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ORIGINAL ARTICLE

Gender, sex, and heteronormativity in high school statistics textbooks

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Abstract

Textbooks have a long history of explicitly and implicitly supporting heteronormative ideologies and effectively erasing marginalized populations, such as people who identify as queer, by exclusion. Students view textbooks as an authority over content and spend large portions of in and out of class time interacting with their textbooks. Because high school statistics teachers feel inadequately prepared to teach statistics, they tend to rely heavily on textbooks to drive instruction. In this study, with a theoretical framework of queer theory and critical mathematics, I used qualitative methods to code three high school statistics textbooks based on their representations of gender, sex, and sexuality. Themes related to the maintenance of heteronormative power structures were deconstructed using Fairclough's (1992) three-dimensional framework for critical discourse analysis. I found that binary gender identities are often conflated with identities related to sex, gender roles are rigidly defined, and relationships are defined as mostly heterosexual. The results of this study have implications for publishers, researchers, and educators in understanding the relationship between gender complexity and curricular resources.

Keywords Statistics · Texbooks · Gender · Sex · Heteronormativity · Mathematics · Critical discourse analysis

Introduction

In the opening section of *Statistics and Probability with Applications* (Starnes & Tabor, 2017), a popular high school statistics textbook used in the USA, the authors highlighted a web-based data collection application (American Statistical Association, 2017). The textbook example illustrated the "random sampler" in which a sample of 10 US high school students has been selected and their responses displayed.

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The example was chosen to demonstrate variables in a data set, and the application was potentially very useful for secondary statistics teachers who wished to use data collected from their students as fodder for a statistically based discussion. The third column in the data table caught my eye: gender. "Male" and "female" were the only two choices available. What if a student does not identify with either of those categories? What if, biologically, they define themselves as female, but they socially identify as a man? How might the mismatch between students' fluid gender expressions and rigid gender constructions in textbooks affect their learning experience in high school statistics classrooms?

Textbooks are commonplace in classrooms and are accepted as products of objective knowledge (Apple, 1990; Apple & Christian-Smith, 1991), which can be concerning when textbooks support hegemonic ideologies oppressive to students and teachers. Ideologies in textbooks related to sex and gender can be manifested as binary conceptions of these categories while also using sex and gender as interchangeable identities. Because conceptions of sex and gender are related to sexuality, heterosexuality can be privileged through binary discourse in textbooks around sex and gender. As Bazzul and Sykes (2011) explained, "a strict distinction between male and female, masculine and feminine, is frequently necessary to frame alternative or same-sex sexualities as abnormal or unnatural" (p. 268).

The purpose of this study was to document the ways that sex and gender are portrayed in high school statistics textbooks by examining representations of sex and gender in a sample of texts. Particularly in statistics, teachers may rely heavily on textbooks as they feel underprepared to teach the statistical content (Hannigan et al., 2013). Statistics is also a discipline that requires context for students to make meaning of the concepts (Groth, 2014). Because textbooks are often written from a heteronormative perspective (Bazzul & Sykes, 2011; Hickman, 2012), statistical contexts in textbooks can erase the identity of gender non-conforming and queer students through exclusion (Levya, 2017). However, a singular focus on the presence (or absence) of queer identities in commercially published textbooks was likely to produce similar results from previous studies on the topic as these identities have historically been excluded in curricular documents in the USA (Höhne & Heerdegen, 2018). Rather, in this study, I examined textbook content to analyze how gender, sex, and sexuality are constructed and how that construction contributes to narrow conceptions of gender and sex identities. Specifically, to identify these constructions, I explored roles assigned to females/women/girls and those roles assigned to males/men/boys.

I begin by defining terms related to gender, sex, and sexuality for the purpose of this article. Second, I examine the relatively recent addition of statistics to K-12 mathematics education and discuss the practice of relying on textbooks for instructional material, a practice that results from underpreparedness of teachers of K-12 statistics. Third, I argue that underrepresented students, specifically queer and/or gender non-conforming students, are marginalized in educational settings by the absence of their identities in textbooks. Fourth, I review the existing literature involving gender analyses of textbooks, both generally and specific to mathematics. Fifth, I present a study in which I critically analyzed three popular high school statistics textbooks published in the United States, paying specific attention

to representations of gender and heteronormative discourses. Critical discourse analysis was then used to highlight the following emergent themes in more detail: females/women/girls portrayed as mothers, males/men/boys portrayed as athletes, male/men dominating representation of real people, one's sex equals one's gender, and the conflation of sex and gender. Finally, I discuss the results of the textbook analysis and provide implications for educators who wish to engage in critical discourse and disrupt the heteronormativity of mathematics curriculum material with their students.

Gender, sex, and heteronormativity

Scholars have discussed the ambiguity in research with respect to sex and gender and have called for clear definitions of these terms (Damarin & Erchick, 2010; Glasser & Smith, 2008; Levya, 2017). For this article, the term *gender* is defined as a socially constructed, fluid identity that may or may not align with biological assumptions of male and female (Damarin & Erchick, 2010). *Gender* is related to personal expressions such as the way one dresses and acts and, historically, binary constructions of gender place emphasis on attributes associated with femininity and masculinity (Kachel et al., 2016). The term *sex* in this article refers to the biological identification of individuals, and *cisgender* refers to correspondence between gender identification and sex assigned at birth (Butler, 2004; Levya, 2017). I use the terms (Damarin & Erchick, 2010) *women* and *men* or *girls* and *boys* in discussions of gender and *female* and *male* when discussing sex. The terms *gender non-conforming* or *gender non-binary* denote those identities that do not adhere to binary gender labels, and the term *intersex* denotes those individuals whose physical characteristics are not strictly male or strictly female (Rands, 2009).

Lack of clarity around sex and gender often results in the merging of these two constructs (Glasser & Smith, 2008). This conflation of sex and gender has led to assumptions that those who possess the biological features of "female" and "male" should also exhibit personality characteristics of femininity and masculinity, respectively (Valdes, 1996). Addressing the conflation is especially relevant to school mathematics where the achievement gap between girls and boys had been historically attributed to sex-related differences (Damarin & Erchick, 2010). Although achievement differences between boys and girls in mathematics are now attributed to socio-cultural factors like those related to gender rather than sex, the language with which researchers are operating does not often reflect this distinction (Levya, 2017).

Binary definitions of sex and gender are problematic for many reasons, and in this article, I focus on three that impact students as consumers of textbooks. First, there are students in K-12 classrooms whose sex assigned at birth does not match their gender. Second, socially-defined roles expected of femininity and masculinity are emphasized through the conflation of sex and gender (Glasser & Smith, 2008). Predicated on the view of gender as binary is the assumption of heterosexuality as the norm, marginalizing other sexual identities as abnormal (Butler, 2004, 2011; Davis & Sumara, 2000), a practice known as *heteronormativity*. Therefore, a third focus of

this article is the textbook tradition of centering heteronormative structures such as heterosexual marriage.

