QUEER HIGH SCHOOL STUDENTS' TAKEAWAYS FROM THE TEACHING OF MATHEMATICS FOR SOCIAL JUSTICE

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This study investigated Queer high school students' participation in the teaching of mathematics for social justice. The goal of this research was to introduce the TMSJ to Queer students and understand their experiences with this type of teaching. This study is centered on the transformative paradigm using a poststructuralist approach. Therefore, knowledge about oneself and the world is the product of discursive constructions. Queer, Critical, and poststructuralist theories guided the design of this study; however, their discussion is omitted in this paper due to space limitations. In addition, a TMSJ framework was implemented in a three-lesson experiment about the injustices Queer high school students go through in schools. Through qualitative analysis using inductive coding and thematic analysis, findings show that Queer high school students see a great value in the TMSJGS and had a positive experience with the learning of math. However, efforts are still needed to make this teaching successful in current schools.

Keywords: Gender, Social Justice, LGBTQIA+; Equity, Inclusion, and Diversity

Mathematics education scholarship to support all learners has expanded to attend to gender and sexuality identities (Neto & Ataide Pinheiro, 2021; Ataide Pinheiro, 2022; McGraw et al, 2019). Most current work argues for the importance of either the inclusion of Queer students in the mathematics curricula (Dubbs, 2016; Rands, 2013; Rubel, 2016; Waid, 2020) or the queerization of mathematics education through dismantling gender and sexuality normativity in the curriculum (Kersey & Voigt, 2021; Rands, 2009; Yeh & Rubel, 2020). The Teaching of Mathematics for Social Justice (TMSJ) is one approach that has recently gained momentum in Mathematics Education and has taken up the recommendations above regarding the inclusion of Queer students in the curriculum and the queerization of ways to conceptualize mathematics teaching (Berry III et al., 2020; Rands, 2013). In this study, we refer to the TMSJ that examines issues of gender and sexuality as TMSJGS-- Teaching Mathematics for Social Justice of Gender and Sexuality. Few studies that examine TMSJGS have addressed the experiences of Queer students in the mathematics classroom or the challenges the TMSJGS might cause for Queer students (see Ataide Pinheiro, 2022). One underlying assumption of the recommendation for the TMSJGS is that Queer students will always benefit from the process of queerizing mathematics education through lessons with social justice aims. But these students may have serious concerns or reservations about such lessons. In order to address this issue, this study investigated: (a) how Midwestate (pseudonym for the significant U.S. Midwestern state where the study was conducted) Queer students experience TMSJGS lessons; (b) under what conditions they experience them as beneficial; and (c) what supports may need to be in place for teachers who are interested in teaching TMSJGS lessons. This study intended to respond to the following research question: What are the takeaways of Midwestate Queer High School students during the TMSJGS?

Review of Literature and Theoretical Perspectives

Researchers (Martin & Larnell, 2013; Tate, 2008; Stinson & Bullock, 2012) have indicated that the current methods for teaching and learning mathematics in K-12 classrooms have resulted

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in inequitable outcomes that do not support all students. Many (e.g., Leyva, 2017; Solomon, 2007; Waid, 2020) have argued that mathematics has historically been taught to propagate a belief system that favors white men and encourages heteronormativity (Ataide Pinheiro, 2021). This becomes increasingly true as students progress to middle and high school (Ataide Pinheiro, 2022). The current instructional systems discourage and may, in fact, prevent the mathematical advancement of people of color, women, LGBTQ+ groups, people with disabilities, and other groups targeted for oppression.

Because of the concerns above and many others, a top priority of the field of mathematics education has been to create equitable classrooms that serve all students (NCTM, 1989; 2000). As theorized by Berry et al. (2020), the TMSJ might be an ideal place to start. A critical component of TMSJ is for students to develop a conscious awareness of the historical injustices that plague society. Below I present the six elements that composed the TMSJ framework:

1. Equitable Mathematics Teaching Practices – 1) Build on social, cultural, family, and community knowledge; 2) Challenge spaces of marginality; and 3) Develop positive social, cultural, and mathematical identities.
2. Authentic, challenging social and mathematical questions or concerns – Local and authentic contexts can increase student engagement and motivation to learn mathematics.
3. Social and mathematical understanding – 1) Mathematics content: what we want students to know; 2) Mathematics practice: how we want students to show what they know; and 3) Social justice standards: how we want students to demonstrate understanding and a response to an issue.
4. Social and Mathematical Investigation – Lessons need to be grounded in the mathematically driven investigation of the social context.
5. Social and Mathematical Reflection – High cognitive demand tasks require students to reflect on mathematics, the social issue, and how one informs the other.
6. Action and Public Product – Take action and develop a public product.

