Diversity and Inclusion: Incorporating History into the Mathematics Classroom

Derar Serhan
Arizona State University, USA, https://orcid.org/0000-0003-3767-1046

Natalie Welcome
Arizona State University, USA, https://orcid.org/0000-0002-7519-9136

Abstract: Math classes do not usually offer students an opportunity to learn about the diversity within the field of mathematics. As a result, students tend to hold inaccurate, negative perspectives about diversity in the world of mathematics and many may not feel a sense of belonging in the classroom when they do not see themselves reflected in the curriculum. The relationship between history and mathematics should be explored as one way to correct inaccurate views about what defines a mathematician and what the benefits are of studying mathematics and its relevance in daily life. One of the teaching practices that can support diversity and inclusion in the mathematics classroom is exposing students to a diverse group of mathematicians. In this study, we investigated the effects of using this teaching practice on creating an inclusive classroom. The participants in this study were 36 undergraduate students enrolled in a Precalculus course. Data were collected using a pre- and post-test tool and analyzed both quantitatively and qualitatively. An in-depth analysis through close comparisons between students' responses in the pre and post-tests. The results indicated that participants gained a new knowledge from the treatment (the historical projects) that expanded their horizons about mathematics diversity.

Keywords: Mathematics education, Mathematics history, Diversity & inclusion.

Introduction

Math classes do not usually offer students an opportunity to learn about the diversity within the field of mathematics. As a result, students tend to hold inaccurate, negative perspectives about diversity in the world of mathematics and many may not feel a sense of belonging in the classroom when they do not see themselves reflected in the curriculum. How can educational professionals establish appreciation for newly discovered mathematics when they are so far removed from earlier discoveries? How can educators overcome assumptions of irrelevance to social sciences and other fields in the college mathematics classrooms? One of the teaching

Serhan, D., & Welcome, N. (2022). Diversity and Inclusion: Incorporating History into the Mathematics Classroom. In M. Shelley, H. Akcay, & O. T. Ozturk (Eds.), *Proceedings of ICRES 2022-- International Conference on Research in Education and Science* (pp. 12-18), Antalya, TURKEY. ISTES Organization.

practices that can support diversity and inclusion in the mathematics classroom is exposing students to a diverse group of mathematicians.

There are countless ways to promote diversity and inclusion in the classroom. One way is the representation and incorporation of diverse groups from a variety of backgrounds. In this study, we look at incorporating history into mathematics curricula to help redirect misguided bias regarding the characteristics of mathematicians. This approach to promoting diversity and inclusion can lead to a positive, authentic shift in students' thinking about their own abilities to engage with mathematics. It can also lead to a relevant shift in students' thoughts about diversity within their communities. In this study, we start with the assumption that students enter the mathematics classrooms with biased views on matters of diversity. We also start with the assumption that learning mathematics is inherently interconnected with learning history. Our exploration begins by taking a closer look at these assumptions. Then, we examine perspectives that reject the incorporation of history into mathematics curricula followed by ideas that promote acceptance.

Do most students believe that history should be incorporated into mathematics courses? Many students seem to believe that history does not belong in the mathematics classroom. "I thought we were here to learn math," says a former student of Precalculus. "Can we focus on math?" Another student asks during the introduction of the project that incorporates history into their mathematics course. This demonstrates a negative perspective about historical content among students who seem to believe that history is not relevant when learning mathematics. Students may have been unintentionally taught that mathematics is an isolated field.

Literature Review

A measure of the sense of belonging in a mathematics community is a predictor of achievement and desire to pursue future studies across the sciences (Good, Rattan & Dweck, 2012). Students who perform well in mathematics courses often see themselves as mathematicians. Students who do not perform well in mathematics courses often do not see themselves as such. This inadvertently provides an advantage to people who belong to groups who are most frequently represented in the curriculum. Most students assume that mathematics has been discovered by European white males (Hobson, 2017). An honest account of history, however, may help provide a new, healthier viewpoint and lead students from all backgrounds to recognize themselves as scientists. History, as it is often taught, attributes mathematical discoveries to white male Europeans when in fact, the original mathematical ideas have been articulated by mathematicians from other ethnic and racial backgrounds (Irvine, 2020).

In using traditional mathematics textbooks, snippets of history about mathematicians might be found throughout the pages. However, these textbooks are written to pursue subject matter without genuinely pursuing the historical events or personalities that motivated them (Panagiotou, 2011). The negative beliefs about history and its relationship to mathematics can be presumed in other ways, as well. Panagiotou (2011) notes that authors are also known to frequently leap to definitions of mathematical terms as an arbitrary occurrence rather than a response to a problem. Teachers also seem to believe that history and mathematics are barely related. They rarely address the historical material provided by the author. When they do address historical detail, they often do not deeply examine the influence of those ideas on current mathematics. They worry that instruction of history might distract students from learning fundamental principles of computation (Panasuk & Horton, 2013).

