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## Incorporating Social Justice into Statistical Instruction: Using Action Research to Impact Pre-Service Teachers

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## Keywords

Equity, Social Justice, Empowerment, Teacher Preparation

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# Incorporating Social Justice into Statistical Instruction: Using Action Research to Impact Pre-Service Teachers

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## Abstract

The following action research depicts how two researchers from two universities merged their courses and goals of instruction to impact change in future teachers. Two currently practicing middle school teachers from one university worked with researchers to develop a social justice lesson that had relevance to seventeen K-8 pre-service teachers at another university to promote changes in beliefs about equitable teaching practices and policy. Findings from pre- and post-surveys, field notes during enactment, and reflections teachers found teaching statistics for social justice (TS4S) in this setting provided an increased responsiveness to the needs of students and statistical connections while also attending to excuses by those facing dilemmas in belief and racial dominance.

## INTRODUCTION

For decades, content knowledge, pedagogical knowledge, and pedagogical content knowledge have been a focus in teacher education programs (Shulman, 1987). However, while deepening teachers' mathematical content knowledge is of high priority, it is not sufficient for mathematics instruction in the 21st century (National Council of Supervisors of Mathematics [NCSM] & TODOS Mathematics for All [TODOS], 2016). Therefore, in recent years, more attention has been given to broaden those knowledge foundations to improve achievement in all students, especially underserved and marginalized students, by using culturally responsive and relevant pedagogy (Gay, 2000; Ladson-Billings, 1994; Greer, Mukhopadhyay, Powell, & Nelson-Barber, 2009) and teaching for social justice in mathematics education (Gutstein, 2003). There is also much argument for the need of culturally relevant pedagogy in Science, Technology, Engineering, Arts, and Mathematics courses (Kant, Burckhard, & Meyers, 2018).

The goal of this article is to explore changes in K-8 teacher candidates' beliefs about the importance of cultural, social, or political knowledge as they learn about statistics through a social justice lens. To reach this goal, a team of two mathematics educators (researchers) from two universities in the southeastern United States and one of the researchers' two graduate students (teachers) co-planned a lesson for K-8 Pre-Service Teachers (students) in the other researcher's course called *Probability and Statistics for K-8 Teachers*. This lesson targeted statistics for the course and social injustices expressed by the K-8 PSTs and was co-taught by the two teachers immersed in teaching statistics for social justice (TS4S).

## LITERATURE REVIEW

### Culturally Relevant Teaching

Culturally relevant teaching is defined as a pedagogy that allows students to bring knowledge and experiences from their homes and communities that can influence the mathematics teaching and learning (Gay, 2000; Ladson-Billings, 1995). Ladson-Billings' (1994) study showed that culturally relevant teaching has positive effects

on teacher beliefs and students' learning. Ladson-Billings (1995) found that regardless of their instructional approaches, educators who were successful with marginalized students recognized the importance of including their students' cultures and valued their identities in the teaching-learning process. Through culturally relevant teaching, educators can broaden their students' participation and engagement and spark their interests in using mathematics to explore issues of equity in schools and their communities. Since raising social awareness is one of the key goals of culturally relevant teaching (Gay, 2000), social injustices naturally arise as culturally relevant pedagogy is implemented.

### Teaching for Social Justice

Gutstein's (2003, 2006, 2009) approach to teaching mathematics for social justice included three goals to help students use mathematics to develop: (1) critical sociopolitical knowledge of their surroundings, (2) a sense of social agency; i.e., seeing themselves as part of the solution to injustice, and (3) positive social and cultural identities. When students develop an awareness of the world in which they live through mathematics, they see mathematics as a tool to understand, analyze, and make a difference to social action and change (Gutstein, 2006).

According to the literature, mathematics standardized tests have served as "gatekeeper" for underserved and marginalized students receiving access to higher-level mathematics, advanced programs, and future goals (Davis & Martin, 2008). In their 2016 joint statement, the NCSM and TODOS described a social justice approach in mathematics education as a way to "transform mathematics from a gatekeeper to a gateway, democratizing participation and maximizing education advancement that equitably benefits all children rather than a select few" (NCSM & TODOS, 2016, p. 3).

