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Multicultural and Gender Equity Issues in a History of Mathematics Course: Not Only Dead European Males

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We address issues related to gender and cultural equity in a history of mathematics course. We first look at the preponderance of male European mathematicians represented in textbooks of mathematics and history or mathematics. Then we discuss ways to highlight the presence of female and non-European mathematicians in the history of mathematics. Next we analyze the cultural and gender bias present in a history of mathematics textbook and how it tends to perpetuate the perception of mathematics as a male domain. Finally, we discuss the development of an activity to connect the history of mathematics with high school mathematics learning, and the need for teachers to be aware of bias in textbooks so they can rewrite women back into their instruction. The activity about statisticians and their contributions, set in a contemporary fictional setting, follows the article.

Keywords: Gender equity in mathematics, multicultural equity in mathematics, history of mathematics, high school mathematics, statisticians

Introduction

In this article we discuss how to address multicultural and gender equity issues in a history of mathematics course designed for prospective secondary mathematics teachers. We also include an activity for high school students in which they can see that contributors to mathematics are not limited to European males. The first author has taught the course four times and the second author, who developed the activity, was a student in the course in the Spring semester of 2012.

What do Mathematicians Look Like?

Some years ago one of the student teachers in our program devised and conducted a high school mathematics lesson that was different from most mathematics lessons. She showed the "human face" of mathematics. The lesson incorporated questions about the lives and some of the major contributions of several famous mathematicians. It was a very engaging lesson and the students participated actively. However, all the mathematicians in her lesson were male, European, and no longer alive. Some possible unintended consequences of such a selection came to mind. By including only male mathematicians would the teacher unwittingly send a message to her female students that mathematics is not for girls? By including only Europeans would students with different ancestries feel left out of mathematics? By including only dead people could we be sending the message that mathematics is a thing in the past, rather than a lively and growing field of study?

It is not surprising that the student teacher chose male European mathematicians for her activity. Looking at mathematics textbooks one can verify that the vast majority of mathematicians mentioned are male and European. For example, when I (Flores) was a student at the university, my calculus book had a list of biographical dates (Courant and John, 1965). All 59 people listed were male and 56 of them were European. The exceptions were Euclid, Ptolemy and Michelson. Present day textbooks do not fare much better. For instance, in the index of a reform calculus textbook (Hughes-Hallett et al., 2009) there are 21 people listed with years of birth and death. All of them are male. Simmons (2007), in his book with 33 brief lives, includes only one biographical sketch about a woman (Hypatia). Except for the ancient mathematicians who lived in Alexandria (Euclid, Heron, Pappus) all the rest are European.

This focus on male European mathematicians may be one of the reasons why some students perceive mathematics as a male dominated field or that it is not for all segments of the population. The title of the book "*Multiplication is for White people*" (Delpit, 2012) reflects the belief that students from some ethnic groups have that mathematics is not for them. Future secondary mathematics teachers need to be aware of such perceptions and of the possible sources that may cause them, in order to provide their students of a more balanced picture of who can participate in and contribute to mathematics.

Female and Non-European Mathematicians in the History of Mathematics

At the University of Delaware, future mathematics teachers take a history of mathematics course the year before student teaching. The main purpose of the course is to prepare them to become better mathematics teachers. This is done several ways. One is by developing their own knowledge of mathematics for teaching through the history of mathematics (Huntley and Flores, 2010). Another purpose of the course is to show prospective teachers that contributions to mathematics have come from individuals, both male and female, from many different cultures and ethnic groups.

In this course, each of the participants becomes the expert in one of the historical topics presented in the textbook. Students make two presentations to the class related to their topic and write three papers about the topic from different perspectives that are then combined into a final paper. One of the papers is a biographical sketch about a mathematician who made important contributions to their topic.

