Journal of Urban Mathematics Education
December 2012, Vol. 5, No. 2, pp.55–86
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Success Made Probable: Creating Equitable Mathematical Experiences Through Project-Based Learning

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In this article, the authors describe a 16-hour project-based learning statistics unit designed for and implemented with elementary-aged, African American children. The unit was designed to provide the children with mathematical learning experiences that allowed them to make personal sense of mathematics or to use mathematics to critique and analyze issues within their communities or in the wider society. The authors worked with thirteen, elementary-aged, African American girls to address an authentic, school-based problem; four dimensions of equity—power, access, identity, and achievement—were used as a lens to examine the quality of the project and the impact of the mathematical experiences on the students.

KEYWORDS: equitable mathematics teaching and learning, project-based learning, statistics education, urban education

Despite the high percentage of African American and Latina/o students in the U.S. education system, too many African American students struggle to meet grade-level competence in core academic subjects (e.g., mathematics, science, reading, and social studies) (Howard, 2003). Identifying and understanding the factors that contribute to low educational achievement for students of color has been the focus for a significant portion of educational research in the past

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decade (e.g., Johnson, 1984; Ladson-Billings, 1997; Lee, 2002; National Center for Educational Statistics, 2009; Secada, 1992). The high rates of underachievement for students of color in general have pushed many educators to rethink their approaches to schooling to achieve the goal of academic success for *all* students.

With the publication of the National Council of Teachers of Mathematics' (NCTM) *Principles and Standards for School Mathematics* (2000), where the organization advocated quality mathematics education for all, attention to equity and diversity issues became more prominent. Equity in this regard means that every child, irrespective of race, socio-economic status, or personal characteristics, should be afforded worthwhile and meaningful mathematical experiences. Embodied in this definition is the view that if students are treated competently, they will achieve high levels of competence (Ladson-Billings, 1994).

With this view in mind, we designed and engaged a group of elementary-aged, African American girls in a 16-hour, project-based learning (PBL) statistics unit. We were confident the children would be able to learn complex statistical concepts if the unit built on the students' cultural knowledge and lived experiences (Civil, 2007; Ladson-Billings, 1994, 1997), and presented opportunities to use these ideas to reason about and solve problems in their world (Gutstein, 2007). Here, we describe how we designed and implemented the unit; the following questions guided our efforts:

1. What happens to students' "mathematics learning" when taught in "mathematically meaningful" ways?
2. How can students develop "mathematical power," and simultaneously, use mathematics as an analytical tool with which to investigate problems that are personally meaningful to them?
3. What difference might such efforts make in the lives of students and also in the larger society, in both the short- and long-term?

In the following sections, we explain the theoretical grounding of our work and describe our data sources and analytical approach. We organize the discussion around

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Gutiérrez's (2009) four dimensions of equity—power, access, identity, and achievement—and conclude with a discussion addressing the questions that guided our work.

Framing our Approach

Equity embodies the notion that all students irrespective of gender, race, class, or socio-economic background can learn and should have opportunities for a high-quality education. Across proposed frameworks that incorporate this construct, a common thread of meaning is that equity involves fair distribution and access to the physical, intellectual, and technological resources that contribute to learning. Both Fennema (1993) and Allexsaht-Snider and Hart (2001) defined equity in terms of (a) distribution of resources to schools, students, and teachers, (b) quality of instruction, and (c) outcomes for students. In addition to curriculum, teaching, and assessment, other researchers have argued that in establishing goals for equity in mathematics education, we must attend to the social, economic, and political issues that impact what happens in schools and classrooms (e.g., Apple, 1992; Tate, 1997). NCTM's (2000) *Principles and Standards for School Mathematics* addresses many of these criticisms, yet there are still calls for specific guidelines regarding how these ideas can be best translated into district and school policies (Allexsaht-Snider & Hart, 2001).

Although these equity perspectives attend to some of the concerns posed by Apple (1992) and Tate and Rousseau (2002), they mainly attend to the physical and quantifiable aspects—specifically, external resources and achievement outcomes. Examining equity issues through an achievement lens tends to ignore the interpersonal and societal factors pivotal in discussions about the education of children. Primarily it minimizes the importance of power and identity, overlooks deficiencies in measurement instruments, and provides a limited perspective of the student as an individual and solely in comparison to the dominant group (Gutiérrez, 2009). We therefore broadened our lens to include issues that were central to the individual. As such, our work reflects an approach that addresses both the internal (psychological) and external (physical, technical, quantitative) aspects of equity. We use Gutiérrez's (2009) four dimensions of equity—power, access, identity, and achievement—to frame our discussion about the unit we designed and how we evaluated its ability to support the development of the statistical literacy of elementary-aged, African American children.

Power

The power dimension reflects the degree to which the curriculum and classroom instruction enable students to use mathematics to consider, analyze, and critique societal structures and the injustices embedded within these structures. It encompasses how the classroom is organized, who gets to speak, who gets heard, and how students are provided with opportunities to examine and critique their world. Gutiérrez (2002) situates the discussion of power within the tensions of a dominant vs. critical mathematics. The former relates to mathematics aligned with the status quo in society, reflecting a Western colonial perspective. In contrast, critical mathematics encompasses mathematics that attends to the idea that students are members of a society organized around power structures and systems of domination. It acknowledges the importance of students' cultural identities and "builds a mathematics around them in such ways that *doing* mathematics necessarily takes up social and political issues in society, especially highlighting the perspectives of marginalized groups" (p. 151, emphasis added). Therefore, adopting a critical mathematics perspective would mean challenging society's established power structures and using mathematics to critique and transform oppressive structures (Gutstein, 2006).

Power also encompasses learning mathematics in ways that are culturally relevant. Ladson-Billings (1994, 2001) proposed a culturally relevant pedagogy that advocates producing academically successful students who are both sociopolitically and -culturally competent. Essential to teaching in this way is acknowledging that students' identities are shaped by sociocultural and sociohistorical factors and that the cultural knowledge brought to the classroom can be leveraged to enrich their learning experiences. Enrichment in the mathematics context goes beyond developing deep conceptual understandings of mathematical ideas; enriching experiences enable the student to be critical of the content they are learning and challenge them to use this content to transform the world they live in (Ladson-Billings, 1994, 2001; Gutstein, 2007).

Gutstein's (2007) pedagogy of questioning also embodies the tenets of this dimension as this instructional approach empowers students. They make mathematics relevant, interesting, and meaningful to them as the questions they pose drive the instruction and the learning (Boaler, 2008). The issues they investigate using mathematics as an analytical tool allow students to better understand their own life experiences within the broader sociopolitical context (DiME, 2007). This dimension involves allowing students to set personal goals with regard to mathematics and providing the knowledge, context, and support needed to actualize these goals. Allowing students to have a voice and to be involved in making decisions that will impact the mathematics they learn and their environment captures the social transformation described in the power dimension.