Having the six elements above, the TMSJ is proposed as a method of teaching where students are (a) exposed to a social injustice in society, (b) encouraged to model the social injustice with mathematics, and (c) encouraged to produce a public product or act towards the injustice in order to dismantle it. These three divisions of the TMSJ were used in this study to teach Queer students TMSJGS. It is important to mention that what makes TMSJGS distinct from TMSJ is just the fact that the social injustice being investigated and modeled through mathematics specifically pertains to injustices concerning Gender and Sexuality.

Methods and Methodologies

We approach this study through the transformative paradigm. In this paradigm, researchers work to transform society, recognizing that power and knowledge are situated politically and structurally to maintain oppression among historically marginalized groups of people (Mertens, 2010). Like others using the transformative paradigm, this research sought to bring social transformation to the lives of Queer students through collaborative efforts among the researchers and research participants (Mertens, 2014). Queer high school students' voices foreground their analyses of the TMSJGS, co-participating with the researchers in the production of knowledge regarding the TMSJGS.

Positionality

The first author is an immigrant Queer of color man. He has lived in the United States since

2017 and in the US, he has undergone training that supported his development of conscientização, or critical consciousness (Freire, 1970/2017). He shares multiple experiences with this study students' participants because of his Queerness. However, he also shares differences since he is not originally from the US. Therefore, he sought support during the data analysis to a critical peer to fully understand students' experience regarding unfamiliar social context of the US to him.

The second author is a cis-gender Latina woman born and raised in the borderlands of South Texas. While she does not identify as a Queer woman, there are other marginalized identities that provide a solidarity lens to make meaning of the participants' experiences. From a young age, she was often positioned as less capable of doing mathematics due to her gender. Additionally, her experiences growing up in poverty and emergent bilingual practices inform her critical consciousness and commitment to support historically marginalized students engaging TMSJ.

Participants

Ten Queer high school students from Midwestate participated in this study. These students came from all around Midwestate and were recruited by Gender and Sexuality Alliance (GSA) club advisors. All advisors were contacted through email requesting them to forward a survey for Queer students inquiring their interest to participate in the study. The emails of the advisors were obtained on school's websites and through a major organization in Midwestate that oversees all GSA clubs. Participants came from a variety of school types (e.g, urban, suburban, rural, etc.), identified with a variety of gender and sexual identities, as well as racial identities, and were at different grades (8-12). It is important to note that when the study started in Spring 2021, all students were in high school. However, one student (Cameron) graduated prior to interview data being collected, but they were still included in the study since they started participating as a high school student. Because of space, a full description of the participants will be provided at the conference.

Data Collection

Primarily, the first author taught ten Midwestate Queer high school students three TMSJGS lessons (named in this study as unity study). The unit study used adapted lesson plans published in the book *High School Mathematics Lessons to explore, understand, and respond to social injustice* (Berry III et al., 2020) [Lesson 5.3]. The TMSJGS lessons explored national data on the bullying and harassment Queer high school students go through in society. On these lessons, Queer high school students needed to use the data provided to model with mathematics how many Queer students in their own schools might be going through bullying and harassment due to their Queerness. Finally, Queer students were encouraged to reflect how to act towards ending bullying and harassment in their schools. After being exposed to the unit study, the ten students participated in a 60-minute semi-structured individual interview. After individual interviews, all students were invited to participate in a focus group interview. Five of the ten students returned to participate in a 60-minute focus group.

Data Analysis

In order to answer our research question, we analyzed the interview data through inductive coding (Strauss & Corbin, 1990) followed by *thematic analysis* (Braun & Clarke, 2006). All data was transferred to a software that can be used for qualitative analysis (MAXQDA) and coded to exhaustion (until authors could no longer find new codes). Then, authors met to discuss the coding and the themes found to ensure they were in alignment and agreed 100% to the codes and the themes. Finally, Queer students were presented with a write up of the analysis for member-checking (Koelsch, 2013) to ensure reliability of the findings.

