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Teaching Statistics for Social Justice - An Autoethnographic Research Report

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Abstract

The following autoethnography was completed by two graduate students at University A learning to enact teaching for social justice while building content underpinnings in statistics at University B. The authors present a research base for teaching for social justice followed by a description of their lesson, observations during enactment, and reflection of change in beliefs about teaching for social justice afterward. Findings in this study are shared from the authors' personal perspectives through the enactment of teaching a lesson for social justice in an undergraduate statistics course at University B. Implications provide encouragement that the inclusion of social justice topics in undergraduate and graduate level teacher educator coursework may improve teacher attention to equity in practice.

Keywords

Mathematics education, statistics, social justice

Introduction

Teaching statistics for social justice (TS4SJ) is the act of using statistical knowledge to empower students to make a difference in their world (Lesser, 2007). TS4SJ enables students to make a personal connection to the statistics that will influence further decisions in their everyday lives (Lesser, 2007). By pairing the two (statistics and social justice), students will not only truly understand statistics, but they will also create real-life connections, which help them to understand the importance of the statistics they are doing. By understanding the why behind the statistics and grasping the significance of how statistics affects our world, students will have a well-rounded statistics education which will empower them for years into the future.

Furthermore, TS4SJ works to help students identify "inequities that face their communities" (Enyedy, Mukhopadhyay, & Danish, 2006) and be agents of change. Lessons focusing on TS4SJ push students to realize an issue by observing, collecting, analyzing, and representing data and determine what changes they can initiate. Teachers who advocate for TS4SJ recognize that strong (statistical) content knowledge is important but not sufficient for (statistical) instruction in the 21st century (National Council of Supervisors of Mathematics [NCSM] & TODOS Mathematics for All [TODOS], 2016). This research helps teacher educators and future teachers understand the impact of including the exploration, understanding, and response to social injustices in their curriculums to improve learning and social outcomes.

The following autoethnographic research reports two middle-grades mathematics education graduate students' experiences and epiphanies TS4SJ in an undergraduate statistics content course geared for K-8 education majors at a different university. The authors were participating in a graduate *Content Underpinnings* course with an emphasis in TS4SJ. They used ideas from the class to create and orchestrate a lesson to undergraduate preservice teachers in a different city and report their findings through an autoethnographic study.

Autoethnography

This autoethnography seeks to share the experiences of two graduate students in their development of learning about TS4SJ. In line with autoethnography, the authors share their past and present involvement of TS4SJ while using these journeys to analyze and interpret their learning, beliefs, and experiences (Adams, Ellis, & Jones, 2017). Autoethnography was used by the researchers to help the teachers or researchers in understanding the struggles and complexities of TS4SJ and sharing these epiphanies with a broader audience. The

authors used a review of the literature, self-reflection, emergence in the phenomenon, and writing to relate themselves to and understand TS4SJ through emergence in hopes to connect readers to the wider cultural, political, and social meanings and understandings of TS4SJ.

Thus, researchers in this study were participant observers in TS4SJ. Researchers used coursework, papers, lessons, field notes, and past experiences to paint a picture of their engagement in and learning of TS4SJ during and after their research (Geertz, 1973). Meetings with others involved in TS4SJ helped provide deeper understanding of the cultural happenings of engaging in such a learning environment. These meetings provided opportunities to reflect on the common language of TS4SJ (Ellis, Adams, & Bochner, 2011) that helped provide common language and understanding. This report, in line with autoethnographic research, was completed after completing a statistics education course dedicated to TS4SJ (Ellis, Adams, & Bochner, 2011). Thus, the report draws from past experiences related to TS4SJ by Authors 1 and 2 and uses a required course assignment to TS4SJ to highlight developed insights during the experience with an epiphany of enlightenment. This epiphany or self-reflection is described by Authors 1 and 2 at the conclusion of the article.

Literature Review

Teaching for Social Justice

While English teachers help students see the importance of reading and writing in all aspects of their lives, mathematics teachers tend to isolate mathematics learning despite mathematics being an integral part of our everyday lives. Due to educational reform, many teachers feel pressure to "cover" the curriculum which leads to teaching mathematics in isolation (Peterson, 2012). Consequently, educators are unknowingly conveying the message that mathematics is basically irrelevant except for success in future mathematics classes, business operation, or specific mathematical careers. Unfortunately, students come to believe that mathematics is not connected to social reality in any substantive way (Peterson, 2012). Peterson, a fifth-grade teacher with a bilingual classroom of many Spanish-speaking students, explored a perspective of teaching mathematics across the curriculum. He shared how he infused math in multiple curricular areas while also teaching for social change. As a fifth-grade teacher, he was a strong proponent for incorporating writing throughout the curriculum; however, he often used to segregate his mathematics instruction. It was not until he was involved in creating social change in his own community that he realized the impact of incorporating mathematics in all areas of the curriculum. This seems to be a common theme presented by Aguirre et al. (2013), in which teachers shared their personal reasons

for how and why they taught mathematics. All of the teachers who shared their experiences said they believed teaching mathematics would initiate change in social disparities that they personally encountered (Aguirre et al., 2013). May researchers in this field view mathematics as a language or a tool to understand and interact with the world and other academic disciplines (Peterson, 2012; Gutstein, 2006). Students should not only be required to write to convey meeting and purpose; they should be required to read and write the world with mathematics (Peterson, 2012; Gutstein, 2006).