Access

In addition to developing strong reasoning and problem solving skills, students should have mathematical experiences where they can see the beauty of mathematics and appreciate its complexity. These goals align with the vision detailed in the *Principles and Standards for School Mathematics* (NCTM, 2000). An integral part of enacting this vision is the six principles; one of which is equity, stating:

> All students, regardless of their personal characteristics, backgrounds, or physical challenges, must have opportunities to study—and support to learn—mathematics. This does not mean that every student should be treated the same. But all students need access each year they are in school to a coherent, challenging mathematics curriculum that is taught by competent and well-supported mathematics teachers. (p. 2)

Access means that students should have the necessary resources to develop a broad mathematical knowledge base and the reasoning skills to apply that knowledge appropriately. These essential resources include a rigorous curriculum, high-quality teachers that can implement the curriculum well, a learning environment that invites and sustains engagement and a school infrastructure that supports learning outside of class and beyond school hours (Gutiérrez, 2009). Although, we contend that all these resources must be made available to all students, we appreciate that equal access may not mean the "same" access, so the type and quantity of resources may vary given the population and the individual student. Access to the same resources would only be equitable if in the past, universally and historically, all students had the similar opportunities. In particular, African American and Latina/o students tend to reside in communities that are segregated and have experienced long-term educational injustices. In this regard, given the limited educational opportunities these students may have experienced in the past, having the same resources as other students with greater access to educational opportunities would in itself continue to perpetuate academic disparities. Therefore, access as it relates to equity must attend to the specific needs of the community and make available the types and quantity of resources necessary for those members of the community to achieve success (Boaler, 2008; Tate, 1997).

Identity

Students' abilities to negotiate between who they perceive themselves to be, how they are perceived by others, and who they want to become tend to affect their participation and engagement in educational activities broadly (Gutiérrez, 2009; Cobb & Hodge, 2002), and more specifically within the mathematics classroom (Martin, 2006). Therefore, identity becomes an important construct to consider in discussions about the participation and achievement of African American students in mathematics. Identity has both an individual and social dimension; it is shaped by cultural factors and social processes (Martin, 2006) but also encompasses the individual's perception of him or herself and how the individual evaluates him or herself in relation to others (Roeser, Peck & Nasir, 2006).

Examining the relationship between identity and students' connections and associations with school has been quite revealing about the academic achievement of students, particularly minority students (Nasir, 2002; Cobb, Gresalfi & Hodge, 2009; Martin, 2007). Research has shown that students who identify strongly with school tend to have higher academic achievement and remain in school longer, often pursuing post-secondary studies (Dolby & Dimitriadis, 2004). For many African American students, participating meaningfully within the educational context involves connecting their cultural identities with their classroom experiences (Nasir, 2002). This connecting is often difficult because of the sociocultural and sociohistorical factors that impact their lives (Boaler & Greeno, 2000; Gutstein & Rogoff, 2003; Stinson, 2009). These factors tend to shape how students see themselves as participants in mathematics, influence the extent to which they have developed a commitment to, and have come to see value in mathematics as it is presented in the classroom (Stinson, 2009). Based on "master-narratives" of what it means to be and the expectations of Black students in the classroom, some African American students often see themselves as inferior to Whites and Asian Americans, and see failure to attain mathematical (and more broadly academic) success as the norm and what society expects of them (Martin, 2007).

Given these prevailing negative stereotypes of African American youth and the likely impact on their academic identity, to successfully teach this group of students, teachers must draw on their cultural knowledge (Dominguez, 2011; Matthews, 2003), providing a bridge between their cultural identity and the normative classroom identity, thereby increasing both students' learning and engagement (Ladson-Billings, 1994; Nasir, 2002).

Achievement

In addition to attending to the aforementioned components of equitable mathematics, it is necessary to give an account of student outcomes. We define achievement broadly, to include scores on standardized tests and other types of assessments (e.g., non-traditional, performance-based) that measure conceptual growth, critical thinking, and reasoning. Moreover, and particularly important in defining achievement through an equity lens, is extending the notion of achievement to include an analysis of the relation between students' ways of participating in mathematics and the norms and practices of the mathematics classroom (Cobb & Hodge, 2002; Gutiérrez & Rogoff, 2003). In acknowledging that students' ways of participating may be influenced by norms of engagement in non-school activities (Civil, 2007; Lubienski, 2002), we were pushed to find ways of examining students' talk, reasoning, and justifications in ways that value their contributions whether or not they aligned with the normative practices of the classroom.

We also incorporated into our definition of achievement students' competencies in mathecracy, a term introduced by D'Ambrosio (1999) and elaborated by Gutiérrez (2002), which refers to the ability to read data, draw conclusions from data and calculations, and propose hypotheses. We found it necessary to include these set of competencies within our criteria for assessing achievement for two reasons: (a) it captured the objectives of the instructional unit we designed, and (b) it targeted the knowledge students need to be functional citizens.

Methodology

Participants

The participants were 13 African American girls in grades 4–6 from a gendered elementary school called Brayton Elementary (a pseudonym, as are all proper names) who were enrolled in a school-based summer camp. Brayton is situated in the metropolitan area of a large Midwestern city. Similar to other schools located in urban areas, Brayton is a school community surrounded with high levels of poverty and crime. The school has a disproportionate number of students who identify as African American (99% African American and 1% multi-racial) and qualify for free or reduced lunch (88 % of the student population qualify for free or reduced lunch). Over the past decade students in grades 4-6 in the wider school district consistently scored below the state average according to the state's standardized test for mathematics. As a part of the district's response to restructure and reform public schools, Brayton had recently transitioned to a single-gender school for girls. Brayton's test scores had been on the rise for the past few years having made adequate yearly progress (AYP) in the year prior to the project.

The summer camp was held at the school as an academic alternative for students required to attend summer school. Sessions were held for four hours over the course of one week with the content focus being mathematics. Although some teachers at the school stopped by and observed the students periodically, none were integrally involved in facilitating sessions. The research team included six researchers (five graduate students and a teacher educator). During the academic year preceding the summer camp, we conducted professional development at the school; therefore, we were aware of the kinds of educational opportunities available to the students. The objectives of the summer camp were to engage available students in authentic statistical inquiry and to help students develop 21st century skills (described below). Members of the research team also served as the instructors for the summer camp, which was held at the school.

The Project: Food for Thought

According to the Buck Institute for Education (www.bie.org), project-based learning (PBL) affords students a lengthened and supported process of inquiry and construction, which occurs in response to a complex question, problem, or challenge posed or encountered. The summer camp focused on the students completing a project-based statistics unit that was aimed at developing students' knowledge of sampling and surveying, measures of central tendency, dispersion, and use of data representations to make statistical arguments. In a conversation about how students can best prepare for learning, students made suggestions that included doing their homework, eating a filling breakfast, and being prepared with necessary materials. Following the discussion, students read a newspaper article about a school that had improved test scores after ensuring that all students ate breakfast prior to taking a standardized test. Drawing on this article, the students suggested that more students might eat breakfast at the school if they could select the breakfast the school would serve on the mornings prior to taking the standardized tests. Given this information, the students investigated the following authentic student-generated question: Assuming students who eat breakfast perform better on standardized tests, what should our school serve prior to standardized tests to ensure that the most students will eat breakfast? To investigate this question, the students brainstormed possible breakfast options and narrowed the list to four choices. The students designed surveys to measure other students' opinions about the four options and used these surveys to collect data from their peers. Using *TinkerPlots*[1] software, they analyzed the data and created representations to support their recommendations. Finally, the students presented their findings to representatives of the school administration. Throughout the investigation, we planned instructional activities to foster understanding of particular concepts. Consistent with other project-based units (e.g., Barron et al., 1998), these activities were integrated into the unit as the need arose. For example, prior to analyzing the data, we introduced the concept of mean, ensuring that students had both a procedural and conceptual basis prior to engaging in analyses. We used activities designed to elicit a conception that the mean could be found by "leveling" data values (Cai, 1998).