Unfortunately, many see equity in education as a means to lower expectations of students or as in opposition to excellence in school policy (Gutiérrez, 2013b). However, culturally relevant teaching and teaching for social justice should actually reduce student misconceptions, make content applicable, and increase conceptualization by students. TS4S should help develop social,

political, and critical knowledge for teaching so educators and students can advocate for underserved and marginalized individuals (Gutiérrez 2013a, 2013b). True equity is in place when rigorous standards are encouraged and content is accessible and applicable to students' everyday lives. To do this educators and students need to "identify, examine, and reflect on their attitudes toward different ethnic, racial, gender, and social-class groups (Banks & Banks 1995)". Importantly, this is required by all persons whether from a majority or minority population or a socially advantaged or disadvantaged group.

### Co-Teaching and Co-Teaching with a Lens toward Social Justice

Co-teaching describes an involvement of "two or more educators working collaboratively to deliver instruction to a heterogeneous group of students in a shared instructional space" (Conderman, 2011, p. 24). Co-teaching practices combined with teaching for social justice benefits teacher candidates through increased pedagogical risk taking and support (Conway, Erickson, Parrish, Strutchens, & Whitfield, 2017; Conway, Strutchens, Martin, & Kenney, 2018). By experiencing co-teaching and developing a sociopolitical awareness, teacher candidates can be better prepared to teach in increasingly diverse classrooms and extend their understanding of a culturally relevant pedagogy (Conway et al., 2017; Mensah, 2011). Berry, Conway, Lawler, and Staley (2020) encourage educators to establish networks and communities to support and plan social justice lessons with their colleagues. When educators use co-teaching to provide social justice lessons, thoughtful feedback and self-reflections from each teaching partner enhance both their teaching practices and learning experiences for their students (Cobb & Sharma 2015).

### Teaching Statistics for Social Justice Education (TS4SJ)

Teaching mathematics for social justice is described by Gutstein (2003, p. 35) as reading the world:

to understand relations of power, resource inequities, and disparate opportunities between different social groups and to understand explicit discrimination based on race, class, gender, language, and other differences. Further, it means to dissect and deconstruct media and other forms of representation and to use mathematics to examine these various phenomena both in one's immediate life and in the broader social world and to identify relationships and make connections between them.

Lesser (2007) suggested that when interchanging the words "mathematics" and "statistics," TS4SJ is similar to teaching mathematics for social justice. In particular, Lesser (2007, p. 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 and transform injustices.

Lesser's (2007) study mentioned various resource distribution examples; for instance, low-income students being less likely to have qualified educators (Spencer, 2005), and argued that this topic is important for students to explore but is not a strong

example of social justice. One explanation is that it is not easy to agree on how much a nation such as the United States should allocate its resources on education, military, Medicare and health, etc. Rather, topics such as racial profiling by police (McAplin, 2000; Berry, et al., 2020) and the death penalty would be more powerful examples of social injustice. This is because these lessons require students to analyze data collected from a probability simulation which attends to the content need while also investigating fairness in real life and engaging in sociopolitical issues.

Enyedy, Mukhopadhyay, and Danish (2007) 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 2007 very little attention has been given to this topic in the International Association for Statistical Education. Sharma (2014) blames this on many statistics education researchers not being familiar with emerging research and perspectives relating to culture and power. In addition, Sharma (2014) argued that many of the cultures and experiences differ internationally. This difference is potentially another hindrance for educators incorporating TS4SJ.

Though this difficulty persists, in 2014 Sharma published an article illustrating the need to attend to culture while teaching statistics to middle aged Fijian Indians. 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). During a probabilistic activity of flipping a coin to determine gender, students had interference when attempting to determine probabilistic inference as a result of their beliefs that only God can decide a baby's gender (Sharma, 2014). In addition, students related their experiences of playing soccer and cultural beliefs (e.g., it is fair for younger children to have more marbles) to a black and white marbles task related to understanding ratios (Sharma, 2014).

