Exploring high school students' perceptions post a social justice mathematics lesson

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EXPLORING HIGH SCHOOL STUDENTS' PERCEPTIONS
POST A SOCIAL JUSTICE MATHEMATICS LESSON

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Abstract

Through the social justice mathematics that has been introduced into the classroom, students now explore issues in the world around them through the lens of mathematics. This study follows a class that was previously unfamiliar with social justice mathematics lessons by giving pre- and post-lesson surveys intending to show the impact of a social justice lesson that was taught over a series of three days on students' perceptions. Specifically, I explored the impact a social justice mathematics lesson had on students’ view of themselves and mathematics. Particularly within the student perception of self, I examined the change of confidence levels as a mathematician and self-identified capacity to do mathematics before and after social justice lessons. Within the perception of mathematics, I explored the students’ perceptions of the relevance of mathematics in their own lives and the world. Further, I determined whether their perceptions of mathematics as a tool to analyze social justice issues changed after the lesson. Due to challenges with data collection, there could not be an adequate comparison between pre- and post-lesson surveys. Instead, I examined the answers given to only single surveys to discover how students are thinking about themselves and the mathematics they use in the classroom and the world around them. The results show that the one student who completed the post-survey found math to be a useful tool to analyze social justice and saw math as very relevant to the real world. I also found that the students who found math enjoyable were all somewhat confident in their ability to do mathematics. Based on my few responses, more research should be conducted to determine whether all students see the relevance of math in the real world and whether it can be used to analyze societal issues.
Background

Given the focus on implementing social justice lessons in high school mathematics classes (Berry et al., 2020), there is a need to determine the impact of social justice lessons on high school students’ learning and perceptions. Since 2000, social justice education has shifted toward socio-political issues (Xenofontos et al., 2021). This shift has introduced ambiguity within the literature as to what exactly is included in this term. Within the mathematics education community there is no overarching definition for social justice education. This can cause confusion, such as multicultural education sometimes mistakenly being included within social justice education by educators (Garii & Appova, 2013; Xenofontos et al., 2021). Though there is no set definition, there certainly are distinct qualities that are generally agreed upon.

One such quality is the inherently political nature of mathematics (Gutstein, 2006; Leonard et al., 2010; Felton, 2010). Deconstructing the common notion that mathematics is both neutral and context free (Gutstein, 2003) allows students to completely reconstruct their perception of mathematics and create the notion of mathematics as an impactful tool (Garii, 2007). While students reconstruct their perceptions, teachers of social justice mathematics have expectations for their students. Students should see themselves as mathematicians and the solution to injustice (Gutstein, 2003). Teachers want students leaving their classroom equipped with an “education that provides students with the knowledge and dispositions to struggle against racism and other forms of oppression [which] ultimately helps create a more just and equitable society” (Gutstein, 2003, p. 41). By teaching students with social justice lessons, teachers are preparing their students to notice and analyze inequalities they see in society.

There are a few concerns as a new teacher stepping into this field. There is not one script that will suit all teachers and classes. Further, teacher education programs often do not share this message across to inservice teachers (Leonard et al., 2010). The lessons teachers choose and how they teach them will also change as they gain experience. New teachers especially should not be judged by their first few lessons (Leonard et al., 2010); it takes time
and experience to cultivate lessons for students. Further, lesson development takes time and, more importantly, “learning to teach critical mathematics takes a long time” (Gutstein, 2012). One struggle that teachers encounter is a culture of silence. In order to have a healthy environment of learning and discourse, all teachers should actively work against creating a culture of silence which “occurs when teachers participate in social injustice themselves or fail to critique students who perpetuate inappropriate stereotypes” (Leonard et al., 2010). This can be especially difficult for a new teacher who is still developing their classroom management skills and who is not yet completely comfortable with the material.

Within the context of social justice, it is important to consider how the students perceive mathematics to be. Hulleman and Harackiewicz (2009) found in their study in science classes that students’ who view the learning content as relevant promotes motivation. While I am implementing the social justice lessons, I want students to be able to see the material we are covering as relevant to them and the world around them. Since the ultimate goal is for students to see themselves as a solution to societal injustices (Gutstein, 2003), students must be able to see the value in learning the material and feel that the content is relevant to their lives.