I use the term *queer* to encompass a fluid range of identities related to gender and sexuality that are incongruous with cisgenderism and heterosexuality (Jackson, 2001). There are important differences between a homosexual man, a lesbian woman, a transgender woman, pansexual and bigender individuals, and so on. In order to narrow the scope of my study, I am using the term *queer* to encapsulate non-normative conceptions of gender and sexualities that deviate from heterosexuality in order to illuminate their collective absence in the school mathematics curriculum (Brown & Nash, 2010).

Statistics in the mathematics curriculum

Proponents of teaching statistical concepts within mathematics education argue that statistical literacy is necessary for the development of an informed citizenry (Franklin et al., 2007; Garfield & Ben-Zvi, 2004). The use of statistics education as a means for students to engage in critiques of injustices in their local and global communities has been argued through the socio-political movement in mathematics education (Frankenstein, 1990; Gutiérrez, 2013). Similarly, the context-rich discipline of statistics allows educators to teach culturally relevant mathematics, which could include social categories that are important to student identities such as race, gender, and sexual orientation (Damarin & Erchick, 2010; Ladson-Billings, 1995).

Despite the increasing necessity of a statistically literate society and the prominence of statistics within several mathematics standard documents in the USA, many elementary and secondary mathematics teachers feel underprepared to teach statistics (Cobb & Moore, 1997; de Vetten et al., 2019; Garfield & Ben-Zvi, 2007; Hannigan et al., 2013). Researchers who measured teachers' statistical competence indicated gaps in their conceptual understanding of foundational ideas in statistics such as distribution (Engledowl & Tarr, 2020; Reading & Canada, 2011), sampling (de Vetten et al., 2019), and variation (Vermette & Savard, 2019). Furthermore, researchers have found that teachers with stronger mathematical knowledge for teaching use curricula more flexibly and adapt textbook lessons to better meet the needs of students (Hill & Charalambous, 2012). As a result, many mathematics teachers charged with teaching statistics may rely heavily on textbooks for demonstrated examples, practice exercises, and class activities. Teacher reliance on textbooks is a barrier to learning for students whose identities are traditionally marginalized in mathematics classrooms and curricula.

Because of the difficulties that mathematics teachers face when teaching statistics, textbooks have maintained their ubiquity and prominent role within classrooms. According to Zittleman and Sadker (2003), students can spend up to 95% of classroom time using textbooks in general. According to Remillard (2000, 2005), mathematics teachers view textbooks as the main drivers of instruction. Textbooks are the purveyor of knowledge, and the examples, exercises, and explanations contained within them send messages to students about not only what knowledge is valued, but

also who is worthy of possessing that knowledge (Sleeter & Grant, 2017). Scholars have theorized about the nature of curriculum, specifically the role of textbooks as physical representations that legitimize certain identities while devaluing others (Anyon, 1979; Apple, 1988; Fuchs & Bock, 2018). According to Gay (2002), most students consider textbooks to be an "incontestable authority" (p. 113).

With respect to teachers' use of textbooks in their classrooms, Qi et al. (2018) found that novice mathematics teachers adhered more closely to the specifications of textbooks than did teachers with more experience. The results of this study paralleled previous research on mathematics teachers' use of textbooks in which teachers with more experience were able to adapt textbook content to better meet the needs of their students than were teachers with less experience (Nicol & Crespo, 2006; Trigueros et al., 2014).

The need for research on the construction of gender and sex in education

Scholars have deconstructed the classification of gender as a binary construct in education (Damarin & Erchick, 2010; Rands, 2009, 2013; Rubel, 2016), yet gender binary thinking is supported in mathematics textbooks through the failure to include contexts and representations of transgender and gender non-conforming individuals (Esmonde, 2011). For example, a classic scenario in many high school statistics textbooks involves collecting data from students based on their gender and the number of shoes they own. The goal of these problems is for students to make a graphical representation of the data from the boys and compare it to the equivalent graphical representation using data from the girls. The assumption is that, stereotypically, girls own more shoes; hence, the graph would show the difference visually (Boujena et al., 2016). Not only does this problem highlight a stereotype that girls own a lot of shoes, but it also assumes that every student in the classroom identifies as a boy or girl.

As students continue to negotiate their identities, around mathematics and around gender, the narrow perspective presented in their mathematics curriculum has the potential to impact their conception of themselves with respect to mathematics (Ewing, 2004; Wenger, 1998). In addition to gender identity, mathematics textbook writers most often assume that marriage is defined solely by heterosexuality (Rands, 2013; Rubel, 2016). By challenging this perspective, teachers and students can interrupt the dominant discourse that marginalizes queer and gender non-conforming students (Sumara & Davis, 1999).

Textbook analysis of gender and sexuality

Scholars have acknowledged that laws governing queer individuals may affect the inclusion or exclusion of queer identities in textbooks (Höhne & Heerdejen, 2018), and therefore, researchers have historically focused their analyses on the ways in which gender and sexuality are constructed through curricular resources. For example, grounded in queer theory and critical literacy, Hickman (2012) examined gender and sex as equivalent identities and the dominance of heteronormativity in a

sample of textbooks but also challenged educators to engage students in a critical examination of the texts through the lens of queer theory. Similarly, Wilmot and Naidoo (2014) noted not only the prevalence of heteronormativity in life-orientation textbooks in South Africa, but also demonstrated negative contexts that accompanied inclusions of queer identities. Wylie (2012) also conducted a study in which negative portrayals were the only instances where queer identities were mentioned.

Scholarly documentation of the presence or absence of queer and gender non-conforming identities alone does not challenge the normativity of identity categories themselves (i.e., non-binary, heterosexual) and the contribution of these categories in maintaining binary constructions of gender and sex (Höhne & Heerdegen, 2018). Using queer and critical theories, researchers can analyze the effects of binary, interdependent categories, such as heterosexuality/homosexuality and masculinity/femininity, manifested through school curricula (Schmidt, 2010). For example, Wylie (2012) built upon queer theory and critical pedagogies to deconstruct the heteronormative narrative of world history textbooks. Wylie posited that using both queer and critical theories as theoretical frameworks allows researchers to both expose the gender-as-binary assumption as well as critique the implications of the absence of "othered" identities in world history. Further, analysis of discourse around sex, gender, and relationships in textbooks can illuminate how the norms around these categories are produced and maintained.

Mathematics textbooks and gender

Although scholars have analyzed textbooks in disciplines like literature, art, and science for representations of gender non-conforming and queer perspectives, mathematics is often left unaddressed with the assumption that the subject is socially and politically neutral (Frankenstein, 1990; Gutiérrez, 2013). A few researchers have more extensively analyzed sex and gender in mathematics textbooks. For example, Sleeter and Grant (2017) analyzed eight mathematics textbooks and found that males/men were pictured in professional roles such as CEOs and doctors. Females/women were occasionally depicted in professional roles such as scientists, but most photographs of female occupations were in roles such as teachers and nurses. Sadker and Sadker (1980) conducted a large-scale study of teacher preparation textbooks, and in their content analysis, they revealed a gender imbalance as well as minimal portions of textbooks devoted to issues of gender equity. In a follow-up study, Zittleman and Sadker (2003) reviewed teacher preparation textbooks, including mathematics methods texts. The researchers found that 0.6% of textbook space was allocated to gender issues in mathematics such as sex-role stereotyping and gender bias. The mathematicians depicted were exclusively men, whereas women were represented as only as characters in word problems. These scholars described the progress from the 1980 study as "minimal and disappointing" (p. 178).