The first year I taught the course I encouraged students in the class to choose females and non-European mathematicians for their biographical sketches. However, even though the majority of the students in the class were female (15 females, 10 males), all the mathematicians chosen for the biographical sketches were males. Next year, I provided students with a list of 30 female mathematicians with a brief description of their contributions to several topics, as well as about 20 references with biographical information about women in mathematics. I highlighted the fact that there are a growing number of women who have made important contributions to mathematics as researchers, teachers, commentators, editors, or disseminators. I mentioned in class that the previous year everybody had chosen a male mathematician. Again, I encouraged them to choose females and non-Europeans. Even though there were 21 females and 5 males in the class, only one student chose a female mathematician (Sophie Germain) for her biographical sketch. In terms of cultural diversity the class did not do better either. Only one student chose a non-European mathematician.

I shared these results with a colleague at another university who is also interested in ways of improving the gender equity of topics presented in her classes. She suggested a somewhat drastic approach. Maybe one semester I could let students choose only from female or non-European mathematicians. She said that it could be argued this is fair because most mathematics books and mathematics classes only mention the European males, and one purpose of the course is to broaden their horizons (Jensen, 2010). She also suggested having students write about living mathematicians, and use that to emphasize the current diversity in the mathematical sciences. I thought about these suggestions, and whether to ask students to write two biographical sketches, where at least one of the biographies should be about a person who was either female, or non-European, or who was still alive during their own lifetime. I discussed the idea with one of my colleagues at Delaware. She thought that requiring two biographies would "allow students to do one of their own choosing and one within the 'confines' of the additional parameters…, giving them a bit more freedom" (Bartell, 2010). So next year I changed the assignment to writing two biographies.

In the last two years, due to the modified requirements for the biographical sketches there was more diversity represented in the people students wrote about. This year, for example, there were 6 males and 14 females in the course. Eighteen students chose a European male mathematician for one of their biographical sketches. Fifteen students chose non-European male mathematicians (among these, six from the United States). Seven students chose a female mathematician (five of them from Europe). In terms of recent contributors to mathematics, six students chose mathematicians who were alive during their own lifetime.

Cultural and Gender Bias in the Textbook

Although it is encouraging that there is more diversity in the list of biographical sketches, there are still some issues that need to be addressed with future teachers as they learn to use teaching tools like textbooks. Future teachers need to realize in what ways textbooks, often unwittingly, may be contributing to perpetuate biased perceptions of mathematics by focusing almost exclusively on contributions of males, Europeans, and people who are no longer alive.

The textbook used in the history of mathematics course pays "most attention to the story of those parts of mathematics that we teach and learn in school" (Berlinghoff and Gouvêa, 2002, p. 5). The mathematics that we teach in the United States has its roots in contributions from Ancient Egypt and Mesopotamia, Greece, India and the Islamic empire. This tradition later continued and flourished in Europe. As a result, in the textbook, some traditions and cultures "receive less attention because they have had much less influence on the mathematics that we now teach" (p. 5). However, many of the topics that we teach in schools nowadays were independently discovered by people from around the world. These discoveries often pre-date the European mathematics that had a direct impact on our curriculum. For example, the Pythagorean theorem and symmetry patterns can be studied using art from Africa (Gerdes, 1999; Zaslavsky, 1973) or other parts of the world. Future teachers can also benefit from a more complex view of how people in different parts of the world interacted with each other and enriched and disseminated each other's mathematical knowledge to produce a wealth of knowledge

that eventually made possible the rise and development of modern European mathematics (Joseph, 1992).

Early in the book, the authors of the mathematics history textbook address the issue that few women are mentioned in the book. The textbook indeed mentions many more males than females. Only 16 females are listed in the index of the book, in contrast to about 226 males. Berlinghoff and Gouvêa explain that before the 20th century in many places women were denied access to significant formal education in the sciences. In an early session of the course, in a discussion conducted by the two of us, we addressed the role of women in mathematics in the past and at present. We invited students' input to the following questions:

> What is your position on the authors' statement that in the past mathematics achievement of women have been "obscured"? (p. 6) Do you agree with the statement that "in our times most of the barriers to women in the sciences have been dissolved" (p. 6). Why or why not? In what ways does your own personal experience coincide or contradict what the authors say?