Sharma expanded a focus on TS4SJ from attention to culture in 2014 to a focus on teaching probability through a socio-cultural perspective in 2016. Sharma's (2016) statistical activity was directed at helping students determine if a game is fair by rolling a die, moving students from an empirical perspective to a theoretical. Sharma (2016) did an excellent job in framing the activity on educational literature that helps develop students' probabilistic thinking, but seemingly lacked socio-cultural relevance. The focus of the activity presented was framed solely around "the game" and its fairness rather than focused around their community and culture. The positive aspect of developing such an activity, allows students to construct a classroom perspective of fairness and investigate this scenario regardless of context. This allows for each student to have similar lived experiences in which they can discuss and develop understanding while framing shared beliefs of equity.

TS4SJ has also been integrated into teacher preparation coursework in statistics (Nguyen & Eisenreich, 2018). Nguyen and Eisenreich (2018) implemented a social justice lesson with K-8 PSTs who were engaged in learning sampling issues and two-way frequency tables through the context of school choice voucher programs. Prior to the study, a survey revealed that the majority of these PSTs were not aware of school choice voucher programs, even though they were future educators (Nguyen & Eisenreich, 2018). Results of this study indicate that the PSTs gained awareness of social issues that may affect their future careers while

making a connection between school choice voucher programs and topics in statistics and probability (Nguyen & Eisenreich, 2018).

Concentrating solely on statistical probabilistic thinking does not directly deal with misconceptions that Sharma discovered in 2014. Students like in Sharma's (2016) research should use "fair game" activity to understand fairness in real life each day and include social and political injustices. The current need for statistics educators to consider is how to deal with relating statistical topics to injustices students face each day. Educators doing this can help reduce injustice while increasing students' sociopolitical awareness and statistical understanding. Potentially, Sharma (2016) could have explored aspects of his students' lives and upcoming professions that could have helped their understanding. Perhaps these were students entering a work force dominated by other genders and in which the game of fairness could have related to these individuals' real-life issues rather than just the game students play. Perhaps the game could have related to different socially and economically advantages subpopulations in Sharma's area. Or perhaps, as in this current study, a lesson could relate to both students developing understanding of probability while learning the influences of race and power.

Research has found that using curricula that is meaningful to students can help break conceptual difficulties and advance student reasoning (Konold & Higgins, 2002; Enyedy, et al., 2006; Garfield and Ben-Zvi, 2009). There are varying conceptions of how educators of statistics may include culturally relevant material to help students make deeper meanings; however, at the root of the issue is the attention of the teacher and the educational system to equity. Bartell and Meyer (2008) described teachers' belief in equity as giving the needed instruction for students to succeed, creating a specific classroom environment with high expectations for all students, giving equal opportunity for students to reach their full potential, and choosing appropriate curriculum that meets students where they are. Aguirre, Mayfield-Ingram, and Martin (2013) maintain that equity is at the root of effective mathematical teaching practices and researchers in this paper argue it should be extended into other areas such as statistics by encouraging teachers to go deep with content (statistics), leverage students content (statistical) competencies, affirm their content (statistical) identities, challenge spaces of marginality, and draw on multiple resources of knowledge. Researchers and teachers in this study used these frameworks to define equity along with Gutstein's (2003, 2006, & 2009) definition of social justice.

## RESEARCH FRAMEWORK

Hine and Lavery (2014) described action research as beneficial for educators who are committed to a critical, investigative process of improving school practice, policy, or culture. Hine and Lavery (2014) also confirm that action research can be used to fill the gap between theory and practice, facilitate teacher empowerment which increases pedagogical risk taking, and is a worthwhile means for professional development of teachers. Given the population of participants in this study, the goals of the classes involved in the research, and the intent to make contributions to the field, an action research design fit seamlessly to address the research questions.

The purpose of this research was to help future teachers, current teachers, and teacher educators begin to integrate TS4SJ. The intent of this research can be eloquently described by Brydon-Miller, Greenwood, and Maguire (2002)'s quote, which

stated, "working collaboratively with others leads not only to community and organizational changes, but also to personal changes in the action researcher" (p. 14). Through the collaboration of teacher educators (researchers henceforth), graduate students who are also current teachers in middle grades education (teachers henceforth), and undergraduate teacher candidates (students henceforth), shared experiences were intended to initiate changes in recognition and beliefs of pertinent factors of their shared community, teaching. Brydon-Miller et al. (2002) stated that, "action research rejects the notion of an objective, value-free approach to knowledge generation in favor of an explicitly political, socially engaged, and democratic practice" (p. 13). Action research provided respect for each of the researchers', teachers' and students' knowledge and their ability to understand and address the issues confronting themselves and their communities (Brydon-Miller et al., 2002). For these reasons, an action research methodology was used.