Projects such as ours allow for students' autonomy and agency and are not solely about helping students learn key academic content. They also have to learn to work as a team and contribute to a group effort. They must listen to others, make their own ideas clear when speaking, be able to read a variety of material, write or otherwise express themselves in various modes, and make effective presentations. These skills, competencies, and habits of mind are often referred to as 21st Century Skills. In addition to expanding students' knowledge of statistics, developing 21st Century Skills was an instructional goal.

[1] *TinkerPlots* is a dynamic, data analysis software program primarily designed for students in grades 4–8 ; see http://www.keypress.com/x5715.xml for more information.

Data Collection

Mathematics interviews. All participants were interviewed. Initial interviews were conducted on the first day of the camp and focused on students' views and knowledge of elementary mathematics broadly and statistics specifically. The second interview was conducted on the last day of the camp and focused on the students' learning experiences and their statistical knowledge. Elementary level students often have difficulty expressing their thoughts and reasoning in writing, so these interviews were integral for the following reasons: (a) to determine students' level of reasoning prior to the implementation of the project, and (b) to identify the ways their reasoning developed throughout the project. Interviews were conducted in groups of two or three and lasted about 15 minutes on average. All interviews were video recorded.

Video-recordings. All classroom activities included in the statistics unit were videotaped. Three cameras were used; each focused on one group of students for the entirety of each activity. During whole-class conversations, one of the group's cameras was refocused on the facilitator to capture teaching behavior that engaged the students and supported their reasoning. Students' work from all the activities and photographs of the students engaged in activity were collected.

Analysis

Given our theoretical framework, we examined the two primary data sources (i.e., interviews and the video-recordings) to locate student statements and classroom episodes that provided evidence that the design and implementation of the unit aligned with Gutiérrez's (2009) four dimensions of equity—power, access, identity, and achievement. Our first round of analyses occurred immediately after the camp. The research team assembled and discussed our initial ideas about the level of success of the PBL unit. We identified specific aspects of the unit's design and implementation that aligned with our equity framework and what elements may have thwarted our goal. We documented these ideas in short descriptive narratives and organized them into four groups with respect to how well they aligned with our descriptions of the four dimensions of equity. Each of the graduate students (co-authors) selected one dimension and examined the videos (approximately 48 hours of video) and other relevant data (e.g., project documents, classroom artifacts) to identify episodes that supported or refuted our initial ideas and thoughts about that dimension. The teacher educator (the first author) independently engaged in a similar process but with all four dimensions in mind. For each dimension, video episodes and other relevant data were discussed between the two team members assigned to that dimension to determine the degree of alignment of their interpretations. Where there was disagreement, the episodes were discussed until we achieved consensus.

Evaluating Success Across the Four Dimensions

Applying the equity framework previously described, we examined the results of our PBL intervention through Gutiérrez's (2009) four dimensions of equity: access, power, identity, and achievement.

Access

To ensure that all students received equitable mathematics education, we considered the qualitative aspect of access by examining the quality of the learning opportunities afforded to students. In light of this, we analyzed access from two perspectives: the quantity of resources available and the quality of opportunities provided.

Quantity of resources. "Good" mathematics instruction requires rigorous curricula, highly qualified instructors, and the physical (cognitive tools) and technological resources to enhance learning. Keeping in mind that *equal opportunities* to learn do not necessarily mean the *same opportunities* for all students (Gutiérrez, 2002), we considered the broader sociohistorical context in which the students were situated. Based on our pre-implementation project observations, students were primarily taught with a focus on memorization and repetition, rather than problem solving and reasoning. Given the type of educational experiences the students had prior to the implementation, we exaggerated the quantity of resources available to the students.

First, there were five instructors for thirteen students so the student-teacher ratio was very low. Second, all five instructors were mathematics educators. In addition, prior to starting this project, the instructors specifically focused on developing expertise in common statistical knowledge and specialized knowledge for teaching statistics. We examined and discussed in depth the fundamental ideas in elementary statistics and the literature on statistics teaching and learning to ensure that the students had meaningful mathematical experiences. Third, all students were taught to use technology in ways that would support their learning. To facilitate sustained engagement, students were paired during computer use. Working collaboratively during computer use provides a better learning situation for girls; they tend to be more social so there is increased enjoyment and benefit because of the collaboration (Doerr & Zangor, 2000; Underwood, 1994).

Quality of opportunities. Our view of quality includes access to resources and experiences that we consider academically beneficial for the students and that serve the interests of individuals and their immediate community (Martin, 2011). As such, we designed the curriculum based on research findings on the positive impact of PBL (Krajcik & Blumenfeld, 2006) and inquiry-based activities (Boaler, 2008) on students' learning. With regard to quality, we designed the project and sequenced the activities so students' statistical experiences would be meaningful.

We wanted the project and related activities to have four main components. It should: (a) be designed to address an authentic problem, (b) be embedded within a culturally relevant scenario, (c) include technology to enhance learning, and (d) engage students in the statistical investigation cycle.

For the first component, the context of the PBL unit was a real situation that was relevant to the students' lives—improving students' test scores. The students decided on a reasonable approach to solving the problem, which was to ensure that all students ate well before the test. Because the problem was relevant to them, they were motivated to solve it, thereby increasing engagement. Through whole-class discussion, students completed the first two stages of the statistical investigation cycle—defining the problem and creating a plan. Initial suggestions were revised based on students' realizations that other students' opinions must be considered. In the process of refining the ideas, students recognized the importance of selecting a sample and administering a survey to determine breakfast options that were optimal for everyone. Designing activities where students were invested in the outcomes motivated students to participate (Gal, 1998; Groth, 2006; Nicol & Crespo, 2005). The following excerpt provides an example:

Instructor:	We need to narrow down what options people really don't like. What do you think people really don't want to eat for breakfast?
Student:	A peanut butter sandwich.
Instructor:	You don't think peanut butter will get many votes. Do you agree or disagree?
Students:	(Almost all students said aloud) I agree.
Students:	(Simultaneously) I don't want toast.
Students:	(Simultaneously) I hate Bagels.
Students:	(Other students said loudly) Oatmeal
Instructor:	Why do you think we should erase oatmeal?
Students:	Because I hate it.
Instructor:	Do you think many people agree with you or disagree with you?
Students:	Agree.
Students:	Disagree.

Later in the discussion…

Instructor:	What do we need to do in order to convince her [the principal] that option one or option three is the best? How would you advise her?
Student:	We should figure out which one of the options is the best.
Student:	Collect the data.
Instructor:	What do you mean by that?
Student:	How many people like this and how many people like that? Which one is the one that most people like?

For the second component, the activities embedded in the project targeted important statistical ideas such as sampling, surveying, distribution, data representations, and measures of center.[2] Several of these activities were based on scenarios that addressed social and political issues relevant to the African American community and to which the students could connect. The activities included people, such as Michael Jackson and Barack Obama, who is the first Black president of the United States about whom the students were quite knowledgeable (See Figure 1). One activity was embedded within current events of the time related to the BP oil spill. Students were able to realize the importance of reasonable sampling by connecting the context with experiences within their own family.