Social justice lessons have been implemented across school curriculum. For example, Brown (2009) studied two seventh grade girls and found that participation in social justice lessons contributed toward a heightened awareness of acting as a mathematician. The students further demonstrated their own agency over mathematics. My research will be more heavily relying on the impact of the content of the lessons rather than the implementation; social status within the classroom will also not be a focus as it was with Brown’s (2009) research. In Gutstein’s (2003) research, his purpose was to “uncover and concretize components of teaching and learning mathematics for social justice” (p. 37). He worked with 7th-8th grade students in Chicago. Gutstein (2003) taught his students to use “mathematics as a tool to analyze social issues like racism and other forms of bias and to understand power relations and unequal resource allocation in society” (p. 49). With my research, I am hoping to have high school
students also recognize and use mathematics as a tool to analyze social issues. Gutstein (2003) found his students “began to examine more generally inequality and discrimination in their lives and society” (p. 45).

There is significantly less literature describing the impact of social justice on high school students than on social justice lessons and implementation. Brown (2009) and Gustein (2003) both analyze middle school students, and I want to expand their ideas about social justice lessons and mathematics as a tool (Garii, 2007) to high school students as well. In my study I also want to connect whether students view math as relevant to the world around them and the correlation with student confidence levels within the context of social justice lessons.

Purpose

The purpose of this study was to determine how a social justice mathematics lesson impacts high school students’ confidence levels and self-identified capacity to do mathematics, students’ feelings on the relevance of math in the world around them, and students’ view of the usefulness of mathematics as a tool to analyze social justice. My study will be guided by the following research questions:

1. What impact does a social justice mathematics lesson have on high school students’ confidence levels and self-identified capacity to do mathematics?
2. What impact does a social justice mathematics lesson have on high school students’ feelings of the relevance of mathematics in the world around them?
3. What impact does a social justice mathematics lesson have on high school students’ view of the usefulness of mathematics as a tool to analyze social justice issues?
4. As a new teacher, what is the impact of teaching a social justice lesson for the first time on my own teaching and future teaching of social justice mathematics I will implement?
With this research, I am hoping to find an increase in high school student’s feelings on the relevance of math in the world around them, as well as an increase in confidence levels and self-identified capacity to do mathematics, as well as an increase in the previously mentioned student’s usefulness of mathematics as a tool to analyze social justice. I am also interested in how teaching these social justice lessons impact me as a pre-service teacher and what insight I can gain from this experience.

**Methodology**

During the Fall 2021 semester, my level three practicum was completed at Waterloo West High School in Waterloo, Iowa. My mentor teacher, Mr. John Fisher, expressed interest in bringing lessons centered on social justice into his high school Algebra I classroom. Having already taught three lessons and multiple small warm-ups in this class, Mr. Fisher allowed me to come and teach a social justice lesson for this research project. His classroom did not implement any social justice mathematics lessons prior to my lessons, so the students’ exposure to social justice mathematics lessons was unlikely. Because I wanted to test the impact these lessons have on the students’ perceptions, no prior exposure to lessons such as these was necessary. Earlier this semester, I met with Mr. Andy Miehe, the principal of Waterloo West High School. Through a brief discussion about proposed research, he disclosed the school has made efforts to show the value of diversity. With such values in place, this school proved to be an excellent choice for my research.

In accordance with the regulation of the University of Northern Iowa, I received Institutional Review Board (IRB) and school district approval before meeting with the students for the purpose of conducting my lessons. The participating students also filled out assent forms in class and the participating students and their guardians completed consent forms. Unfortunately, obtaining guardian consent forms from students proved to be a challenge. While students could fill out their assent form in class, their IRB-required guardian consent forms
needed to be completed outside of the school day. These forms were initially given to students as printed documents for both them and their guardian to sign. The forms were initially done on paper to be the most equitable; it was accessible for all students and parents with no internet connection being necessary. The students were reminded multiple times at the beginning and end of each lesson by both me and their classroom teacher to bring their guardian consent forms to class no matter if they were participating in the study or not. After the last day of the lesson was completed, only five consent forms out of nineteen students in the class had been returned. Out of necessity, consent forms were approved to be sent out via email to the guardians after the lessons had been completed. The email was forwarded out by the classroom teacher with the hopes of reaching more guardians and minimizing the impact of lost guardian forms; two more responses were received via email communication. This led to only five usable responses that could be analyzed in my final research.