Action research is the act of generating theory through practice. Thus, the values of action research suggest that theory is really only useful insofar as it is put in the "service of a practice focused on achieving positive social change" (p. 15). Thus, researchers worked alongside the teachers in creating and implementing a TS4SJ lesson that sought to influence positive social change. The theory of action research framed the following research question:

**How do students' social, political, and statistical perspectives change when taught using a TS4SJ lesson?**

## METHODOLOGY

To answer this research question using action research, the researchers planned to monitor changes in perception of students in different phases: Pre-TS4SJ, during TS4SJ, and after TS4SJ. Initial coursework of participating teachers was geared at understanding both statistics and frameworks for equity and social justice (Conway & Lilly, 2019). The researcher journaled during this early portion of the coursework to record conversations related to student perceptions. After IRB approval, the teachers and researchers reflected and developed a survey that helped design a TS4SJ lesson and monitor students' change in socio-political views and cultural beliefs. This methodology was proposed in alignment with TS4SJ as described by Gutstein (2003, 2006, & 2009) which requires lessons to be aligned with students' cultures and socio-political dilemmas while also maintaining the distance and separation of the teachers from students. This survey was then administered to participating students and reviewed by the teachers. The teachers and researchers used the survey to develop a TS4SJ lesson plan to implement in the field.

During implementation, the researchers recorded field notes from the lesson implementation. Field notes focused on the interactions of the teachers and students, statistical content knowledge of teachers and students, and conversations connected with the socio-political injustice being explored. Discourse between the teachers and researchers were informal conversations which attended to salient perceptions related to statistics and the socio-political dilemma.

Researchers lastly sought to monitor students change in perception after the TS4SJ lesson and course. This monitoring was completed through the use of post surveys for students. Teachers and researchers analyzed student work to monitor their develop-

ment of the statistical standards while reviewing the post surveys to monitor students change in perceptions about the injustice being investigated. Figure 1 summarizes the action research methodology.

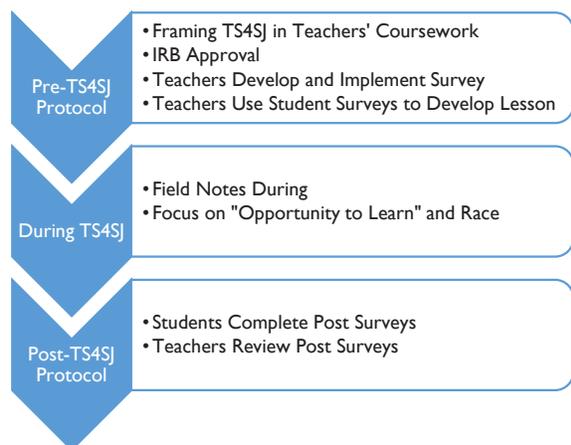


Figure 1. Research Protocol and Methodology

### Pre-TS4SJ Implementation

Researchers in this study were from two different universities in southeastern United States, University A and University B, working together to develop and implement a TS4SJ lesson in a statistics classroom geared for K-8 education majors. At University A, a graduate course in TS4SJ was being administered by the first author and is described by Conway & Lilly (2019). As a course project, graduate students (teachers) from University A had to develop and teach a lesson in conjunction with the professor teaching statistics at University B that aligned with both the classes' content standards and cultural dilemmas from the population of the students. The researcher's graduate course at University A had three major goals (Conway & Lilly, 2019): teaching for social justice, statistical pedagogical content knowledge, and statistical content knowledge. The two teachers team teaching the social justice lesson from University A were both African American women, who were currently practicing middle school teachers. The undergraduate K-8 education majors, students, at University B were composed of 16 Caucasian women ( $n = 16$ ), one Caucasian man ( $n = 1$ ), and two African American women ( $n = 2$ ). The researchers identified as a white male (first author) and a Vietnamese female (second author).