Over half of 45,000 Michael Jackson fans who have voted in a music-focused website's world-exclusive "Death Hoax Poll" say the King of Pop did, in fact, fake his death of a heart attack and is still alive today. Visitors to the website were asked to sign up for an account (at a charge of $2.50) to give their opinion about whether or not Michael Jackson was really dead. It turned out that 56% of the callers felt that Michael Jackson was alive.

1. Identify the population of interest and the sample actually used to study that population in this example.
    a. Population:
    b. Sample:
2. Do you think that 56% is an accurate reflection of beliefs of all Americans on this issue? If not, identify some of the flaws in the sampling method and suggest how it could have been improved.

Figure 1
Sampling task.

For the third component, students used *Tinkerplots* to expand their understandings of statistics. The goal of including the technology was to provide students with opportunities to analyze data and reason with the statistical tools without the tedium of paper-and-pencil calculations, hopefully increasing the strength of their arguments. Figure 2 provides a screenshot from *Tinkerplots*. The figure shows how students used the tool to create multiple representations of the data,

[2] Also referred to as measures of central tendency.

including interpreting the data as individual case cards (upper left), within tables (upper right), and as graphs (below). *Tinkerplots* provided an opportunity for students to organize and compare datasets efficiently. For example, they used the software to visually inspect the data, calculate means, compute percentages, and graph statistical results. Through using the tool, students were given more access to instruction that focused on conceptual development, rather than on computation or tedious tasks, such as creating graphs by hand.

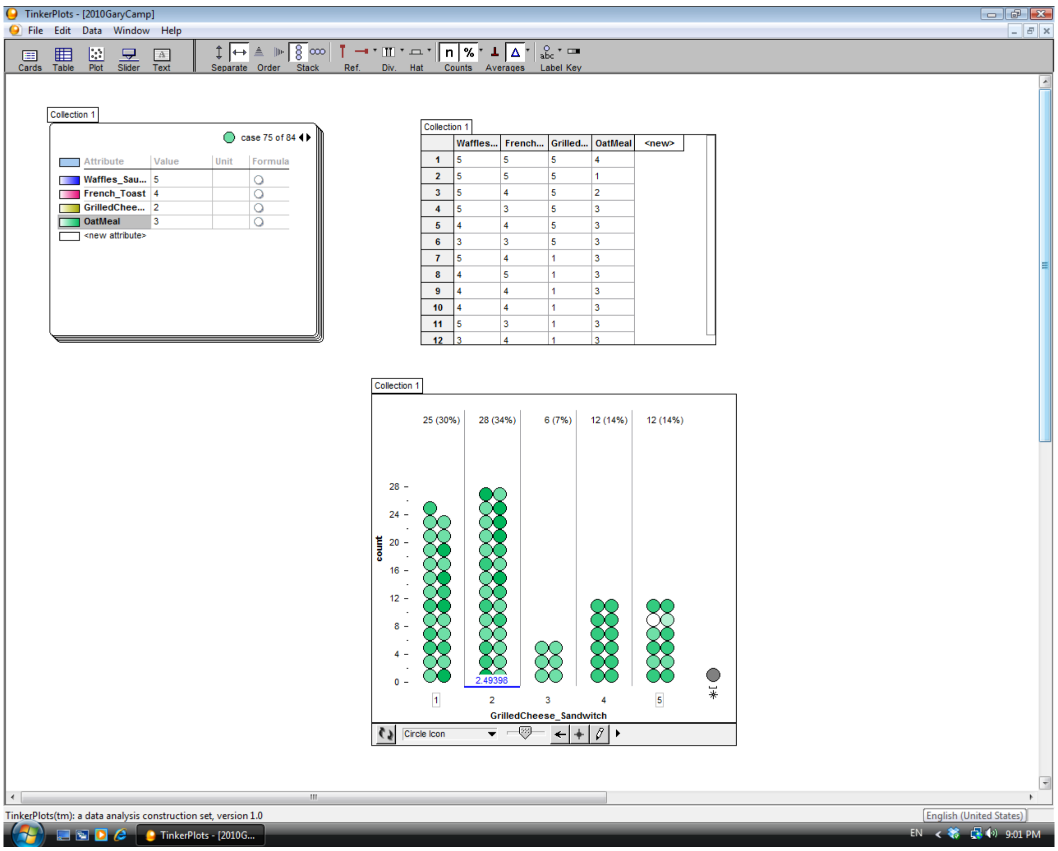


Figure 2
Sample student exploration of data using *Tinkerplots*.

In the following dialogue, a pair of students analyzed data collected from the survey using the *Tinkerplots* program. To enter the data in *Tinkerplots*, they had to discuss appropriate ways to code categorical data. Additionally, the program provided percentages and values for mean, mode and median (see Figure 2), so instead of spending time manually calculating these values, students discussed what these values told them about the data. Specifically, they used percentages and the means to decide which options to recommend for breakfast on the day of the test. In this way, access to *Tinkerplots* was useful for students to efficiently analyze the data. In the excerpt below, two students used *Tinkerplots* to organize, analyze (using percentages and means), and interpret the breakfast data (making decisions about which breakfast option is best). During their discussion, one of students, Moriah commented on the average of the menu item grilled cheese sandwich, 2.493, as shown in Figure 2.

Kaycia: What are you supposed to be doing?
Moriah: Figuring out which one had the most appeal?
Kaycia: Let me do something.

[*Kaycia plotted the stacks of preferences according to the options available by moving plots and adding attributes to the two axes of the Tinkerplots graph*.]

Moriah: (trying to figure out how to code the data) Which one is preferred; which one is not preferred?
Kaycia: Um…Oh, wait. Sort them in order of greatest preference; we use 1, 2, 3, 4, 5. Where 1 is the most preferred, 2 is simply preferred, 3 is unsure, 4 is disliked, 5 is strongly disliked.
Moriah: This is the preference for waffles. 87 people really liked it.
Instructor: [teacher reconvened students to explain how to use "average" icon in *Tinkerplots*] Okay. Stop everybody. What tool can be used to help analyze the data?
Kaycia: Mean, average, mode, and range
Instructor: Right. Sometimes statisticians calculate the mean by computer. At the top, can you see a bluish, purplish triangle? If you click on that triangle, it tells you the mean.
Kaycia: (dragging various attributes into the horizontal axis of *Tinkerplots* graph) The average of "waffles and sausage" is 4.036, and this (average) is 3.645.
Moriah: Let's go to French toast. It is 3.987. Let's try grilled cheese. It's 2.493. Which one is the most do you think?
Kaycia: Actually "waffles and sausage" is the most. It's 64% and its mean is 4.036.
Moriah: Right. The highest one will be first choice.