In my review of the literature, I found few empirical studies of school mathematics textbooks focused on representation of gender, sex, and sexuality and no studies specific to the analysis of statistics textbooks. This study adds to the current

evidence of the bias in textbooks while adding a level of analysis pertaining to the presence (or absence) of gender-nonconformity and queer identities in mathematics textbooks. More importantly, this study adds to the literature on how mathematics textbooks establish a boundary between gender/sex in upholding gender binarism and, in doing so, support heteronormative ideologies.

This work is situated within the theoretical frameworks of queer theory (Rands, 2009; Sumara & Davis, 1999) and critical mathematics (Frankenstein, 1983, 1990; Frankenstein & Powell, 1989), and I use these lenses to make visible the heteronormative power structure underlying popular high school statistics textbooks. Specifically, the research questions that I addressed are:

1. How are sex and gender portrayed in high school statistics textbooks and to what extent do these representations align with dominant views of gender roles as fixed and binary?
2. What role does heteronormativity play in high school statistics textbooks and to what extent does diversity of gender and sexuality, or lack thereof, contribute to the message of heteronormativity?

Theoretical framework

Frankenstein (1983) drew on Freire's (1970) critical education theory as it applies to the mathematics curriculum. First, critical mathematics education depends on the analysis of language as it occurs in situations of both oppression and emancipation (Frankenstein, 1983; Freire, 1970). Second, in Frankenstein's application of critical theory to mathematics, she pointed directly to the subjectivity involved in statistics courses (Frankenstein, 1983). Frankenstein (1983) posited that "statistical knowledge can be analyzed critically by examining its underlying interests" (p. 326). Because mathematics has traditionally been viewed as a neutral discipline (Gutiérrez, 2013), the contexts that make up mathematics curricula have gone unchallenged (Giroux, 1984). Statistics textbooks, then, can be a site for both students and teachers to critique hegemonic ideologies.

Researchers and educators can use queer theory to engage in the deconstruction of sex and gender binary, and of heteronormative culture more generally, that are present in textbooks (Butler, 2004, 2011; Hickman, 2012). Binary constructions of identity, such as gender, hold social power in aligning categories, such as man and woman, as distinct and contrasting. Queer theorists posit that gender, sex, and sexuality are constantly shifting and seek to destabilize static, binary constructions of these identities and the social power that they hold.

Due to the lack of queer perspectives in textbooks, there is a strong hold that heteronormativity has over textbook ideology (Hickman, 2012). Queer theorists (e.g., Damarin & Erchick, 2010; Rands, 2009) seek to "deconstruct and trouble the power given to categories of identities" (Wylie, 2012, p. 131). Through that deconstruction, the curricular resources can be used as vehicles of empowerment rather than oppression.

In a summary of historical moments in mathematics education research, Stinson and Bullock (2012) provided evidence for what they refer to as the Break in sociopolitical research. They defined the Break as an epistemological stance that oscillates between emancipatory theories (such as critical mathematics education) and deconstruction theories (such as queer theory). Specific to this study, queer theory provides a platform to deconstruct binary conceptions of sex and gender, and critical mathematics education releases mathematics (and the mathematics textbook) from its authoritarian position. As argued by Bazzul and Sykes (2011), "queer theory provides a lens to recognize biological discourses of heteronormativity and binary sex/gender" (p. 273), and critical mathematics education provides the tools to apply this lens to high school statistics textbooks. Critical mathematics education allows for the use of mathematics to critique social inequalities (Gutstein, 2003); queer theory allows for the critique of what counts as "mathematics" and challenge the notions of mathematics as static and closed.

Method

I selected three high school statistics textbooks published in the USA: *Statistics and Probability with Applications* (Starnes & Tabor, 2017), *Stats Modeling the World* (Bock et al., 2019), and *Introduction to Statistics and Data Analysis* (Peck et al., 2016). For simplicity, I refer to them as *Applications*, *Modeling*, and *Introduction*, respectively. The textbooks were chosen because of their recent publication and their circulation in the USA's market of high school statistics textbooks. *Modeling* and *Introduction* are both Advanced Placement (AP) editions and were listed as College Board recommended textbooks for AP Statistics (The College Board, 2020). *Applications* is a non-AP edition and was one of the few non-AP statistics textbooks on the market written for high school students.

Textbook analysis

I conducted the analysis in four phases. My coding scheme was informed by Commeyras and Alvermann (1996) whose data collection consisted of both identifying coverage of women in world history textbooks as well as analyzing how language in textbooks positioned women. The inductive, flexible determination of coding categories coupled with a critical analysis of the way textbook language positions particular identities aligned with the focus on disrupting dominant discourses outlined by queer theory (Motschenbacher & Stegu, 2013).

Phase 1: Identifying references to gender, sex, and sexuality

Phase 1 of the data collection involved reading each textbook and marking all problems (including problems in the narrative text), images, sidebars, and summaries that used words attributed to sex (e.g., female, male, intersex), gender (e.g.,

Table 1 Marked problems and images by textbook

Textbook	In-text Problems	Images
Modeling	310	93
Applications	224	59
Introduction	172	10
Total	706	162

woman, man, girl, boy, non-binary), or relationships (e.g., marriage, dating, family). I chose these categories to address my research question in identifying sex, gender, and heteronormativity. This phase resulted in 706 marked in-text problems and 162 images across the three textbooks, and the results for each textbook are displayed in Table 1.

Phase 2: Development of a coding scheme

In phase 2, I began inductively developing a coding system using the marked in-text problems from the two physical textbooks, *Modeling* and *Applications*, by identifying recurring categories that aligned with my research questions. For example, the context of pregnancy was used frequently in problems involving females/women across the two texts, so it became a coding category. I then applied this coding scheme to the digital textbook, *Introduction*. If new categories arose when examining the third textbook, the categories were adjusted and applied to all three textbooks. I then coded the third textbook to check the appropriateness of the coding scheme and ensure that the coding categories were mutually exclusive. Although another researcher examining a similar topic may utilize different coding categories, the broad themes are likely to overlap strongly since these are recognizable and common throughout gender-related cultural contexts. I concluded that this coding scheme would allow me to extrapolate broad themes related to the ways that gender, sex, and relationships were presented in the textbook sample. I explain the codes developed in phase 3.

Phase 3: Applying the coding scheme

In phase 3, I applied the coding scheme created in phase 2 to all three textbooks (the full coding scheme is displayed in Table 2 and described in the following paragraphs).