In order to support students to begin thinking about mathematics in this new way, teachers may start by asking students to explore different ways that mathematics is used in their homes, communities, and even the world (Peterson, 2012; Gutstein, 2006; Ladson-Billings, 1998; Tate, 1997). This can help make students education culturally relevant (Ladson-Billings, 1998; Tate, 1997), critically important for teaching statistics for social justice (Berry et al., 2020). This can encourage students to think about how relevant mathematics is to their everyday lives. Activities that connect to student assets and culture are important to discussing sensitive social issues that are important to students (Peterson, 2012). This method of introducing mathematics to students can make a smooth transition to linking mathematics to issues of equality, current events, and understanding history and is paramount for students and others who are oppressed to become active agents of change (Freire, 2018; Berry et al., 2020).

Mathematics can be exciting and somewhat difficult to master. Peterson (2012) also spoke on how mathematics is similar to foreign language, sports, science, and building construction. Students often find mathematics irrelevant to their lives; hence, they begin to shut down during mathematics lessons. Not only is mathematics often the subject that everyone dreads, but no one takes the time to interweave mathematics into other content areas (Peterson, 2012). The struggle lies in how to connect the current mathematics standards teachers are required to teach to mathematics students can apply in the "real world." Peterson argued for culturally relevant mathematics that valued cultural assets while also challenging spaces of marginality. Doing these things are important because mathematics becomes increasingly more difficult and seemingly less relevant as students move through their academic careers.

Murrell (1994) posited that "practices that are intended to promote deeper understanding of mathematics for all children actually diminish African American students' opportunities to understand, communicate, and apply mathematical ideas" (pg. 557). Murrell argued that this is because of cultural differences between teachers and students. He went on to explain that teaching and learning in the classroom was a social process with subliminal and obvious messaging that

coordinates common action and understanding (Murrell, 1994). Aguirre et al. (2013) similarly emphasized the need for integrating mathematics, social injustices, and identity in the five equity-based practices that encourage teachers to go deep with mathematics, leverage multiple mathematical competencies, affirm mathematics learners' identities, challenge spaces of marginality, and draw on multiple resources of knowledge. Additionally, inequitable practices lead to opposition, as minority students begin to struggle against the dominant culture. Murrell cited prior research conducted by S. Fordham and J. Ogbu, which found that academically talented African American high school students either tacitly or openly evaded using characteristics associated with 'acting White' in an effort to remain culturally 'Black' (Murrell, 1994). Emdin (2016) wrote extensively of this and coined the term nonindigenous to refer to urban youth, members of a historically oppressed group who are often educated for compliance. Emdin speaks specifically of this situational identity as code switching.

In an effort to explore this behavior further, Murrell (1994) conducted an ethnographic study with four urban middle schools where the African American population exceeded 50%. The results of his research concluded that during mathematics talks, African American males tended to give an impression that they understood the subject matter even though they did not. Indeed, according to Murrell (1994), students were more concerned with "having the floor" and participating as the talker than they were with sharing their understanding of mathematical concepts ideas, which is consistent with Berry (2016) and Emdin (2016). In order to prevent these behaviors and assist with the achievement of African American males, Murrell argued that responsive teaching is necessary. This means that it is essential for teachers to comment on how students present as well as what students present (Murrell, 1994, pg. 567).

Similar to Murrell's (1994) research, Berry (2016) explored the impact of personal identity on students' belief in doing mathematics successfully. Specifically, Berry investigated this by examining the mathematics experiences of eight African American middle school boys. Berry argued that access to important mathematics, parental involvement, and support in addition to "the understanding of the complexities of the racialized experiences, stereotypes, lowered expectations, and challenges faced by African American boys" is essential to helping African American males develop an identity as a student who is "good at math" (pg. 34). Emdin (2016) similarly encourages cultural presentations that draw on Black students' assets that value voice, video, community, social media, and dialogues to reshape students' mathematical identities.

According to the research conducted by Berry (2016), personal identity and mathematical identities become interwoven as students begin identifying with

college and career paths. For example, a young man named Andre in Berry's study shared, "I want to go to the Air Force Academy and become a pilot. You have to be good at math to get into the Academy. Good math grades will get me into college" (Berry, 2016, pg. 29). Because of this, Berry asserted the importance of teachers' understanding of students' identities in order to provide activities, presentations, and other opportunities for students to 'do' mathematics (Berry, 2016). This is similar to how Aguirre et. al (2013) argued for teachers' identities as mathematics learners to shape their teacher identities. These teacher identities, in turn, influence the decisions and actions influence the enacted curriculum in K-8 mathematics classrooms. It is important that mathematics educators not only be aware of their students' identities as learners but also be cognizant of their own identities, which may shape the way they provide access to high-level mathematics experiences within the classroom.

It is important for educators to understand social class and status, especially those in an area that has a low social and economic background. Students who are labeled with low socio-economic status are often difficult to find, because they will often appear to dress and act like the students who have a higher socio-economic status (Spencer & Castano, 2007). Students who have a low socio-economic status often perform lower in school, have lower test scores, and perform worse on daily tasks (Spencer & Castano, 2007).

