The Canadian General Public’s Views of Gender and Mathematics: A Comparison of Findings from Binary and Non-Binary Studies

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Abstract

In this paper, we discuss findings from a portion of a larger study, in which members of the Australian and Canadian general public were queried about their views of gender and mathematics. Specifically – and novel to the field – the questionnaire that was used to collect the data was completely non-binary in nature (e.g., “For which gender...”). Here, we focus on the Canadian dataset, and draw comparisons to findings from an earlier study \cite{8}, in which the general public were asked about their views of gender and mathematics using a similar questionnaire, but with binary (e.g., “girls or boys”) wording. We discuss differences in the findings of the two studies and consider how the wording of the questionnaires may have contributed to the differences in findings. We conclude by providing suggestions for conducting “gender issues” research in mathematics education in ways that reflect contemporary perspectives of gender.

1. Introduction

Research about gender issues in mathematics has been ongoing for more than four decades, with a particular focus in the 1980s and 1990s. In early studies (e.g., \cite{1}, \cite{2}), researchers referred to findings of research considering differences between girls and boys as “sex differences”. However, over time, as researchers found that such differences were linked to social and cultural factors, rather than biological factors, the terminology moved to “gender differences” to recognize this change in focus.

Despite this change, there remain issues in this research area, with a lack of nuance often seen in “gender issues” research in mathematics education (and other educational fields). Namely, researchers tend not to define what they mean by “gender”, thus implying that it is a benign term, and they often use a mix of “sex” (e.g., male, female) and “gender” (e.g., boy, girl) terminology \cite{3}, \cite{4}. Mathematics education research about gender continues to be conducted in a binary manner, implying that, for instance, girls and boys comprise the only two (homogeneous) gender groups, which is a troubling and incorrect suggestion \cite{5}. Treating gender as a binary erases and marginalizes individuals whose genders are non-binary in nature. In the past few years, there has been an increased societal understanding and acceptance of non-binary gender identities, but such ideas have been slow to permeate mathematics education research. In prior publications (\cite{6}, \cite{7}, \cite{8}), I (Hall) questioned the ways in which “gender issues” research in mathematics education was conducted and urged researchers to interrogate their own practices, as I have done to mine, becoming increasingly sensitive to these issues throughout the course of my doctoral studies and beyond. (Note: Herein, “I” refers to Author 1, Hall.) Thus, the research reported on here marks a shift in the field and provides a novel example of non-binary research in mathematics education.

2. Theoretical Perspective

This study is framed by a feminist and social constructivist lens (e.g., \cite{9}, \cite{10}, \cite{11}, \cite{12}), where both mathematics and gender are seen as social constructions that are specific to time, place, and culture. We view both gender and related concepts (e.g., sex) as performative social constructions that occur on spectrums, rather than in binaries \cite{13}, \cite{14}, \cite{15}. Although there are inconsistencies in terminology, Pryzgoda and Chrisler note that sex is typically defined as referring to “the biological aspects of being male and female”, whereas gender is typically defined as referring “only to behavioral, social, and psychological characteristics of men and women” \cite{16} (p. 554). While we also conceive of sex as biological and involving the terms “male” and “female” and gender as behavioural, social, and psychological and involving the terms “men” and “women” (as well as “girls” and “boys”), we do not feel that these definitions are adequate due to their binary nature. Instead, we envision sex as a spectrum ranging from male to intersex to female, with a wide range of variety within each category. Similarly, we envision gender as much more complex than...
Pryzgoda and Crisler’s binary conception [16], not only including men/boys and women/girls categorizations, but also including non-binary gender identities (e.g., gender fluid, agender).

3. Review of Literature

While there is a wealth of research about gender and mathematics, very little of this research is from the perspective of the general public, “ordinary people, especially all the people who are not members of a particular organization or who do not have any special type of knowledge” [17]. Instead, studies about perceptions of gender and mathematics are typically conducted with elementary, secondary, and tertiary students (e.g., [18], [19], [20]) who are, arguably, convenient populations for researchers to access. Even when considering mathematics education research more broadly, research with the general public is rare [21].

