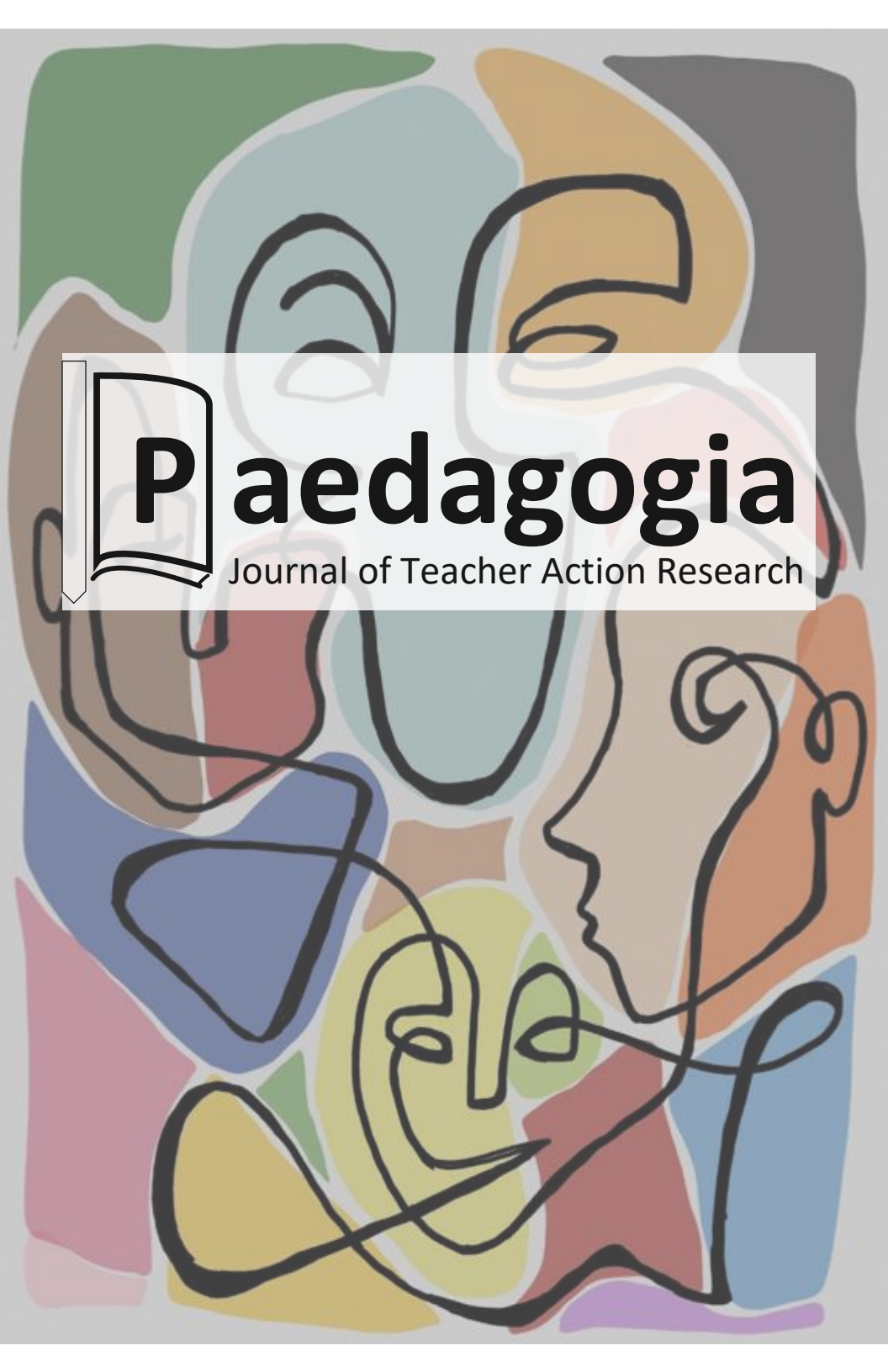
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Action Research on Strategies to Support LGBTQ Students in High School Biology Classrooms