While students with a higher socio-economic status are likely to excel in the classroom, students with a low socio-economic status or background tend to act out and be disruptive in class because of family stress from a financial and personal account (Mistry et al., 2009). Students from various backgrounds will often group together and cause mischief due to their background and kindred spirits. As students begin the process of gaining and identifying their identity, they will compromise their own expressions of self in dynamic interaction with others who may attempt to ascribe unwanted and ego-degrading projections to the individual (Murrell, 2007).

Educators have students who have the mindset that "math isn't for them." Though no one would dare of saying they could not read, one may often here they are terrible at math with considerable laughter (Powell, 2012). At school, teachers often hear students saying and portraying this. At home, this mindset is generally accepted because the parents themselves might not have done well in the subject. It is often difficult to engage some students into mathematics discussion (or to simply put forth an effort) after they have made up in their minds that they will never be able to do well in mathematics. The struggle lies in not only how to change their thoughts on the subject but also make every effort to remind them that they are capable. To overcome this obstacle, Powell (2012) suggested building positive

relationships with students as well as using the community and relevant topics so that students can relate to the subject they learn and feel comfortable discussing various issues with their teacher. TS4SJ has the ability to engage students, interest students, and teach statistics all at the same time.

Teaching Statistics for Social Justice (TS4SJ)

The previous section has highlighted teaching for social justice with little direct connection to TS4SJ. Statistics are all around us and are used to read and write our worlds (Gutstein, 2006). Lesser (2007, pg. 3) defined TS4SJ as "the teaching of statistics with nontrivial inclusion of examples related to (our previously defined version of) social justice, offering opportunities for students to reflect upon the context of these examples as they learn or apply the associated statistical content." This means that TS4SJ helps students see statistics not only as a useful tool to their everyday lives but also to bring awareness of social justice issues and transform injustices. According to the Enyedy et al. (2006), teaching statistics with respect to students' cultures and lived experiences offers students' opportunities that they can reflect on and apply throughout life. This is further echoed in the book *Seeing Through Statistics* (Utts, 2005), where educators are able to give students a sense of mounting empowerment to use the art of statistics and using that to make an impact on the world.

Garfield and Ben-Zvi (2008) mentioned that using statistics in an everyday setting during instruction helps students learn more effectively. Educators "pulling back" from a mode of lecture give students an active role in uncovering the material. In addition, this allows questions of social justice to be more inviting (Lesser, 2006). Students are allowed the opportunity to uncover or declare instances of apparent injustice themselves. For the purposes of enrichment in mathematics and in creating real-life scenarios, students can explore statistics as they pertain to the earning power of the socio-economic setting they are in (Lesser, 2007).

An example of real-world applications educators can use is the lottery or other forms of winning various amounts of money. According to Lesser (2007), most of the state sponsored lotteries and gambling establishments make the bulk of their profit on those who come from a poor and non-mathematical background. Teachers and educators must show the true probabilities so we can empower our students and make better choices on whether or not to play (Lesser, 2007).

In 2006, Enyedy et al. presented an argument that the statistics education community was not progressing in attempts to improve achievement in underserved and marginalized students with the use of culturally relevant pedagogy and curriculum. Since this time, very little attention has been given to this topic. Sharma

(2014) blamed this on many statistics education researchers not being familiar with emerging research and perspectives relating to culture and power. This difficult is compounded as Sharma argued that many of the cultures and experiences differ internationally and within community contexts.

Though this difficulty persists, Sharma published an article illustrating the need to attend to culture while teaching statistics to middle aged Fijian Indians in 2014. Using three different tasks not directly related to TS4SJ, students' responses about the understanding of probability related back to their religious views and other experiences (Sharma, 2014). Students had interference of determining probabilistic inference based on their beliefs of how babies are formed during a probabilistic activity of flipping a coin to determine birth (Sharma, 2014). In addition, students related their experiences of playing soccer to a black and white marbles task related to understanding ratios (Sharma, 2014).

Though difficulties persist in finding curriculums that focus on TS4SJ, Berry et al. (2020) provide lessons that can help practicing teachers. Though many of the lessons provided in the book may be completed in less than a week, many offer opportunities for engaging statistical units. In addition, Casey et al. (2020) have completed an introductory statistics curriculum that focuses on TS4SJ. The curriculum uses current events and injustices along with digital technology to develop students' understanding of introductory statistics concepts through the investigation of current social injustices (Casey et al., 2020).

Developing TS4SJ

Before embarking on a journey devoted to understanding the experiences and epiphanies of the researchers TS4SJ, it would be unjust not to lay a short history of the development of TS4SJ. TS4SJ is rooted in critical race theory (CRT) that was initiated during the American civil rights movements (Conway & Lilly, 2019). The focus of CRT sought to expose the injustice both socially and economically of laws that were racially discriminate (Ladson-Billings, 1998; Tate, 1997). These ideas were then connected to culturally relevant teaching which sought to value the knowledge and experiences students bring from their homes and communities that influence students' mathematical teaching and learning (Ladson-Billings, 1998).