Using the 716 textbook examples from phase 1, I coded each problem as "comparison" (comparing of sexes or genders), "female/women/girls," "male/men/boys," or "relationships" (involving relationships such as dating or marriage). Identities of gender (woman, girl, man, boy, etc.) were combined with identities of sex (female, male, etc.) to reflect the textbooks' merging of these identities. No problem included non-normative sexes, genders, or sexualities (e.g., non-binary, intersex). I then coded each example based on its context. Contexts pertinent to answering my

Table 2 Coding for textbook content

Code	Sub-code	Example
Reference to sex/gender		
	Comparison	Side-by-side boxplots to compare travel times to school for boys and girls
	Female/ women/girls	Cholesterol levels of a sample of 40 female patients
	Male/men/boys	Number of goals scored by Wayne Gretzky by NHL season
	Relationships	Questionnaire to measure participants' views on marriage
Context		
	Sports	Boxplots of the points scored during 10 women's basketball games
	Health	A study to measure the association between fish consumption and prostate cancer of Swedish men
	Pregnancy	Infant mortality data based on level of prenatal care of the mother
	Family	A couple wants to have three children and they want to know the probability of having three girls
	Physical characteristics	A study to measure the neck circumference of 250 men
	Politics	A questionnaire to measure the relationship between sex and political affiliation
	Education	College graduation rates of men versus women at community colleges
	Occupation	Assumption of job discrimination based on sex and job status
	General	Histograms comparing desired superpower of a sample of boys and a sample of girls
External		Correlation between high-jump distance and long-jump distance for athletes in the Summer 2016 Olympics
Fabricated		Association between job type and sex for a fictitious company
Conflation of sex and gender		"Male" and "female" referred to as "gender" in the Census at School database
Heteronormative assumption		Marriage that specifies wife and husband

research questions were sports, health, pregnancy, family, physical attributes, politics, education, occupation, and general (e.g., number of hours spent watching television per day).

Next, I coded each problem as "fabricated" (written for the purpose of the textbooks or fictional) or "external" (adapted from an external study or data source). With this coding category, I was able to examine the construction of sex, gender, and heteronormativity in the fictional problems written by the authors for the textbooks separately from those which incorporate actual data from a source outside of the textbooks.

I also coded for the conflation of sex and gender to determine how the textbooks were constructing sex and gender as equivalent identities. For instance, if a problem used the term *gender* to describe the categories of "male" and "female," then that problem was coded as conflating sex and gender. Finally, I coded the examples that

Table 3 Coding scheme for textbook photographs

Code	Sub-code	Definition
Gender presentation		Indicates whether the photo depicts men, women, boys, girls, or a combination
	Women/girls	Photos containing only women and/or girls
	Men/boys	Photos containing only men and/or boys
	Mix of men/boys and women/girls	Photos containing both women/girls and/or men/boys
Stock photo or real person		Determines whether the photo is stock photography of unidentifiable people or a photo of a known person

reflected heteronormative assumptions such as defining a couple as "husband" and "wife."

The coding categories for the textbook photographs are presented in Table 3. Because the textbooks did not distinguish between sex and gender, I coded each photograph based on the gender presentation of the individuals. The photographs were also coded as a stock photograph or a photograph of identifiable individuals.

To ensure the reliability of the coding over time, I recorded a random sample of 90 problems (30 from each textbook) and compared that with the original coding. This sampling and comparing process was done twice over a 3-month period. Additionally, 10 problems from each textbook were independently coded by a colleague. The interrater reliability was 94% for the self-coded sample and 87% for the independently coded sample.

Phase 4: Critical discourse analysis

In phase 4, I applied Fairclough's (1992) framework for critical discourse analysis to the coded data, which enabled me to uncover dominant views of heteronormativity pertinent to my research questions. Using the tools of critical discourse analysis, I was able to apply queer theory and critical mathematics education to evaluate how the constructs of gender, sex, and sexuality are positioned through textbook language (Commeyras & Alvermann, 1996). A few scholars (Herbel-Eisenmann & Wagner, 2007; Le Roux, 2008; Oughton, 2007) have used critical discourse analysis to examine written discourse within mathematics textbooks.

Fairclough's (1992) analytic framework for critical discourse analysis consists of three processes connected to three related dimensions of discourse. The three dimensions are the object of analysis (the visual and/or verbal texts), the processes in which the text is produced and interpreted, and the sociocultural practices that regulate the production and interpretation as shown in Fig. 1.

Analysis of each of these dimensions requires description (text analysis), interpretation (processing analysis), and explanation (social analysis). By using Fairclough's (1992) model for the analysis (see Fig. 1), the text itself, how the text is interpreted, and the social practices reproduced by it can all be deconstructed. Janks (1997)

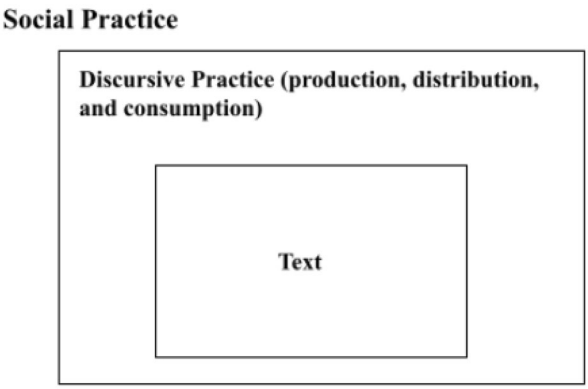

Fig. 1 Fairclough's (1992) three-dimensional model for critical discourse analysis

describes these dimensions as "boxes nesting one inside the other rather than as concentric circles" (p. 330). Critical discourse analysis using Fairclough's (1992) framework, then, requires moving back and forth between the dimensions of analysis, which is demonstrated in the findings section of this article.

Positionality of the Researcher

Because of the sociopolitical nature of this research, my positionality as a researcher has the potential to impact the analysis (Foote & Bartell, 2011). First, I am a cisgender woman. I am married to a cisgender man, which affords me the privilege of heterosexuality even though I do not identify as such. As a woman in mathematics, my identity is never fully central, but my heterosexual privilege makes it such that my identity is never fully marginalized. My capacity for empathy as a woman in mathematics and experience as an ally of the queer community allow me to engage in this research authentically. Second, I am a former high school statistics teacher, a position that I held for 14 years. I view that position positively with respect to this research because that experience provided background knowledge in statistics and a sense of the potential impact of curriculum on student identity.

Findings

In this section, I first explain the quantitative data that resulted from coding the textbooks. Then, I describe four themes that emerged in the quantitative data and demonstrate how I applied critical discourse analysis (Fairclough, 1992, 1995) to uncover the way the textbooks in this study construct gender, sex, and sexuality.

Quantitative results

The quantitative results helped me uncover themes that could be further explored through critical discourse analysis. In the following figure (Fig. 2), my primary findings from my coding data are summarized with respect to the context of the problems. For example, 24 of the 188 problems coded in the female/woman/girl category used sports as a context.

The number of textbook problems related to pregnancy was the coding category with the highest frequency in problems pertaining to females/women/girls, while sports was the coding category with the highest frequency pertaining to males/men/boys. Additionally, in each of the context categories (except for pregnancy), several problems were coded as "comparison" (221 problems). The frequency with which females/women/girls were compared to males/men/boys could be interpreted a reinforcement of binary gender and sex categories.

In Table 4, the coding results are shown for conflation, fabrication, and heteronormativity in the same categories as Fig. 2 (females/women/girls, males/men/boys, comparison, relationships).