Surveys were administered electronically through the Google Classroom used by Mr. Fisher and taken on Google Forms. Students were given approximately fifteen minutes in class to complete the pre-survey (Appendix A) to determine the knowledge base and perceptions of the students prior to the lessons. Immediately following the pre-lesson survey, the lesson began.

To guide my construction of the lessons, I used the recently published High School Mathematics Lessons to Explore, Understand, and Respond to Social Injustice (Berry et al., 2020) and received approval by both my research advisor and mentor teacher. This book includes resources such as lesson planning design tools, prepared lessons, and guidelines. The lesson taught for this study was the Culturally Relevant Income Inequality lesson (Berry et al., 2020). With the added time of the pre- and post-lesson surveys the lesson was taught over three days. The lesson explores income inequality between White, Black, Latinx, and Asian populations in the United States. To begin, the students watched a short video that exposes what life was like during the segregation of the 1950s and 1960s. The intent was to get the
students to compare how challenging life was then as a racial minority and being thinking how this might impact income inequality now. The students were then broken up into groups and read one article per group as they completed a worksheet to organize their thoughts on the articles. The articles explored the differences in income of two different families, the differences in income based on race in the United States, and an example of the disparities in income within one county in the United States. Students read the articles, and then a spokesperson shared about the article to the whole class. On the final day, students were given the opportunity to use math to discover the rates of change for the increase in wages per year for each represented racial demographic. The lessons ended in a discussion on what these rates of change mean.

On the final day, the students were immediately sent the post-lesson survey (Appendix B) to complete. However, only about five minutes were allowed of class time to work on the post-lesson survey, with the students electing to complete the survey at a later date. Because class time was not used, the majority of students did not end up completing the post-lesson survey. Multiple reminders were sent out by the teacher, but in total only five surveys were completed. Of these five, only one was able to be used due to lack of parental consent forms returned.

I was initially anticipating a change in the student’s perceptions of math. Above all, I wanted students to recognize the usefulness of mathematics as a tool to analyze social justice. I expected the lessons would increase the places students can identify math in the world around them and the relevance of math in the world. I expected students to identify an increase in personal mathematical capacity and increased confidence level. In addition, it was my hope that the students find math more enjoyable and see themselves represented in the mathematics. Based on the lack of responses and parental consent forms I received, I am unable to compare survey answers from before the lessons to after for any one student. This means I cannot confidently confirm a change in any student mindset and survey responses can now only offer insight into how students thought either before or after the lesson.
Challenges

While completing this project, a few challenges were encountered; some were more impactful than others. This morning class often has low engagement. There are quite a few students who are quieter and need more encouragement to speak out during class. Oftentimes discussions with tablemates needed to be initiated by a teacher with each table before the students were willing to engage with one another. Group work is relatively uncommon and ungainly for this class.

On the day of the second lesson, a sudden emergency kept the classroom teacher out of the room for the day. With a substitute teacher in the room, we had no access to the smartboard and no way to show the presentation for the day. There was no method to access student emails or google classroom to disperse information. Because of this, extra time was needed to help the students navigate to the necessary articles and the difficulty of beginning the lesson seemed to increase disengagement.

On the days of the lessons, students were completing The Iowa Statewide Assessment of Student Progress (ISASP) testing. Students expressed mental fatigue and were lackadaisical at times. This interruption to their normal school day could have been upsetting to some students, which may be the reason for lower engagement.

Additionally, obtaining consent forms from students proved to be challenging. While students could fill out their assent form in class, their IRB-required parental consent forms needed to be completed outside of the school day. These forms were initially given to students as printed documents for both them and their guardian to sign. The forms were initially done on paper to be the most equitable; it was accessible for all students and parents with no internet connection being necessary. The students were reminded multiple times at the beginning and end of each lesson by both me and their classroom teacher to bring consent forms to class no matter if they were participating in the study or not. After the last day of the lesson was completed, only five consent forms had been returned. Out of a necessity to make the consent
forms easier for parents to complete, consent forms were approved to be sent out via email to the guardians after the lessons had been completed. The email I drafted was sent out by Mr. Fisher with the hopes of reaching more guardians; two more responses were received via email communication. This led to a dwindling number of usable responses that could be analyzed in my final research.