Culturally relevant pedagogy arose from the need and desire to improve academic achievement in all students, especially marginalized and underserved students. Ladson-Billings (1995) described *culturally relevant pedagogy* as an approach to teaching that uses students' cultures and experiences to engage them in the learning process. Ladson-Billings (1995) presented three principles on culturally relevant pedagogy. First, teachers must help students realize their full

potential to reach high achievement. Second, teachers must support students to maintain their cultural integrity while helping them succeed academically. Third, teaching must help students to "recognize, understand, and critique current and social inequalities" (Ladson-Billings, 1995, pg. 476). Gay (2010) introduced *culturally responsive teaching* as a teaching approach that uses "the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant to and effective for them" (p. 31). Gay's culturally responsive teaching framework emphasizes on instructional strategies and practices, particularly cultivating strong relationships with students, while Ladson-Billings' culturally relevant pedagogy framework stresses on respecting students' cultures. Both Ladson-Billings and Gay placed emphasis on engaging students to explore issues of equity in their own or their communities.

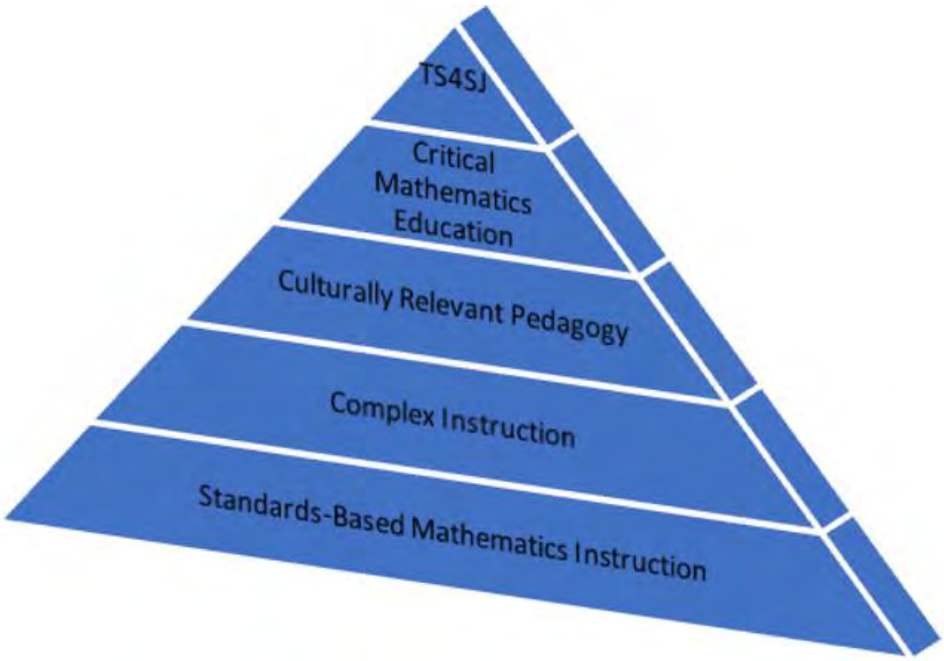
Recently, culturally responsive teaching has engaged education researchers to understand *complex instruction* (CI). A person's perception of themselves is deeply rooted in their culture and teacher values. In addition, the teacher and student are engulfed in the complexities of the classroom environment. Cohen and Lotan (2014) recognized that the inequities of the larger society are often replicated in small groups. Thus, CI seeks to counteract this ideology by valuing the different ways of being statistically "smart" in the classroom (Featherstone et al., 2011).

To help build a strong mathematics foundation for all students, the National Council of Teachers of Mathematics (NCTM) first published standards for mathematics in 1989 (NCTM, 1989) and revised in 2000 (NCTM, 2000). These standards outline important mathematical content and practices to be taught in schools, which have been adopted by many states in the United States and were expanded in NCTM's 2018 document *Catalyzing Change in High School Mathematics*. Since these standards emphasize understanding mathematics, developing mathematics reasoning, and communicating mathematically for all students, standards-based instruction tends to call for in-depth investigations, discussions, and reflections (NCTM 1989; 2000; 2018; Flynn et al., 2005). For instance, standards-based instructional practices include the use of physical models or hands-on activities, discovery methods, communications through group discussions, and real-world contexts (Thompson, 2009).

In essence, TS4SJ rests on four major frameworks from educational research: standards-based instruction, complex instruction, culturally relevant pedagogy, and critical race theory (Berry et al., 2020). As seen in Figure 1, without each of the following groundwork, TS4SJ falls apart.

Figure 1

Frameworks Underlying TS4SJ



Embarking on a Journey

In this section, the authors share their brief histories of teaching for social justice and initial perspectives on teaching for social justice prior to this study. These personal reflections were taken from Authors 1 and 2 before their immersion into the field and the completion of this research.

Author 1

Growing up, I had a very contentious relationship with mathematics. This was primarily due to my relationship with my dad. My dad was the most important person to me, and his opinion meant everything. He was also one of those people whom mathematics came easily to. However, much to his and my frustration, his only daughter was not one of those people. I hated disappointing him; I invariably did every time mathematics was brought up. I remember him helping me with my mathematics homework many nights as a child. Every single time, these nights ended in tears, on both of our ends. As a child, I remember being taught that mathematics was a series of steps that I needed to follow and memorize in order to be successful. I had two problems with this method of learning mathematics. First, I had and still have a terrible memory. So being asked to memorize multiplication facts and algebraic formulas was an extremely daunting task. The second problem

that I had with this method of learning mathematics was that I did not understand why these steps needed to be followed. Who came up with the formulas? Why do these particular steps and in this particular order give you a right answer? There was no rhyme or reason to the steps I was being asked to carry out, and because everyone seemed to understand, I was afraid to speak up and ask these questions in class and risk being the student that asked all the "dumb questions." As a result of these early mathematical experiences, I spent most of my youth avoiding mathematics at all costs.