One of the earliest studies about the general public’s views of mathematics was conducted in the United Kingdom with approximately 550 adult participants [22], [23], [24]. Encouragingly, most participants did not agree with the “mathematics as a male domain” stereotype. More recently, Forgasz and Leder led a team of international researchers (in Australia, Canada, South Korea, Spain, and the United Kingdom) in a large-scale project about the general public’s views of gender and mathematics (reported in such publications as [8], [25], [26], [27]). Street-level data were collected in the aforementioned countries; data from these and other countries were collected via Facebook. While there were differences by location and by participant demographics (e.g., age, gender), in all countries, many participants held gender-neutral views of mathematics. Concerningly though, when participants held gendered stances, they typically favoured boys and men.

4. Research Design

The research discussed here is derived from two studies. The first study was led by Helen Forgasz and Gilah Leder of Australia, and I (Hall) was responsible for the data collection and analysis of the Canadian dataset. The Canadian findings are discussed in detail in [8] and will be summarized here to draw comparisons to the findings of our study.

Our current study (“non-binary study”) builds on Forgasz and Leder’s work (“binary study”). With their permission, we reworded the questions from the original survey to be non-binary in nature, plus made other changes, which will be discussed next.

4.1. Data Collection Instruments

In the binary study, a survey designed by Forgasz and Leder was used. Demographic questions were asked about each participant’s age and home language. Participants’ genders were assumed based on appearance, whereas the two other demographic questions were asked explicitly. The main portion of the survey comprised 14 questions: two about the participant’s school mathematics experiences, three about mathematics education generally, and nine about gender and mathematics (or related fields, such as science). All of the “gender and mathematics” questions were worded in a binary manner, with “girls or boys” at the end of each question (e.g., “Who do parents believe are better at mathematics, girls or boys?”). This order (girls before boys) disrupts the commonly-used ordering (“boys or girls”) that unconsciously privileges boys. During data collection, participants were told, prior to being asked these questions, that they could answer however they wanted; they did not simply have to choose from “girls” or “boys”. At the end of the survey, participants could provide additional comments.

We used Forgasz and Leder’s survey as the basis for our non-binary survey, as we wanted to be able to make comparisons as well as possible, given the different wording. The first major change that we made was to add a demographic question in which we explicitly asked participants for their genders (“What is your gender?”), as we found it problematic to assume participants’ genders simply based on appearance. We kept the age and home language questions the same as those on the binary survey. We also added a question about the highest level of schooling that the participant had completed, as we plan to do analyses by education level. We removed any questions about related fields (e.g., science) or topics (e.g., computer use), instead strictly focusing on mathematics, which resulted in five questions. We re-worded these questions to be non-binary. For instance, the “parents” question (See previous paragraph) was reworded to “Do you believe that parents think that mathematics ability is related to gender? Please explain.” This wording does not include options that might prime participants [28] and does not presume gender as a binary.

We added a new section to the end of the survey, after the “gender and mathematics” questions, focused on gender and sex terminology, as we wanted to explicitly query participants’ views of these constructs. Participants were asked to define the word “gender”, discuss how the term “gender” relates to the term “sex”, and provide terms that they associate with each construct. As with the binary survey, participants could provide additional comments about gender and mathematics at the conclusion of the survey.

4.2. Data Collection

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In the binary study, I (Hall) collected data from four different locations (e.g., city, rural area) in the Central Canada between December of 2012 and August of 2013. In the non-binary study, we collected data from four locations within a large city in Central Canada in July and August of 2017. In each study, approximately 200 participants took part. Here, we report on summary findings from the binary study [8] and our initial findings from the analysis of data from the first two locations in the non-binary study, a shopping centre (mall) and a tourist area.