Findings

Through thematic analysis, we found four themes for Queer students' takeaways in the TMSJGS. These themes can be summarized as (a) comfort in being around the Queer community; (b) the importance of the TMSJGS; (c) perspectives in the TMSJGS in schools; and (d) the intersections of mathematics and social identities.

Comfort in being around the Queer community

Being part of a minoritized group, such as LGBTQ+, makes Queer students feel alienated from those who are not part of the Queer community. Students discussed how feeling safe plays a significant role in how they experience school in general and mathematics in particular. Therefore, many times, Queer students need to negotiate their identities (not be who they are). However, in the TMSJGS, all the participants identified as Queer. Thus, the sense of comfort during the lessons became apparent, and Queer students were satisfied with the TMSJGS because it was a safe space for them. When Eric was asked what he liked about the TMSJGS lessons, he said:

> Hmmm, well, working together with people that I don't know, but I know have experienced something similar to what we were even studying. It felt comforting to know that we can you know, work together, maybe even power through this discriminatory stuff. Like see the numbers, but we're trying to change the numbers, to be lower percentage of people that are getting discriminated against, hopefully, one day, there will be no discrimination. And it's comforting to know that we might be able to do that one day.

Eric not only expressed how much he appreciated being able to work with people who also experienced bullying and harassment because of their historically marginalized gender and/or sexual identities (Queer students), but he also expressed how comforting that experience was for him. He said how pleasant he felt to know that there is hope that someday, they, Queer students, might even be able to lower the percentage of Queer students that go through discrimination. He felt comforted knowing that with the Queer community's efforts, they might succeed "one day" in lowering discrimination. Eric's feelings of comfort can be connected to his feelings of hope and agency. The lack of agency Queer students feel at school is being turned into a sense that working together as a community can bring about change (transformation). Closely related to the fact that by being around Queer students, the experience with the TMSJGS was positive, Queer high school students also demonstrated the willingness and hope for change, as emphasized in Eric's last quote above.

The importance of the TMSJGS

Amid the TMSJGS lessons applied in this study to Queer high school students, they had the opportunity to find out, through matrix multiplication, how many students in their school were experiencing harassment and assault due to having historically marginalized gender and/or sexual identities. As Queer students reflected on the experiences during the TMSJGS, they brought back the importance they saw in this type of teaching. To better understand the second theme, we analyze Tom's quote below. When asked what he liked the most about the lessons, Tom said:

> If I'm honest, looking at what I did like the most was the discussions. I liked how we were able to reflect on the data, and I liked how when you guys would ask specifically: what did this data mean to you? And, what is this data trying to say? I liked how the lessons were

about more than just getting the numbers, but actually understanding what they meant and understanding what they reflected in the real world.

Above, Tom expressed the power of discussions during the TMSJGS. He appreciated being given the opportunity to reflect on what the data meant. Being engaged in this activity helped Tom shift his perspectives on the doing of mathematics. The TMSJGS went beyond "just getting the numbers," it was an opportunity to understand what the numbers meant and the impact the data has in the real world. This was so important to Tom that later in the interview, when trying to understand his mathematical identity and experiences with the TMSJGS, he said, "I don't care about you know finding x, but I do care about the social issues." This statement shows that the social issues being discussed, bullying and harassment, were more important than doing "procedural mathematics." Therefore, by implementing the TMSJGS in the classroom, we might be able to help Queer students develop more powerful mathematical identities since this type of teaching can shift the perspectives of what mathematics is and why it is crucial to learn it (mathematics can be used to combat social injustices).

Queer students who had experienced bullying and harassment at their schools because of their Queer identity also expressed how change could be accounted for through the TMSJGS. When we asked Olive what stood out the most about the lessons, she said:

Olive: It was just really how calm and just collected everyone was. There was no, like, craziness and we actually felt like we were doing something at the end. It wasn't just like useless numbers, I felt like these numbers could actually do something. And help people at my school.

Interviewer: Nice, you said like we felt like we're doing something, can you tell me more about that?

Olive: So, finding out these potential numbers could help us identify people at, like, my school. And then identifying people that can help bring them together, have a community, and then ultimately try to heal and learn from everyone's experiences and make it better.