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LGBTQ youth are particularly vulnerable to negative outcomes in and out of school such as school dropout, chronic absenteeism, homelessness, depression, and suicide when compared to their heterosexual and transgender peers. Current school curriculum does not adequately represent LGBTQ youth, as only 19 percent report positive representations of LGBTQ identities in their school (Kosciw, 2020). I adapted high school biology curriculum to be more explicitly inclusive of LGBTQ identities and used a pre-post surveys and student interviews to refine and develop methods to support LGBTQ students. Pre and post surveys were conducted in two biology classes (n=26) of 14 and 15 year old freshman a week before and after a biology unit on genetics and pedigrees. Two LGBTQ students in separate classes were also interviewed about their experiences in science classes. Differences between pre and post test were not statistically significant (Figure 1). Research and interview responses were synthesized to create strategies for teachers to develop LGBTQ inclusive classrooms (Figure 2). Using these LGBTQ inclusive practices can help reduce the alienation of LGBTQ students and increase the chance of positive outcomes.

Keywords: LGBTQ, Inclusivity, High School,

Introduction

Research Background

Lesbian, gay, bisexual, transgender, and other queer (LGBTQ) students are known to be more at risk than the general cisgender heterosexual population. They are a population often ignored by the education establishment, and in science only 2.4 percent of 22,760 middle and high school students surveyed had positive LGBTQ representation in a science class (Kosciw et al., 2018). Even after secondary school, LGBTQ people are less likely to be retained in STEM fields (Hughes, 2018) creating an environment of underrepresentation that perpetuates the cycle.

LGBTQ students are especially high risk for experiencing psychological distress, such as suicidality, depression, school dropout, bullying, and homelessness (Wofford, 2016). However, school representation such as queer organizations, textbooks, lectures, and other classroom material can reduce the odds of these negative outcomes (Heck, 2013; Hansen, 2007). In this emerging field there is very little literature on actionable teaching strategies to incorporate queer perspectives in science classrooms or practice, making intervention more difficult and leaving a gap for more research to be done.

Instructional design justification

The purpose of this study is to better understand LGBTQ high school student's needs in science classes, and to analyze the impact of teaching LGBTQ inclusive curriculum on students' views of science equity in one urban high school science classroom. These genetics lessons are designed to combat the causes of LGBTQ student vulnerability as mentioned in Samaroo (2017) and discussed in the review of literature, fighting against the stigmatization of queer and nonbinary people by normalizing their existence, and clearly defining the difference between biological and cultural norms and terms. These science lessons work towards being more inclusive of LGBTQ identities through the explicit distinction of gender and sex, discussing the meanings of nonbinary and intersex, and by including a thorough explanation of the genetic concept of parents and how that differs from societal ideas of parenthood.

Gender identity and biological sex are two independent pieces of an individual's identity, and the distinction is often ignored in biology classes despite becoming more well known in younger society. Common modern usage defines gender as the social roles and expectations surrounding men, women, and nonbinary people, while sex describes the biological traits of male, female, and intersex people (Schudson et al., 2019). While the gender identities of the cisgender majority align with their sex assigned at birth, to assume that all people have this experience while ignoring the distinctions between gender and sex is to dismiss the lived experience of transgender and non-binary people. Differentiating and clarifying the ideas of gender and sex in a genetics unit stops science curriculum from making the harmful inference that transgender, nonbinary, and intersex people are unnatural, and furthers students' understandings of biological concepts and human experiences.

Traditional genetics curriculum also ignores the differences between biological and cultural understanding of parents. When talking about genetics, parents refer to one person with XY and one person with XX chromosomes who physically have a child, which is different from many people's everyday understanding of parents as the people who raised them. Children in single parent households, raised by their grandparents, with same-sex parents, or with more than two parents are all made invisible when this distinction is not made. Through the explicit discussion of the differences between the cultural and biological meanings of these terms genetics, lessons will ideally reduce the alienation of LGBTQ students in science classes.

Research design

The convergent mixed methods approach used in this study collects qualitative and quantitative data in tandem. A quantitative, quasi-experimental pre and post survey has students

rank their understandings of science equity on a five-point Likert scale, and whether they think the field of science, and their science classes, include the experiences of all people. These surveys were given to two biology classes, each with 30 students, one week prior and post the genetics lessons. If the above instructional design has any impact on student's views of science and of the validity of queer experiences, we expect to see a change between the pre and post survey with answers that would reflect science as more equitable, inclusive, and culturally relevant.

Concurrently, I conducted private interviews of LGBTQ identifying students to better understand their experience with queer representation and heteronormative bias in science and other classroom subjects. Answers to all survey questions were anonymous, interviewees were anonymized and assigned pseudonyms.