Although overwhelming evidence exists to urge the instruction of history in a mathematics classroom, studies show that most teachers do not believe on its impact on the learning of mathematics and therefore do not incorporate the practice into their lessons. Hobson (2017), suggested six strategies to support diversity and inclusion in the mathematics classroom. One of these strategies is exposing students to a diverse group of mathematicians by describing "mathematicians as multidimensional individuals with struggles, hobbies, and families". For example, this can be done by presenting students with short biographies and showing them pictures of mathematicians from underrepresented groups. According to the National Council of Teachers of Mathematics (2000), one benefit of teaching history in a mathematics classroom is to inform students of their own abilities (Wilson & Chauvot, 2000). Students typically believe that mathematics is done by others, such as boys, the smartest students, and sometimes ethnic groups other than their own, rather than believing themselves to be mathematicians. These beliefs can span across race, gender, ability, and various categories of diversity.

Research shows that intense, targeted studies of the history of mathematics immediately and positively impacts learning by improving student attitudes about studying mathematics (Butuner, 2015). Additionally, students often report increased interest in subject matter in a mathematics classroom when the history is taught concurrently with theories about numbers (Goktepe & Ozdemir, 2013). Many educators teach that mathematicians are white male introverts. Many believe that the study of history has no direct relevance to the study of mathematics. This is demonstrated in textbooks and in attitudes of textbook authors, teachers, and students. However, there remain educators and influencers who hold positive perspectives about the relationship between history and mathematics and they bring novel ideas to the classroom.

Research Questions

This study aims at answering the following question: What are the effects of exposing students to a diverse group of mathematicians on supporting diversity and inclusion in the mathematics classroom?

Method

The participants in this study were 36 undergraduate students enrolled in a Precalculus class at Arizona State University in Fall 2021. The class was taught by one of the researchers. Students were enrolled in the class by regular registration procedures and were asked to volunteer to participate in the study. Students were informed that no private data will be collected, and that confidentiality is granted. Data were collected using a pre- and post-test tool, the researchers administered the pretest during the second week of Fall 2021 and then they administered the posttest during the tenth week of Fall 2021 after the students had completed the required historical projects and gave related presentations in the classroom. The pre- and post-test items were developed by the researchers based on the aim of the study. From the 36 students who participated in the pretest, only 27 participated in the posttest. The items in both the pretest and posttest were exactly the same. The items were divided into two parts: the first part consisted of six multiple choice questions and the second part consisted of 7 open-ended questions.

Procedure

Participants in this study completed a project about a selected mathematician and gave a presentation during the semester as follows:

- Participants completed a pre-test to measure their perspectives on diversity in mathematics.
- Students were given an overview of project expectations.
- The instructor divided the classroom into random groups.
- Students worked independently and collaboratively with their group members outside of class to explore requirements, conduct research, and complete projects.
- Students used limited classroom time to work on their assigned projects and ask the instructor any questions related to their project.
- Students uploaded the final project presentation documents.
- Students delivered oral presentations during class time, on a scheduled date (in order of relevance to course content).
- Participants completed a post-test to measure their perspectives on diversity in mathematics.

Analysis

The collected data were analyzed both quantitatively and qualitatively. An in-depth analysis through close comparisons between the participants' responses in the pre- and post-tests were conducted. For the qualitative data, a color-coding scheme was used to analyze participants' responses. Data were organized in categories based on participants' responses. The objective of the data analysis was to compare between participants' responses in the pre- and post-treatment (completing the mathematics history projects).

Results and Discussion

In analyzing the responses collected from the pre-and post-test items, the items were divided into three parts: the first part focused on the first six multiple choice questions, the second part focused on the next five questions which asked participants to mention three things they knew about a particular mathematician, and the third part focused on the last two questions which asked participants to provide answers to the following: Which population(s) come to mind when you think of people who are best in math? and Which population(s) come to mind when you think of people who are not good in math? For the first part of the pre- and post-test questions, the six multiple choice questions, the percentage of correct responses was calculated for each question (see Table 1). As can be seen from Table 1, the percentages of correct responses in the posttest improved in comparison to the pretest. For Question 3, the percentage increased from 27.8% to 81.5%

Table 1. Percentages of Correct Responses of each Question

Question	Pretest	Posttest
Q1: Algebra is named in honor of a mathematician from	58.3	85.2
Q2: The mathematician Leonhard Euler was	2.8	14.8
Q3: The mathematician Srinivasa Ramanujan was	27.8	55.6
Q4: Then “Man Who Knew Infinity” was from	27.8	81.5
Q5: The mathematician Evariste Galois died at age	8.3	40.7
Q6: The word *Algebra* comes from the following language	75	85.2

To have a better understanding of participants’ total correct responses, the percentages of the total number of correct percentages was calculated (see Table 2). As Table 2 indicates, 29.6% of the participants were able to provide at least 5 correct responses after the treatment, while none of the participants was able to provide any correct response for at least five questions in the pretest. Also, the percentage of participants who were not able to provide any correct response decreased from 13.9% to 3.7%, which indicates that the participants gained new knowledge regarding the six topics that were covered within the historical class presentations (see Table 2). For the second part in which participants were asked to mention three pieces of information that they knew about a particular mathematician, data were organized based on participants’ responses and percentages were calculated to compare between pretest and posttest responses for each mathematician.