Prior to the TS4SJ lesson, the teachers and researchers categorized student responses to the pre-survey into different areas to understand the beliefs and attitudes. After discovering a large proportion of survey responses related to race and power, the students' majors, and the situational contexts, the teachers decided to intertwine race, power, and education. Teachers hoped that the shared passion for teaching would engage students in investigating a shared social education injustice while connect to their course's statistical standards.

### During Implementation Protocol

The professor at University B in charge of the students was beginning probability and its relationship to sampling and statistics with the students. Given the professor's learning objective for the course and the context of the students in the class, the teachers and researchers formulated ways to help the students critically

examine their own perspectives related to social injustice such as race, segregation, and power as well as statistics related to probability and sampling. Thus, the teachers planned a TS4SJ lesson that began with an engaging video of a Caucasian woman making a significant impact on an African American man, a member of a marginalized group in the United States (<https://www.youtube.com/watch?v=RXJGcqcJckA>). The teachers decided that this may help set the tone of the discussion and discourse for the class where the majority of students were white women while helping them understand their impact on marginalized students. Once students were engaged with the conversation of teaching in a statistics course, the teachers moved the students to the exploration phase of their lesson which began tackling the content focus (probability) while maintaining the initial context.

The activity required students be put in five groups. Each group was given five different bags through rotating stations to randomly sample cubes (black, white, and brown) and record their samples on large chart paper with tallies. The teachers purposefully did not tell students what the content of the bags represented. After each group in the classroom had sampled from the different bags, students performed calculations to determine the expected proportion of each color cube. The teachers then led discussion around the mathematics of sampling to estimate population parameters, and then asked students to guess the context of their observations in the activity. Students developed ideas about what the population of each bag represented.

The teachers chose populations related to the students' home state to help drive the discussion, require students to critically analyze their own situations, and make posters with their initial guesses. The populations represented in five bags are displayed in Table 1.

Table 1. Demographics in Georgia, Georgia Universities, and Georgia Teachers

Description	Caucasian	African American	Other
Race of people in Georgia	60%	30%	10%
The largest land grant university in Georgia	72%	8%	20%
The students' institution at University B	62%	26%	12%
City B in which University B was located	54%	41%	5%
Teachers in Georgia	60%	20%	20%

After some initial guesses by students on what the populations in the bags represented, the teachers gave each group a notepad and provided the actual populations on the board. Groups were then assigned the task to place a sticky note title on top of each sampling chart poster in which it represented. Implementing the activity like this allowed for the students to share their own experiences from their childhood and teaching field experiences. In addition, students were able to begin to visually and kinesthetically connect ideas of sampling variability.

Following this activity, the teachers and researchers highlighted key differences of actual populations with student guesses of population demographics. Table 2 displays students' perceptions of the five populations. The patterns in the table highlight the misperceptions of students based on their own lived experiences and some of the internal inconsistencies students were grappling with. Students sampling estimates of population demographics were compared with actual population demographics to determine whether they believed there were more or less of a particular race for a given context. Some of the largest gross mispredictions by students were that they believed there were

more African American students who attended the large land grant institution of the state and less Caucasians and there were less African American teachers in Georgia than there actually were.

Table 2. Students' Perceived Demographics of Local Areas

		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 GA	African American	4	1	0
	Caucasian	1	1	3
	Other	4	1	0
GA Teachers	African American	3	2	0
	Caucasian	1	3	1
	Other	0	2	3

Discussion followed this activity in which the teachers planned a scaffolding activity with the five different groups. Each group was presented with a different short news article that examined issues related to segregation, inequity, and power struggle related to race. Each group was given approximately five minutes to read the article, five minutes to debrief with one another, then two minutes to share back with the class on what the news article discussed. The article debriefs were then followed with some actionable steps for students to take as they enter the field of education both from a policy stance and a teacher stance.

### Post TS4SJ Protocol

After the lesson, students at University B completed a post-survey to inform researchers of their change in social beliefs about the cultural, social, or political phenomenon that related to their interest. This took place in the class immediately following the teaching demonstration. In addition, they responded on their change in beliefs of how statistics may inform and change these beliefs in others. Student work, notepads, and large chart papers were collected to record student predictions of populations in regard to race and further enlighten the researchers on potential patterns that may emerge from student experiences. Seventeen students completed the survey after the teaching demonstration, answering the following questions (Figure 2) along with providing their demographic information:

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?