Olive argued that through the TMSJGS, it felt like "we were doing something." She compared the TMSJGS to her experiences with other mathematics classes where the numbers seemed "useless" because of a lack of connection to problems that could actually change people's lives. The numbers that Olive was referring to are the ones she found using matrix multiplication that represented the number of students at her school who were going through bullying and harassment because of their Queer identities. Olive also saw the possibility of using these numbers to help students in her school going through these experiences. She continued to discuss how the numbers could be used to find people going through bullying and harassment and create a pro Queer community in her school. She argued for the possibility of helping students heal, as we infer she recognized the traumas Queer students go through as they experience bullying and harassment. In sum, Queer high school students saw an opportunity to reflect on the consequences that bullying and harassment have on Queer high school students' lives through engaging in TMSJGS. Using mathematics to model discrimination and understand how discrimination looks in their schools, Queer students showed sentiments toward the community and argued the importance of advocating for changes.

Perspectives in the TMSJGS in schools

Multiple times throughout their interviews, Queer students shared their perspectives of what would happen in their regular classroom if the TMSJGS was introduced. When asked about her

impression of the TMSJGS, Olive said:

> Um, I mean, personally if this was to be taught at my school, I'm sure there would be like, if it was not just a bunch of LGBTQ teens, it would go a lot differently, and there might have been some like retaliation, and like read this, I don't know, I just appreciated it for once that when we're talking about these topics that there was no like jeering or just like general put downs and stuff like that.

Olive's experiences in school showed that the TMSJGS could lead to retaliation rather than a productive conversation in her high school. It is possible to infer that when things such as Queerness were to be brought up in her school spaces, students would not be open to it. She said she appreciated the TMSJGS study because there was peace. No students were jeering and disturbing the lessons. She expressed that the TMSJGS would only be possible if it were to happen among many LGBTQ teens; otherwise, there could be retaliation by other students. To follow up with Olive, I asked her to go deeper and share her school experiences with me. She said:

> Okay, so probably about half of my school wouldn't really enjoy these lessons very much. They wouldn't try to listen or try to do anything because they simply don't like LGBTQ people, and that's sad and horrible, but it's also a reality that we have to face, you know. So if it were to be taught at a real school um, I don't know, maybe, just like for GSAs or I don't know, but I feel like this might help people become more acquainted and understand what LGBT people go through, so I'm not sure.

Olive complemented the above with her personal experiences in school and how they reflect on her perspectives of the TMSJGS happening in her school. When she mentioned, "half of my school… don't like LGBTQ people," it made it evident that she knew LGBTQ were disliked by half of the people in her school. The consequences would be at least half of non-Queer students not listening or enjoying the TMSJGS. It seems stronger for Olive to see the possibility of the TMSJGS happening in schools through GSAs. However, she also expressed the possible benefits the TMSJGS would have if it happened in the regular classroom. She emphasized the importance that the TMSJGS would have in helping those that are not LGBTQ understand the everyday lives of an LGBTQ person, which are framed by negative experiences due to their Queer identity.

Like Olive, Mackenzie thought that the TMSJGS would not be taken seriously if taught in her school. She expressed these perspectives saying:

> Um, I don't know, I think the lesson would probably end up sounding, it probably, end up being a bit more like bottomless, like a joke lesson, I guess. Like it would just be like at the butt end of a lot of jokes, you know.

Mackenzie clearly expressed how the TMSJGS would not be taken seriously in her school. She mentioned the large number of jokes that would happen if this type of teaching was happening in her classroom and how others would not respect the TMSJGS. Her strong statements as "sounding," "joke lesson," and "butt end of a lot of jokes" showed how much her experiences in her school demonstrated that Queer issues are not taken seriously, even when there are discussions of discrimination taking place in the classroom. It is important to mention that the way students discussed the possibilities of the TMSJGS happening in their schools varied significantly according to the experiences and the type of schools these students attended. More nuances on these findings will be presented at the conference.

The intersections of mathematics and social identities

It is not new that mathematics educators have argued that the context of mathematics teaching matters in students' mathematical learning (see Ataide Pinheiro, 2022). The TMSJGS did not prove to be different. Queer high school students had a very different experience with the TMSJGS because it was something relevant to all Queer students in the study. As we see in Lin's quote, "I was a lot more engaged with the lessons because this applied to me. I really wanted to figure out what the numbers meant and how we could improve things." In this quote, it became clear that because the TMSJGS was something that applied to Lin, she could get herself more engaged with the lessons. Consequently, it also made her want to figure out the numbers to improve the experiences of LGBTQ+ students in schools. In alignment with Lin, Olive expressed her experiences with the TMSJGS, she said:

> Oh, you know what, yeah, being LGBTQ myself definitely played a role of you know, personal accountability and just interest you know, since I am LGBTQ, I can relate to these numbers and look at them and be like oh there's people like me finally. And like, how can we help people like me, you know. So, I think that definitely plays a role.