Due to the absence of many parental consent forms, only five students’ results were able to be analyzed. Of those five students, each completed only one survey. Four students completed the pre-lesson survey and one student completed the post-lesson survey. The one student who completed the post-survey was absent the first day when we completed the pre-lesson surveys in class. The survey was available to her but failed to be completed prior to the completion of the lesson. The students who completed only the pre-lesson survey did not take the time available in class to begin or complete the post-lesson survey. The survey could not be assigned for a grade and lack of completion of ungraded assignments is typical for this classroom. Since no students completed both surveys, I was unable to analyze the impact of social justice lessons adequately and any change in student answers.

Data Analysis

To analyze results, I first compiled the student data into a spreadsheet. I was looking for any similarities within answers across student responses. Because students only participated in one of the surveys, I could not compare one student’s answers from before to after the lessons unfortunately. This means I spent more time focusing on the one post-lesson survey response to see what was learned.

Results

All who completed the forms were ninth grade female students who identified as white, Mexican, and Asian races. This represents the majority of races found in this classroom, though not all. Out of the class of nineteen, twelve students were female. As far as their own
perceptions of their math ability, these students all viewed math as at least somewhat relevant to their lives. The two students who rarely found math enjoyable were not confident in their ability to do mathematics. The other students who found math enjoyable were all somewhat confident in their ability to do mathematics.

Students who said they were very capable of doing math also said that they sometimes found math enjoyable. The student who said they were somewhat capable, said they rarely found math enjoyable. For two students, understanding impacts how enjoyable they find math to be. One student who rarely found math enjoyable expressed they are discouraged when they don’t understand.

Students saw math in the world around them:

- 4 of the 5 students said shopping or at the store (other student said everywhere)
- 1 student said everywhere
- 3 students said cooking/baking
- 2 students said something related to an occupation
- 1 student said when you tip
- 1 student said gas prices

Overall, I was pleasantly surprised that all students identified somewhere they saw math in the world around them. Of the five students, four students said they saw math while shopping or at the store; the only student who did not said they saw math everywhere. Baking/cooking was also another common answer, and as a teacher I could change problems to make them more relevant to students by incorporating cooking into the problems we encounter in class. Two students mentioned they saw math in an area related to occupations and this shows me students notice how adults in their life use math at work.

Since my lessons include using math to analyze social justice issues, I was interested in the responses from students about how math can be applied in this way. This is the first social justice mathematics lesson these students have experienced, though they have discussed
social justice in other classes. To show the differences in how students viewed math as a tool, I analyzed this data based on whether or not the students had completed the lesson yet or not. In the pre-lesson survey, two students were not sure whether mathematics could be a useful tool to analyze social justice issues and one student said percentages or statistics could be used to make comparisons.

The only student who completed the post-lesson survey said her ability to do mathematics was “greater than I know if I actually try” and labeled herself as very capable of doing math. Earlier she stated she was “very lazy and doesn’t want to try sometimes” as a reason math was not enjoyable. She labeled mathematics as very relevant to the real world and said math can be used as a tool to analyze social justice by showing statistics and data on the situation, and “mathematics can be applied to the real world in different situations.”

As a new teacher, there were certainly challenges. This was not my class and so I had not established communication with parents before this point. It is my belief that if it was my classroom and I could have established communication prior to conducting the study, more guardians would be responsive to me. Thus, I would have more usable survey data. To do this, I would like to have a newsletter to send to parents to keep them engaged and updated on what is happening in class. Group work is also not a norm in this classroom, and students were not as receptive to this. Beginning discussions at each table was slow, and the groups did not have the groundwork necessary to start the discussions on their own; I did end up assigning some roles in the lesson to boost engagement (i.e., group spokesperson). In my own classroom, I would like to try to make group work a common strategy, so students are familiar and know my expectations. While I recognize that this lesson was a struggle as I was in someone else’s classroom, I did get to see the value of these lessons with the responses from the students I had access to. I will also improve with more time and practice.
Conclusion

Through this project, I wanted to find the impact of social justice mathematics lessons on high school students’ perceptions. I found that all the students viewed mathematics as at least somewhat relevant to their lives. The student who completed the post-lesson survey demonstrated a high perspective of her own capability to do mathematics though she does not want to try at times. She also labeled mathematics as a useful tool to analyze social justice and very relevant to the real world. Half of the students who took only the pre-lesson survey did not know if mathematics could be a tool to analyze social justice.