Figure 2. Survey after the teaching demonstration

Researchers met with the teachers to debrief the lesson afterward. During the debrief, the teachers shared comments and insights with the researcher and these comments were written down for further analysis. During the teaching demonstration, the

researchers took notes of student participation, teaching interactions between the teachers and students, and pertinent comments of teachers and students that related to TS4SJ.

Triangulation was used by curating several data sources listed, which were class activities, observation during the teaching demonstration, researcher journals of interviews and teaching, and surveys to examine the effects of the TS4SJ lesson on the community of learners. Observation notes during the lesson were shared and discussed by the researchers. Data from student surveys were first independently analyzed by the researchers and then reviewed and merged after in-depth discussion.

## FINDINGS

Perceptions of students in this action research showed social, political, and statistical change. Techniques suggested by Bernard, Wutich, and Ryan (2016) were used to analyze and report findings from this research in order to describe student changes in perspective. The following sections use themes created by the researchers when analyzing surveys to monitor changes in perception.

### Social Change

During the social justice lesson, 14 out of 17 students were awe struck by their inability to predict racial demographics in areas they lived. During discourse in the class, students made comments such as, "I can't believe there are that many Blacks in [City B]." Students participating had an apparent conscious distinction of their initial guesses and actual reality. This could be seen through classroom discourse and incorrect assumption of racial demographics to each population (Table 1). During the activity, three-fifths of the groups under-predicted the number of African Americans teaching in Georgia, four-fifths over predicting the number of African Americans attending the state's largest land grant institution, and four-fifths under-predicting the number of African Americans in the state (Table 2). During discourse related to population prediction of the samples, one student said, "I've never had an African American teacher."

From survey results, most students involved reported change in some way. Table 3 displays results for Question 1 from the survey (Figure 2) regarding students' perspectives about demographic differences in Georgia, Georgia universities, and Georgia educators. Results after the TS4SJ lesson show how the lesson impacted student social, political, and statistical perspectives.

Table 3. Students' Perspectives about Demographic Differences in Georgia, Universities, and Educators (Question 1 in the Survey)

Description	Frequency	% (n = 17)
Change	15	88%
Did not change	2	12%
Unsure/No opinion	0	0%

Fifteen students (or 88%) indicated that their perspectives about demographic differences in Georgia, universities, and teachers was changed after the lesson. Of the 15 students, 14 expressed how shocked they were to learn that the racial demographics to each population are different from their expectation. Students were "surprised to see a lot of the demographics concerning the differences in university and teachers," quoted one student. Another student commented:

I know that there were more white teachers/professors/students, but I was still surprised at some of the percentages. Especially [the largest land grant university in GA], I always

thought of [the largest land grant university in GA] being very diverse because it's such a big school. I was surprised to learn I was wrong.

A number of students during the lesson mentioned comments related to wanting to be different than K-12 educators they had in the past and being a caring educator. After students watched the video during class, several of them shared the impact educators had on their choosing to be a teacher. One student discussed her work in extracurricular activities at school and the encouragement of her coach to work with students in special education. The inclusion of a topic relevant to the students increased interest and discourse around the topics as reported by the professor instructing the course.

Among the students who acknowledged a change in their perspectives, only one did not confront his/her prior knowledge about the demographic differences but commented, "It made me realize that diversity is important amongst teachers and students in the way that they learn, are engaged, and how comfortable they are." For two students (or 12%) whose perspectives remained unchanged, one did not give reason while the other one remarked, "My perspective did not change, but it was a fun activity."

Integrating the social justice lesson with the students' statistics class seemed to increase attention of the class as reported by the researcher assigned to the course. Students were engaged throughout the class in both discourse and statistical reasoning and sense making. One of the teachers orchestrating the lesson reflected afterwards, "using a lens of social justice while teaching statistics empowers students to make a personal connection to the statistics that will influence further decisions in their everyday lives." Responsiveness and engagement were found to be consistent with findings in Mensah's (2011) and Cobb and Sharma's (2015) for TS4SJ.