Review of Literature

Queer theory, an emerging field that comes from the groundwork of feminist critical theory, questions the deterministic categorization and structuring of societal norms and expectations, especially focused on the male/female and straight/gay binaries that are enforced and expected in much of society (Gunckel, 2009). Gunckel applies critical queer theory to the realities of modern science education and discusses how "Queer theory provides a framework for examining schools, curriculum, and pedagogy to find those identities, bodies, and experiences that have been silenced, ignored, and rendered invisible" (p. 65).

Science, including science education, is laden with references to sexuality but typically only includes heterosexuality. This exclusion of other types of sexuality is damaging to those whose identities are ignored (Letts, 1999). Relatively simple actions, such as dismissing the idea that sex is only for reproduction, providing representation of all students and their families identities, showing the many examples of homosexuality in nature, and studying the history of the HIV and AIDS crisis which was ignored due to homophobia, can help to reduce the alienation of LGBTQ students from science.

An 8th grade science classroom I observed had a project in which students made a pedigree of their family, including four generations. The teacher made no reference to the possibility that students may not know their biological family because of adoption, death, divorce, surrogate, or any other number of reasons. During this lesson I noticed many students were deeply uncomfortable, as some whispered questions to me about what would be ok for their "specific" family situation. Had the teacher had a discussion on the complexities of biological vs adopted parenting, gender vs sex, and all the ways that life does not neatly fit in a Punnett square, students could see their own life be in congruence with, and not opposing, science.

Some political figures suggest that the responsibility to protect LGBTQ students lies outside of the classroom, which appears to be a common opinion given that only 2.4 percent of 22,760 middle and high school students surveyed had positive LGBTQ representation in a science class (Kosciw et al., 2018). However, this dismisses the role schools have in promoting students' health, and even if current anti-bullying policies in many districts were 100 percent effective, LGBTQ students are more than three times as likely to consider and attempt suicide, even when victimization is taken into account (Robinson, 2012).

Samaroo (2017) considers three theories for this LGBTQ student vulnerability, the minority stress theory, interpersonal theory of suicide, and structuration theory. The minority stress theory views social stigmatization and disguising identity as crux to the vulnerability, which can be seen through the phenomenon of "being in the closet." Science education can be used to reduce the social stigmatization of queerness through educating on the natural diversity of sexuality in humans and nonhumans, and human gender expression.

The interpersonal theory of suicide observes the social stigmatization from a different view, and places the risk onto the the psychological states of "perceived burdensomeness and thwarted belongingness" (Samaroo, 2017, p. 22). The theory considers fighting these concepts as central to reducing suicide risk.

Structuration theory explains LGBTQ student vulnerability through observing the deeply rooted practices and rules that enforce the experiences of majority groups on minority groups. These rules can be written rules, like "no promo homo" laws that prevent the discussion of homosexuality in classrooms of Alabama, Louisiana, Mississippi, Oklahoma, and Texas, or be an unspoken fear of introducing LGBTQ issues due to parent and administrative backlash common in many more communities. This structuration can also be seen in the common assumption that people rigidly identify with their birth sex, and the ignoring of non-binary experiences. Fighting against vulnerability in this theory means directly addressing these biases and oppressive forces and providing education about the experiences of minority groups, which provides a direct link to why we need queer education in the classroom.

By having LGBTQ inclusive practices in the classroom, the teacher can normalize and actively speak on the experiences of all students. Regardless of the theory used to describe the particular vulnerability seen in queer students, teaching practices that are including of them and their experiences can ideally improve outcomes by reducing stigmatization, avoiding the enforcing of heterosexual norms onto queer students, and providing a sense of belongingness to LGBTQ students in the community.

Methods and their Justification

This study has two primary goals: testing the impact of one method of gender inclusive teaching on overall student perceptions of science equity and gaining insight on LGBTQ students' past experiences in science classrooms. Both of these goals come from the same question of how science classroom teachers can reduce the heteronormative, masculinist character of modern science practice. To test the first goal, I used a quasi-experimental quantitative method, surveying two freshman biology classes' perceptions of science equity one week before and after genetics lessons that deliberately include differentiation of gender and sex and queer representation. These Google Surveys ask questions about student's views on queer rights, on student's understandings of how cultural phenomena impact scientific understandings, and if queer experiences and identities are scientifically supported. These questions were randomly sorted, had the option to mark from 1-5 "strongly agree" to "strongly disagree." Each question was also paired with another that asked the opposite to reduce the possibility of acquiescence bias. Through those surveys and observations during the lesson, I gauged the entire classroom's perspective on how science views

issues of gender and sexuality, and if there are any changes on that perspective after the queer inclusive lessons.