Table 2. Percentages of the Number of Correct Responses

Number of correct responses	Pretest	Posttest
0	13.9	3.7
1	13.9	0
2	41.7	11.1
3	16.7	22.2
4	13.9	33.3
5	0	25.9
6	0	3.7

The percentages of participants who were not able to mention anything about a particular mathematician went down (see Table 3). For example, in Galois case, it went down from 100% (participants did not know anything about him) to 55.56%, which means that almost half of the participants were able to mention at least one piece of information about him after the treatment (completing the project and class presentations). There were similar improvements for almost all the other four mathematicians.

Table 3. Percentages of Participants Mentioning Anything about a Mathematician

	Mentioned at least one thing		Mentioned nothing (no answer)	
	Pre-test	Post-test	Pre-test	Post-test
Al-Khwarizmi	13.89	55.56	86.11	44.44
Ramanujan	16.67	40.74	83.33	59.26
Galois	0	44.44	100	55.56
Germain	13.89	62.96	86.11	37.04
Euler	5.56	25.93	94.44	74.07

In addition, Table 4, lists the pieces of information that the participants gave about each mathematician and it shows how student responses advanced in comparsion between the pre-treatment and post-treatment responses. As can be seen in Table 4, participants were able to list three different pieces of information about Galois in the posttest vs not listing any information at all in the pretest. In the case of Al-Khwarizmi, participants' listed responses increased from two to five. Similar results can be seen for the other mathematicians. This indicates that participants gained a new knowledge from the treatment (the historical projects) that expanded their horizons about mathematics diversity.

Table 4. Information Listed by the Participants about each Mathematician

	Pre-test	Post-test
Al-Khwarizmi	*Man, Middle East*	*Man, Middle East*, Father of Algebra, India, Spoke Arabic.
Ramanujan	*Woman, India, Vegetarian*	*Woman, India, Vegetarian*, Poor, Infnity.
Galois		Died early, Europe, Never completed a university.
Germain	*Female, Europe*	*Female, Europe*, Publised under a male name.
Euler	*Man, UK*	*Man, UK*, Europe, Blind, Deaf, Graph theory.

In regards to the last two open-ended questions: Which population(s) come to mind when you think of people who are best in math? and Which population(s) come to mind when you think of people who are not good in math? student's responses were categorized into the following seven categories: African, American (including USA), Asian (including China & Japan), Europe (including UK, France, Germany), Indian, Middle Eastern (including Arabs), and Other/No answer (including general categories such as Engineers, chemists, doctors, and journalists). The majority of students agreed in both the pre-test and post- test that Asian were the best at math while Americans were not.

Table 5. Percentages of Participants' Perception of Populations' Math Ability

	Best in math		Not good in math	
	Pretest	Posttest	Pretest	Posttest
African	5.6	0	5.6	3.7
American	0	0	27.8	33.3
Asian	44.4	40.7	0	0
Europe	13.9	7.4	5.6	7.4
Indian	11.1	22.2	0	0
Middle Eastern	5.6	7.4	0	0
Other-No answer	19.4	22.3	61.1	44.4

References

Bütüner, S. O. (2015). Impact of Using History of Mathematics on Students' Mathematics Attitude: A Meta-Analysis Study. *European Journal of Science and Mathematics Education*, *3* (4), 337-349. Retrieved from https://files.eric.ed.gov/fulltext/EJ1107871.pdf

Goktepe, S. & Ozdemir, A.S. (2013). An Example of Using History of Mathematics in Classes. *European Journal of Science and Mathematics Education*, *1* (3), 125-136. Retrieved from https://files.eric.ed.gov/fulltext/EJ1108226.pdf

Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of Personality and Social Psychology*, *102*(4), 700-717. DOI: https://doi.org/10.1037/a0026659

Hobson, N. (March, 2017). Six Ways Mathematics Instructors Can Support Diversity and Inclusion. AMS Blogs. Retrieved from https://blogs.ams.org/matheducation/2017/03/06/six-ways-mathematics-instructors-can-support-diversity-and-inclusion/

Irvine, Jeff. (2020). The History of Mathematics-Whose History Is It? *Gazette–Ontario Association for Mathematics*, *59* (1), 40–42.

National Council of Teachers of Mathematics (2000). *Principles and Standards for School Mathematics*. Reston, Va.: NCTM.

Panagiotou, E.N. (2011). Using History to Teach Mathematics: The Case of Logarithms. *Science & Education*, *20*, 1–35. Retrieved from https://doi.org/10.1007/s11191-010-9276-5

Panasuk, R. M. & Horton, L. B. (2013). Integrating History of Mathematics into the Classroom: Was Aristotle Wrong? *Journal of Curriculum and Teaching*, *2* (2), 37-46. Retrieved from https://files.eric.ed.gov/fulltext/EJ1157766.pdf

Wilson, P. S. & Chauvot, J. B. (Nov, 2000). WHO? HOW? WHAT? *Mathematics Teacher*, 00255769, *93* (8). Retrieved from https://cs.appstate.edu/~sjg/class/5125-375/2whohowwhat.html