Many of the girls in the class said that they were encouraged by their mathematics teachers in high school to continue their mathematics career. This was true for both their male and female teachers. However, gender differences in terms of expectations still exist. A boy with mathematical talent is likely to be encouraged by family and teachers to become an engineer rather than a teacher. All the students in the class, male or female, agreed that their high school textbooks left out many women mathematicians, and that was a major reason why they could not recite many names of female mathematicians when we asked. Furthermore, a survey of the research literature on girl's confidence in mathematics conducted by the second author shows that even today there are also other factors that affect girl's confidence in mathematics differently from boys, such as the competitive nature present in the mathematics classroom and curriculum (Niederle & Vesterlund, 2010), the onset of adolescent puberty (Buerk and Oaks 2001), and the availability of mentors and role models (Rogers & Kaiser 1995).

Berlinghoff and Gouvêa also mention that the "perception that mathematics is a male domain has been a remarkably resilient self-fulfilling prophecy" (p. 6). However, by listing so few women who have contributed to mathematics, textbooks may be helping to perpetuate this perception. There are several chapters in the book, such as statistics and computer science, where more women could have been easily mentioned. Future teachers need to be aware of that, and they can provide a more balanced picture. Although students in the class chose female mathematicians in only seven out of forty possible choices, this can still be viewed as an improvement compared to the gender ratio in the textbook (16 to 226).

Relating the History of Mathematics to the High School Curriculum

Another course assignment students were asked to do is to develop activities that relate their historical topic to the teaching of mathematics in today's high schools. I (Kelly) designed an activity incorporating information about contributions of different statisticians. Referencing the class textbook, "Math Through the Ages," I first presented in class a brief synopsis of real contributions to the field of statistics from various mathematicians. This slide presentation allowed me to illustrate the history of statistics visually. Students learned about the works of John Graunt, the first to see patterns in numerical burial records in 1662, Abraham de Moivre, who in 1733 discovered the importance of the normal distribution, Sir Francis Galton, who developed regression and correlation to help study human heredity and genetics, as well as other statisticians. I then gave my fellow students an activity in which they had to match the name of the statistician with his/her corresponding quotation. This activity, named "Celebrity Statisticians" (see Figures 1 and 2), creates a fictional situation where statisticians from different ages are interviewed in the present day and make outrageous comments. Through this activity, I hoped to increase student motivation by putting historical statisticians in a more contemporary context. The lives of today's pop-singers, Hollywood actors, and professional athletes are heavily featured in today's media. Thus, most, if not all, adolescents have a famous celebrity that they look up to and idolize. So why not transform historical statisticians into modern-day celebrities? Each comment, although invented by me, is based on the actual work of the statistician. Creating clever quotations that fuse together modern day references (Justin Bieber, Madison Square Garden) with past mathematical contributions makes each statistician much more relatable in the classroom.

Looking back on my lesson, I found that this was a very effective activity because it presented the pioneers of statistics in a new light. It made students search for the underlying clues that reinforced what they learned in my initial presentation. For example, Gertrude Mary Cox should be paired with the comment, "I could have sold out Madison Square Garden faster than Justin Bieber, if I hosted my lecture conferences on economics, biological and nutritional problems, and plant and animal science there." With Justin Bieber's popularity, most adolescents can recite his life biography, let alone tell you how fast his concert sells out Madison Square Garden. Students should be able to piece together the parallelism between Bieber and Gertrude Cox. While Bieber holds pop-concerts, Cox held many popular mini-lectures and conferences that applied statistics to other life disciplines.

The list of nine names in the activity includes two women and one African American statistician. However, in the first version of the activity all nine people were European

Celebrity Statisticians

They said what??

Name _____

Directions: Nine statisticians were caught saying these outrageous comments during their interviews on E! Match up the historical statistician to the quotation that he or she would most likely have said

John Graunt	"Statistics is such a normal part of everyday life! How can anyone not use it?"
Edmund Halley	"The likelihood that research workers started using statistics because of me is high."
Gertrude Mary Cox	"Haters can hate. Our physical and mental characteristics can be mapped to the normal curve!"
Abraham de Moivre	"I could have sold out Madison Square Gardens faster than Justin Bieber if I hosted my lecture conferences on economics, biological and nutritional problems, and plant and animal science there."
David Blackwell	"These guys are getting too much credit. After all, I was the first mathematician to analyze and understand my data!"
Lambert Quetelet	"Some of these statisticians think they had it so hard. I had to also fight racial discrimination to become a credited statistician. My hard work made me become the first African American mathematician to be inducted in the National Academy of Science!"
Sir Francis Galton	"Men say that math is a male's domain. Ha! As a nurse, I saved so many of their lives during war using statistical charts, tables, and graphs!"
Florence Nightingale	"Insurance companies are forever in my debt. I am the father of actuarial science!"
Ronald Aylmer Fisher	"Statistics was the best fit for me. After all, I did invent regression and correlation!"