The lesson itself was supplementary to the discussion of genetics and inheritance in two 9th grade biology classrooms of about 30 students each. It included one class which defined and clarified the biological and cultural meanings of the terms gender, sex, child, parent, nonbinary, and intersex, and then regular inclusion of these terms in the subsequent unit on genetics and inheritance. Along with this content material, other inclusive practices were maintained throughout the whole teaching placement including asking for and respecting chosen names and pronouns, taking care not to "out" students to parents by asking if I may use their name and pronouns with parents, talking with students about queer cultural icons before class, and through mentioning queer scientists while doing daily "scientist of the day" activities.

As experiences with queer identities are not universal or steadfast, it is central to interview LGBTQ students and incorporate their experiences with a queer identity into this research to supplement the quantitative data around one teaching method. This leads to the second goal, examining LGBTQ experiences with representation in previous science classes. By focusing deliberately on two LGBTQ students in the phenomenological qualitative aspect of the action research, we were able to hear more from the students themselves on how educators have or have not provided them support in the past, and what we can do going forward. These two interviews were around fifteen minutes each and conducted over video call.

Participants and demographics

The surveys were conducted in freshman biology classes in a title I urban high school with about 88 percent of students on a free or reduced lunch plan. The school population is majority Hispanic, and the surveyed population was 20 percent Black or African American and 80 percent Hispanic or Latinx. Surveyed students were also 44 percent male, 48 percent female, and 8 percent nonbinary; 20 percent of students identified as LGBQ, 16 percent preferred not to say, and 64 percent did not identify as LGBTQ.

Originally, four potential interviewees between the age of 14 and 16 were identified for this research study based on their self-identification as LGBTQ in the survey and willing to be interviewed about their previous experiences in science classes. Two potential participants were ineligible as they did not submit the required parental informed consent for the interview. The other two left my class during the transition to the fourth quarter and into hybrid learning. Because of this, I instead interviewed two "out" students in other classes who did not participate in the pre or post survey. For the sake of anonymity, the first interviewee will be referred to as "Jose" and the second, "Sarah."

The two students who were interviewed were in different classes – Jose was a sophomore in a chemistry class, and Sarah, a freshman in a physics class. Jose identifies as "I don't know, but I know damn well I'm not straight," has taken biology and environmental science classes in the past and is currently in Chemistry. He is 16, Mexican American, and said he has felt shy in previous science classes due to it being a new environment and a fear of getting questions wrong. Sarah identifies as a transgender female, does not label their sexuality, has taken general

science classes in middle school, and is currently in Physics. She is 15, an American Jew, and is outgoing and has enjoyed her science classes, especially labs.

Results and Discussion

Survey results were not statistically significant and were unable to reject the null hypothesis. To analyze the survey data, questions that were inverse of one another, such as "according to scientific research there are two genders: male and female" and "scientific research supports the idea that there are more than two genders" were combined by flipping the results of one. Then, the categories "strongly agree" and "partially agree" were combined into one category, agree. The same was done for "strongly disagree" and "partially disagree." This simplification of the data was done to reduce the impact of the central tendency bias. This created a three-point scale of agree, undecided, and disagree that was analyzed using the sign test. Results can be seen in Figure 1.