For the fourth component, we engaged students in the practices of statisticians by designing activities that corresponded to the statistical investigation cycle. These steps included identifying the problem and the research questions (which breakfast foods would appeal to the most students), planning the procedures to collect data (deciding on a suitable sample and an appropriate survey), engaging in the data collection process (administering surveys to fellow students), analyzing the data (using statistical tools within *Tinkerplots*) and drawing conclusions (determining which breakfast food most students would eat). They were not restricted to data analysis, which is usually foregrounded in a traditional elementary statistics unit. Engaging in a curriculum designed around the statistical investigation cycle allowed students to enact the practices of statisticians and provided mathematical experiences that were practical and relevant (to the problem being addressed). For example, after defining the problem, in thinking about data collection instruments and procedures, students were not just told to use a survey with a Likert scale; instead, the activity was designed to enable students to think about the advantages and disadvantages of various survey types (See Appendix A). Below is an excerpt from the discussion about which survey would be best to use:

Instructor: Why do you say survey B?
Student: Because you can know how they really feel about it.
Instructor: What's our goal again? What do we want to know?
Student: What people really like.
Instructor: We want to know which the best breakfast is. What survey do you like best?
Student: I like the second one best…because it tells us what is strongly disliked, disliked, undecided, liked, or really liked.

With scaffolding by the instructor, students reasoned about and discussed the different surveys to decide why using a Likert scale was most appropriate given the data they wanted to collect.

Power

Gutiérrez (2009) states, "equity is ultimately about the distribution of power—power in the classroom, power in future schooling, power in one's everyday life, and power in a global society" (p. 5). Below we describe how we tried to position and self-empower the students to be change-makers.

Establishing voice. Classroom power relations can be characterized in many ways, such as who controls the conversation, who determines the mathematical accuracy of statements, and who determines how the lesson unfolds. We deliberately planned the activities and orchestrated classroom conversations so students would feel a sense of ownership over the project from inception. For example, on day one of the summer camp we engaged the students in a conversation about what ideal conditions would be for taking a test in order to maximize students' scores. Suggestions were elicited from the students, one of which was that eating a hearty breakfast on the morning of the exam would increase the students' scores. The students determined that if others liked the breakfast then most would eat it. In the excerpt below, we see the students making decisions about how to maximize scores on the test and selecting breakfast options.

Instructor: So what are some things you would do on the day of the test?
Student: Think hard.

Instructor: What are some of the things that make you think hard? If I say think hard, is it like a magic button?
Student: Eating breakfast.
Instructor: So to think hard you would need to eat breakfast.

[*Students provided additional responses including go to bed early, get enough sleep, relax, concentrate, etc*.]
[*5 minutes*]

Instructor: So what are some of the foods you would like to eat that you think would help you to think hard on the test? … And is really good and a lot of people eat it? ...

[*Students' thinking*]

Students: Waffles…eggs…bacon…sausage…orange juice…grits…oatmeal…biscuits…grilled cheese…French toast…soup…pancakes

Later in the discussion the students narrowed these options down to four[3] based on what they thought were the most popular breakfast items among their peers. From this initial conversation the students knew that their ideas and thoughts were heard and that they had a powerful voice in this classroom. These early conversations established the students' voices as primary in decision-making, allowed students to take ownership of the task, and set the tone for the rest of the project. Later, with scaffolding, the students identified their target population, all the students at Brayton Elementary School taking the state exam, and their sample, all summer school students at Brayton. In order to collect the data needed to accurately represent their population, the students developed a survey with the food items discussed in the group discussions.

We also organized the classroom to facilitate personal interactions and communication among students. Over the duration of the summer camp we saw the girls gain confidence in stating their ideas and independently providing justifications for their responses supported by data. We attributed these changes to deliberate efforts on our part to ensure that the students had a clear and powerful voice within the classroom. We ensured that all major decision-making aspects of the project were driven by the students and incorporated the choices they made.

Controlling decision-making. Statistics educators have developed theories about statistical thinking and the cycle of investigation in statistics (Wild & Pfannkuch, 1999). These frameworks suggest that statisticians make many choices in the process of conducting a statistical investigation, such as how populations

[3] The fours options were: (a) waffles and sausage, (b) French toast and sausage, (c) grilled cheese and soup, and (d) grits, eggs, biscuits, and bacon (the options will be referenced by the first food item from here on).

will be sampled, what instruments will be used to collect data, what measures and representations will be used to analyze the data, and how the results will be disseminated. Throughout the project, we provided opportunities for the students to make these choices themselves. In particular, students made suggestions about possible breakfast items, and with scaffolding, students determined the appropriate survey to use to gather data.

One of the primary goals of the unit was to have the students identify a single breakfast option to recommend to the principal. After conducting the analyses, the students determined that the waffles and French toast options had the highest mean. Further analyses showed that a higher percentage of students chose “like” or “really like” for waffles (78%) than French toast (76%). Thus, the students and instructors initially determined to make waffles the breakfast of choice. This decision was reconsidered following Kaycia’s objection. Below she describes why she thought another recommendation was viable:

> **Kaycia:** Well, we realized that the most choices were the waffles and the French toast, and you know, not a lot of people like waffles. I know I don’t eat waffles…so we were thinking. Why don’t they have both waffles and French toast out there…that way, whoever wants which could just grab them and go.
>
> **Instructor:** Well, that’s a recommendation that you could have, right?
>
> **Kaycia:** Those are the highest [percentages of the four options], and they’re almost the same.
>
> **Instructor:** Then, it’s hard to distinguish between…
>
> **Kaycia:** [nodding her head in agreement] Yeah, so we should give what the students really, really like. That way, half the kids won’t be eating cause they didn’t like the food.

In this dialogue, we see that Kaycia was likely motivated by her personal opinion about waffles; however, she also acknowledged that both options had similar data. Rather than suggest that only one option was viable, the instructor suggested to Kaycia that she could include both options as part of the students’ recommendation, which she supported with data showing that the percentage of students that liked both breakfast items was very close. In such cases, the students were empowered to make their own recommendations and adapt these recommendations when necessary, granted they could support their decisions with data. Of significance here is not that the students were allowed to make the decisions but they had acquired the necessary statistical knowledge and skills to consider the situation and make informed decisions that would impact their school community.

Identity

Developing identity in this framework relates to optimizing students’ cultural and linguistic experiences when partaking in mathematics teaching and learning activities (Gutiérrez, 2002). In particular, we wanted to situate the mathematics within contexts that the students would connect with and consider relevant, allowing the students to see mathematics and statistics as meaningful and providing them an opportunity to legitimately participate in disciplinary practices. In this section, we describe what we observed with regard to identity development as we engaged students in activities to help them develop strong mathematical identity, specifically that of a statistician.

Embracing the name. We ensured that from the first day of the project students made connections between what they were doing in the activities with the work of statisticians. Deliberate efforts included discussing what statisticians did and the importance of their work to society, emphasizing that the work they would be engaging in was important and the ways it would impact their school community. Also, to strengthen this identity we thought it important that in addition to the students seeing themselves as statisticians, the larger school community also needed to identify them as such. To support this goal, we enlisted the help of the principal and the other instructors at the school to acknowledge the students as statisticians and inquire about the daily activities in which they were engaged. The pivotal moment was on the morning of data collection when the principal announced to the entire school that: "Statisticians are coming to collect some important information for the school." This act on the second day of the project was sufficiently powerful that afterwards several students began to refer to themselves as statisticians. The following statements from the students reflect this emerging identity:

Paula: (While smiling and covering her mouth) They're talking about us.
Eugena: We are S-T-atisticians.