It was not until I entered college that I truly began to have success with mathematics. I was fortunate enough to have a professor that not only shared her struggles with mathematics, which seemed to mirror mine, but she also began teaching new concepts by building a strong conceptual understanding before moving to algorithms. Because of her "transparent" way of teaching, I not only felt comfortable asking questions and making mistakes, but I also began to truly understand why the algorithm worked. This meant that I did not need to rely on memory because now I could talk myself through the process. After having success in this particular college mathematics course, I began to wonder why mathematics was not taught like that when I was in my K-8 classes. I could not help but feel that if I had the type of learning experiences that I had with my mathematics professor while I was in grade school, I might not have had such a low opinion of my mathematics ability growing up. As a result, when I began teaching mathematics in my own classroom, I vowed to teach mathematics in a "transparent" way as well.

It is my belief that in order for students to feel comfortable and be successful in mathematics, educators must teach students the importance of making mistakes and persevering through difficult concepts. In addition, conceptual understanding must come before rules and algorithms for students to truly understand mathematics.

As a fifth-grade teacher, even though I had not personally taught for social change prior to this research project, I have made a conscious effort to incorporate mathematics in multiple areas of the curriculum. For example, one of the lessons that I taught during a unit on the civil war, included a combination of Social Studies, Math and English Language Arts standards. The lesson was a focus on History, Economics (profits and losses), operations with whole numbers, and English Language Arts Speaking and Listening Standards. In the lesson, we investigated the profits and losses of a plantation with and without slaves in order to understand the south's financial perspective on slavery. In addition to realizing the profound human rights violations that slaves endured, we were able to see the financial implications that owning slaves provided for slave owners. From there, we conducted a mock debate, and students began to comprehend some of the

underlying reasons for the civil war. Because my students come from a challenging environment with little resources, I believe that teaching mathematics with a social justice focus will empower my students to change their environments for the better.

Author 2

Peterson (2012) showed how mathematics can be used not only in the actual mathematics classroom but in each subject area. Not only did he demonstrate how mathematics can be integrated but he also planned engaging lessons for his students. During these lessons, the students were able to see how mathematics can be used daily with realistic issues (Peterson, 2012). I believe lessons should spark the desire to be an agent of change. I can imagine the thoughts going through the minds of such young children while completing Peterson's (2012) sweatshop lesson because these students were required to think of children of their own age, or younger, working for a little of nothing. I hope my mathematics classes provides meaning like this.

To make mathematics more interesting and enjoyable, I try to incorporate real-life activities in my own classroom like Peterson (2012). Teaching at a school where 91% of the student population is African American, the topic of social justice and injustice is a common occurrence. I often have students complete tasks that require them to determine how much money they spend on different things such as food, clothes, and housing. Using tasks like this allows for students to connect with the difficulties of living under and above the poverty line. While the numbers in the tasks are often designed to create teachable moments, some students still wanted to know why they needed to budget money in the first place and not just spend more freely.

The social justice project that was noted by Peterson (2012) and the thought of incorporating relevant lessons to my students' lives seem to be just what is needed to gain student interest and make mathematics meaningful. I was under the assumption that social justice was simply trying to get justice for a group of students (e.g., achievement gap), but it appears to be more than that. Based on my understanding, social justice also includes data and issues relevant to students' lives. Some of my students are the second parents in their homes, so I believe that they would be interested to discuss minimum wage or how governmental decisions affect them. These topics would answer the common question, "When are we ever gonna use this?" or "Why do we need to learn this?" It was nice to see how Powell's (2012) students were more apt to complete the assignment about minimum wage since they were adult students and likely in the workforce themselves.

Designing the Social Justice Lesson

The research is a collaboration among two middle-grades mathematics education graduate students and two professors from two different universities in the southeastern United States. At University A, the professor (the third author) of a graduate-level course arranged with a professor teaching statistics (the fourth author) for his two graduate students (the first and second authors) to teach a social justice lesson in the fourth author's undergraduate content course called *Statistics and Probability for K-8 Teachers* at University B. The two graduate students from University A will be referred to as *teachers*, and the undergraduate education majors in the K-8 content course from University B will be referred to as *students*.

Preparation for the teaching demonstration required several steps. The professor from University B provided the team from University A with topics and timeline of the K-8 content course. Using this information, all four researchers decided on a statistical topic, which is estimating population parameters, and began to develop a survey to learn about the students in the K-8 content class from University B. For this reason, survey A found in Appendix A included two additional questions for students to help the teachers learn of injustices and culturally relevant topics that related to the students (two open-ended questions). The survey was designed to assess student perception of statistics as well as teaching for social justice (three open-ended questions). Additionally, there was a need to determine the population of the students in the classroom as well as their concerns about social issues in their communities, state, and nationally (three questions). The survey (Appendix A) was created by the Authors 1 and 2, revised by Authors 3 and 4 in a meeting with Authors 1 and 2, and administered by Authors 3 and 4 in lines with approved Institutional Review Board (IRB) protocol. In order to ensure anonymity, students were instructed to use a random number instead of their names as they completed their surveys. After that, the completed surveys were returned to the researchers where they were divided into groups based on students' social justice concerns. The surveys revealed that 16 students reported themselves as Caucasian females (n = 16), one student as Caucasian male (n = 1), and two students as African American females (n = 2). The common themes regarding social justice concerns were economic disparities and racial discrimination.