While there may be concerns that the data might not be comparable due to the demographic (and other) differences of the locales, a chi-squared analysis of the data from the binary study showed no significant differences by location. Hence, we decided to consider the data in aggregate, rather than by location. In both studies, data collection took place in public locations (e.g., street, shopping mall). Passersby were approached and asked if they would participate in a brief survey about gender and mathematics. Participants were then asked if they agreed to be audio-recorded. Virtually all participants agreed; answers were hand-written for the few who disagreed.

4.3. Data Analysis

For the purpose of this paper, we analyzed two questions with parallels on the surveys, as shown in Table 1:

<table>
<thead>
<tr>
<th>Question on Binary Survey</th>
<th>Parallel Question on Non-Binary Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who are better at mathematics, girls or boys? Why do you say that?</td>
<td>Do you believe that mathematics ability is related to gender? Please explain.</td>
</tr>
<tr>
<td>Is it more important for girls or boys to study mathematics? Why do you say that?</td>
<td>For which gender is it most important to study mathematics? Why?</td>
</tr>
</tbody>
</table>

We found it easy to come up with parallel wording for the second question (herein Importance of Studying Math question), but we struggled to come up with suitable parallel wording for the first question (herein Math Ability question). When I (Hall) was collecting the data for the binary study, participants would sometimes ask what was meant by “better” (e.g., school grades, ability). I could not answer this question, and I remember feeling that at the time that it was vaguely worded. For our version of the survey, we selected the word “ability” as we felt that it was the most suitable term to represent the idea of “better”.

For the binary study, participants’ responses were analyzed using codes provided by the lead researchers, Forgasz and Leder. Responses to both questions were coded with “girls”, “boys”, “same”, “don’t know”, or “depends” (e.g., if the participant responded “girls” for certain levels of education, but “boys” for others).

For the non-binary study, the participants’ responses were analyzed using similar codes. Namely, participants’ responses were coded with “woman/girl/female”, “man/boy/male”, “no/same” (or “both/all” for the Importance of Studying Math question), “don’t know”, “depends”, “yes/unspecified” (meaning that the participant indicated that mathematics ability was linked to gender but did not indicate a “superior” gender), and “no answer/unclear”.

We also coded the responses to the two questions in terms of (a) use of language (“sex”, “gender”, “mixed”, or “no indication”) and (b) whether a binary or non-binary understanding was shown in the response (“binary”, “non-binary”, or “no indication”). A code of “sex” was applied when participants used the terms “male” and/or “female”, whereas a code of “gender” was applied when the participants used the terms “woman”, “girl”, “man”, and/or “boy”. A “mixed” code indicated that the participant used both “sex” and “gender” language (e.g., males and girls). A code of “binary” was applied when the participant listed only a pairing (e.g., men and women) and/or used a term that indicated only two groups (e.g., either, both). Conversely, a code of “non-binary” was applied when the participant listed more than two gender groups and/or used a term that indicated as such (e.g., all, any).

Codes were applied to the participants’ responses (one code for the binary study and three for the non-binary study, per question) and then counts were tallied and percentages calculated for each code.

5. Findings

In the following sections, we summarize our findings for two “parallel” questions. In each section, we discuss the findings from the binary study and then those from the non-binary study. We conclude each section by discussing the participants’ use of gendered and binary language in their responses.

When providing quotations, for the binary study, the categorizations used are those provided by the lead researchers, Forgasz and Leder. There were four locations where data were collected: rural, town, suburb, and urban. For the non-binary study, the participants’ genders are provided using their own language (typically “sex” rather than “gender” language), while the age ranges were provided in the questionnaire. In both studies, the ‘Under 20’ (18-19) and 20-39 age categories were combined since there were so few in the younger category. Here, we report on two of the four locations in the non-binary study: a shopping mall and a tourist area.
5.1. Mathematics Ability