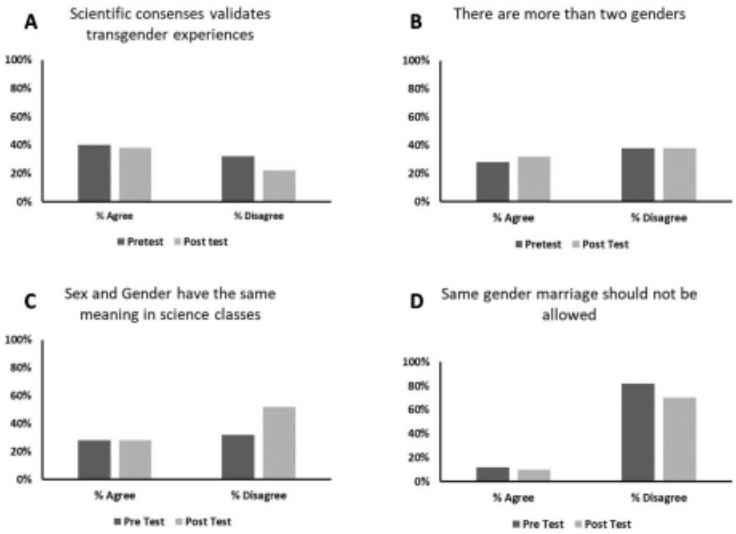

Figure 1. Summary of the collected survey data from freshman Biology classroom April 2021. High school students' (n= 25) responses to survey prompts before and after LGBTQ inclusive genetics curriculum. (a) Percent of students that agreed and disagreed with the prompt "Scientific research shows that transgender people's gender identity and names should be validated by peers and schools " and its inverse, no significant difference was determined (p>.05) (b) Percent of students that agreed and disagreed with the prompt "Scientific research supports the idea that there are more than two genders" and its inverse, no significant difference was determined (p>.05). (c) Percent of students that agreed and disagreed with the prompt "In science classes and research, sex and gender have the same meaning." no significant difference was determined (p>.05). (d) Percent of students that agreed and disagreed with the prompt "Marriage should only be between a man and a woman " and its inverse, no significant difference was determined (p>.05).

For the question, "Scientific research shows that transgender people's gender identity and names should be validated by peers and schools" and its inverse, no significant difference was determined between the pre- and post-test using the sign test ($p=0.149$). For the question, "Scientific research supports the idea that there are more than two genders" and its inverse, no significant difference was found ($p=0.457$). The question, "In science classes and research, sex and gender have the same meaning" had no significant difference ($p=0.724$). Lastly the prompt "Marriage should only be between a man and a woman" and its inverse also had no significant difference ($p=0.131$).

Interviewed students had little to no experience with LGBTQ topics coming up in classes. Both interviews began with a discussion of the LGBTQ representation they have seen in previous science classes, which Jose responded with, "Never, like never, like nobody ever brings it up at all." He continued that the topic had never come up in any of his classes, including History, English, or health classes. Sarah had a similar experience, mentioning that LGBTQ topics never came up in science classes, and the only time she remembers any sort of representation was when providing background on the author of one book in English class. Their experiences align with national data, as the most recent 2019 national GLSEN survey showed only 19.4 percent of LGBTQ students were taught positive representations of LGBTQ people, history, or events in any form in their schools (Kosciw, 2020). Both interviewed students mentioned that this lack of representation also included a lack of differentiation between gender and sex in biology classes, which I also observed in my student teaching experience.

The internet is the primary source of information about LGBTQ topics for students. As neither Jose or Sarah learned about gender, sex, LGBTQ identities, and sex education through school, I asked about where they usually found information about these topics, as they did have good understanding of them. They mentioned social media and internet resources, such as Buzzfeed's YouTube channel. Sarah and Jose's experience here also parallels national data, as queer youth are four times more likely to look up sexual health information online compared to their heterosexual peers (Mitchell et al., 2014). While it is helpful that this information is available somewhere, there is concern about the quality of this information relative to that provided in a controlled academic environment and the impact of this on students' health.

After this discussion of their prior experiences in school, I asked Jose and Sarah about their ideas for how teachers can help queer students feel more comfortable, the results of which can be seen in Figure 2. Jose emphasized the importance of knowing your student's identities so you can provide more individualized resources to the class and to individual students as needed. By asking for student's chosen name, pronouns, gender, and even sexuality you can better know what representation students might want to see in the classroom and "make it just seem as normal because it isn't something that is weird at all, it just is how people are." Sarah raised a similar idea of knowing students' identities, continuing that "Sometimes [people] don't feel accepted, they want to feel like somebody is accepting of them and caring for them."

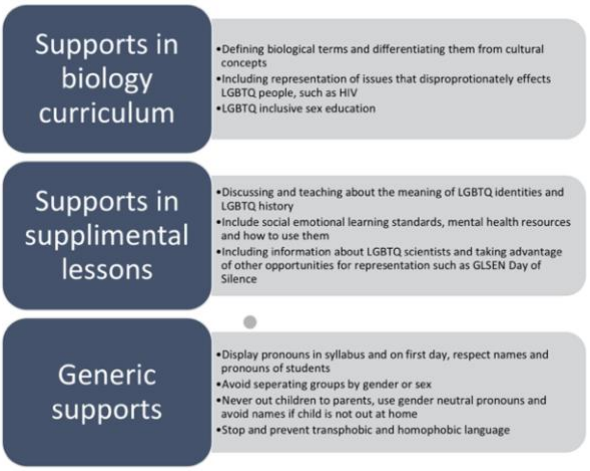

Figure 2. Methods for teachers to support LGBTQ students in biology classes, synthesized from research and interview responses.

