task was planned to give students a powerful method for developing positive cultural identities, one of the three critical components of teaching mathematics for social justice (Gutstein, 2006). Creating a space for student dialogue among various identities was essential to this task's implementation (Welton et al., 2015). Cultural relevance aided in awareness of the multicultural dynamics of the groups given the teachers knowledge of the student participants and their socially constructed identities. Vanessa and Shonda implemented this task utilizing the six stages of effective instruction (Figure 1).

The task was designed using a sixth-grade standard, apply and extend previous understandings of multiplication and division to multiply and divide fractions, achieving Stage 1 of effective mathematics instruction. The curriculum supported the use of this task given that the concepts associated with multiplication and division of fractions were taught earlier in the school year leaving this task as an extension to prior knowledge students had obtained from previous learning opportunities. Students have to be exposed to the mathematical and social justice content before the opportunity of engagement in order to participate fully in the task.

The teacher informed the students of Stage 2 – Student Learning Outcome: students will be able to multiply a fraction by a fraction. After review of the student learning outcome, a location-specific modification of the *Welcome to Orlando* task was posed to students.

Upon the initial overview of the directions and task, students were given independent time to work on the task (Stage 4 – Task Implementation). The teacher-researchers purposely did not provide guidance as students were encouraged to come up with their own problem-solving strategies. As students individually worked on the task, the teacher-researchers circulated and observed the students work. Next students worked in small groups sharing their respective problem-solving strategies (Stage 5 – Task Discourse). During this time the teacher-researchers utilized multiple assessing and advancing questions to ascertain students' levels of understanding. A great deal of scaffolding accompanied this step as the mathematical content became an apparent challenge among the majority of the student participants.

Vanessa mentioned that there were challenges associated with implementing the task, especially for students who had extreme difficulties with the conceptual aspects of multiplying and dividing fractions. She stated, "this social justice task represented an alternative learning experience compared to the norm for which the students (South Middle School) were accustomed." Students admittedly struggled with the fraction operations, due to a lack of computational understanding and application of prior knowledge. Students who lacked computational skills to successfully create expressions and calculations, coupled with the complexities of mathematical literacy, experienced a faster rate of disengagement in the mathematics task compared to others who continued to preserve throughout the entire session.

Vanessa observed that "many students were discouraged by the mathematics but remained committed to the context." Given the familiar context of the local neighborhoods within the task, the students did not completely turn away from the task, but instead asked more questions to understand it more clearly.

Tasks that couple procedures with connections require that students use mathematical procedures and computations in ways that construct conceptual understanding of essential mathematical ideas (Matthews et al., 2013). Vanessa stated, "I noticed that all students were engaged in the discussion and eager to advocate for their communities." In addition, Vanessa mentioned the exhilaration she felt with the responses provided by students in their realization of the unjust disparities that are handed to the citizens within their own communities.

Shonda observed, "at the start of the task, students were apprehensive, and disconnected until they connected with their neighborhood on the community map in each group. Once students identified the location of the school, their residence, and surrounding neighborhoods, their engagement significantly increased, rendering it easier to complete the investigation."

The research team intentionally sought to promote student engagement by eliminating a focus "on learning procedures without any connection to meaning, understanding, or the applications that require these procedures" (NCTM, 2014, p. 2). Students had to determine the correct procedure, based on the meaning it yields to the context of the task, for performing the operation. One aspect of the task that allowed the students to continue through the task given its mathematical complexity was the familiarity of the context of task. Shonda stated, "initial task engagement was based upon students knowing the communities stated in the task and making connections to their neighborhoods, these connections peaked students' interest as it relates to completing the task."

Following group discussions, the teacher-researchers facilitated a whole group discussion of the task and strategically called upon students to describe their strategies, building upon student strategies with each subsequent response. Due to time constraints the teacher-researchers were unable to complete Stage 6 – Assessment through the use of the researcher-designed rubric (Figure 3); however, traditional feedback was provided to students.

Grading Scale	What does this mean in student terms?	
+	*Achieving Scholar*	Continue to develop and improve one's skills and knowledge
✓	*On Track*	Skilled in completing the task(s)
☺	*Getting It*	Progressing in a way that is likely to result in success
—	*Not Yet*	Ask for help; try again by completing an alternative assignment
0	*Not Enough Info*	Anything incomplete

Figure 3. Feedback rubric adapted from Deddeh et al. (2010).

During tasks student takeaways

Upon completion of the mathematical operation portion of the task, students then had a lively discussion regarding the inequities in energy efficiency. When asked what contributed to the cost of utility usage by both communities, the participating students suggested:

- Solar panels = less bills for everything overall
- Many new environmentally safe electrical items
- Leaving lights on
- Water, electricity, cost of high-tech electronics, and gas
- Automatic lighting systems

When asked "Do you think it's fair?" some students responded yes, and others no. Sample student comments are in Figure 4.

	Do you think it's fair?
Yes	Yes, it is
	Scenario B lives in a better neighborhood.
	Scenario A is historic.
	Running water, plumbing, washing dishes, using the heat.
	Yes, somewhat.
	Because some people have a bigger family, and they shouldn't pay more for one person.
No	People in City B have a better environment and they have working stores.
	If they are using the same amount of utilities, they should get the same price.
	No, because I don't get that. If they're using the same amount of utilities, they should get the same price.
	They spend less money and we use the same amount of utilities.
	I don't think it is fair that we have the same utilities but pay different prices.
	Because people in the older homes should have to pay less since their stuff is older than the people in City B.
	This ain't fair, because everything should be equal.
	Because they mostly have very new stuff, while we have historic stuff.
	Because they pay less than those in Scenario A; B uses a lot of power.
	No, it almost feels a bit racist. It is just not right.
	Because I think that people should pay the same. People are paying less money for wonderful things while other people are paying more for not so wonderful things.
	I don't think it is fair b/c people in Scenario A have less money than those in B.
	I don't think it's fair.
	I think it's not fair because we are African American.

Figure 4. Student responses to the second discussion question, "Do you think it's fair?"

During the open discussion emotions ranged from shock to rage among most students. Shonda stated:

> A lot of them (East Middle School students) stated "this ain't fair, this isn't fair", but two students in particular got so upset, threw their pencils down, and one of the students walked out of the library. When he came back, he continued to say, I mean you know this isn't right. We had that particular student to come up and lead the discussion, because he had to "get it out." The student's energy and excitement were used an as catalyst to develop a plan of action for change.

Vanessa, Shonda, and Olivia found that the mathematical task made the student participants a bit uncomfortable initially and they needed to provide more scaffolding to guide them through small group mathematical discoveries. In the end the student take-aways included:

- There are systems in place that keep rich neighborhoods richer.
- We are not being fair; (adults) are not being fair to poor neighborhoods.
- It costs more money to live in poor neighborhoods.
- It is a conspiracy.
- Pricing impacts urban areas more than the suburban areas (smaller communities).
- People who are struggling to survive have extra undue stress given this reality.
- Although it looks like suburban areas are more expensive, they really are not.
- They use the same amount of energy, pay less, and it is not fair.

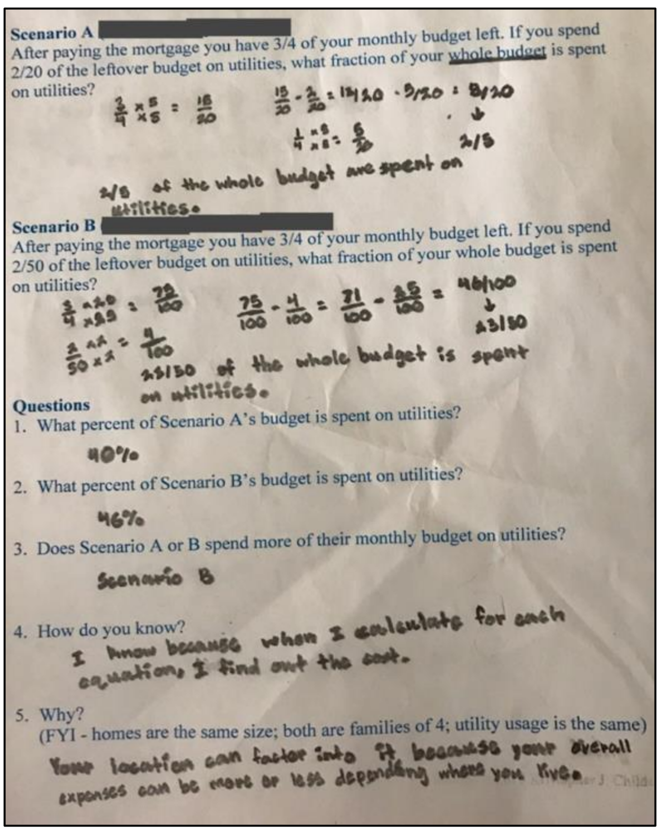
Post-Task Teacher-Researcher Observations

The task provided students an opportunity to develop a deeper understanding of multiplying fractions by fractions with context connections. The rich problem-solving task challenged students thinking and understanding of the content. Students made sense of problems and persevere in solving them, throughout the task, one of the Mathematical Practices. This task required students to have prior knowledge of fractional computation and a keen conceptual knowledge of fractional operations. Fractions and their equivalencies (i.e. decimals, percentages, ratios, rates, and proportions) are considered to be essential for student's later success and is determined to be a predictor for algebra readiness and their overall mathematics success (Siegler & Lortie-Forgues, 2015).

