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Improving Diversity Among Textbook Exercises

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How can teachers use provided curriculum to create a welcoming classroom environment for all students?

This article provides examples of how teachers can slightly alter existing textbook exercises to be more inclusive of students from diverse backgrounds. These simple alterations are important because women and people of color continue to be underrepresented in STEM (Science, Technology, Engineering, and Mathematics) fields. Past research shows that "in 2009, African-American, Hispanic, and Native American students comprised nearly a third of all undergraduate students, yet these students only earned 15% of STEM degrees awarded" (Piatek-Jimenez, Madison, and Przybyla-Kuchek 2014, p. 56). Our research on the representation of women and people of color in high school precalculus textbooks reveals much room for improvement in representing people from diverse backgrounds in STEM careers. We believe that altering textbook exercises to be more inclusive is an essential step towards diversifying STEM fields.

Within mathematics textbooks, we often see a lack of gender representation, representation of people of color, and an absence of STEM careers. Improving diversity and STEM career representation within textbooks builds genuine connections to the material. These connections could lead to more diversity within the STEM field since mathematics engages students with enticing future career options.

While many textbooks lack examples of diverse professionals in STEM careers, teachers fill this gap by slightly altering existing textbook exercises during classroom use. To begin this conversation, we provide three examples of modified textbook exercises. As readers will see in the altered exercises in ***Table 1***, the changes we make are subtle but important. We slightly altered the original exercises to include non-binary names, pronouns associated with women, names related to diverse backgrounds, and authentic STEM careers. We hope the examples we provide will inspire teachers to be more mindful of representation within existing textbook exercises.

Example 1: Improving Gender Diversity

Table 1 on page 25 provides the original textbook exercises alongside our revised versions. The first exercise we modified is from Edwards and Larson (2011). The original exercise is about a bicyclist riding on a path and asks students to find the rate of change in elevation. The exercise does not provide demographic information about the bicyclist. We chose to

Original Exercise	Revised Exercise
A bicyclist is riding on a path modeled by the function: $f(x) = 0.04(8x - x^2)$ where x and $f(x)$ are measured in miles. Find the rate of change of elevation at $x = 2$. (Edwards and Larson 2011, 219)	Sam is riding their bike to a research lab where they work, and the path is modeled by the function: $f(x) = 0.04(8x - x^2)$, measuring x and $f(x)$ in miles. Find the rate of change of elevation at $x = 2$.
An engineer is asked to design a water sprinkler that will cover a field of 100 square yards that is in the shape of a sector of a circle of radius 15 yards. Through what angle should the sprinkler rotate? (Sullivan and Sullivan 2017, 361)	Virginia, a member of the National Society of Black Engineers (NSBE), is asked to design a water sprinkler that will cover a field of 100 square yards in the shape of a sector of a circle of radius 15 yards. Through what angle should the sprinkler rotate?
An automobile travels 540 kilometers in 4 hours and 30 minutes. What is its average velocity over the entire 4 ½ hour time interval? (Demana, Waits, Foley, and Kennedy 2003, 803)	Ms. Gonzalez is on her way to a chemistry conference and travels 540 kilometers in 4 hours and 30 minutes. What is her average velocity over the entire 4 ½ hour time interval?

Table 1. Original Textbook Exercises Alongside Revised Exercises

name the bicycle rider "Sam," an intentionally uninsex name, and we used the gender-neutral pronouns "they/them." According to Marzocchi (2019), it is important to consider the representation of gender in mathematics tasks. In March 2019 of the *ComMuniCator*, Marzocchi (p. 14) changes the context of a mathematics task from a school dance (which may reinforce gender stereotypes) to a tug-of-war competition that does not involve problematic gender-binary constructs. In another study, Rubel (2016) explored the connection between gender and sexual identity in mathematics tasks. She discussed an activity where the teacher gave blue **Fraction War Cards** to boys and pink **Fraction War Cards** to girls and then told them to create rankings of their marriage preferences. In this situation, gender was labeled as binary and relationships specified as heteronormative relationships were reinforced without considering students' identities. We suggest that teachers and curriculum developers increase their awareness of gender representation in mathematics tasks. Educators can create tasks that are more inclusive by increasing the use of unisex names, names typically associated with women, names typically associated with diverse cultures, pronouns associated with women, gender non-binary pronouns, and showcasing characters' non-stereotypical gender roles (such as men baking and women coaching), etc. Also, featuring a job in a research lab in the mathematics problem provides students with a connection to STEM careers.

Example 2: Improving Racial/Ethnic Diversity

The second exercise we revised is from Sullivan and Sullivan (2017). In the original exercise, an engineer designs a water sprinkler and the exercise focuses on the angle the sprinkler will rotate. Although the exercise contains a character in a STEM career (engineer), we found that the task did not use a name, gender, or race/ethnicity. We found this problematic. If we want to see an increase in women and people of color joining the STEM field, we need to show diversity among a "variety of occupational and professional roles" within our textbooks (Garcia, Harrison, and Torres 1990, p. 3). Therefore, we altered the exercise by naming the engineer Virginia, a woman, and a member of the National Society of Black Engineers (NSBE). We provided the character with intersecting identities as a Black woman because of the importance of diverse representation (Garcia, Harrison, and Torres 1990). To increase students' awareness of underrepresented STEM groups, we feature a rea-life society of engineers that focuses on the Black community. Altogether, these changes could encourage a child to pursue a career in STEM.

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Example 3: Improving STEM Career Examples

The final exercise we revised is from Demana, Waits, Foley, and Kennedy (2003). The original exercise is about a car driven at a certain speed but does not provide any information about the person driving the car. We revised the exercise to involve a driver and used a title typically associated with women and a last name typically associated with Latinx backgrounds. We also gave this character a STEM career by stating that she is driving to a chemistry conference. According to Martinez, Truong, and Marzocchi (under review, p. 6), "STEM career representation is important in mathematics textbooks, as this communicates to students the usefulness of mathematics and the potential to use mathematics in future careers." Past research indicates that women are represented less than men in mathematics textbooks and are often involved in less scientific activities than men (Garcia, Harrison, and Torres 1990; Piatek-Jimenez, Madison, and Przybyla-Kuchek 2014). For example, textbooks often show women working as receptionists and men working as doctors. The detrimental gender-specific stereotyping of careers is why we decided to include a woman in a STEM field. The goal of the revised exercise is to show students that women and people of color also belong within STEM fields.

Conclusion

We altered three exercises from mathematics textbooks to be more inclusive of people from diverse backgrounds. We revised each exercise to improve the representation of STEM careers, gender, and race/ethnicity. Readers should note that we did not change the mathematical content of the exercises; all changes related to the identify of the characters while preserving the mathematical learning goals.

One way to improve representation is through the names of textbook characters. By incorporating a name, the exercise becomes more personalized, and children can find a meaningful connection. We also expanded the idea of gender norms to help girls and gender non-binary children feel more included in mathematics. Incorporating exercises that include diverse genders and feature characters in non-stereotypical gender roles allows students with multiple identities to feel a sense of belonging in STEM.

All three authors identify as women and find it essential for textbooks to show women, especially women of color, in STEM roles because of the lack of mentors at the college and career levels. According to Rubel (2016), this is significant because many have associated mathematical ability with masculinity. The three exercises we revised serve as examples of the many ways a teacher can alter existing textbook exercises to be more inclusive. Teachers who take the initiative to change textbook exercises in the classroom can improve a sense of inclusion for students from diverse backgrounds.

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