The extent to which sex and gender are conflated is illuminated in this table. Most often, sex and gender conflation occurred in problems that involved a comparison of women to men, girls to boys, or females to males. Table 4 also shows the extent to which relationships were defined as heterosexual. Although only 9 of the 34 problems

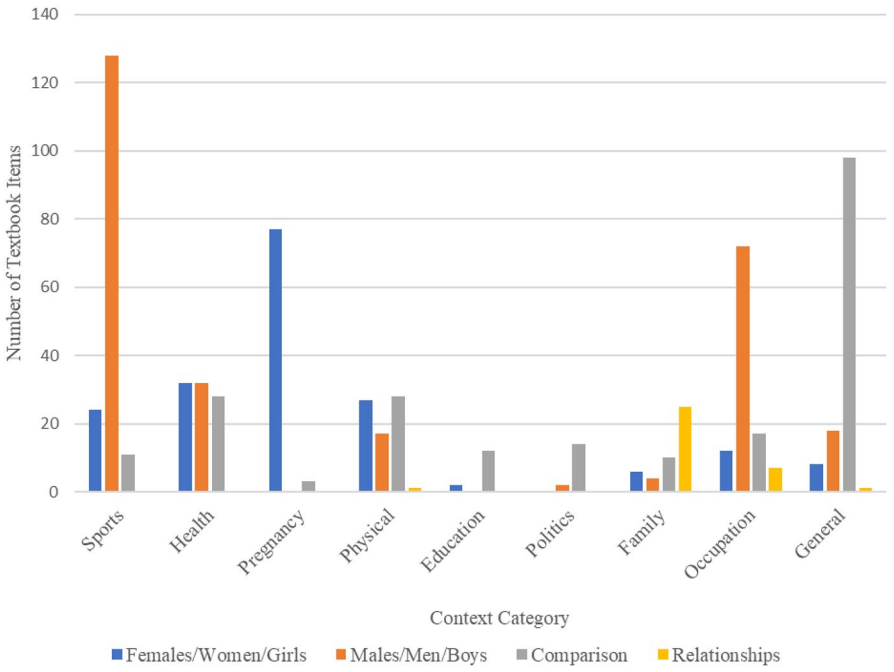

Fig. 2 Distribution of contexts across all three textbooks

Table 4 Distribution of gender/sex conflation, fabricated problems, and heteronormative context across textbooks

	Females/women/girls (*n* = *188*)	Males/men/boys (*n* = *273*)	Comparison (*n* = *221*)	Relationships (*n* = *34*)	Total
Conflation	7.4%	2.9%	35.3%	5.9%	102
Fabricated	24.4%	16.8%	41.6%	52.9%	202
Heteronormative	2.1%	0.3%	1.8%	26.5%	18

None of the textbooks included non-binary individuals

coded as "relationships" (26.5%) used explicit terminology to suggest heterosexuality (i.e., husband and wife), the problems did not reference any non-heterosexual relationship.

Themes uncovered through critical discourse analysis

Through systematic coding of references to gender, sex, and relationships, I uncovered themes and related language that maintained heteronormative ideologies and mapped binary genders onto sexes (Mullet, 2018). By applying Fairclough's (1992) three-dimensional framework of discourse analysis, I developed four themes across the three textbooks that illustrate the dominant ideologies related to binary constructions of sex and gender embedded in these textbooks: females/women/girls portrayed as mothers and males/men/boys portrayed as athletes, males/men/boys-dominant representation of real people, one's sex equals one's gender, and the assumption of heterosexuality in relationships. Each of these themes is detailed in this section.

Theme 1: Females/women/girls portrayed as mothers; males/men/boys portrayed as athletes

In all three textbooks, pregnancy was the most common context used in problems involving women/females/girls, and sports was the most common context used in problems involving men/males/boys (Fig. 2). Using the inner layer of Fairclough's (1992) three-dimensional model, the text could be scrutinized directly. All three textbooks orchestrated a narrative about what females/women/girls do and what males/men do. For example, in the *Applications* textbook, 40 scenarios were coded as referencing females/women/girls, and of those 40, 14 (35%) were related to pregnancy. In contrast, more than double the number of problems (97) were coded as referencing males/men/boys and 56 of those (58%) involved sports. In the *Modeling* text, 37 (44%) of the 85 scenarios referencing females/women/girls involved pregnancy, whereas 62 (44%) of the 140 scenarios referencing males/men involved sports. In the *Introduction* text, 21 (40%) of the 52 scenarios referencing females/women/girls involved pregnancy, while 10 (28%) of the 36 scenarios referencing males/men/boys involved sports. These patterns, in turn, may have the effect of reinforcing stereotypes and negatively impacting students' self-concepts.

The frequency of sports context reflects a cultural interest in assumed physical abilities of males/men/boys, such as those attributed to professional athletes. Students are provided with a narrow view of the way sex/gender is studied in the field of statistics (the middle layer of Fairclough's (1992) framework). A possible wider social implication (the outer layer of Fairclough's (1992) framework) of frequently representing females/women/girls in terms of pregnancy and failing to represent them in other ways, such as through sports or any other non-biologically based category, is the conception that the importance of a female/woman/girl is a function of the biological ability to reproduce and to a lesser degree a female's/woman's/girl's contribution to an area like sports.

Next, an example from *Modeling* using Fairclough's (1992) framework was deconstructed to illustrate this theme at the micro level (Fig. 3).

I began my analysis on the first level of Fairclough's (1992) framework (the text), and the title "Smoking and pregnancy" tells the reader the context of the problem. The year 2011 allows the reader to mentally place this context historically to perhaps determine what they expected rates of smoking and pregnancy to be in 2011 in the USA. The reference to the Child Trends Data Bank and the words *issues related to children* signal to the reader that smoking while pregnant is a behavior that is detrimental. This wording lacks any reference to women, placing the focus on the *children*. Using the term *expectant mothers*, rather than *pregnant women*, further emphasizes the assumed *children* that result as well as the roles that *mothers* are expected to fulfill. Each of the four occurrences of *pregnancy* or *pregnant* is accompanied by the word *smoking* or *smoked*. The combination of these lexical choices sends the message to the reader that mothers who smoke while they are pregnant are harming their children. The ideological stance is asserted in the problem that smoking while pregnant hurts the children who result. I moved outward on the framework to examine the producers (the textbook authors) and consumers (high school statistics students) with respect to this problem while pointing to evidence in the text that serves to position the producers and consumers relevant to the ideological language.

The students' response to this stance is then subverted by using a set of questions disconnected from the scenario. Students are asked to *create*, *find*, and *write* in parts a, b, and d of the problem, required actions that separated the context of the problem from the mathematics being performed. In other words, students do not need to interact with the context to solve the problem. In part c, students are asked to critically examine the data. The question, however, stems from the way the data are presented rather than from the context itself, which further subverts student agency over weighing in on the ideology and helps to reinforce the cultural neutrality myth of the mathematics itself. Therefore, even though relevant mathematics was addressed by the questions, the producers maintain their implicit judgment and the students' and teachers' passive/submissive roles by disconnecting the context from the tasks required of the consumers.

According to the outer layer of Fairclough's (1992) framework, the text connects to social practices. The clear connection in this example involves the societal view of smoking while pregnant. Even if one subscribes to the idea that one should not smoke while pregnant, the social positioning of pregnant women is notable. First, women were identified by their ability to reproduce and then this

Smoking and pregnancy 2011 The Child Trends Data Bank monitors issues related to children. The table shows a 50-state average of the percentage of expectant mothers who smoked cigarettes during their pregnancies.