Students engaged in explaining to themselves the meaning of the problem and looking for entry points to its solution. The participating students benefited from the task having multiple entry points and most importantly found benefit in the real-world application. The presented task (Figure 2) introduced the middle school (6^{th} – 8^{th} grade) students to a scenario that encouraged them to use mathematics as a tool to identify a common reality for residents in their own community and others within their shared city of residence related to the cost of utilities for each group. Using conceptual understanding of fractions students calculated and compared the fractional allocation used by residents based on their locale.

South Middle School students who were familiar with the content were able to reason with mathematics. Many students identified that one group of residents in the Scenario A community spent a larger fraction of their entire budget on utilities compared to the other residential group who resided in the Scenario B community. In reality the Scenario A residents spent practically a little over double the amount (8%) that the Scenario B residents spent (3%) in relationship to their monthly budget. The majority of the students thought this reality was unfair given the residents used the same amount of utilities but paid varying, in most cases double, amounts of money. The remaining students suggested this reality was just given the residents in Scenario B had nicer homes and a better living environment. Another rationale provided by the students for the fairness of this injustice included the fact that the Scenario A area had more historic homes, therefore the utility cost would be more expensive because the homes and sources of utilities (i.e. breaker boxes, lighting system, lack of upgrades such as solar panels) were older.

The student artifact in Figure 5 shows the connection that Student M made between the mathematics and the social injustice that is happening within their neighborhood. This student answered the mathematical questions partially correct and made the connection that there is an inequity among the different neighborhoods and how much they spend on utility bills.


Scenario A [redacted]
After paying the mortgage you have 3/4 of your monthly budget left. If you spend 2/20 of the leftover budget on utilities, what fraction of your whole budget is spent on utilities?

2/5 of the whole budget are spent on utilities.

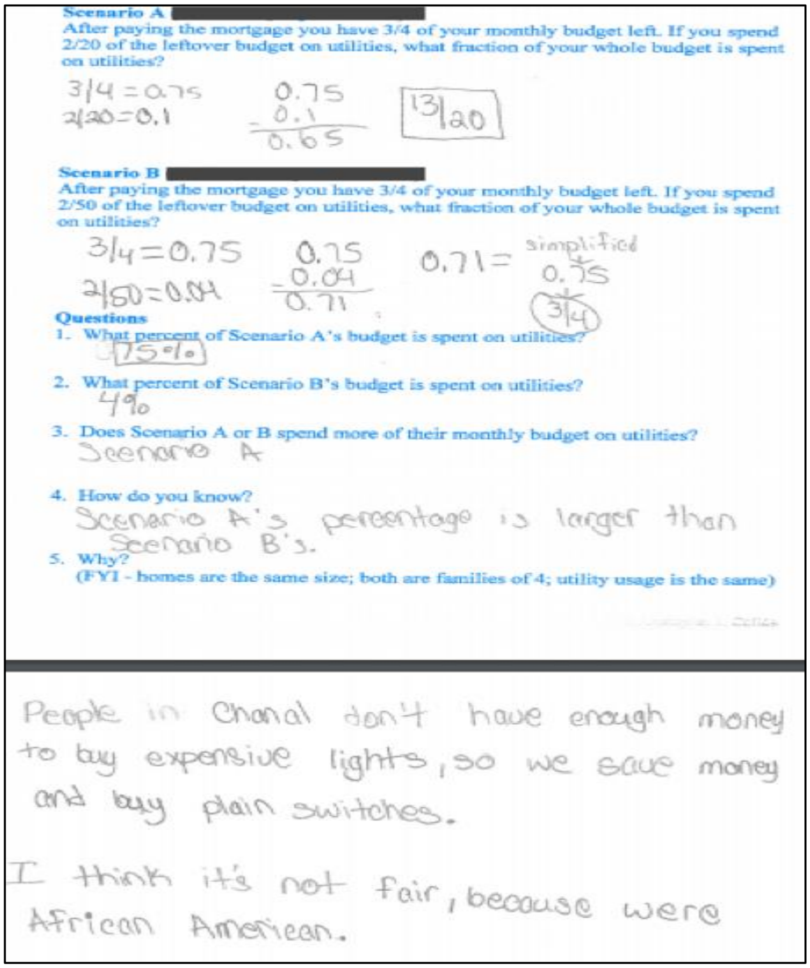
Scenario B [redacted]
After paying the mortgage you have 3/4 of your monthly budget left. If you spend 2/50 of the leftover budget on utilities, what fraction of your whole budget is spent on utilities?

23/50 of the whole budget is spent on utilities.

Questions
1. What percent of Scenario A's budget is spent on utilities?
40%
2. What percent of Scenario B's budget is spent on utilities?
46%
3. Does Scenario A or B spend more of their monthly budget on utilities?
Scenario B
4. How do you know?
I know because when I calculate for each equation, I find out the cost.
5. Why?
(FYI - homes are the same size; both are families of 4; utility usage is the same)
Your location can factor into it because your overall expenses can be more or less depending where you live.

Figure 5. Student M response.

On the other hand, one facilitator was astonished to realize the individual difficulties her students experienced overcoming the rigor presented in the task itself. For example, the student work shown in Figure 6 represents the work of Student N, a gifted 8th grade accelerated learner. Student N's calculations supports a strong fractional background of following procedures for adding and subtracting fractions but lacks conceptual understanding for problem solving. The mathematics represented in this work defends their conclusion about location being a factor in the cost of bills is true, but their mathematical process was incorrect. Both students in the examples below are good "rule followers" but lacked skills in problem solving. The level of rigor in problem solving with rational numbers was high therefore the facilitator found it to be beneficial to ensure that students have a good grasp of the content before engaging in the social justice aspect of the task.


Scenario A [redacted]
After paying the mortgage you have 3/4 of your monthly budget left. If you spend 2/20 of the leftover budget on utilities, what fraction of your whole budget is spent on utilities?

3/4 = 0.75 0.75 − 0.1 = 0.65 13/20
2/20 = 0.1

Scenario B [redacted]
After paying the mortgage you have 3/4 of your monthly budget left. If you spend 2/50 of the leftover budget on utilities, what fraction of your whole budget is spent on utilities?

3/4 = 0.75 0.75 − 0.04 = 0.71 0.71 = simplified 0.75 3/4
2/50 = 0.04

Questions
1. What percent of Scenario A's budget is spent on utilities?
75%
2. What percent of Scenario B's budget is spent on utilities?
4%
3. Does Scenario A or B spend more of their monthly budget on utilities?
Scenario A
4. How do you know?
Scenario A's percentage is larger than Scenario B's.
5. Why?
(FYI - homes are the same size; both are families of 4; utility usage is the same)

People in Chanal don't have enough money to buy expensive lights, so we save money and buy plain switches.

I think it's not fair, because were African American.

Figure 6. Student N response.

Reflection

The researchers, educators, and students in this study had the opportunity to engage in a mathematical standard through the use of a rich problem-solving activity. Students were able to actively engage in the mathematical practices through the educator's facilitation of the implementation process. The most impactful component of the task was when students were able to see the mathematical content connection to a real-world scenario related to their respective community. Students had a very lively discussion and debate centered around community wealth, socioeconomic status, race, and a possible rationale for the unfair disparities between the two communities. South Middle School student participants expressed a desire at the conclusion of the lesson to continue the discussion and identify a plausible plan of action. East Middle School students took on a different perspective as they joined together to discuss the wrongs of this situation but took on a "city swag" mentality that left them with very few solutions. Time restrictions at both research sites limited their solution-based actions.

As a shift from the norm in terms of instructional activities, this task provided all parties with an experience that will be memorable for years to come. As a fresh new perspective, this task allowed for the student participants to situate their thinking on a local issue and invited them in to find solutions to the problems they discovered.

> When students are taught mathematics through the thoughtful implementation of a social justice approach to a mathematics curriculum, they have learned not only mathematics concepts and skills, but more importantly they recognize both the legacy of achievement in their ancestry and the responsibility that has been passed on to them. (Scott, 2018, p. 9)

Due to the students rise in passion as a result of unbelief related to the inequities apparent in their neighborhoods, it is believed that the students will continue discussions related to advocacy surrounding this reality and the lack of equity centered on energy conservation in their city with friends, parents, and community members. This advocacy through social justice will become a newfound power that is meant to be utilized for the good of the community through responsible means. Given this outcome, Vanessa reported that this opportunity exceeded the social justice expectations she initially sought out to achieve with the task implementation.

Shonda and Olivia also were satisfied with the results of implementing this task. Shonda stated, "the students did struggle with mathematics, some more than others. We did see all levels of learners, especially when trying to do the math piece, but the lesson was learned. We couldn't figure out if it was the wording of the problem or the actual doing of the math problem that confused the students. It is hard to say if it is reading comprehension, because this was like a word problem." As she spoke, we could tell that Shonda was very intrigued with finding a reason for the student's misconceptions. She continued, "as we all read through, giving that additional support, then we were able to get through it."