Engaging in the practices of statisticians. Consistent with frameworks on statistical thinking (see, e.g., Wild & Pfannkuch, 1999) and research findings (see Shaughnessy [2007] for a review) that recommend engaging students in all aspects of statistical inquiry, we designed the project so the students progressed through the various stages of the statistical investigation cycle (previously described). We considered this important because we wanted the students to complete the project successfully so they would be able to see themselves as problem solvers and statisticians.

In our interviews with the students at the end of the unit, we tried to elicit how students defined their roles in the project and how they described the work of statisticians. The excerpt below provides an example of how students viewed their role on the project:

Interviewer: What else did you learn this week?
Kiley: Ahhh…I learned some new, funny words.

Interviewer:	Like what?
Kiley:	Statisticians
Interviewer:	So who are statisticians?
Kiley:	For the past week, we've been statisticians.
Interviewer:	So what do statisticians do?
Kiley:	We had to give out surveys and use the data to figure out what breakfast to serve.
Interviewer:	What do other statisticians do?
Kiley:	They do the same kinds of things but for different reasons…different purposes.

Other students had difficulty saying the word "statistician" and articulating what statisticians did in statistical terms. Instead of using words like "data" and "analyze," these students described some of the activities they had completed during the week. When asked, "Can you tell me what statisticians do?," some simply replied, "What we did."

Achievement

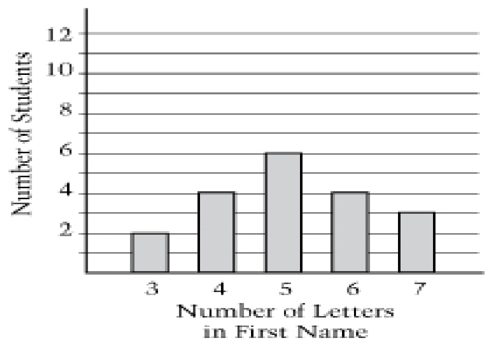
Equity concerns include the conditions under which learning occurs as well as the outcomes (Gutstein et al., 2005). It is a foremost concern because students' level of mathematical achievement tends to have greater impact on their long-term economic and professional goals. We do not limit our measures of achievement to test scores, but we sought to identify growth in the set of knowledge and skills that would create opportunities for the students to take advanced mathematics courses and to consider math-related careers; that is, knowledge that will help students progress through the mathematics pipeline (Gutiérrez, 2009). In examining the data for evidence of this growth, we attempted to answer the question, "What knowledge did the students have at the end that was not present at the start of our work with them?"

An analysis of the pre-interviews showed that the students varied widely in their knowledge of statistical concepts—ranging from no knowledge of statistics[4] to being able to state definitions for the measures of center. Specifically, 85% of the students stated that they did not know what statistics or data meant. Interestingly, three students were able to describe the "add and divide" formula for mean and state that median meant "middle," but either had not heard the word statistics before or did not know what it meant. Sixty-nine percent did not know what average, mean, median, or mode meant or gave unclear responses. For example, when asked what came to mind when they heard the word mean (in relation to mathematics), responses included: "answer to a problem," "the total," "like when you have a C average or a B average." Thirty-one percent were able to state the defini-

[4] No knowledge refers to not having the terms (such as statistics, data, median, mode) in their vocabulary and little to no understanding of meanings of the terms.

tions of the mean, mode, and median (although some confused them) but were not able to use the definition in their reasoning. None of the students were able to use the measures of center to make data-based arguments; for example, solve and provide justification for problem in Figure 3. More that 50% of the students were able to state that the diagram in Figure 3 was a graph, but only two students stated it was a bar graph. Below, we describe growth in two main areas: statistical knowledge and generalized knowledge.

1. The students in a class each counted the number of letters in their first names. The class made the graph below of the results.



a. A new student, Victor, joined the class. Draw on the graph to include the data for Victor.

b. What effect will Victor have on the mean of the number of letters in the first name of the class—will the mean increase, decrease, or stay the same?

Figure 3
Task adapted from released NAEP item 2007-4M11 #4
(National Center for Educational Statistics, 2011).

Statistical Knowledge. In this category we included growth in students' understanding of statistical ideas.

Alternative conceptions of mean. Results from studies on the learning of statistics state that students tend to hold narrow conceptions of mean and do not simultaneously conceptualize mean as typical value, fair share, data reducer, and as a signal amid noise (Cai, 1998; Konold & Pollatsek, 2002; Mokros & Russell, 1995; Watson & Moritz, 2000). One of our goals was to help students develop a broad conception of mean to encompass the above mentioned. Students who knew the term came in with one way of thinking about mean, specifically, applying the procedure of adding the numbers and dividing by the number in the set of data. Throughout the sessions we engaged students in activities that targeted mean as "fair shares," "leveling out," and "balance point." We observed students who already had knowledge of the formula (add all data values and divide by the number of data values) grow in their understanding to include mean as leveling out, providing meaning to their procedures (See Figure 4).

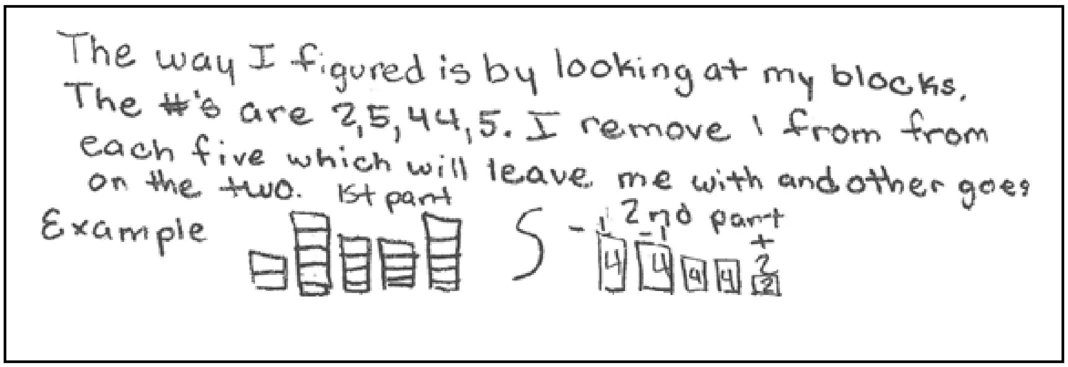


Figure 4
Example of student work from the "Leveling Out" task.

In the post interviews when asked about their understanding of the mean, some students, in addition to talking about the procedure, they included the idea of leveling out in their descriptions. When asked what she understood by the term mean, Kaycia responded:

> Well it's what you get when you add up the numbers and divide by the numbers—the amount of numbers…you can level them out; like with the cubes and get the mean. You can have different sets of numbers, like a lot of different numbers [that have the same mean].

In addition to conceptualizing mean as leveling out, some students considered the notion of mean as balance point. After calculating the mean grade of a particular dataset, students were asked to examine the numbers in the dataset and state their observations about the numbers in relation to the mean. Students observed that some of the numbers had to be above the mean and some had to be below the mean. The excerpt below shows the classroom conversation that supported students' understanding of this idea:

Instructor: If you were a teacher, so you taught your class about fractions. You gave them a test with ten questions. After you grade everyone's paper and the class average was five. Would you be happy or would you be sad?