When asked what type of individualized resources they would like to see, Jose mentioned he wanted to see material on LGBTQ history, what different identities mean, and how one can figure out their own gender identity and sexual orientation. Specifically in biology he mentioned there is "A huge dilemma in the community about things like HIV... many people are uniformed" along with other important topics in sex education. He would also like to hear about sex and gender determination.

Supports in supplemental lessons. Outside of things that neatly fall within biology curriculum, both Jose and Sarah mentioned that they would like to have classes sometimes that "step away from things like science and learn more about reality." Jose mentioned that he would like to see weeks dedicated to an outside topic where a small portion of each day would introduce a new idea, with maybe one day that week dedicated to it entirely. He mentioned some key ideas like mental health week, LGBTQ history, sex education, and other topics students find relevant, would be great ideas. Sarah also mentioned how key mental health resources are and wanted more information on drop-in centers and therapy, not only their contact information, but what they look like and what one could expect.

Sarah's focus through the whole interview was that many of the ways teachers can be most supportive apply to everyone, and just being kind, supportive, and showing respect will go far. She mentioned how she felt far more comfortable in one of her classes when her teacher listed their own pronouns, as she knew they would be someone that is supportive and then Sarah knew what pronouns to use. She mentioned showing respect can be easily done through correctly using of student's pronouns, names, avoiding outing transgender students to their parents by using gender neutral terms and avoiding names when they are unsure if the students are "out."

Potential Biases, Sources of Inconclusive Data and Future Studies

There are multiple possible reasons for the inconclusive survey results, starting with the effects of me as the observer. As I am an out queer person and their student teacher, my students' answers may bias towards something I would rather hear, such as answers that are more LGBTQ inclusive or reflect better on the practice of science. While I attempted to reduce the odds of this behavior by keeping results anonymous, ungraded, and stressing that I am looking for students' honest opinions, the inherent power imbalance that comes with a teacher-student relationship could lead to this bias. The inconclusive data could also come from students not being present during lessons on LGBTQ inclusion. During the COVID-19-induced online learning, many students did not respond when prompted during class, suggesting they are not present in class and would lead to no change between pre and post survey. Finally, I did not have the option on Google Survey to both keep students' responses anonymous and keep track of if the same people participated in the pre and post survey. While the same students tended to consistently participate in school assignments, slight differences in demographic response between the pre and post surveys suggest there was some difference in who participated, complicating data analysis and introducing some error into the study. In a future study, I would use a different survey software such as Qualtrics that would allow me to compare each individual's pre and post survey response while keeping students' responses anonymous. Lastly, there might have been a ceiling effect; many of the students' responses did not leave much room for positive change, such as 82 percent of students already affirming in the pre-test that same gender marriage should be allowed . While this is great news for LGBTQ inclusivity, it reduces the statistical ability to reject the null hypothesis.

Knowing both student interview participants would also introduce social desirability bias into the study, as they may be more likely to answer in a way that they would see favorable to me, their queer student teacher, and my analysis of the data may be biased towards looking for new methods and rejecting the null hypothesis that no change is required to help LGBTQ students. I attempted to avoid this bias by providing more opportunities for students to talk freely about their own experiences and avoiding leading questions, but it still could not be fully avoided. In a future study, I would have another queer LGBTQ adult conduct the interview and analyze results as this could still provide students with an interviewer that could empathize with them and reduce their likelihood of biasing their own answers consciously or subconsciously.

Conclusion

These methods, designed through discussions with LGBTQ youth and prior research in the field, can assist science teachers in creating classroom environments that support all students and provide a framework for larger research in the future. While survey responses in the pre- and post-test were not statistically significant, they provide a useful baseline of the general perceptions of high school student perceptions and a basis for future studies and interview responses provide context to statistics provided by GLSEN's climate survey and others. Overall, this project provides actionable steps to reduce the alienation felt by many LGBTQ students, designed by student's own input and research in the field of education and queer theory.

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