After determining the social issues that were important to the students in the class, the researchers worked together to brainstorm a social justice topic to incorporate in the statistics lesson. Because the majority of the students were Caucasian education majors and had an interest in racial equality, the researchers chose to emphasize the social justice portion of the lesson on the shortage of teachers of color in schools, including where Caucasian students are the minority. Furthermore, the researchers wanted to stress the importance of recognizing and consciously building relationships with students despite cultural differences so that all students feel that they have a place in the classroom.

To engage students in the social justice topic, at the beginning of class the teachers showed a video of a White female teacher positively affecting a former gang member who was an African American male student. The video was approximately 10 minutes long of the student and teacher's stories from their own vantage points and clips from their classroom. The video was followed by a short discussion of whether any students in the K-8 content course were influenced by their former teachers to become future educators. The teachers then used the discussion as a means to introduce a conflict of race in the classroom.

To intertwine the social justice issue of cultural differences affecting student-teacher relationships and the statistics topic of estimating population parameters, the researchers used unlabeled bags of black, brown, and white cubes. The cubes in five bags represented the racial demographics of the city B (where University B is located), University B, the largest land grant university in Georgia, the state of Georgia, and teachers in Georgia. The black cubes represented the percentage of African Americans, white cubes representing the percentage of Caucasians, and the brown cubes representing the percentage of all other ethnicities. Table 1 displays the populations represented in five bags for students to sample from.

Table 1

Bag Demographics in Georgia, Georgia Universities, and Georgia Teachers Using Cubes

Description	Caucasian	African American	Other
Race of people in Georgia	(6) 60%	(3) 30%	(1) 10%
The largest land grant university in Georgia	(7) 72%	(1) 8%	(2) 20%
The students at University B	(10) 62%	(4) 26%	(2) 12%
City B in which University B was located	(11) 54%	(8) 41%	(1) 5%
Teachers in Georgia	(6) 60%	(2) 20%	(2) 20%

Note: These percentages were found using the Google search engine by the lesson creators and represent approximations of values in each bag that were similar to characteristics of the group at the time of the study. Actual cube counts listed were put in bags for student sampling during the lesson.

Students participated in a random sampling activity by randomly selecting cubes from each of the five bags 10 times to estimate the demographics of each area. Then students were instructed to discuss the representations of their observations from the random sampling activity and the populations in the bags.

By taking this route, the researchers hoped that the students would notice how their thinking might change.

The closing activity focused on students reading news articles related to the topic of cultural differences in education and discussing them in groups and as a class. Five articles were chosen for their ability to help explain the phenomenon of demographic differences and their influence in education. These articles were: Adjusting micro-messages to improve equity in STEM (Morrell & Parker, 2013), 'Some unpleasant truths' on race, poverty, and opportunity revealed in CMS report (Helms, 2018), Parent Group Sues School District Over Alleged Segregation (Flanagan, 2018), Racial Inequality a Problem in Georgia Schools (Steuart, 2018), Georgia State Students Close Education Gap (Chiles, 2016). Each article presented a different connection and the effect racial demographics have on student populations.

Orchestrating the Lesson

The lesson presented at University B started off with two African American graduate students (as teachers) nervously standing in front of a predominantly White undergraduate statistics class. The undergraduate students were not used to the group seating that had been prepared before their arrival to the classroom; therefore, there was a group of students who isolated themselves from everyone else. As the students trickled in, the statistics professor collected the tests that the students had previously received. At this time, the second author could be seen dancing at the front of the room as she attempted to patiently wait for the lesson to begin while the first author appeared to be calm as she sat off to the side of the room.

The lesson continued with introductions from both graduate students, including the school they were currently teaching at and grade levels. A friendly competition was created when the second author mentioned that she teaches at "The Best Middle School in the World." This statement seemed to provide humor and relieved nervousness. Following the introductions, the video provided insight on how teachers can form relationships with their students, in turn leaving a lasting impression on the student throughout the social justice lesson. The video opened the floor to dialogue from the students to discuss teachers that have impacted them or motivated them to want to become a teacher. One female student mentioned that one of her former teachers had engaging lessons and a fresh outlook on teaching. This teacher pushed her to become a teacher. Another student shared that she initially joined a school club so that it would look good on her record. The sponsor of this club is responsible for encouraging her to take the Special Education route in her career as a teacher.

When it was time to calculate the percentage of each color cube that was pulled from each bag, the authors noticed that a few groups were using calculators while other groups used scratch paper to do the calculations. Both teachers monitored the groups during their percent calculations and noticed some had not scaled their answers up to match the 100 pulls total. The teachers questioned the groups about their results so that they would realize their error. One particular group was unsure of how to calculate the percentages and received guidance from the second author. One person in the group seemed indifferent when the calculations were shown to be incorrect. This could have been because she was embarrassed or due to being corrected by an African American. This same group offered an excuse when reflecting upon an article about the lack of African Americans represented in honors classes. During a private conversation within the group, a female student was observed stating "It's not like we [White people] don't give them [Blacks] more opportunities."