In terms of meeting the social justice goal of this project, Shonda stated, "It is a strong yes; it may be because the students learned more through the discourse and the social justice component allowed them to engage a deeper level." Olivia, the teacher that worked collaboratively with Shonda, was very interested in continuing activities similar to this task. "When teachers create a bridge between their students' home and school lives, while still meeting the demands of the district and state curricular requirements, they also create a culture of rigor and high expectations, along with growth and achievement opportunities for each and every learner" (Holliman et al., 2018, p. 22). She commented thoroughly in a positive way stating, "Wow, these are neighborhoods right here, they would love this, this is right here." Shonda was very familiar and aware that when you connect the students to the tasks, they are going to "eat it alive" an aspect of culturally relevant pedagogy that his proven to yield success with students of diverse backgrounds (Ladson-Billings, 2009). Shonda stated the shocking aspect of the task resided with the mathematical levels of the students and how several students didn't know where to start in figuring the math in the task. "For some students I had to sit at their tables, and literary go step by step; and that is what shocked me." In the end all teacher-researchers were totally overwhelmed with the passionate response that they received by the students from the social justice aspect of this task.

Moving forward all teacher-researchers agreed that growth in this process would look specifically at the concluding advocacy aspect of this social justice process. Vanessa stated, "we talked about the issue and how unfair it was, but we didn't lead the students through solution-oriented opportunities.

It would have been nice to have time to plan an advocacy activity in response to the injustice and have a mock simulation to lead the students into a results-oriented solution." Hackman (2005) suggested,

> If the goal of [Social Justice Education] SJE is to support critical thinking, then we must create classroom spaces that provide the opportunity to do so. Educators need to disrupt the notion that silence is patriotic and teach students that their rights as citizens in this society carry responsibilities—of participation, voice, and protest—so that this can actually become a society of, by, and for all of its citizens. Students need to learn that social action is fundamental to the everyday workings of their lives. (p. 106)

The student participants were very passionate about the outcome of the mathematics reality of inequities that they discovered, so much so that they were moved to take action. Planning for future social justice tasks requires that time is allocated to mediate *action* as a byproduct of the opportunity.

The South Middle School used a 45-minute class period and East Middle School participants engaged in a one-hour session to implement this task. In hindsight, both time allocations were not sufficient in meeting the needs of the students in getting the most out of the task. Given the rich nature of the task, there is a need for an extension to get the full wealth of the task in moving the students forward in their social justice journey.

Recommendations for Implementing in Your Classroom

Going forward, more time must to be spent unpacking the social justice component of the task. While students had the opportunity to initially engage in the task, they were unable to fully reap the benefits of it due to time constraints. "A social justice approach to a mathematics curriculum will enrich the teaching and learning of all students by showing them how the subject is applied critically in solving real life issues" (Scott, 2018, p. 9). A full engagement would move beyond a discussion on the social justice component and include the collaborative development of a plan of action to rectify the issue. This plan should be organically developed by the students, monitored, adjusted and modified by educators, and implemented over time. Thus, the social justice component could be spread out over the course of a module, opposed to just a singular task in order for students to see multiple mathematics content connections.

In order to implement a mathematics social justice task in your classroom we recommend the following five keys to success:

1. Collaborate with your students to identify a relevant community issue.
2. Develop a social justice task using the mathematics standards as a foundation.
3. Keep the mathematics content at the forefront of the task.
4. Upon solving the task, have students develop a feasible plan of action to address the issue.
5. Have students implement their plan of action.

First, collaborate with your students to identify a relevant community issue. Collaboration is important as students are rooted in the community; thus, one does not want to individually identify a perceived issue. Second, the task must be rooted in the mathematics standards. Alignment to the standards ensures students receive a comparable mathematics as it relates to their peers based upon the progression of the standards. Third, during the implementation phase of the task keep the mathematics content at the forefront. While ultimately, we want students involved in social change, but prior to this occurring, students must have a solid mathematics foundation. Fourth, students need to collectively develop a plan of action to address the issue. This development of a plan of action could range from a plan to bring about community awareness to the blueprint of a tangible product. Finally, have students implement their plan of action. This is the most important step as students have identified an issue, developed a plan, and in this step, they actually begin the process of change. Following these five steps will help educators successfully implement a mathematics lesson about social justice.

Conclusion

Instead of asking how we can teach mathematics equitably, we should begin by asking how we can teach for equity and social justice. And because mathematics is what we do as humans, a mathematics education will emerge (Lawler, 2016, p. 42). Students at all levels are eager to know, "When will I ever use mathematics in my real world," and "why do I have to do math?" Educators at times grapple with the answer to these questions in response to students.

"It is time for us to humanize the teaching and learning of mathematics so that students see value in the mathematics they are learning and how it extends beyond the goal of being college and career ready" (Staley, 2018, p. 38). Students desire true meaning to their learning activities.

The mathematics social justice task outlined in this article is meant to serve as an example of how social justice and mathematics can come together to provide students with real life experience. Social justice in the mathematics classroom is a beneficial tool not only to open students' eyes to the issues their community faces, but also to take action against those injustices.

While mathematizing social issues is one strategy of social justice curriculum, it is not the goal. "A social justice curriculum should facilitate students' critical examination of the world and critical consumption of information and engage the larger community beyond the classroom walls" (BBA, 2017, p. 2). This particular task used proportional reasoning to enlighten students about the issue of the varying proportional costs for utilities among neighboring communities of their city. Although time did not permit the teachers to facilitate a call to action, students were enlightened and had a desire to take action. As a result of the task and student resources, teachers reported high levels of student engagement, rendering classroom management seamless. The task proved to be beneficial for students' understanding of the mathematics concepts, student engagement, and student enlightenment.

The other part of teaching about social justice is having high expectations for all students (Good, 1987). Throughout the high demand task, teachers expected students to succeed and did not allow students to give up. As a mathematics community it is imperative that we change our perspective of mathematics teaching as well as help change students' perspective of learning mathematics. A part of embracing this change includes acknowledging that "people don't need mathematics; mathematics needs people" (Gutiérrez, 2016). As mathematics evolves with new discoveries and innovation, we will need diverse and intriguing people with varying perspectives and voices to significantly change the trajectory in this scientific work and research. One way to achieve change is through teaching about social justice through the lens of mathematics which includes, having high expectations for all students and mathematics social justice tasks.

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I C U CARE: A Framework for Creating More Equitable Math Classrooms

Pamela A. Seda

Educating all students has been at the center of school reform efforts for several decades, yet school math structures and system policies have been resistant to change. While the student population in the United States is becoming increasingly more diverse, the teaching profession is becoming less so (D'amico et al., 2017), resulting in many students sitting in math classrooms with racial, cultural, ethnic, and socioeconomic backgrounds that are different from their teachers. Too often, teachers assume that all students share the same ways of thinking, behaving, and working in school. When these assumptions do not match the realities of their students' lives, a cultural mismatch ensues, often resulting in depressed academic achievement and lack of positive mathematics identity for marginalized students.

Why is an equity framework important?

Implementing "reformed" instructional strategies without attending to inequities that have been ignored for decades, socio-economic discrimination and racist structures will continue to resist improved outcomes for marginalized students. Without an intentional and deliberate focus on equity and access, even well-meaning teachers will perpetuate inequitable practices that produce the current achievement gaps. In today's educational landscape, teachers have so many things that demand their attention that it is easy for them to be overwhelmed. An instructional framework provides a structure for teachers and educational leaders to reflect on their practices and strive to change systemic barriers and policies that prevent all students equitable access to advanced mathematics learning.

The I C U CARE framework grew out of my dissertation research (Seda, 2008), where I applied design principles from the multicultural teacher education literature (e.g. Zeichner et al., 1998) specifically to the mathematics classroom. This framework not only provides a starting place for *what* teachers can do to create more equitable mathematics classrooms, but also *how* to accomplish that goal. It provides a structure for the myriad of instructional decisions that must be made by teachers daily. Teachers using this framework are not expected to blindly follow a script but rather understand the reasoning behind each framework principle, so they can assess the efficacy of their own efforts as they implement each principle. The principles of the I C U CARE framework are as follows:

I C U CARE Framework Principles

1. **I**nclude others as experts
2. Be **C**ritically conscious
3. **U**nderstand your students
4. Use **C**ulturally relevant curricula
5. **A**ssess, activate, and build on prior knowledge
6. **R**elease control
7. **E**xpect more

Include others as experts - Create classroom environments that extend beyond the teacher as the sole authority to develop competence and confidence in others as experts, including the students themselves.