In the binary study, where the question was worded “Who are better at mathematics, girls or boys? Why do you say that?”, the modal category of responses (37.3%) was that there were no gender differences in mathematics ability. The reasons provided for such responses tended to relate to a perception of everyone being equal: “Men and women are equal and have the same brain power” (town, P51, woman, 18-39). More than half of the participants provided a gendered option: 31.9% selected boys, compared to 20.6% who selected girls. Stereotypical ideas were provided for these responses, such as the notion that girls are better at language arts, while boys are better at mathematics. Participants also suggested that girls are stronger students overall, while boys have a more “mathematical nature”. For example, one participant suggested that “the way that their brains work, I think that they focus more in, like, little boxes, so they can focus on specific things better than girls, who are, in my experience, generalists” (town, P46, man, 18-39). A small proportion (10.3%) were unsure or ambivalent about this question.

In the non-binary study, where the question was worded “Do you believe that mathematics ability is related to gender? Please explain.”, a far larger proportion of participants purported that mathematics ability was not related to one’s gender. Specifically, 84.2% claimed that gender and mathematics ability were not related, an encouraging finding. Many participants seemed to query the entire premise of the question: When asked why they said “no”, participants gave responses like, “I mean, why would it be?” (mall, P44, male, 20-39). Many participants provided reasons related to ideas about individual differences, such as “I believe that intellect, including mathematical ability, just relies on the individual and not the gender itself” (mall, P24, female, 20-39). Others relied on personal experience to support their claims, such as “Well, I’ve known girls who are really good at math, so I don’t think so” (tourist area, P42, masculine, 20-39). Such reasoning was also common in the binary study [8], and is indicative of innumeracy, as participants are making broad claims based on personal experiences with relatively few people [29]. No participants suggested that women/girls/females are superior in mathematics ability, while 5.3% of the participants suggested that men/boys/males are superior. The remaining participants (don’t know, depends, yes/unspecified, and no answer) accounted for 11.1% of the sample, with “don’t know” responses comprising half of this group.

Additionally, the responses to this question in the non-binary study were analyzed for the type of language used. More than half (56.8%) of the participants did not provide any “sex” or “gender” language in their response; some of these participants provided no explanation for their answer, while others simply spoke in generalities (e.g., “No, I just – I have no reason to think it has anything to do with gender.” – tourist area, P11, male, 20-39). Of the other participants, nearly twice as many (22.1% vs. 12.6%) used “sex” language (male/female), compared to “gender” language (man/woman/boy/girl). A small proportion (8.4%) of the participants used a mix of “sex” and “gender” language.

Participants’ language choices were also analyzed by the use of binary language (e.g., “both genders”, “males and females”) or non-binary language (e.g., “all genders”). Unsurprisingly, given the previous findings, most participants (62.1%) did not provide any indication of a binary (or not) in their responses. The difference between binary and non-binary responses was quite stark, with 11 times as many participants (34.7% vs. 3.2%) using binary language.

In summary, when the question was asked in a non-binary way, a far higher percentage of participants provided a response indicating that they did not think that gender and mathematics ability were related (84.2% in the non-binary study vs. 37.3% in the binary study). This difference is particularly notable since the question in the binary study was the first one, which immediately followed an introduction by the interviewer in which participants were told that, while the questions were worded “girls or boys”, they could respond however they wanted, such as saying “no difference”. With respect to language choices, it was perhaps unsurprising to find that more participants used “sex” than “gender” language, and that far more participants used binary language than non-binary language.

5.2. Importance of Studying Mathematics

In the binary study, where the question was worded “Is it more important for girls or boys to study mathematics? Why do you say that?”, 94.6% of participants argued that it was equally important for girls and boys to study mathematics. Of the few participants with a gendered stance, it was more common to provide a response in favour of boys (2.0%) than girls (0.5%). The arguments in boys’ favours focused on the idea that boys tended to go into fields that were mathematics-focused, such as engineering and the trades.