Year	% Smoking While Pregnant	Year	% Smoking While Pregnant
1990	19.2	2001	13.8
1991	18.7	2002	13.3
1992	17.9	2003	12.7
1993	16.8	2004	10.9
1994	16.0	2005	10.1
1995	15.4	2006	10.0
1996	15.3	2007	10.4
1997	14.9	2008	9.7
1998	14.8	2009	9.3
1999	14.1	2010	9.2
2000	14.0	2011	9.0

a. Create a scatterplot and describe the trend you see.

b. Find the correlation.

c. How is the value of the correlation affected by the fact that the data are averages rather than percentages for each of the 50 states?

d. Write a linear model and interpret the slope in context.

Note. Adapted from Stats Modeling the World (5th ed., p. 257), by (Bock et al., 2019), Pearson Education

Fig. 3 Example of pregnant women

core identity was associated with a choice that society considers both voluntary and harmful to children. Thus, the pregnant woman is situated such that the norms of society can regulate her behavior. By featuring a practice that most of society in the USA view as negative (i.e., smoking while pregnant), the example creates the potential for acceptance of other regulations governing the behaviors of pregnant women. In turn, pregnant women and their actions must be closely scrutinized because of the children involved. The textbooks do not exhibit the same regulatory-type scenarios around men/males/boys, as detailed in the next section.

Theme 2: The male/men/boys-dominating representation of real people

In all three textbooks, the number of stock photos depicting women/females/girls was greater than or equal to the number of stock photos depicting men/males/boys. The results are summarized in Table 5.

Table 5 Summary of representations using stock photography by textbook

Textbook	Representations of males/men/boys (*n* = *38*)	Representations of females/women/girls (*n* = *48*)	Representations of males/men/boys and females/women/girls (*n* = *38*)
Modeling	29.9%	40.2%	29.9%
Applications	34.7%	34.7%	30.6%
Introduction	12.5%	50.0%	37.5%

In each of the textbooks, the percentage of stock photos representing females/women/girls is equal to or exceeds those depicting men/males. These results could be interpreted as an attempt to balance gender/sex representations using stock photos, but it may also be the result of random processes.

Despite the textbooks' demonstration of gender/sex equality through stock photos, two of the textbooks showed clear bias with respect to references to real people. (*Introduction* made only two references to real people and was excluded from this portion of the analysis.) In Table 6, I show the distribution with respect to gender/sex of references to specific people.

A bias exists in the summary data alone, but the linguistic choices in the textbooks for references to males/men/boys versus references to females/women/girls was worthy of further analysis. In Table 7, I summarize the findings.

When mentioned by name, men/males were given additional positively attributed adjectives to describe the magnitude of their contribution to their respective fields. Females/women/girls were given a title, but no other descriptive information was given. The reader encounters an implicitly biased distinction between males/men/boys and females/women/girls through the way language is used to describe them. For example, a woman/female was described merely as a "psychologist," but a man/male was described as the "founder of modern psychology." The message a reader might take away is that females/women/girls can participate in fields such as psychology, but these are fields that males/men/boys have led and in which they have the high status.

Theme 3: One's sex = one's gender

The merging of sex and gender occurred most often in each of the textbooks in scenarios where genders/sexes were compared. Specifically, 78 of the 221 coded problems (35.3%) interchanged terms attributed to gender with those attributed to sex (Table 4) leading the consumer to interpret that no distinction was made between these two identities. Most often, the term *gender* was used as a synonym for *male*

Table 6 Summary of representations of real people by textbook

Textbook	Females/women/girls (*n* = *43*)	Males/men/boys (*n* = *172*)
Modeling	20.4%	79.6%
Applications	19.2%	80.8%

Table 7 Words used to describe males/men/boys and females/women/girls

Words used to describe males/men/boys	Words used to describe females/women/girls
"Great philosopher and hall of fame catcher"	"Researcher"
"One of the greatest scientists and mathematicians of his time"	"Advice columnist"
	"Climatologist"
"Famous statistician"	"Psychologist"
"Founder of modern psychology"	"Olympian"
"One of the greatest statisticians of the twentieth century"	"Actress"
"Founder of modern statistics"	"Candidate"
"Professor at Cornell University"	

and *female*. I deconstruct an example from *Introduction* to demonstrate the conflation (Fig. 4).

The levels of Fairclough's (1992) framework are blurred in this example since the meanings of the textual references "*gender*," "*male*," and "*female*" may vary based on social practices and the consumer's individual interpretation. In the table, "*gender*" is linked to both male and female. The terms "*newborn*" and "*baby*" are used repeatedly in this example. The repetition solidifies to the reader that "*male*" and "*female*" refer to biological components rather than a social identity. The implication in ultrasound prediction is that specific biological features are used to determine whether the fetus is male or female. The binary conception is explicitly stated within the two-way table labels of "*male*" and "*female*" and is then reinforced by the binary classification of predictions as either correct or incorrect. Therefore, equating gender with the binary classifications of male/female and correct/incorrect reinforces ideals of gender as equivalent to biological sex, which is assigned at birth.

Is an ultrasound a reliable method for determining the gender of an unborn baby? The accompanying data on 1000 births are consistent with summary values that appeared in the ***Journal of Statistics Education*** **("New Approaches to Learning Probability in the First Statistics Course," 2001)**.

	Ultrasound Predicted Female	**Ultrasound Predicted Male**
Actual Gender is Female	432	48
Actual Gender is Male	130	390

a. Use the given information to estimate the probability that a newborn baby is female, given that the ultrasound predicted the baby would be female.

b. Use the given information to estimate the probability that a newborn baby is male, given that the ultrasound predicted the baby would be male.

c. Based on your answers to Parts (a) and (b), do you think that a prediction that a baby is male and a prediction that a baby is female are equally reliable? Explain.

Note. Adapted from Introduction to Statistics and Data Analysis (5th ed., p. 6.73), by Peck et al. (2016), Cengage Learning 1

Fig. 4 Example of gender/sex conflation

Learning Exercise 2: Predicting Sex of Babies

Many couples take advantage of ultrasound exams to determine the sex of their baby before it is born. Some couples prefer not to know beforehand. In any case, ultrasound examination is not always accurate. About 1 in 5 predictions are wrong. In one medical group, the proportion of girls correctly identified is 9 out of 10 and the number of boys correctly identified is 3 out of 4. The proportion of girls born is 48 out of 100.

What is the probability that a baby predicted to be a girl actually turns out to be a girl?

Think about the next 1000 births handled by this medical group. How many should be girls? How many should be boys? Of the girls, how many will the test indicate are girls? Of the boys, how many will the test indicate are girls? From these numbers you can calculate P(girl | test says girl).

Note. Adapted from "A New Approach to Learning Probability in the First Statistics Course," by Keeler & Steinhorst, 2001, Journal of Statistics Education, 9(3), http://jse.amstat.org/v9n3/keeler.html.