### Statistical Change

During the lesson, students developed a key idea of using samples to estimate population parameters. Interestingly, students failed to pay close attention to the measure of variability that was created from the true proportion to the sampled proportion. The students seemed to accept this variability without much discussion. The students, however, were curious to why they needed to replace the cubes. One of the students in the class did an excellent job describing this necessity based on the finite structure and small sample size in each bag. The student said that "the first sample from the bag changes the probability of the next sample."

In post surveys (Figure 2), students consistently made connections between the probability of selection and its relationship to the true population. A student stated, "It was very surprising to see that the real percentages were nothing like how I expected." In each of these descriptions, students related the sampling procedure to the probability of selection; however, they did more than this by relating it to the context of the situation.

Table 4 summarizes the results for Question 2 from the survey (Figure 2) regarding students' perspective about using statistics to orchestrate change. Of 17 responses, two students (or 12%) retained their perspectives because they already know how useful statistics is, and one (or 6%) offered no opinion on this matter. Fourteen (or 82%) indicated a change in their perspectives about using statistics to orchestrate change about an area of the world, state, or community. Results indicated that TS4SJ influenced students' perceptions of how statistics may be used to

orchestrate change. Though not as strong, Table 5 also supports the use of TS4SJ lesson on the students' future professional practice in the classroom.

*Table 4. Students' Perspective about Using Statistics to Orchestrate Change (Question 2 in the Survey)*

Description	Frequency	% (n = 17)
Change	14	82%
Did not change	2	12%
Unsure/No opinion	1	6%

Table 5 displays results for Question 3 in the survey (Figure 2) regarding whether or not students would pursue social change using statistics on their own.

*Table 5. Pursuing Social Change Using Statistics or Not (Question 3 in the Survey)*

Description	Frequency	% (n = 17)
Pursue	11	65%
Not pursue	1	6%
Unsure/No opinion	5	29%

Among 17 responses, one student (or 6%) specified that she will not pursue social change using statistics on her own while five (or 29%) were indeterminate or without opinion about this. Two of these six students may not pursue social change using statistics because they are unsure of how to use statistics on their own to engage social justice topics, which may be due to their lack of confidence in their statistics knowledge or unfamiliarity with using statistics for social justice. Three of these six students provided no reason as why they may not desire social change using statistics. One student, who is African American, expressed a concern that her belief about social change may be biased because of her race.

For the remaining 11 (or 65%) students who confirmed that they will pursue social change using statistics, their reasons can be categorized into the following groups: (1) benefiting academics; (2) informing socio-political issues; (3) being attainable; and (4) taking action for social change. Table 6 displays the results.

*Table 6. Reason to Pursue Social Change Using Statistics*

Theme	Common Responses	Frequency	% (n = 11)
Benefiting academics	"To ensure that I can better connect with my students & cater to their needs."	4	36%
Informing sociopolitical issues	"I would to make the world aware of diversity & it's [its] importance."	5	46%
Being attainable	"I [it] seems very complex but can actually be simple."	1	9%
Taking action for social change	"People want change but don't do anything about it"	1	9%

### Political Change

As shown in Table 7, three themes emerged from these 14 responses as to why their viewpoints on statistics have changed and it is because statistics can be used to: (1) understand these students' surroundings and address sociopolitical issues; (2) view themselves as part of the solution to injustice; and (3) develop positive social and cultural identities.

During the lesson, two groups of four students had issues changing the frequency counts to percentages. The students were trying different things on their calculators. The two African American teachers used probing questions to help students connect proportional relationships to percentages as proportions of 100. One particular group seemed to be annoyed by the teachers' questions and even seemed to dismiss the teachers' assistance. This group later in the class also provided excuses (described later) related to student differences based on opportunity to learn.

Table 7. Reason for Change in Students' Perspective about Using Statistics to Orchestrate Change about an Area of the World, State, or Community

Theme	Common Responses	Frequency	% (n = 14)
Understand their surroundings and address sociopolitical issues	"It made me realize that by assessing data we can address problems that we have and see shortcomings."	8	57%
View themselves as part of the solution to injustice	"I want to inspire students of any race/gender to want to teach."	5	36%
Develop positive social and cultural identities	"With the statistics about teachers in Georgia I would like to see more African-Americans getting into the education field."	1	7%

During the investigation of social justice, the five groups each read one of the following five news: *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). The group who had difficulty and was helped by the teacher to create a percent from frequencies was given the Flanagan (2018) article. One white female student in the group said, "It's not like we don't give them more opportunities."