Upon completing the percentage calculations, five posters of five populations were hung around the classroom, and each group of students was asked to place sticky notes with their guesses of the demographics on the posters. As the actual populations are revealed, the students were shocked at the demographic makeup of each category. The students acknowledged that demographics of City B and students at the land grant university were the most shocking. One student stated that it may be because their "lenses" typically only consider what they see daily on the campus of University B. Some students thought that their perspective of the land grant university was likely due to who they saw playing football. In reference to the lack of African Americans in the teaching professions, one student responded, "I've never had a non-White teacher." Table 2 summarizes population predictions by student groups.

Table 2

Student Predictions of Local Areas' Demographics

		Number of Groups Under Predicted	Number of Groups Over Predicted	Number of Groups Correctly Predicted
City B	African American	3	0	2
	Caucasian	0	3	2
	Other	3	0	2
University B	African American	3	1	1
	Caucasian	1	3	1
	Other	1	3	1

Land Grant University	African American	0	4	1
	Caucasian	4	0	1
	Other	4	0	1
State of Georgia	African American	4	1	0
	Caucasian	1	1	3
	Other	4	1	0
Georgia Teachers	African American	3	2	0
	Caucasian	1	3	1
	Other	0	2	3

Table 2 provides some interesting characteristics. For each sample, the number of groups that under predicted, over predicted or had correct predictions are identified in the chart. According to the data collected, the students typically over predicted the number of African Americans in four out of five populations. The students see University B from a different lens because three of the five groups under predicted the number of African Americans on the campus. Overall, the students are unaware of the demographics throughout the state and those around them.

Triangulation was used by collecting several sources (class activities, observation during the teaching demonstration, researcher journals of interviews and teaching, and surveys) to determine the effects of implementing the TS4SJ lesson on students at University B. Data from student surveys (see Appendix A) were first analyzed independently by the researchers. The analysis was then reviewed and discussed to resolve any differences.

Findings: Reflecting After the Lesson

The lesson goals were to empower students to create social change within their own communities while also learning statistical concepts. Table 3 presents the results of post survey questions (see Appendix A).

Table 3

Post-Survey Results

Survey Question	Frequency	% (n = 17)
Changed perspectives about demographic differences	15	88%
Changed perspectives about using statistics	14	82%

Would pursue social change using statistics	11	65%

Based on the post surveys, 15 out of 17 (or 88%) of the students reported that their thinking about cultural differences had changed. One student responded, "Wow! I had no idea these were the numbers. So surprising! The teacher numbers were not diverse at all." Regarding using statistics to orchestrate change, 14 (or 82%) students answered that their perspectives have changed because statistics helps them their surroundings and address sociopolitical issue. For instance, a student noted, "You can use real data to show problems in our communities while still teaching content of the classes." Another one remarked, "It made me realize that by assessing data we can address problems that we have and see shortcomings." Additionally, when asked whether they would pursue social change using statistics on their own, 11 (or 65%) students confirmed that they would. Several students discussed ways in which they could orchestrate that change through building relationships with their students; for example, a student wrote, "To ensure that I can better connect with my students and cater to their needs".

However, students still struggled with the statistical concepts that were presented, and many were unable to accurately answer the mathematics related questions. In one instance, a group of students seemed to struggle to change a fraction with a denominator of 10 into a percent. As a result of this difficulty, they reported that they were less likely to pursue social change using statistics. One participant wrote, "I would not only because I am still not totally sure how to do this." This could mostly be attributed to the fact that the researchers were only with the students for one class session. This did not give much time to fully delve into mathematics concepts while also discussing the social justice topic.

Implications and Next Steps

The following describes the final thoughts and next steps after teaching for social justice at University B by the two teachers. The teachers share how preparing and teaching the lesson changed or impacted their views of teaching statistics for social justice. Additionally, the teachers reveal how the experience shaped their thinking about current teacher preparation and some elements of the lesson that they would change if others choose to use a lesson such as this to help teaching sampling in a statistics course while incorporating a lens on teaching for social justice.

Author 1

Preparing and teaching this lesson impacted my views of teaching statistics for social justice in several ways. Before participating in this lesson development, I never thought about the importance of empowering my students to change their world. Now, having experienced the impact of a social justice teaching demonstration, I am constantly looking for ideas to incorporate social justice topics that affect my students into my mathematics lessons. One example of this would be a sixth-grade statistics lesson on collecting and analyzing data that I teach every year. Typically, I instruct my students to create a statistical question based on something they are curious about, and we use a sample population from the school in order to make a conclusion about the data. However, my plan for the next time that I teach this lesson will be for students to collect data about the adults in their areas who are eligible to vote and whether or not they intend to vote in the next election. Then students can compare that data to the state officials who had been elected to represent them in the past and the officials' record on making changes for the better in the community. Using this information, they can organize a voting drive or community event in order to encourage adults in their community to get out and vote.