Fig. 5 Conflation of gender/sex, original data source

The textbook reference is a fabricated example based on (potentially) a real statistic (see Fig. 4). In both versions, the original data source (Fig. 5) and the textbook translation (Fig. 4), sex and gender are categorized as binary.

However, the original data source uses the phrase "sex of their baby," signaling the determination based on biological markers seen on the ultrasound. Although "boy" and "girl" are connected to biological sex in the original version of the problem, this terminology could be considered common parlance in designating the sex of babies in utero (Reiner, 2002). Even if one considers the use of "boy" and "girl" in the original problem to be a conflation of sex and gender, this conflation became more prominent when the problem was modified for the textbook by labeling "male" and "female" as "gender."

Theme 4: The assumption of heterosexuality in relationships

Heteronormativity is reinforced through binary conceptions of sex and gender as heterosexuality is privileged through strict distinctions between opposite gender/sex categories (Knudsen, 2004; Kuzmic, 2000). Heteronormativity can be expressed in several different ways. For example, in *Modeling* and *Applications*, stock photographs depicted all couples as heterosexual. *Introduction* did not overtly define relationships as heterosexual; however, the absence of any specificity around relationships in the texts and the use of culturally dominant ideas concerning sex and gender lead the reader to assume heterosexuality (Hickman, 2012). Although these textbooks were published after same-sex marriage became legal in the USA (*Obergefell v. Hodges*, 2015), the inclusion of queer relationships in statistics textbooks was not evident in the sample. Therefore, in the critical discourse analysis, I focused on how heterosexual relationships were constructed in the textbooks and the ways in which students' critical capacity is subdued through the mathematics they are asked to complete.

Using an example from *Applications*, I demonstrate how heterosexuality constrains the text (Fig. 6).

The example from the text begins by addressing the ideal reader with the phrase "a statistics student wonders". Therefore, the analysis of this problem started with

The heights of dating A statistics student wonders if tall women tend to date taller men than do short women. She measures herself, her dormitory roommate, and the women in the adjoining rooms. Then, she measures the next man each woman dates. Here are the data (height in inches).

Women	66	64	66	65	70	65
Men	72	68	70	68	71	65

a. Make a scatterplot for these data, using women's height as the explanatory variable.

b. Calculate and interpret the correlation for these data.

c. What effect does the pair (70, 71) have on the correlation? Explain.

d. How would the correlation change if the heights of the women were measured in centimeters instead of inches?

Note. Adapted from Statistics and Probability with Applications (3rd ed., p. 176), by Starnes & Tabor, 2017, Bedford, Freeman, & Worth.

Fig. 6 Example of heteronormativity

the middle of Fairclough's (1992) framework (producers and consumers of text). By using the concept of dating, the producers constructed this problem such that heterosexual dating was assumed. The statistics student, her roommate, and "the women in the adjoining rooms" are all presumably women. The consumer of the text, then, is to interpret this narrative as a dormitory where the room occupants, as well as the occupants of rooms in proximity, are of the same gender. Heteronormativity is based on the binary construction of sex and gender as male and female. Also, the separate but opposite categories are reinforced. Here, the problem is constructed such that "women" and "men" operate both as opposite sides of a dating couple and as opposite dimensions of a coordinate point (x, y).

There are additional social practices at play in this problem related to the heteronormative assumptions. Through the context, a cultural stereotype is reinforced about men and women that women tend to date men who are taller than they are (Yancey & Emerson, 2016). The beginning of the problem states that the statistics student "wonders if tall women tend to date taller men than do short women." Each ordered pair represents a woman and her corresponding "man" who is taller than she (with one exception where the partners are of equal height). Engaging in a problem based on that stereotype communicates its acceptance and reinforces it for students.

Additionally, parts c and d of the problem involve an unusual data point (70, 71). The fact that the focus is on this data point where the woman is shorter than her date by 1 in., rather than (65, 65), where the woman and man are the same height, signals to the reader that the issue is with the 70-in.-tall woman. This woman is 4 in. taller than the next tallest woman (66 in.) in the data set, yet there are two other men that are approximately the same height as the 71-in.-tall man (70 in. and 72 in.). This discrepancy implies that the abnormality exists in the 70-in. woman; she is too tall. Students are asked, "What effect does the pair (70, 71) have on the correlation?". The correlation coefficient (r), increases from $r=0.57$ to $r=0.62$ when (70, 71) is removed from the data set. In other words, the removal of the abnormally tall

woman increases the correlation of the data. Thus, the statistics is positioned in such a way that the "normality/best fit" of shorter women in heterosexual relationships is reinforced.

Lastly, as in the *Modeling* example (Fig. 3), the student is situated in a subordinate position as one who needs to be told explicitly how to interact with the problem. Words like "make," "evaluate," and "calculate" direct the student toward specific tools to use create a solution. Even though part c is worded in a more open-ended manner with the word "explain," the student is directed toward a specific part of the data that requires further explanation. Although the issue of heteronormativity is not addressed explicitly, the critical capacity of the student is subdued through procedural exercises and authoritative content and instructions, including, presumably, the social norms around height in compatibility. The consumer is not invited to critique the sampling of people in the dorm in this scenario even though developing students' capacity to be critical consumers of statistics is a recommended focus in the statistics curriculum (Petocz et al., 2018). Statistics educators could use the context to both challenge the heteronormative assumptions as well as strengthen the critical capacity of their students.

Summary of Findings

In summary, within the first theme, females/women/girls portrayed as mothers; males/men/boys portrayed as athletes, the textbooks contained an abundance of textbook problems in which gender and/or sex were performed through pregnancy and athletics, respectively. In the second theme, male/men represented as real people, when referencing those from the real world, the statistics textbooks analyzed most often included individuals who identify as males/men/boys. In the third theme, one's sex = one's gender, gender and sex were merged into equivalent identities through their conflation in the examined textbooks. Within the fourth theme, the assumption of heterosexuality in relationships, the absence of queerness in defining relationships was evident in the textbooks. Additionally, heterosexuality was constructed in ways that constrained what is deemed "normal" within the heterosexual identity.

Discussion

In both the *Guidelines for Assessment and Instruction in Statistics Education* (Franklin et al., 2007) and the *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics, 2000), statistical literacy is depicted as a foundational component of college and career readiness and informed citizenry in the USA. What differentiates statistics from mathematics is that statistics is built from context, whereas in other areas of school mathematics, context is not required. Because of this context-dependent nature, teachers of statistics are encouraged to connect concepts to the real world using real data. However, a real-world application does not necessitate relevance. The statistics textbooks commonly used in high schools marginalize groups of students by perpetuating the narrative that one's

biological sex and socially constructed gender are necessarily equivalent and one of only two possibilities.

The nature of the high school statistics curriculum in the USA marginalizes and "others" individuals and groups who deviate from the norm. In the discipline of statistics, normalizing tools are developed and used in fields like science to produce "evidence" for hierarchies based on sex, race, and class. I am not arguing that the study of statistics itself is necessarily flawed, but that the emphasis on narrow categorizations of society (such as binary conceptions of gender) reduces students to feeling that "normal" means identifying with those narrow categories. When sex and gender are used as drivers of context, the boundaries around males/men/boys and females/women/girls are reinforced. The constant comparison of a binary understanding of sex and gender places male/female, men/women, or boys/girls in an assumed hierarchy based on the outcome of that comparison. The authors of the examined textbooks may not intentionally have written content to reinforce a dominant ideology of heteronormativity, but the statistical focus of mathematics standards in the USA privileges the discussion of normalcy and marginalizes those who identify in non-normative ways.