Who are the experts in the classroom? If the teacher is the only person that students trust and listen to, then students miss out on the learning opportunities that come from explaining and justifying their answers to others. In equitable classrooms, both teachers and students are learners. Correctness lies in mathematical argument, not with the teacher. Effective teachers learn how to build the competence and confidence of their students by strategically creating a community of learners where it is the expectation that students take responsibility for their own learning, as well as the learning of their classmates. That means teachers will have to move from being the "sage on the stage" to the "guide on the side." One-way teachers can do this is by providing rich problems with multiple solutions paths, asking students to use multiple representations, and having students share their solution methods. To help students understand the connections between solution methods, content across domains and courses, and multiple representations, the teacher needs to have a deeper understanding of math content and connections across courses than with traditional methods of teacher preparation. However, the trade-off is that students will learn more deeply, and thus retain more.

Examples:

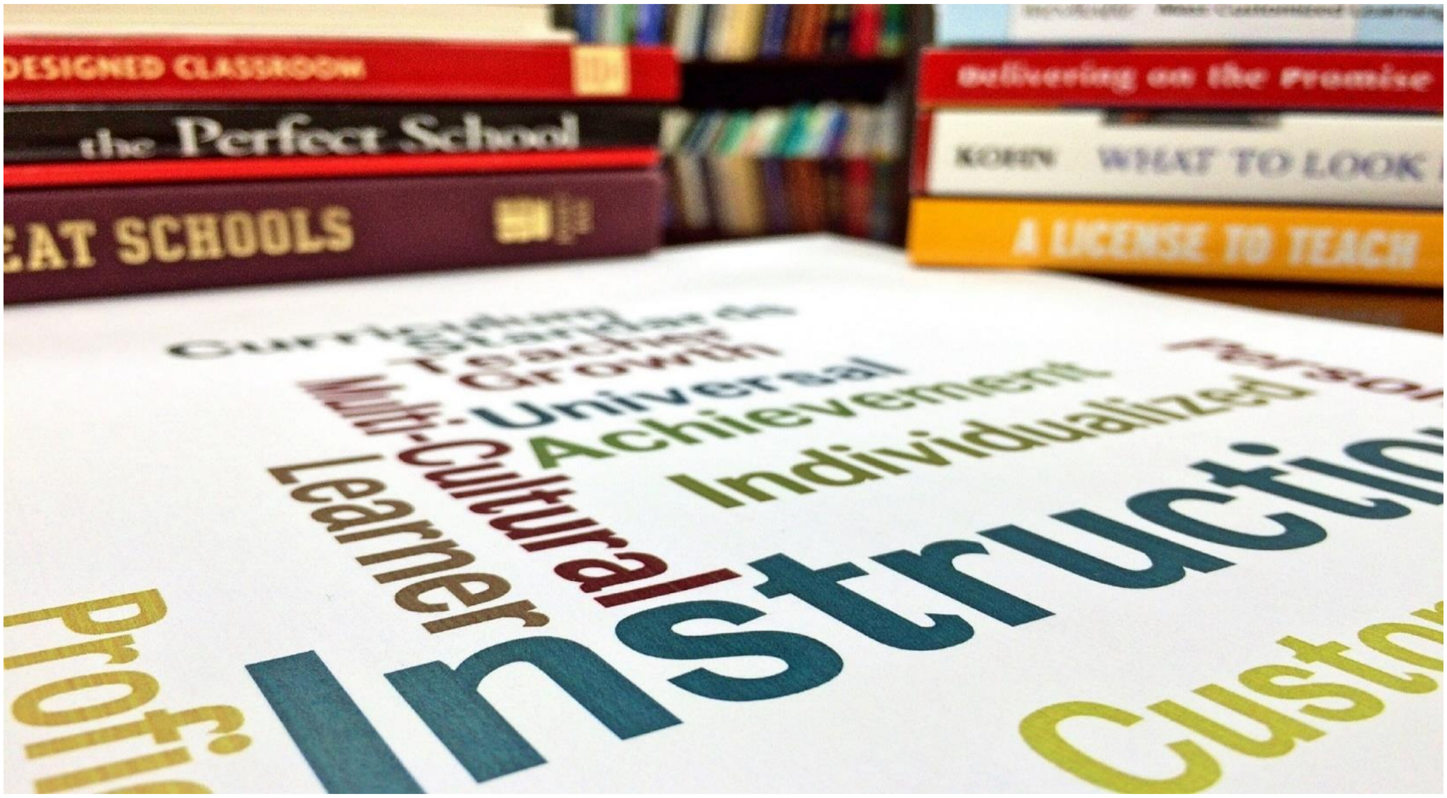
- Have students to seek out answers from sources other than the teacher (i.e. textbook, notes, internet, classmates, upper classmen, etc.).
- Redirect student questions to other students to answer.
- Gather feedback from community members on authentic assignments (i.e. feedback on student portfolio that illustrates academic behaviors that translate into the real world).
- Use remedial high school students as tutors for elementary students instead of a traditional intervention program for students who struggle (c.f. The Young People's Project http://www.typp.org/about_us)

Be Critically conscious - Take the time to understand how negative stereotypes impact your students and actively work to erase the effects of those negative stereotypes on the educational outcomes of marginalized students.

Critically conscious teachers cannot be colorblind. Teachers who do not acknowledge the racial and ethnic identities of their students cannot understand the impact of negative stereotypes on them. In her book, *"Why are the Black Kids Sitting Together in the Cafeteria?" and other Conversations about Race*, Tatum (1997) asserts that everyone has prejudices because everyone is continually exposed to misinformation about others through stereotypes, omissions, and distortions. Therefore, she likens prejudice to smog, an inescapable consequence of living in a racist society. While sometimes it is so thick it can be seen and other times it is invisible, nevertheless, people breathe it in and out every day, not because they want to, but because it is the only air available.

Tatum (1997) extends the smog metaphor by explaining that people do not introduce themselves as "smog-breathers" in the same way that they do not want to be identified as prejudiced. Still, if a person lives in a smoggy place, constantly bombarded by stereotypes and misinformation, he or she cannot avoid breathing the air.

No one is completely free of prejudices. Even people of color, because they breathe the same polluted air, often internalize these stereotypical images to some degree. Tatum continues that because prejudice is part of a person's socialization, it is not his or her fault. Although he or she may not have polluted the air, because



everyone experiences the negative consequences of air pollution, each person needs to take responsibility for cleaning it up. Each person must examine his or her own behavior. Unless people commit to examine actively and to challenge their own prejudices, they will be guilty of perpetuating and reinforcing the negative messages so pervasive in society. Critically conscious teachers constantly reflect on how their interactions with students either reinforce or challenge these negative messages.

Elizabeth Cohen and Rachel Lotan (2014) developed an instructional approach called Complex Instruction that requires teachers to pay attention to the unequal status interactions in the classroom and disrupt the status differences in classrooms by assigning competence to low status students.

Examples:

- Assign competence by using your power as a teacher to provide public, intellectual, and specific positive feedback that is relevant to the group task to students perceived by their peers as low status.
- Create learning environments that encourage growth mindsets, as opposed to fixed mindsets.
- Praise students for their efforts and the strategies they use, not their intelligence.
- Understand how stereotype threat and negative stereotypes depress student achievement and implement strategies to reduce it in the classroom.

Understand your students well – Learn about your students, their families and their communities for the purpose of improving instruction. (*Not making assumptions*)

Marcus: No, that don't fly Ma.

Erin Gruwell: First of all, I'm not anybody's mother.

Andre: No, that's not what it means.

Eva: It's a sign of respect... for you.

– *dialogue from Freedom Writers* (DeVito et al., 2007)

This dialogue illustrates how words can easily be misinterpreted when they are filtered through cultural lenses that are different. In the movie Freedom Writers, the main character thought her student was disrespecting her by calling her, "Ma." However, Marcus explained that he meant exactly the opposite. When teachers don't understand the cultural backgrounds of their students, they can easily misinterpret interactions in the classroom, often leading to negative assumptions regarding marginalized students.

Gloria Ladson-Billings (2012) stated that culturally competent teachers think of their students as a group of people from whom they can learn. They do not make assumptions about who their students are simply based upon their membership of a particular group. Because any given individual may be very much like most of the members of their historical groups of reference or may operate in ways that are quite outside the norms of that group, simply learning about the cultural norms of different cultural groups is insufficient (Hilliard, 1992). Culturally relevant teachers build the relationships necessary to understand their students well enough to intentionally design instructional plans to engage and motivate all students in mathematics learning experiences. This requires a concerted effort from the teacher to find out about their students' interests, learning styles, life experiences outside the classroom, extracurricular activities, etc. In order to do this, they must implement various procedures for acquainting themselves with the specific students in their classes, talking with parents, consulting with other teachers, conferring with community members, and observing students in and out of school (Zeichner et al., 1998).

Examples:

- Allow your students to teach you. For example, I recall a time that a Calculus teacher shared with me how he would ask his students to teach him the meaning of the latest slang terms. Even though he shared the same racial background as the majority of his students, the fact that he grew up in Jamaica meant that he was often baffled many of the terms that his students used. After demonstrating his willingness to learn about the meanings of terms that his students clearly understood (that he did not), he explained that his students were much more willing to put forth the effort needed to learn the meaning of the calculus terms he wanted them to know.
- Build positive relationships with your students.
- Ask about students' lives outside the classroom such as sports, family life, where they live, etc.
- Make real life connections and provide learning activities to maintain the interest of your students.