The statement presents an important construct related to critical race theory. The student positioned herself in a place of authority as a member of the white dominant class. In addition, the statement comes from a place of authority because the student felt like it was her role to give opportunity. Importantly for the development of teachers, the student was providing excuses for the effects that were being described in the article. The social justice lesson was intended to promote action by the students to overcome barriers related to race and teaching, where this student resisted change by giving excuses.

Though only one group of students was overheard discussing excuse, this belief may have spanned a larger continuum of the class. During the group discussion, students in the group did not disagree or highlight other ideas from the article or their experiences they may have that contradicted this belief. After discussion related to opportunity to learn, one of the teachers shared her own experiences with lack of opportunity. This and another student sharing out actually provided access to the class discussing opportunity to learn from different perspectives.

## IMPLICATIONS, LIMITATIONS, AND STEPS FORWARD

TS4SJ in a classroom for future K-8 educators had many positive outcomes. During the next class periods, students commented that they enjoyed the TS4SJ lesson. Students had the opportunity to reshape and consider alternative perspectives to what they had originally been accustomed which in turn changed their social, political, and statistical perspectives as reported by students. Students developed a deeper understanding of sampling probability and parameter estimation. Change, though not monitored in action, was a common theme throughout discussion and surveys. Students noticed benefits for teaching for social justice in their classrooms. Lastly, these students noticed their inaccurate perception while connecting it to others' perspectives.

One limitation for this research is that findings may not be generalized to all students or all classes, because students in this study are K-8 PSTs. Furthermore, though many students in the class seemed to gain positive benefits from the experience, a number of opportunities to enhance the research design still existed. Certain aspects of the statistics related to sampling had to be de-emphasized to make time to discuss and address the social justice issues related to the differences in populations. In the future, a stronger focus on variation in sampling and sampling differences would be highlighted over a longer two-day time span. In addition, the same amount of time for discussion of articles and post-surveys would be allotted over multiple days to encourage reflection and chances to confront socio-political dilemmas of equity. Lastly, rather than discuss steps for creating social justice in the profession of teaching, a project would be incorporated to help alter the views of reality and make change. There would be a number of opportunities that students could pursue, but including them in servicing a disadvantage school would help shed light on the phenomenon of lack of opportunity.

Shaughnessy (2003) described how personal experience can shift student perception of actual probabilistic occurrence. For future educators to be adequately prepared to understand the world they will be teaching, it is imperative they be given diverse placements related to race. The class discussion and students' perceptions of different demographics highlighted many students coming into university programs with limited exposure to different races and cultures. Providing exposure to diverse clinical experiences and incorporating social justice lessons can greatly enhance their understanding of social justice issues.

Based on this research, other researchers are encouraged to monitor the impact of TS4SJ may have on students in their related fields. This may be in health care, agriculture, teaching, etc. Finding ways for students to reconstruct their view of reality was key to helping students change their perspectives. Researchers continuing research on teaching for social justice should ensure to monitor both the statistical cognitive implications of teaching for social justice but also the social beliefs of students. Researchers may consider using formal interviews with participants of TS4SJ lessons to gain a clearer image of how their lessons may impact their beliefs and steps towards promoting social justice in their own lives. Researchers may also want to include tools such as Multicultural Mathematics Dispositions (White, Murray, & Brunaud-Vega, 2012); Learning to Teach for Social Justice-Beliefs (Enterline, Cochran-Smith, Ludlow, & Mitescu, 2008); Culturally Responsive Teaching Self-Efficacy Scale (Siwatu, 2007); or other appropriate scales as means to monitor students development of sociopolitical awareness when implementing TS4SJ to develop students sociopolitical and multicultural development in their fields. Using validated and reliable scales at the beginning and end of a course can provide stronger evidence for direct impact TS4SJ may have on students. Lastly, researchers should carefully consider students' past experiences when constructing lessons in order to exemplify alternate realities and develop actionable plans to reshape the true reality.

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