Students: Sad.
Instructor: Why?
Students: Because that is just half of the test
Instructor: What percent is that?
Students: Fifty percent?
Instructor: Is that good or bad?
Students: Bad…it's alright…
Instructor: So if the average is 50, does it mean that everyone got a 50? Does it mean that Tana got a 50, and Jada got a 50?
Students: Not really.
Instructor: Does it mean that Paula had to get a 50? Or Heather?
Students: No.
Instructor: So what kind of scores would everybody have to get to get an average of 50?
Dara: Ten.
Instructor: If everyone got ten, would it average out to 50? Let's see…

[*Instructor lists ten repeatedly on the board to represent ten students' scores*.]

Instructor: Would that average out to 50?
Ashley: No, that would be ten.
Instructor: How do you know?
Ashley: Because if I added then up and divide by ten, I get ten
Dara: Because they are already level out
Instructor: Well, can you give me some other numbers that would give me an average of ten?

[*Students silent for about 90 seconds*]

Instructor: So what if this one was 15? [Teacher writes five on the board]. What is another number that could be included?
Alyssa: Five [Teacher places 5 next to 15]
Instructor: What's another one?
Ellie: Eight.
Instructor: So do the numbers have to be close to 10 to average out to 10?
Students: No.

[*Instructor directs the students to look at a problem completed earlier in the lesson where they had to find the mean*.]

Instructor: What was the average of these numbers?
Students: Five.
Instructor: Were they all close to five?
Students: No…yes…no.
Instructor: Some of them are what?
Students: Above…
Instructor: Some are above 5 and the others are?
Students: Below five.

Instructor: Ok, so some are above and below the average. So if we wanted to create a set of numbers that have an average of 10, what do we need to do?
Alyssa: Have some numbers above 5 and some below 5.

[*Students made suggestions for other numbers that were above and below ten to create a dataset with an average of ten.]*

Although initially students did not appear to see the numerical relationship between the mean and data values on each side of the mean they were able to apply this notion of "balancing" to finding a new dataset with a mean of 10 reasonably well. Additionally, they used compensation to justify their increasing of one number with a corresponding decrease of the same value to another number. We must note that the students who were able to make these connections initially were the students who had prior exposure to these ideas. As the activity progressed, more students were able to recognize that you did not have to always give and take away from the same two numbers but that the simultaneous increasing and decreasing could be spread across the individual numbers in the dataset.
Mean not necessarily a part of the dataset. One major misconception that students hold is that the mean must be a value in the dataset. We directly targeted this misconception by giving the students a task where they were required to create several datasets that had a given mean. Applying the notion of mean as leveling out, students were able to create several datasets for a given mean. In particular, we asked students to create a dataset of five numbers that had a mean of five. Students worked in groups and started by creating five towers, each having five blocks. Then they redistributed the blocks to make five towers of different heights. Students repeated this process several times and recorded each of the new sets of heights as a new dataset with a mean of five; some datasets did not include five as a data value (See Figure 5).

Paula: 10, 5, 4, 5, 1
Kaycia: 3, 4, 5, 6, 7 and 2, 3, 4, 7, 9
Tyisha: 8, 5, 5, 4, 3 and 9, 6, 5, 3, 2
Eugena: 17, 2, 2, 2, 2

Figure 5
Student-constructed datasets with a mean of 5.

From pre- to post-interview, we progressed from 85% of the students not being able to define "statistics," "average," or "mean" to 90% of the students describing data, statistics, the work of statisticians, and how statisticians use mean data and statistics in their work. This reversal shows that by the post-interview, students were better able to talk about and explain relevant statistical concepts in context. For those students who had knowledge of mean, mode, and median in the pre-interview but could not use the measures to reason about data within a context, by the post-interview, they understood that the mean did not need to be a part of the dataset and could conceive of mean as fair shares.

General knowledge. In this section, we highlight the skills students acquired that were not specifically related to statistics.

Self-identification of concepts they still misunderstood. Often when we refer to knowledge and understanding we only include in this description ideas students can clearly articulate. The ability to reflect on and think about one's own thinking, referred to as metacognition, is essential for developing mathematical expertise (Schoenfeld, 2006; Schunk & Zimmerman, 2006). An awareness of what one does not know and needs to learn shows metacognitive awareness. Eugena's statement provides an example. She stated, "What I think about median…I'm not so sure; I think I need to talk more about that." Her statement shows that she knew there was another statistical tool called the median but she was aware that currently she did not know how to define this tool or use it to summarize data. In our pre-interviews, most students showed no awareness of these tools (69% stated they did not know what average, mean, median, or mode meant), and those who did struggled to differentiate between them. Being able to distinguish between the three measures of center and recognize deficiencies in their understanding, we considered notable improvements.

21st Century Skills. Our project focused on statistics but also intentionally tried to help students develop communication, critical thinking, collaboration, and oratory skills. Although most students would readily talk in small groups, they were initially very hesitant to interact with the instructors or explain their thoughts and solutions in whole-class discussions. Students demonstrated growth in these areas during the final presentation of the findings. Several of the students were able to confidently explain their part of the presentation, making significant eye contact with the audience well-composed and speaking knowledgeably.

Equitable Mathematics Education or Not?

In 2005 the *Journal for Research in Mathematics Education* published an article written by the NCTM Research Committee, the goal of which was "to raise the awareness about equity and issues surrounding equity from a research perspective as well as to support the NCTM's commitment to the Equity Principle" (Gutstein et al., 2005, p. 92). The authors strongly supported equity research in mathematics education and encouraged researchers to use a critical equity lens to examine their work with the goal of better understanding the complexities of teaching and learning mathematics. The authors also included important equity-related research questions that remain unanswered within the field and implored researchers to use them to guide their advancing research agendas. Three sets of questions directly targeted the dimensions of equity relevant to our project; here, we use modified versions of those sets to frame the discussion of our findings.

How can students develop mathematical power, and at the same time, use mathematics as an analytical tool with which to investigate problems that are personally meaningful to them? Can they also then begin to see themselves as mathematicians capable of shaping their communities? How might this occur, and under what conditions?

We designed a unit we considered to be mathematically rich and personally meaningful so the students would not only learn important mathematical ideas but also learn how to use mathematics as a critical, analytical tool. The statistics concepts were embedded in a context that was authentic and that the students saw as relevant. Students, with support, were able to describe and suggest possible solutions to the problem of low test scores; determine that a survey would be an appropriate data collection instrument and select the items for the survey; describe what an appropriate sample would be so we could make inferences about the school population; collect and analyze the data, and use the data to make recommendations to the principal with regard to the most appealing breakfast. Community (within and outside of the school) support is essential. Specifically, enlisting the principal and other members of the school community to support the students as they went through the data collection and analysis phases motivated and increased the level of confidence the students had in their ability to solve the problem. In addition to school staff, we also had support of parents; one parent provided feedback on the students' presentations. Additionally, the camp was funded by a national organization that promotes educational equity for girls. Members of the local chapter provided and still provide support to the school with members serving as "big sisters" to some of the girls at Brayton.