Use Culturally relevant curricula – Use instructional materials in ways that help students see themselves as doers of mathematics and help them overcome the negative stereotypes and messages regarding who is mathematically smart.

Where am I in this picture? That is the natural question we ask ourselves when viewing a group photo. Likewise, students ask themselves the same questions in mathematics classrooms. For many students, negative stereotypes and messages tell them that they do not belong in the picture of successful mathematicians. They hear messages like "I can't do math. Math is hard. Math is boring and has nothing to do with real life." Negative stereotypes often limit students' views of themselves and their abilities to be successful in careers that require mathematics. Culturally relevant teachers understand that the mathematical experiences of students in their classes will either reinforce or challenge those negative views. Therefore, they use curriculum materials to help expand students' vision of themselves as doers and creator of mathematics. They ask themselves, "Are there people who look like my students positively portrayed in the materials we use?" Culturally relevant teachers understand that teachers who strictly adhere to one type of strategy will invariably disadvantage some students whose primary learning style is different from that of the teachers. Therefore, a variety of strategies and assessments that take a student's cultural background into consideration are important for increasing the academic achievement of diverse learners.

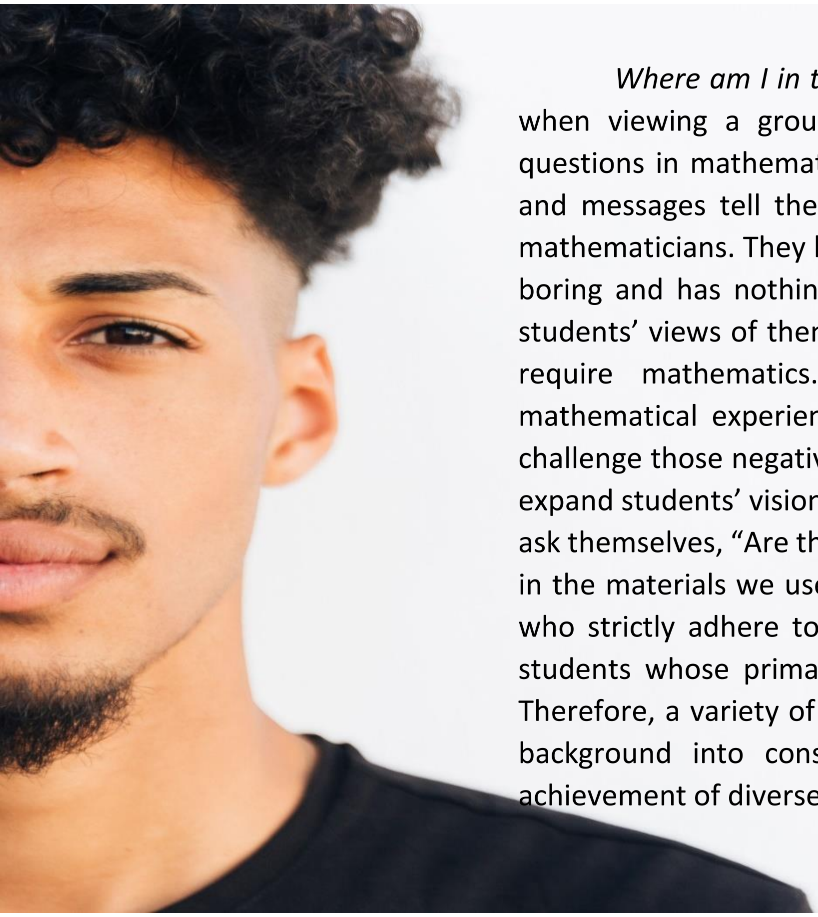


Image from https://www.freepik.com/free-photo/half-face-black-young-man_5028270.htm#page=4&query=teen&position=35

Examples:

- Acknowledge the racial and ethnic identities of your students.
- Use references that consider students with varying cultural and linguistic backgrounds.
- Use mathematics materials where people of color, females, etc. are favorably portrayed, such as Mathematicians of the African Diaspora (Williams, 2019) and Biographies of Women Mathematicians (Riddle, 2019).

Assess, activate, and build on prior knowledge – Value the prior knowledge that students bring to the classroom, both personal and cultural, and use that knowledge as a resource for creating new knowledge.

Negative stereotypes and biases cause many teachers to wrongly assume their students have no prior knowledge about a topic, and thus make no attempts to find out what they already know about a topic. Research has shown that a learner's prior knowledge can interfere with a teacher's attempts to accurately deliver new information, because learning proceeds primarily from prior knowledge, and only secondarily from the materials presented by the teacher (Roschelle, 1995). Teachers that fail to identify prior knowledge, including misconceptions at the beginning of instruction, do so at the peril of their students' learning.

Culturally relevant teachers understand the importance of connecting new concepts to things that are already familiar to students. This is especially important in mathematics due to the abstract nature of many mathematical concepts. They assume that all students bring knowledge, skills, and experiences, both personal and cultural that should be used as resources in teaching and learning (Zeichner et al., 1998). Culturally relevant teachers take the time to engage in formative assessment strategies that identify what students already know and identify gaps that could potentially hinder the learning of new math content. Rather than using these gaps as an excuse to stop teaching grade level content to remediate, they build on that prior knowledge to introduce new concepts and use cooperative strategies that allow students to fill in the gaps of their classmates where needed.

Examples:

- Engage in formative assessment strategies that provide evidence of what students really know, rather than relying on assumptions or labels. For example, instead of asking, “Does anyone have a question?” ask a specific question and call on a variety of students to answer (not just volunteers). That way you get an accurate picture of what students know, rather assuming that they understand the material because no one asks questions.
- Use culturally sensitive assessment practices like restorative justice practices, and Positive Behavior, Interventions, and Support (PBIS).
- Use strategies for activating prior knowledge like Turn and Talk.
- Use examples from students’ daily lives to clarify a concept, such as using denominations of money to teach the role of denominators in fractions.

Release Control – Empower your students to take ownership of their own learning by focusing on sensemaking and allow them to make choices about things that are important to them in the classroom.

Critical theorists make the assertion that political and economic power are unequally and unjustly distributed in society (Stanic, 1991). Traditional classroom structures that prioritize order and control, often serve to preserve the inequities already prevalent in society at-large. This is especially prevalent in low-performing schools in poor neighborhoods with high concentrations of students of color. Culturally relevant teachers seek to redistribute power and privilege in their classrooms by sharing their power with their students. They act as gate openers, rather than gatekeepers, by facilitating critical thinking and helping all students see themselves as constructors of knowledge. Two things must happen for this redistribution of power to occur: (1) Teachers shift the focus of mathematics instruction away from answer-getting techniques to focus on sensemaking, and (2) teachers give students choices about what they learn and how they learn in the classroom. Culturally relevant teachers understand the need to effectively balance decentralized control (student-centered activities) and accountability (organized randomness). Rather than making students accountable to the teacher, culturally relevant teachers engage in strategies that hold students accountable to each other.

Examples:

- Communicate that mistakes are a normal part of the learning process and encourage students to learn from their mistakes and the mistakes of others.

- Board Buddies: Allow students to choose a classmate to come with them when called to the board.
- Empower students to take ownership of their learning.
- Use culturally responsive classroom management strategies.

Expect More – Hold high expectations for all students and avoid deficit views of diverse learners.

High expectations for learning should be held for all students. However, traditionally structured schools privilege the experiences of dominant groups and tend to view ways of learning that differ from the norm as deficient. Unfortunately, teachers who hold deficit views of certain students cannot accurately assess their strengths because they tend to view students in terms of their deficits rather than their strengths (Hilliard, 1992). Teachers often lower their expectations and "water down" the curriculum because they believe that a certain group of students cannot handle the rigor of critical thinking. It is important to maintain high standards and rigor for struggling students. Well-meaning teachers often differentiate the learning for their struggling learners by making problems easier for them. However, according to the Expectancy-value Theory of Motivation (Wigfield et al., 2004), this approach often backfires because students, who no longer value the task that has been assigned, often won't even bother to try.

Examples:

- Make it a goal for all students to use Standards for Mathematical Practice every chance they get, because these are the behaviors that will make them "smarter."
- Engage all students with rich problems and critical thinking, not just the ones perceived as high achieving.
- Focus on students' strengths (what they CAN do) and use them as bridges to build skills they don't currently possess, rather than viewing students primarily in terms of the skills they lack (i.e. low level, level 4, remedial, special ed., etc.). When analyzing student work, begin with the question, "What does this student know?"
- In addition to the dialogue between the teacher and students, make sure students are engaged in student-to-student discourse.

Summary

My intention for writing this article was to help others develop an understanding of what equitable mathematics classrooms look like in a practical context by providing examples from which others can learn how to help diverse learners achieve mathematical success. I am in no way suggesting that these examples are enough to create the equity and access to advanced mathematics marginalized students have been denied. I simply provided these examples with the hope they would generate dialogue about the suitability of these practices and alternate ways of implementing these aspects of the I C U CARE framework. My goal was to demystify equitable mathematics classrooms by providing concrete examples and to encourage others who may read this to say, "I can do that." It is my hope that this article can serve as a springboard for others to begin the dialogue and instructional practices necessary to create more equitable mathematics classrooms.