An important component of statistical literacy is the ability to "understand how statistical studies are conducted and interpreted" (Utts, 2003, p. 74). Researchers who measure statistical literacy skills indicate that students can perform procedures and use vocabulary specific to statistics but fail to use statistical thinking meaningfully (Ridgway et al., 2007). As a result, scholars have recommended that statistics be taught through authentic data collection relevant to the lives of students (e.g., Weiland, 2019). Students can then ask and answer their own questions about the data and develop more robust statistical thinking skills. Given the issues of heteronormative dominance in the statistics textbooks analyzed, statistics teachers need access to authentic data not drawn from rigid gender/sex categories in order to provide these experiences to their students. This need and other implications from this study are discussed in the next section.

Implications

As statistics continues to be an important part of the mathematics curriculum in the USA, textbook publishers, educators, and researchers must critically examine the identities reflected in statistics curricular resources. Through this study, I contribute to the understanding of how gender, sex, and sexuality are constructed in statistics textbooks, and in this section, I discuss the implications this study has for publishers, educators, and researchers.

Implications for textbook publishers

Textbooks are created for students who reflect growing complexities of sex/gender and sexuality. Given that many textbooks are moving to an online format, publishers can provide alternative sets of data around conceptions of identity. For instance, the

United States Census Bureau (2017) now provides specific data sets on same-sex couples that can be used to supplement the plethora of textbook examples centered around wife-husband relationships. Textbook authors and publishers make use of external sources for their data sets, including the U.S. Census Bureau, and could incorporate more diverse data sets. Fabricated data sets could be created to accommodate gender/sex/sexuality inclusivity; however, manufactured examples may be interpreted as a superficial gesture rather than genuine inclusion (Rands, 2019).

Implications for statistics teachers

The results of this study were consistent with similar research on gender, sex, and sexuality in textbooks (e.g., Bazzul, 2014; Bazzul & Sykes, 2011; Hickman, 2012). To create classrooms in which a spectrum of gender/sex and sexual identities are acknowledged by teachers, educators must look beyond textbooks. Educators may be untroubled by the binary conception of gender in their mathematics, but the extent to which it permeates the statistics curriculum reinforces its power.

Gutiérrez (2012) refers to this tension as *Nepantla/conocimiento*, a space in which teachers and students can examine the mathematics curriculum through multiple lenses and critique the socio-political ideology maintained therein. Critical mathematics can be used as a framework for privileging critical interpretations of curricula that otherwise simply reproduce hegemonic power relations (Frankenstein, 1990). Asking students to critically examine mathematics textbooks as they relate to issues of sex and gender can empower students to break down dominant discourses around heteronormative conceptions. Students and educators can acknowledge identities missing from textbooks and together search for more inclusive data sets.

In identifying textbooks as tools that reinforce heteronormative ideologies, educators can reimagine the role of textbooks in their classrooms as a site for critical examination (Hickman, 2012). For example, Weiland (2019) suggested that data sets with female and male categorizations (such as those in statistics textbooks) could help foster critical conversations around the adequacy of these categories and their relationship to gender and sex with respect to data collection and analysis.

Implications for researchers

Through this study, I contribute to the body of research on textbook analysis of gender, sex, and sexuality representation and add to it the critical analysis of gender as a binary category. Because mathematics is often portrayed as a neutral discipline, critical analyses of textbooks specific to mathematics are scarce. The results of this study may have implications for other mathematics textbooks. For example, algebra and geometry do not depend on context in the way statistics does; however, contextualized word problems in algebra and geometry textbooks include gender binary characters and heteronormative scenarios (Esmonde, 2011).

Researchers (e.g., Herbel-Eisenmann, 2007; Lloyd et al., 2017; Remillard & Heck, 2014) have provided some answers to how teachers interact with textbooks

and curriculum, but according to Sleeter (2012), research about how teachers make use of curricular materials with respect to social justice issues such as sex/gender equity and identity is scarce if not non-existent. Given the amount of time that teachers spend interacting with curricular materials while planning instruction (Banilower et al., 2013; Remillard, 2005) and the importance of connecting mathematics with students' cultures and identities (Gay, 2002; Ladson-Billings, 1995), scholars must seek to understand relationships between curricula and culture. The results of this research can be used to help establish a foundation to examine how teachers attend to issues of gender, sex, and heteronormativity in statistics lessons given that textbooks may fail to provide direction in doing so.

Limitations

Although these textbooks represent those used in both AP and non-AP statistics, the results of this study were limited by the small sample size and by the US context for which the books were produced. Statistics textbooks produced in other parts of the world may feature different themes related to gender, sex, and heteronormativity because of different cultural practices. Additionally, this research was situated within a specific place and time. Just as textbook analyses of the 1990s and 2000s showed progress toward equality of gender/sex representations (Sleeter & Grant, 2017), future editions of high school statistics textbooks may move beyond the binary and conflated representations of gender and sex.

Secondly, an inherent tension exists between a theoretical framing rooted in queer theory, which is used to problematize the act of categorization, and the use of those categories to uncover themes within the text. My use of categories in this way is not intended to reinforce their legitimacy, although this reinforcement may be an unintended consequence. However, combining categorization with a methodological tool such as critical discourse analysis allowed me to reflect a competing account to the categorized data (Höhne & Heerdegen, 2018). That is, using the delimited categories provided by the textbook seemed necessary to deconstruct the way statistics textbooks use discourse to define females/women/girls and males/men/boys.

Conclusion

In this article, I detailed a study in which I used a theoretical framework of queer theory and critical mathematics education to highlight the rigid, binary, and heteronormative structures that constitute gender, sex, and sexuality in a sample of US statistics textbooks. Using Fairclough's (1992) framework for critical discourse analysis, I articulated four themes reflecting common assumptions about the relative status of women and men, their representation in textbook content, the conflation of gender and sex, and the norm of heterosexuality. In the absence of queer and gender non-binary individuals, I illustrated the ways in which gender, sex, and sexuality are narrowly constructed through textbook contexts.

There exist few examples in which researchers and developers have explored queer representation with respect to mathematics (e.g., Rands, 2019; Waid, 2020). It is important to expand this work, not just in statistics, but in other mathematics topics such as geometry and algebra where relevance and social perspective may be even more challenging to incorporate. Given the current state of mathematics textbooks in this regard, mathematics and statistics teachers must have the skill and confidence to deviate from the materials available. Although statistics teachers may want to use contexts and data sets that are more inclusive of their students' identities, many may feel constrained by their knowledge of statistics for generating appropriate and powerful learning materials. In this context, researchers and curriculum developers can focus on helping practicing and preservice teachers further advance their statistical knowledge for teaching and make use of data sets that reflect diversity of gender, sex, and sexuality.

Declarations

Conflict of interest The author declares no competing interests.

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