For Olive, being able to relate because she is also part of the LGBTQ+ community played a role of accountability and interest. She not only saw herself in the numbers, but she also saw that there are people out there just like her that have gone through similar experiences with bullying and harassment due to their Queer identities. So, the context of the lessons played a role in making her more interested, holding her accountable, and making her want to help make a change in the lives of those going through negative experiences due to their gender and/or sexuality.

Discussion and Conclusion

Queer students specifically liked how the TMSJGS opened up spaces for discussions of how other Queer students were being oppressed in schools, how that oppression related to the study participants, and what those specific oppressions looked like in the world around them. Queer students were fascinated that the TMSJGS lessons were specifically about people like them. They could see themselves reflected in the data, and they could compare the data and their lived experiences as Queer students in high school in the United States. And because in the proposed lessons within the framework for the TMSJ, we specifically aim to use mathematics to model the injustices happening at students' community and/or schools; through the TMSJGS, Queer students were able to find the concrete numbers that reflected the injustices Queer students go through in their own schools. They were able to map the number of students that were probably going through oppression in their schools due to their Queer identities. The numbers became even more important to those coming from schools where Queer identities were not welcomed, such as Olive, Tom, Eric, and Mackenzie. Queer students discussed that during the TMSJGS, they were actually "doing something," which can be interpreted as Queer students contrasting the TMSJGS with their everyday mathematics, where in their mathematics classes they learn little that can be used to change the world around them. And with this new "doing - something," they could bring the changes needed to their schools. One of the Queer students, Olive, discussed the implications of the TMSJGS in her school. She saw the possibility of mapping out Queer students in her school and bringing the students together to create community, heal the traumas, learn from shared experiences, and move towards making changes, as Olive expressed "finding out these potential numbers could help us identify people at like my school and then identifying people that can help bring them together, have a community, and then ultimately try to heal and

learn from everyone's experiences and make it better." Therefore, I propose that having such a concrete number helped Queer students see that they are not alone and that other Queer students go through bullying and harassment in schools due to their Queer identities. Since numbers are concrete, these numbers also created in Queer students the safety to see and believe that others are going through these experiences, and they need to move towards "doing something about it," which can be translated as action towards the creation of communities where Queer students are safe, can also work towards healing traumas, and can continue to be organized to brainstorm ways to continue increasing acceptance of Queerness in schools.

TMSJGS was directly connected to Queer students' gender and/or sexual identities. The lessons Queer students were exposed to specifically discussed the ways Queer students experience harassment and bullying in their everyday lives in school in the U.S.; therefore, TMSJGS lessons hit close to home. Consequently, Queer students demonstrated that they were more interested in learning mathematics that way. There are many reasons why that possibly happened, but we specifically think there are several inferences that can be made from the findings in this study. First, Queer students demonstrated many experiences with mathematics learning through memorization and procedures, which could have impacted the ways these students understand the discipline conceptually, which can also influence the ways that Queer students might not understand the usefulness of mathematics. In the TMSJGS specifically students could develop what it meant to multiply two matrices through a contextualized approach. Throughout the study, Queer students demonstrated that they learned better through the TMSJGS. Perhaps that was one of the first times in high school that they worked with a procedure that maintained meaningful connection to a context Queer students cared about, rather than just memorizing procedures for matrix multiplication. Extending to other mathematics topics, Queer high school students could have thought about how other areas of mathematics would be if they were learning it the way we did through the TMSJGS. Secondly, Queer students saw mathematics closely connected to something relevant to the world (injustices to Queer students) and something relevant to them since they are part of the Queer community. Many of the mathematics Queer student participants had experienced with were not connected to the real world or were not connected to contextualized life issues. But the TMSJGS was a lesson that used real-life data to calculate the number of Queer students in their schools who would be experiencing oppression due to their Queer identities. That made the teaching "real" and meaningful. It was more than just playing with numbers; as many students said, "it felt like they were really doing something important." Finally, TMSJGS was relevant to Queer students, it was connected to Queer students' community, and it was about understanding Queer students' experiences. It helped them see a way to make positive changes towards dismantling the oppression they face in schools.

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