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Dr. Seda is passionate about changing the negative mathematical experiences of students who have not previously experienced mathematical success. She feels that, for too many students, mathematics class means confusion, failure, heartache, lack of confidence, and feeling like a "dummy." It is her desire that all students experience mathematics the way she did—as something positive and empowering. You may reach her at pamseda@bbamath.org.

Black Girl (Math) Magic: Her Voice

Lesa M. Covington Clarkson
Elena A. Contreras Gullickson

Being a girl is kinda like having power… everybody would have like these different cultures and, like, these different ways of thinking. I really like that because I like a lot of people's ideas. – April

The "magic" of African American women is ubiquitous in the media recently. The message creates a positive image for women who have traditionally been marginalized by curriculum, society and careers. The first line of Mahogany L. Browne's (2016) poem, *Black Girl Magic,* describes the common message perpetuated by the media when she begins, "Black Girl, they say you ain't 'posed to be here…". A similar critical filter about who is welcome to participate in Science, Technology, Engineering and Mathematics (STEM) careers and discourse permeates educational spaces (Tate, 2005). Moreover, "negative stereotypes can impair engagement and confident performance of girls and women in [STEM]" (Halpern et al., 2007, p. 19). This highlights the need for a space with the potential to transform the pervasive message that STEM fields are intended for white males. This is one of the goals of a near-peer mathematics tutoring program called Prepare2Nspire (P2N). As described previously, P2N

> prepares under-served students to succeed on grade level, high-stakes, mathematics exams and to inspire them to continue their study of mathematics. The mission of P2N is to (1) develop mathematics confidence, content knowledge, connections, communication skills, and community through cascading tutoring/mentoring and technology, and to (2) create a STEM pipeline for urban underrepresented youth to postsecondary opportunities. (Covington Clarkson & Contreras Gullickson, 2018, p. 31)

For a more detailed description of this program see further discussion in Covington Clarkson and Contreras Gullickson (2018). One of the inherent messages of P2N is self-efficacy. Ultimately, this is the message conveyed in Browne's (2016) *Black Girl Magic* poem, "You are a Black Girl worth remembering.…" Being a Black girl holds power and beauty that cannot be contained. This article uses the lens of "Black Girl Magic" to expound on the mathematical experiences of African American female P2N participants.

Theoretical Lens

Often missing in critical conversations about success in mathematics are the voices of African American females. As such, this research interrogated factors they face in mathematics. This research aimed to reframe the factors as sources of agency. These factors include racial identity, gender, and the importance of role models. Each factor was explored through a lens of perpetuating narratives of success for African American female secondary and post-secondary students in mathematics. Collins (2000) asserts that there is value in examining the voices and experiences of Black women. This assertion provides a theoretical lens for this research.

Racial Identity

In order to begin to understand the ways in which African American female scholars break through some of the challenges they face as students of color, we must first understand what those challenges look like. One challenge young Black female scholars face in schooling is figuring out who they are in that setting. Doing so entails understanding that their blackness plays a role in how they navigate academia. Sellers et al. (1998) define racial identity as a multidimensional construct that represents individuals' perceptions of the importance and meaning of race in their lives.

There is also research that looks at the burden Black students face when navigating White-normed schools. Fordham and Ogbu (1986) argued that when students are academically successful in school, they get accused of "acting White" by their same-race peers (p. 176). The question is, then, how do we disrupt the notion that being academically successful is a White norm? In this article, we do so by highlighting narratives of success for African American female students, providing a counter story to the overrepresentation of white males in STEM spaces (Tate, 2005).

Gender

Gender plays a role in academic achievement. Girls tend to choose careers that spark their interest. Wigfield et al. (2006) assert that math and science careers will be chosen by female students when their interest in these areas is piqued and nurtured in learning situations. Halpern et al. (2007) expand upon this by stating that in order to encourage girls in math and science, we must create a "classroom environment that sparks initial curiosity and fosters long-term interest in math and science" (p. 23). A normed construct views mathematics as a subject dominated by White males. This construct makes it difficult for women to break norms and even more difficult for minority females to develop a sense of belonging within the discipline (Booker & Lim, 2016).

According to Collins (2000), knowledge created by Black females is subjugated. She claims that this created knowledge has been suppressed as a result of living within the context of mainstream social institutions. Young Black female scholars work around this suppression through meaningful relationships with like-minded individuals. Riegle-Crumb et al. (2006) assert that females "who are proficient in math create a unique social and academic context on which they can draw as they pursue a trajectory of achievement in historically male fields" (p. 207). They further argue that female students who have a friend group that is both female and successful provides a supportive framework for taking advanced courses. Their peers can provide them with social encouragement, academic support, and validation. Providing learning communities that are predominantly female perpetuates their narrative of success.

Mentoring and Role Models

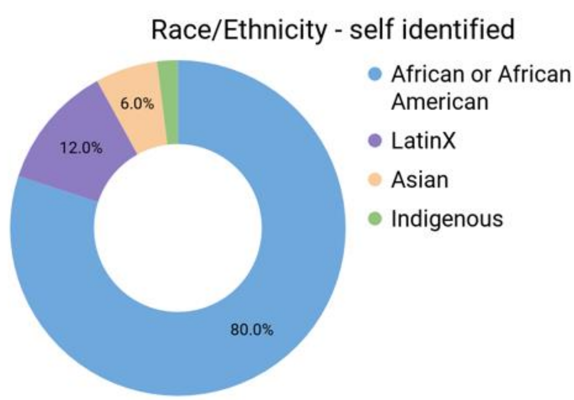
Recognizing that African American scholars who pursue success seemingly do so at a cost is important to keep in mind. As such, there are genuine emotions and challenges they will encounter as they push back against the White-normed mainstream. Mentors can play a role in helping Black females conceptualize and work through what they are experiencing. Hurd et al. (2012) assert that African American adolescents who have supportive non-parental adults in their social networks contributes positively to their racial identity beliefs. The confidence they gain then allows them to further explore and develop their racial identities. An implication of this finding is that mentors are needed in order to perpetuate success in Black female scholars. Students view mathematics differently when they can relate to adults personally (Booker & Lim, 2016; Walker & McCoy, 1997). Likewise, Halpern et al. (2007) recommend "exposing girls to female role models who have succeeded in math and science" (p. 19). Scholars want to work harder and they feel culturally supported when they share a similar identity in culture or socioeconomic class.

This research sought the voices of ten P2N Black female participants about what contributes to their success in STEM classes. We used critical ethnographic approaches to find emergent themes. We then discuss pedagogical approaches for nurturing black female scholars.

Methodology

Prepare2Nspire is designed to allow scholars to exist in a setting that inherently embraces their race, gender, and ability while supporting mathematical growth, perseverance, and relationships. The setting eliminates notions of feeling like the scholars should fit into normed constructs. Additionally P2N's design creates communities comprised of one university undergraduate mentutor (mentor + tutor), three eleventh-grade, and six eighth-grade participants. All participants benefit from this cascading tutoring model, and support and encouragement are fluid and natural components of the program design.

In the academic year of this research, 80% of P2N participants self-identified as African/African American, 87% qualified for free or reduced lunch, and 76% identified as female. While the participant pool was racially and gender diverse, there was a high percentage of African American female participants. Thus, this research focused on this group and chose a purposeful sample of participants for this study. The sample was based upon consistent participation in the tutoring program, self-talk about successful school performance, and researchers' observations of communication abilities. In order to interrogate program benefits and participants' notions of success semi-structured interviews were conducted with three eighth-grade participants (DeeDee, Desiree, and Renae), four eleventh-grade participants (April, Queen, Susannah, and Zara), and three university undergraduates (Anika, Olivia, and Roxanne). Sample interview questions included: "What makes a person successful at STEM? Describe what being a girl feels like in your family. Describe a time you were successful in mathematics. How did it feel? And do you feel as a person of color you get treated differently?"



Findings

Several themes emerged from this qualitative investigation including notions of confidence, connection, competence, culture, community and communication. For this article, we will use participants' voices to expound upon the themes of confidence and culture.

Confidence

Students who attend P2N always describe a change in their level of confidence. For example, Renae stated, "... cause you know my confidence is high. If I understand how to do it and I get good grades on my assignments, I feel happy." Interestingly, P2N scholars often seem to measure their success by assessment scores. Participants have demonstrated that due to the time and effort spent grappling with mathematical concepts in a collaborative setting, they tend to perform well on their mathematical assessments.

This causes a shift in their confidence and they develop perseverance. As DeeDee, an eighth-grade participant states, “getting a good grade feels good cause you feel like you’ve accomplished something.” Zara, an eleventh-grade participant follows that thought with

> *I feel like for you to be successful in anything you have to put in effort and for you to get something out of it. You can’t just be like I wanna do this. You have to give your time and give your work ethic.*

Roxanne, a university undergraduate with a self-designed women’s health major, described a time where she persevered.