Additionally, I think that all teachers of all disciplines should take a course on teaching for social justice. A disconnect between teachers and their students may easily occur because of the difficulty the students had in matching the population percentages to the demographics in the random sampling activity. I would suggest that teacher educators require students to not only experience a social justice lesson within their program of study, but also design their own to use in their future classrooms. This will give them insight into how powerful teaching for social justice can be.

Unfortunately, I do not think that the students in the class developed a strong understanding of statistics. Because the primary focus was on TS4SJ during one 75-minute lesson, we did not get to really dig deep into statistical reasoning. Therefore, in the future, I will strive for more balance between engaging students in a social justice issue and providing opportunities for them to discuss their statistical understanding as it relates to the social justice topic. One idea to achieve this is by having students create their own lesson based on the statistics concept that is being examined. This way students would be able to apply their statistical understanding while extending their work with the social justice topic.

Author 2

The lesson that was planned and completed opened my eyes to the lenses of other people beyond my normal classroom that consists of mainly African Americans. The students, mostly White, were unaware of the significant difference

in the demographics in the various populations. As an African American I see daily how Blacks are being killed or killing others. I would like to do a similar lesson with my students since I teach at a predominant minority school. My students tend to be unaware of matters outside of their own neighborhoods, so I believe that a similar lesson would be an eye-opening experience for them.

Though many of my students are familiar with or experience living at or below the poverty line, they have less knowledge of the achievement gap and more specifically the opportunity gap. The achievement gap is the difference in performance of Caucasian-American students compared to and with Hispanic, African- American, and other students that are economically challenged compared to students on the scale of low socio-economic status; however, the opportunity gap is the difference in resources (i.e., "opportunities") afforded to students based on their race and socio-economic status that affect the achievement gap. It continues to be a confounding issue in urban education particularly since the scholarly literature on the topic has tended to frame African- American underachievement in terms of a deficits, rather than as an assets perspective that considers Black achievement excellence.

When we initially sat down and considered options that we could prepare a social justice lesson based on the students' interests and concerns, I was amazed at the number of issues that we desire to change. There were various choices, so it was difficult to select which one to focus on. What change could we attempt to enact using the students at University B? What could we influence the students to be agents of change for? It was clear that they could enter the teaching profession with the desire to be influential and inadvertently lead others to this profession. Through the process of selecting a social justice topic expressed by the students, I encourage those who are looking to incorporate social justice lessons in their statistics classroom to draw ideas and social justice issues from their own students, cultures, and injustices.

However, as we left the campus, I was unsure whether the lesson accomplished all that we set out to do both mathematically and socially. Mindsets are difficult to change in a one classroom meeting; thus, teachers incorporating social justice lessons in their classrooms should devote at least multiple days to formatively assess students' development of a social belief and incorporating multiple opportunities to tackle different beliefs. Therefore, I believe this research project would have even more significant impact if it were extended to two days to ensure that students recognize the issue and comprehend the statistical aspect of sampling and population parameter estimation.

Conclusion

This autoethnography has highlighted the impact a course's focused attention may have on developing both practicing and pre-service teachers' cultural perspectives. Pre-service teachers experiencing the TS4SJ lesson saw a connection to their training as teachers and provided them with richness and experience to teach with equity (Lesser, 2007; Peterson, 2012; Powell, 2012). The TS4SJ lesson offered pre-service teachers an opportunity to consider how their actions and privilege may be used to empower their future students. Highlighting culturally relevant contexts such as the power of teachers and education that students are seeking degrees in helped them reflect on their own practices that contribute to access and opportunity (Lesser, 2007; Peterson, 2012; Powell, 2012).

Practicing teachers in this study saw a renewed focus towards TS4SJ in their own courses and how their actions (Aguirre et al., 2013) or lack thereof play a critical role in positioning students as learners and doers of mathematics (Berry, 2016, Murrell, 2007; Murrell, 1994). Author 1 noted an increased need and focus towards finding lessons that empower her students. She also noted the power of experiencing a TS4SJ lesson in her graduate curriculum that fostered the learning and experience. Author 2 expanded her notions of meaningful mathematics to include ideas related to the opportunity gap and racial injustice. Both Authors 1 and 2 presented worries with the diminishment of standards-based objectives when TS4SJ instruction but saw more value in developing the practice based on its positive impact on students when TS4SJ.

After an immersion of graduate students working together to TS4SJ in an introductory statistics course for undergraduate elementary majors, both undergraduate and graduate students benefited. Undergraduate students experienced effective teaching practices through TS4SJ that helped them think through what it means to challenge spaces of marginality. Graduate students re-examined their practices and gained a renewed passion for their profession and dismantling injustices in their world.

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Appendix A

Survey Before Teaching Demonstration

1. Why do you or do you not think statistics is useful to understand the world?
2. What are some areas of the world you would like to see changed?
3. What are some areas of your state that you would like to see changed?
4. What are some areas of your community that you would like to see changed?
5. How could we use statistics to orchestrate a change in these areas?
6. What is your gender?
7. What is your race?
8. What is your age?

Survey After Teaching Demonstration

1. How did your perspective change or not change about demographic differences in Georgia, Georgia universities, and Georgia teachers?
2. How did your perspective change about using statistics to orchestrate change about an area of the world, state, or community you would like to see changed?
3. Why or why would you not pursue social change using statistics on your own?
4. What is your gender?
5. What is your race?
6. What is your age?