This research was limited due to the few usable responses, being in another teacher’s classroom, and my inexperience in teaching social justice lessons. Participation and engagement in class was also a struggle at times as small-group discussion was not an established norm. While I could not compare data from before and after the surveys due to low participation, useful information was still gathered about how students see themselves and the mathematics they interact with. These lessons may be challenging to implement at first and repeated experience is needed to become more comfortable with the material. I noticed on the last day, I felt more comfortable beginning the discussion. Future research should be done to further explore the impact social justice lessons have on high school students’ perceptions since this research had limited participation. Teaching more than one lesson in a class would potentially allow a more conclusive answer on the impact of social justice lessons on students’ perceptions and student engagement. This research was consistent with the prior research and brought new insight into an older grade level.

For new teachers, they must get approval from their administrators to make sure these lessons are allowed and they will be supported if there is any push-back from guardians. They should also work to establish reliable communication with parents/guardians if the data is going to be shared and consent forms are needed. Teachers should also work to create an environment of open discussion that is respectful towards all and give the students time to
understand how discussions will function in the classroom. I would suggest seeking out lessons made by teachers who have experience implementing social justice mathematics lessons to gain insight. With more experience, teachers should have the confidence and knowledge to create their own lessons if they choose. As discussed earlier, the first few social justice lessons will be challenging, but over time teachers who persevere will gain experience and be able to position their students as active participants to find solutions to social injustice in the world around them.
References


Appendix

Appendix A

Pre-Lesson Survey Questions

1. What is your name?
2. What is your gender?
   a. Male
   b. Female
   c. Other:
   d. Prefer not to answer
3. To which race(s) do you identify?
   a. White
   b. Black or African American
   c. American Indian or Alaska Native
   d. Asian
   e. Native Hawaiian or Other Pacific Islander
   f. Other:
   g. Prefer not to answer
4. Where do you see math in the world around you (besides school)?
5. Are you capable of doing math?
   a. Not capable
   b. Somewhat capable
   c. Capable
   d. Very capable
6. Do you find math enjoyable?
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always
7. Why? What is/is not enjoyable?
8. How confident are you in your ability to do mathematics?
   a. No confidence in my ability
   b. Not very confident in my ability
   c. Somewhat confident in my ability
   d. Very confident in my ability
9. Do you see yourself represented in mathematics?
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always
10. If yes, where do you see yourself represented in mathematics?
11. How relevant do you feel mathematics is to your life?
    a. Not relevant
    b. Somewhat relevant
12. How relevant do you feel mathematics is to the real world?
   a. Not relevant
   b. Somewhat relevant
   c. Relevant
   d. Very relevant
   e. Extremely relevant

13. Where do you see mathematics in the real world?

14. Can mathematics be a useful tool to analyze social justice issues (issues that impact different aspects of society)? Why or why not?

Appendix B

Post-Lesson Survey Questions

1. What is your name?
2. What is your gender?
   a. Male
   b. Female
   c. Other:
   d. Prefer not to answer
3. To which race(s) do you identify?
   a. White
   b. Black or African American
   c. American Indian or Alaska Native
   d. Asian
   e. Native Hawaiian or Other Pacific Islander
   f. Other:
   g. Prefer not to answer
4. Where do you see math in the world around you (besides school)?
5. Are you capable of doing math?
   a. Not capable
   b. Somewhat capable
   c. Capable
   d. Very capable
6. Do you find math enjoyable?
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always
7. Why? What is/is not enjoyable?
8. Do you see yourself represented in mathematics?
   a. Never
b. Rarely
  c. Sometimes
  d. Often
  e. Always

9. If yes, where do you see yourself represented in mathematics?

10. How relevant do you feel mathematics is to your life?
    a. Not relevant
    b. Somewhat relevant
    c. Relevant
    d. Very relevant
    e. Extremely relevant

11. How relevant do you feel mathematics is to the real world?
    a. Not relevant
    b. Somewhat relevant
    c. Relevant
    d. Very relevant
    e. Extremely relevant

12. Where do you see mathematics in the real world?

13. What have you learned about mathematics after these lessons?

14. What have you learned about your ability to do mathematics after these lessons?

15. How can mathematics be a useful tool to analyze social justice?

16. Any final comments?