> *One night I sat there, and I put like an extra, I don’t know, eight hours, just getting familiar with procedures and whatnot. And then the next time I walked into the classroom, I was the one, you know helping my lab group with what we’re supposed to be doing. So, I feel like in that sense I just have to put in the extra work and I will be confident in what it is I’m doing.*

Roxanne learned that success takes effort and time, and the result is not only understanding the mathematics, but ultimately gave a boost in confidence. For the younger participants, having Roxanne as a mentutor, and others like her, is invaluable as they are able to connect with participants in ways that are meaningful and genuine to the younger participants. Advice from a “near-peer” is perceived more positively than the advice of a parent or teacher (Walker, 2006; Weiston-Serdan, 2017).

The effectiveness of P2N is obvious when looking at what participants explain about the program. Queen, an eighth-grade participant, stated, “before coming here if I didn’t understand math, I just didn’t do it all. When I came here, I found help that I could get. I realized that I could understand how to do it instead of just leaving it to the side.” This aligns with a conclusion stated by Halpern et al. (2007), “one major way is to foster girls’ development of strong beliefs about their abilities in these subjects—beliefs that more accurately reflect their abilities and more accurate beliefs about the participation of women in math- and science-related careers” (p. 31). Prepare2Nspire, inherently and evidentiary, supports participants building a strong sense of self.

Culture

We also used the interview data to identify evidence about the effectiveness of the P2N culture on shaping students’ achievement in mathematics. For the purpose of this article, we define culture as the way students understand, react, and do mathematics in a learning environment. In addition, we use their perception of factors of success while “doing” mathematics. High expectations and genuine feedback play a role in student success. Booker and Lim’s (2016) research stated that “African American students’ sense of connection with their larger school environment has direct effects on student academic performance. In short, students who believed they were accepted and welcomed at school by teachers and peers demonstrated higher levels of achievement” (p. 1038). Similarly, Desiree described a parallel feeling: “P2N communities are supportive. They show you that they care.” In addition, DeeDee stated,

> *[8th grade algebra teacher] made sure that we had all the support that we needed to succeed, and it really paid off… because [8th grade algebra teacher] expects a lot from you so if she’s saying that you did a good job, then it means something.*

The African American female participants spoke of what it was like to work in an environment that held high expectations for them and at the same time supported them in the learning of mathematics. In turn, they internalized their successes and continued to work hard. These participants were very clear on what they needed to experience success in mathematics.

> *You can go far in life only if you work hard. If you want something you gotta work hard to get it."* – Renae

Discussion

There are several implications from this analysis of girls' experiences in the P2N program that we offer as suggestions for pedagogical practices. The list includes:

- The more students are exposed to diverse STEM professionals, the more they are able to identify as a STEM person.
- When students feel like they belong, they can focus on academics.
- Students should work collaboratively.
- When students receive high expectations, they work towards them.
- Students want to be acknowledged for their hard work and successes.
- Students should be given opportunities to communicate about challenging mathematics content.
- Students view homework differently when they get to work in a group.

The purpose of this article is to follow-up our Spring 2019 NCTM presentation, "Black Girl (Math) Magic: Multilevel Narratives of Success" and to continue the discussion of the difference that confidence and culture make for the success of African American females in mathematics environments. While there is clearly much work to be done in nurturing Black female students toward a trajectory of success in Mathematics, P2N is making a profound impact. In order to counter the commonly held belief that successful learning spaces and their associated successful outcomes are out of reach for African American females we must acknowledge the narratives of success that already exist. As such, this research illuminated that validating the intersectionality of race, gender, and mathematics is crucial in perpetuating such success.

We must continue to arrange for as well as research mentoring relationships that can provide encouragement, advice, and support while students are trying to navigate the racial and social issues that come with being a Black female in mathematics spaces. "Little rigorous research exists assessing mentors' effectiveness in math and science per se, but mentoring programs may provide many high-school-age girls with exposure to and connections with a woman who has succeeded in math and science" (Halpern et al., 2007, p. 21). Supportive learning environments should be created where student voices are valued. Such spaces should include collaboration, communication, and mentoring while pursuing mathematical knowledge.

Further implications for this work include a more balanced approach to understanding the scholarship of marginalized communities. Pushing back against White-normed constructs is a way to gain agency and validation for students of color. It is our hope that by modifying and being intentional about perpetuating narratives of success in mathematics for African American female scholars that we make grand strides in redefining norms.

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We the People: Math Literacy for All

edited by Michael Soguero for the *We the People – Math Literacy for All Alliance*

This summer, the national "We the People: Math Literacy for All" Alliance, took a very public, very meaningful step forward in service of a movement whose time has come: Math literacy as a civil rights issue.

During July 16–18, 2019 at the University of the District of Columbia, a coalition of youth, teachers, principals and superintendents representing eight local Alliance sites came together for three powerful days of sharing, planning and community-building. Each team led creative and engaging sessions highlighting their particular approach to serving young people and building math literacy, and all representatives had a chance to set programmatic priorities, strengthen collaborative infrastructures, and plan for the continued growth of the Alliance.

Teams attended from the Florida Local Alliance for Math Literacy & Equity and Broward County Schools, FL; the June Jordan School for Equity, San Francisco, CA; the Fannie Lou Hamer Freedom High School, Bronx, NY; the PreK–16 Historically Black Colleges and Universities project, New Orleans, LA and other sites; the Ohio Math Literacy Institute, Mansfield, OH; Excel High School, Boston, MA; the Baltimore Algebra Project, Baltimore, MD; and Flint Community Schools, Flint, MI.

This meeting of the Alliance was particularly exciting because it coincided with a public briefing on Capitol Hill that addressed congressional leaders, staff, and the public to spotlight the fact that school districts nationwide are struggling and therefore failing to provide large numbers of students, mostly young people of color living in poor economic circumstances, with opportunities to become math literate.

We believe that every student should have the resources and support to achieve math literacy. Specifically, our campaign calls for direct federal investment and involvement to support structured opportunities for students at risk of or currently performing in the lowest quartile on state standardized exams. This direct federal investment could support a variety of nationwide initiatives, including wider access to STEM activities, a focus on supporting students through the transition from arithmetic to algebra, structured opportunities for students to be involved in how the teaching and learning of math is taking place, the addition of more engaging content like computer science and coding to

Image from https://mathliteracyforall.org the curriculum, near-peer tutoring programs for students, professional development and pipeline strategies for recruiting and supporting teachers, and integrated assessment systems.

We are committed to owning this space, and we intend to put our voices out in a public way, announcing the Alliance as a force with momentum to be reckoned with on this topic.

The Roots of the Alliance's Work https://mathliteracyforall.org

The gathering came together with the spirit and conviction of purpose of Robert Moses' influential work. Moses has long offered a vision of school reform that builds on the power of communities, and the work of the Alliance aligns with his vision. Indeed, his powerful observations about the nature of true change ring as true today as the day he said them:

> *"Everyone said sharecroppers didn't want to vote. It wasn't until we got them demanding to vote that we got attention. Today, when kids are falling wholesale through the cracks, people say they don't want to learn. We have to get the kids themselves to demand what everyone says they don't want." — Robert Moses*

The Alliance believes in creating a collaboration that places key stakeholders—students and teachers, school leaders, community and parents—at its center, surrounded by the support of researchers, policy makers, and organizers. This collaborative structure is in alignment with the legacy of Robert Moses' work as well as the National Science Foundation's (NSF) current call for building local and national alliances that broaden participation in STEM (NSF, 2019).

We know that there are large segments of society that are excluded from political and economic access. We also know that those exclusions often fall along race and class lines. The result is that our most vulnerable populations are poor children of color. While we have found that our schools are failing to meet math literacy outcomes across the board, we also know that this is particularly true for poor children of color.

It is for all of these reasons and in this collective and enduring spirit that the Alliance pushes forward with the important work at hand.

What's Next for the Alliance

This summer's meeting of the Alliance gave birth to a platform for our work this upcoming year, including several key activities and projects that will engage local Alliances nationwide. These include:

- Documentation of our pedagogical approach, whether through maintaining the grouping of students through two years of Algebra (Math Cohort model) or through HBCU partnerships with local communities;
- Holding the National 2020 Flagway Game Tournament (http://www.typp.org/flagway) at The Ohio State University at Mansfield campus; and
- Supporting a strong youth voice component throughout Alliance work.

The public coming-together of the "We the People: Math Literacy for All" movement was an opportunity for our message to be heard on a national scale, holding up the voices of the representatives themselves to talk about the important work of the Alliance. Concurrently, a public briefing on Capitol Hill with Congress, people helped to raise our profile, increase our visibility, and help position us as a national voice for the important challenge of math literacy.

For more information, we encourage you to explore this brief montage of our work together: *We the People: Math Literacy for All* https://youtu.be/fBj0pZ_avko. If you are interested in knowing more about the ongoing work, please email Ben Moynihan at ben@algebra.org. He will provide you an invitation for our weekly Wednesday calls.