Figure 1.

males. It was not until the instructor pointed this fact out that I realized the activity could have some unintended messages. One of my interests is gender equity in mathematics, and during the semester I did a literature review on the topic as an independent study, with special emphasis on strategies to encourage girls' participation in class. One of the four main factors I focused was the availability of mentors and role models. In the report of my study I pointed out that especially when teachers discuss the history of mathematics, many vital female mathematicians are left out of the picture. I found this part of my research very interesting because it relates to what I noticed in our History of Mathematical Ideas course.

Answer Key

"Statistics is such a normal part of everyday life!..." (de Moivre—normal curve)

"The likelihood that I encouraged research workers to use statistics is high." (RA Fisher, who created the likelihood function and in his "Statistical Methods of Research Workers," connected statistics to experimental design)

"Haters can hate. Our physical and mental characteristics can be mapped…" (Lambert Quetelet, whose average-man concept faced backlash from others.)

"I could have sold out Madison Square Gardens…" (Gertrude Mary Cox—she held many popular mini-lectures and conferences that illustrated how to apply statistics to every day life)

"These guys are getting too much credit…" (John Graunt, who was seen as the first person to analyze data when he was recording London's burial records)

"Some of these statisticians think they had it so hard…" (David Blackwell—a world famous African American statistician)

"Men say that math is a male's domain…." (Florence Nightingale—as a military nurse she used statistics to understand the health issues and lack of sanitation. She created statistics that showed how many people died, when they died, and how they died. This saved many lives.)

"Insurance companies are forever in my debt…." (Edmund Halley, who studied life expectancies and other demographic trends)

"Statistics was the best fit for me…" (Sir Francis Galton, who was interested in how traits were distributed in the population and who established the concept of regression and correlation to compensate his data variability)

Figure 2.

I found that in the textbook the history of mathematics is dominated by White, European males. If teachers neglect to incorporate female role models and mathematicians into their instructional lesson, it automatically makes femininity a powerless force in mathematics. When girls do not see relatable mathematicians within the pages of their textbook and their teacher does not discuss their exclusion, then the stereotype that 'math is a male's domain' is forever strengthened (Sadker & Sadker, 1995). A lack of role models inside the classroom creates a "culture of mathematics [that] remains distant, cold, and undesirable for too many women" (Rogers & Kaiser, 1995, p. 15). So it was especially interesting that my initial list of statisticians had only males. The reason is that my activity was based on the information provided by the chapter on the history of statistics in the textbook, in which all statisticians mentioned are males. From this activity, I realized how important it is that future teachers are not only aware of gender biases in textbooks, but that we create classroom activities with a conscious effort. Our students deserve a well-rounded mathematics education that provides a balanced picture of who can make contributions to mathematics. To promote girl's confidence inside the classroom, teachers need to rewrite women back into their instruction. By discussing how women have made significant strides in history we can show that mathematics is for everyone.

Final Remarks

Exposing the history behind mathematics shows that it is never a field studied in isolation, but it has its own story and tradition. It sears open a new life that helps students see mathematics as an integrated subject. A history of mathematics course can effectively portray mathematics through a historical means. Students in the class researched the lives of its individual contributors and became aware of its underlying culture. In return, students learned how to employ more creative, yet engaging activities in the classroom. When students take on a more active status in the classroom, they gain a better foundation for the information presented. The way this course was conducted did also provide students with a wider academic scope that has expanded their teaching horizons. It has given new instructional strategies and ideas that can help future teacher create more cultural and gender equity in the classroom. This is an important component in the preparation of future teachers.

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