Along with feeling empowered to have a voice in making meaningful decisions, students also felt like they had a right to critique other issues within the school environment that troubled them. In particular, Kaycia thought that in addition to selecting breakfast, they could also engage in similar statistical processes to determine whether or not the breakfast should be catered or made at the school. This suggestion was based on her observations from her years as a student that irrespective of what was provided for breakfast, only a limited number of students would partake.

With learning how to use statistics to identify and solve problems, as statisticians do, students were now informed about how to use mathematical tools to examine and critique issues in their environment. We purposely sought to cultivate a positive identity towards mathematics as research studies have identified this as a key contributing factor towards mathematical success for African American students (Martin, 2009; Stinson, 2010; Berry, 2008). Through engaging the students in the practices of statisticians, they were able to positively identify with the role.

What happens to students' mathematics learning when taught in mathematical meaningful ways?

The activities within the PBL unit addressed core statistical ideas that are not only included in the standards for elementary school but are tools used by a range of professionals in their jobs to make sense of the world and construct data-based arguments. Given the variation in statistical knowledge the students possessed at the start of the project, reporting aggregate achievement scores would not accurately capture the students' learning over the course of the project. So instead we measured achievement based on analyses of the students' responses focused on answering the question: "What do the students know about statistics now that they did not know at the start of the project?" For example, students who began the project not knowing how to describe statistics or data were able to provide sensible descriptions and relate them to the work of statisticians, with whom they identified. Others who had only procedural conceptions of mean, mode, and median broadened their conceptions to include mean as leveling out, mean as balance point, and mean as typical value. We acknowledged this broadening as a notable achievement as the literature in statistics education states that these ideas are particularly difficult for students to grasp and for which students hold major misconceptions (Konold & Pollatsek, 2002; Mokros & Russell, 1995). Although some students still struggled to provide clear explanations of what these measures tell us about datasets, they could articulate that they are important tools that statisticians (and others) use to make decisions and state clearly which ideas needed further refinement. Having this exposure will not only position students to be critical of the statistical ideas they are taught in the future but also to be critical of the basis on which decisions are made that impact them.

Additionally, PBL is often touted as instructional reform that will motivate students because its context-rich nature tends to readily engage students securing their investment in solving the posed problem. Our findings suggest that not only is PBL implementation motivational but also it supports equitable teaching practices (Boaler, 2008). In this case, the approach allowed students to build on their own cultural experiences, develop expertise relevant to solving the problems and foster 21st Century Skills. Twenty-first century skills are often not associated with or addressed in mathematics classes; however, we cannot overlook the importance of preparing our students for the future. As it pertains to collaboration, thinking, and communication, there were visible improvements among the students. With scaffolding by the instructors, students were able to describe the problem they addressed, the phases of the inquiry process, and explain how they arrived at their conclusions in presenting their recommendations to the principal.

What difference might such efforts make in the lives of students and also in the larger society, in both the short- and long-term?

It is widely accepted within the educational community that attaining equity in education is worthwhile and essentially “the right thing to do” (Gutstein, 2005). Nevertheless, teaching for equity is extremely challenging even *with* abundant resources. The data supports our conclusion that the intervention provided access to the resources necessary for quality mathematical learning. Students saw mathematics as an activity in which they could be full participants and felt empowered to use statistics to enact change while embracing the role of statistician. Therefore, in the immediate short-term we are confident that the tasks and activities the students engaged in during the summer camp left important mathematical residue; specifically, students had more productive dispositions towards mathematics, gained insights into the nature of statistical inquiry, and developed useful problem solving strategies (Hiebert et al., 1996, 1997).

One major drawback is that the project design did not allow us to assess the long-term impact on the students’ subsequent learning, views of mathematics, and mathematical identity. Although we know, based on the data, students saw statistics as an analytical tool that could be used to help make important decisions and to make changes within their school community, we are cautious here with our statements. We restrict them to the school environment and to statistics because we are not confident that their identity as statisticians developed to be a part of their core mathematical identity (Gee, 2001). Specifically, we are not certain that the students would see regular school mathematics as a tool to enact change or if they would embrace their role as change-makers outside of the school context. We can only hope that the residue from our intervention helped students to position themselves differently with regard to mathematics, more as constructors and not just consumers of mathematical ideas, so they can successfully navigate through the mathematics pipeline.

Facing the Realities of “Equity for All”

We were able to provide access to the physical and intellectual resources necessary to engage the students in mathematically meaningful activities, yet we faced significant challenges. Many of these challenges we were able to overcome but question how realistic it is to hold similar expectations for individual classroom teachers. Although the students who were enrolled in the camp were not considered struggling students, many of them had weak conceptions of number sense. We were able to address these deficiencies readily because of the approximately 2:1 ratio of students to teacher. Given the number of instructors, we were able to attend to all students even if it meant rearranging the responsibilities of the instructors in a particular session. It was possible to pinpoint the students who were struggling and provide individual support. Providing this level of scaffolding is extremely difficult if not impossible in regular classrooms.

In addition to the scaffolding, all the instructors were particularly sensitive to equity issues, so we were consistent as it relates to holding the students to high standards. Therefore, in situations where we felt students were not grasping the concepts, we more readily questioned our practices than the intelligence of the students and modified our approach when necessary. We spent hours collectively reflecting on the day's activities, identifying instances of student learning and evidence of struggles, and using this information to develop student-centered (some student-specific) instructional goals for upcoming sessions. Given the realities of schooling, this kind of teacher collaboration and support is often not feasible.

The main challenge to our success was the mathematical deficiencies of the students. These deficiencies are reflective of the harsh social realities these students face in their daily lives. Our intervention could not erase the larger societal and fiscal barriers that have impacted and will continue to influence the mathematical development of these students. However, our goal was to provide worthwhile mathematical experiences for African American students so that they could envision the possibilities—as mathematics learners and as citizens with resources to enact change. We also hoped to be able to tell a tale of success adding to the other counter-narratives about African American students (e.g., see, Martin, 2007; Stinson, 2010). We can only speculate about the long-term impact that our intervention may have had on the students. As stated by Apple (1992) and Tate (1997), teaching for equity cannot solely reside on the shoulders of teachers; without a complete reshaping of the political and social structures that impact these students' lives, the long-term impact will be minimal, at best.

APPENDIX A
Sample Surveys

Survey A

Circle which breakfast food you think is the best:

I. Waffles and Sausage
II. Grits, Eggs, Biscuits, and Bacon
III. French Toast and Sausage
IV. Grilled Cheese Sandwich with Soup

Survey B

Rate each of the following breakfast foods by responding: strongly dislike, dislike, undecided, like, or strongly like. Circle your response.

Waffles and Sausage	Strongly Dislike	Dislike	Undecided	Like	Really Like
Grits, Eggs, Biscuits, and Bacon	Strongly Dislike	Dislike	Undecided	Like	Really Like
French Toast and Sausage	Strongly Dislike	Dislike	Undecided	Like	Really Like
Grilled Cheese Sandwich with Soup	Strongly Dislike	Dislike	Undecided	Like	Really Like

Survey C

Rank the following breakfast foods, with #1 being your favorite breakfast, #2 being your second favorite breakfast, and #3 being your least favorite breakfast.

Waffles and Sausage
Grits, Eggs, Biscuits, and Bacon
French Toast and Sausage
Grilled Cheese Sandwich with Soup

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

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