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Michael Soguero has been a leader in education reform since 1993 when he was a founding member of the Eagle Rock School & Professional Development Center in Estes Park, Colorado. Michael became the Co-Director of an Expeditionary Learning School, the School for the Physical City, in New York City and later the Founder and Director of a Big Picture Learning school, the Bronx Guild, where his work was held up as an exemplar of effective small school leadership. Michael served as a lead facilitator for the Scaffolded Apprenticeship Model program within the New York City Leadership Academy where he sharpened his facilitation skills, his broad understanding of urban school reform, and the power of dynamic leadership as a means to reform schools and change the lives of students. Michael led the Professional Development Center at Eagle Rock for 12 years expanding its impact nationally to hundreds of secondary schools to increase student engagement and achievement. He has assisted schools and organizations in developing alternative assessments, integrating restorative practices, implementing effective math pedagogy, launching entrepreneurship-focused programs, and developing executive leadership, and strategic planning. Michael facilitates projects for Education Reimagined, the "We the People – Math Literacy for All" Alliance, Future Focused Education, and the CARPE College Access Network out of the High Tech High Graduate School of Education.

Mathematics Literacy for the Information Age and Knowledge Economy: Leveling the Playing Field for Students in the Bottom Academic Quartile

edited by B.J. Walker for the *We the People – Math Literacy for All Alliance*

In mid-2017, two national convenings, supported by NSF INCLUDES Design and Development Launch Pilot award #1649342 and NSF INCLUDES Conference award #1650533, launched a new national "We the People – Math Literacy for All" Alliance. The Alliance's shared goal is that students in grades K–12 who on state tests perform in the bottom quartile in mathematics should graduate from high school able to do college mathematics without remediation or pursue careers without their mathematics education being an obstacle. We recognize that achieving this goal requires confronting long standing issues of social justice and the quality of public education in this country. It requires, as a civil right, a new standard for education in the 21st century and citizenship in a democracy. We believe that meeting this goal requires collective action from organizations, groups and individuals working at the national, state and community levels, inside and outside of formal school environments. We believe this bottom up work requires an alliance that can build effective collaborative structures that achieve the greatest shared and collective impact.

In July 2019, the Alliance held a public briefing on Capitol Hill to launch a national campaign, *Math Literacy for All 2020* (see https://www.youtube.com/watch?v=fBj0pZ_avko). The campaign will advocate for Math Literacy for All legislation to:

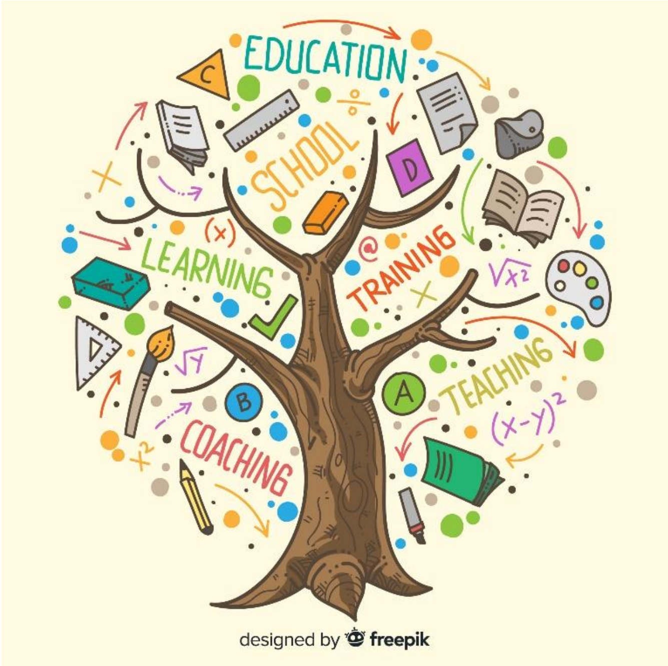
- enhance educational opportunity in schools that are disproportionately serving minorities and all students at the bottom academic quartile;
- offer schools the direct funding needed to change what are now minimum expectations about what and how mathematics can successfully be taught, to whom, and by whom; and
- coordinate funding across multiple federal agencies (such as the U.S. Department of Health and Human Services and the U.S. Department of Labor) to address a broad spectrum of academic as well as social-emotional needs many of these students have, that if better met, would enhance their ability to stay on grade level and leave high school ready to apply mathematics in college and/or career.

The Math Literacy for All legislation is an important ask because we live in a nation of unequal opportunity. Poverty, race and geography all contribute to inequities that effectively deny millions of our young people their constitutional right to full citizenship and to participation in the modern knowledge economy. The result is that as many as 40% to 70% of high school graduates entering college are not ready to take college math without remediation. We seek legislation that must accomplish two critical things:

- affirm that the protections of the 14th Amendment guarantee equal access to quality education, and
- deploy federal resources directly to local school districts and their communities, to provide additional time, attention and expertise to those students performing at the bottom on standardized mathematics tests.

Why mathematics?

The 21st century's Knowledge Economy requires mathematics literacy as a prerequisite to quality jobs and economic growth in an increasingly competitive and international labor market. Math competencies are the portal to a STEM-driven world. Without math young people will not be able to qualify for the educational opportunities, the internships, and the careers that STEM offers.



The Goal: Change the trajectory of success for our nation's youth by providing the teaching, coaching, mentoring and support necessary for all to learn mathematics on grade-level. Stop the common practice of asking our most vulnerable teachers to teach our most vulnerable students. Replace redundant and remedial curriculum with the kinds of robust, relevant, and engaging curriculum used with high achievers. Increase the in- and out-of-school mathematics electives and similar opportunities that are offered in schools serving disproportionate numbers of students in the bottom quartile. Stabilize teaching and learning settings by creating multi-year opportunities for teachers and students to work together. Achieve increased high school student graduation into post-secondary education and/or employment without the need for remediation. In short, raise the "floor" of mathematics achievement for young people from our nation's working-class families, families of color, and those living in under-resourced communities and neighborhoods.

The Anticipated Result: A significant expansion of educational opportunity so that more students in the bottom quartile can take advantage of efforts to offer free college tuition and to expand state-of-the-art schools and local job opportunities that are anticipated in the Rebuilding America's Schools Act (GovTrack.us, 2019).

What This Legislation Would Support: The nation is seeing numerous efforts to open up STEM opportunities for those who are currently being left behind. The Math Literacy for All legislation proposes activities inside local schools to widen the door to STEM; giving students and their teachers the time, resources and strategies they need to build the confidence and stamina and skills they need to achieve math literacy. These activities will open up structured opportunities for teachers and students to embrace math content; to be more actively involved in how teaching and learning are taking place so as to bring their interests to how the curriculum is structured; to provide their input to how assessments are designed and delivered; to work in collaboration with their peers; to work with math during in-school and out of school time; and to see themselves as assets to the teaching and learning of math, not simply as recipients of the knowledge and expertise of others.

Policy and Research are very clear about what works:

- ***A laser beam focus on the transition from arithmetic to algebra.*** Mastering basic algebra is key to mathematical literacy for a knowledge economy. Helping students generate a conceptual understanding of arithmetic operations, especially fractions, rather than simple memorization of rules, is key to a smooth transition to algebra.

- ***Increased ways to add high interest and engaging content*,** such as computer science and coding, into school curriculum to open alternative pathways to acquire algebraic mastery.

- ***Near-peer tutoring programs*** offer students multiple and varied opportunities, during in- and out-of-school activities, to explain what they know and to apply what they know in interactive settings, enhancing their own learning as well that of others.

- ***Professional development and pipeline strategies that recruit, groom and continuously build teacher experience, expertise and empathy.*** Successful work with vulnerable, often disaffected students requires more skill, experience and caring than other teaching environments. That work should be rewarded professionally in ways sufficient enough to retain and nurture those teachers in those classrooms over far longer periods than is currently the norm. Moreover, those teachers need to be recruited early, developed across their college careers, and sustained by membership in a collegial community where they can exchange ideas, learn from one another, grow professionally, and get recognized for their service.

- ***Mentoring programs.*** To help struggling, marginalized students stay the course and do the math required to achieve math literacy, they need mentors who are also willing to stay the course and who have legitimacy and credibility in their eyes.

- ***Research that identifies what works and supports its replication by working hands-on with actual schools.*** There needs to be interactivity between those whose work it is to study, understand and disseminate what works and those working on the frontline—students and teachers—so it is clear what success looks like and how to achieve it.

- ***Integrated assessment systems*** that measure academic and social emotional learning throughout the year, offering teachers, students and parents the data and information they need to continuously evaluate learning, to focus on effective teaching and to tailor instructional and other supports to the individual needs of students.

Change is a matter of great urgency: the federal government must put in place not just the policies but the resources and practices needed in public schools to make sure that each high school graduate has an equal opportunity to learn mathematics without requiring remediation in any post-secondary educational or career setting, and that each of their math teachers has an equal opportunity to acquire the training and certification to teach to this expectation.

For additional information about the "We The People – Math Literacy for All" Alliance, visit https://mathliteracyforall.org or email Ben Moynihan ben@algebra.org.

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B.J. Walker offers passion, leadership and management experience over 30 years of work in human services and education. She has successfully led reform efforts in state and local government and played key roles in promoting and supporting change and innovation in both the private and not-for-profit sectors. She is President and Founder of *In the Public Way, Inc.*