In the non-binary study, where the question was worded “For which gender is it most important to study mathematics? Why?”, 77.9% of participants provided an “everyone” response (e.g., both, all). When participants provided explanations for such responses, they related to the idea that everyone needs to know mathematics, such as “I think it’s a really important tool – not necessarily algebra, but basic math is something that you really need later on, no matter what field you go into” (tourist area, P43, female, 18-39). Five times as many (10.5% vs. 2.1%)
participants responded that it was more important for women/girls/females, compared to men/boys/males. The explanations for the former related to opportunities in what remains a field dominated by men: “simply because there is not of course a surplus but just so many more men in mathematics. Encouraging women to pursue careers in things that they might not think that they might enjoy obviously understanding they have the right to choose what they want.” (mail, P42, male, 18-39)

With regard to language usage, again, the majority (67.4%) of participants did not provide any indication of “sex” or “gender” language in their responses, instead providing general responses like “all” or “both”. Interestingly, similar proportions of respondents (15.8% and 16.8%, respectively) used “sex” and “gender” language for this question. A similar pattern to the previous questions occurred for the use of binary or non-binary language: The largest group of people had no indication of binary/non-binary language in their responses (45.3%), while there were more participants who used binary language (41.1%), such as “both”, than non-binary language (13.7%), such as “all”. Notably, the difference between the groups (three times as many using binary language as non-binary language) was far less pronounced than for the Math Ability question (11 times as many participants using binary than non-binary language). A couple of participants self-corrected from a binary to a non-binary response when answering, such as “I guess I’m using the wrong phrase with gender, aren’t I? Gender is not binary and I’m using it as a binary phrase. I need to remember that.” (tourist area, P16, male, 18-39)

Encouragingly, participants in both studies overwhelmingly agreed that it was important for everyone to study mathematics, regardless of gender. In contrast to the Math Ability question, a higher proportion of participants agreed with the statement in the binary study, compared to the non-binary study. While gendered responses were a small proportion of the responses in each study, the patterns were different, with more participants selecting boys in the binary study, compared to more participants selecting girls/women/females in the non-binary study.

6. Conclusion

As shown in our findings, there were some differences in the responses of the participants depending on whether they were in the binary or non-binary study. These differences could be attributable to the varied research sites or simply the make-up of the participants. We suggest that recent societal shifts also played a role in the different response patterns. In the past few years, there has been increased visibility in mainstream media of trans, non-binary, and queer gender identities (e.g., [30], [31], [32]). Some of our participants showed awareness of these ideas in their responses, particularly as they acknowledged shifts in their thinking and/or made self-corrections. Another key contributing factor to the differences in response patterns is arguably the manner in which the questions were worded (binary vs. non-binary). As noted earlier, simply saying the words “girl” and “boy” can prime participants to respond in certain ways [28]. We argue that the manner in which the questions were worded played an important role.

The findings presented here arose from our initial analyses of data from a large, complex dataset (~400 participants from Canada and Australia). By analyzing the other “gender and mathematics” questions, we will garner a clearer understanding if there are trends in response patterns across the questions (particularly in comparison to the findings from the binary study). We will further analyze the data in numerous ways, such as investigating whether there are patterns in the responses by the participants’ genders, ages, and educational backgrounds. We also plan to conduct analyses in which we make links between the participants’ responses to the “gender and mathematics” questions and the “gender and sex” questions, where their views were explicitly queried.

As mentioned earlier, there was far more focus on “gender issues” research in mathematics education in the 1980s and 1990s, with fewer researchers focusing on this topic in recent years. Part of this situation can be attributed to the (mis)perception that gender issues have been “solved”. However, as many researchers (e.g., [33], [34]) have shown, there remain gender inequities in students’ experiences with mathematics. As Esmonde argues, “ignoring gender hides the fact that gender is part of the foundation of the cultural houses we inhabit” [5] (p. 30). Thus, we feel it is crucial to continue to examine these topics in mathematics education (and other) research, and to push for change in research, to better reflect the people’s genders and gendered experiences.

7. References


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[31] J.S. Ferguson, “We are Non-Binary Trans People and Yes, We Exist”, HuffPost, 2016.

