Betsy Biernat
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Multicultural Education in Mathematics

 Teaching mathematics with a multicultural education perspective is a unique challenge because math is often viewed as a neutral field of study that is universal in its concepts. When teaching math in its purest form only of numbers, formulas, graphs, and theorems, which do not change no matter the context of the classroom one is in, it does seem difficult to infuse aspects of multicultural education into the subject. One may wonder how math can be used to create dialogue about diversity, when the subject matter seems so detached from issues of diversity, dialogue, and social justice. Other subjects such as language arts and history lend themselves more obviously to the incorporation of multicultural education, because literature, language, and history are filled with perspectives of multiple people, which can be showcased when the curriculum studied is affectively created. Math, on the other hand, does not seem to be told or represented through any perspective; it is something that simply exists as true. Yet, this assumption can be fatally challenged, and when it is, one can see that it is possible to teach mathematics from a multicultural perspective.
 The literature on multicultural education in math is very broad, and the strategies one can use to incorporate the philosophy and goals of multicultural education are numerous, but can be grouped in three ways. Specifically, one can teach mathematics from a social justice perspective, create an ethnomathematics curriculum, and create a culturally responsive curriculum by focusing on the social construction of the language of math. Teaching math from a social justice perspective means engaging students to investigate social justice issues, particularly ones that are relevant within their communities. Students would use math as a way to investigate, understand, and possibly come to a conclusion about these issues. Ethnomathematics embraces the idea that math is in fact *not* a neutral subject, but in fact has been developed and used by many different cultures throughout history in different and unique ways. Ethnomathematics teaches math concepts through the ways in which these concepts would have been used in different cultures. A culturally relevant pedagogy (as used here) builds math content through a framework that puts the language and underlying principles of math into culturally relevant terms for the specific student population. Teaching for social change, ethnomathematics, and culturally relevant pedagogy through language construction reflect three main ways in which a multicultural perspective can be incorporated into a math classroom.
 Before discussing the different strategies to create multicultural math curriculum/classroom, the myth that math is a neutral subject needs to be debunked. Numbers and their resulting manipulations in various fields of math seem to exist as abstract concepts that are simply true. Numbers themselves can exist in a completely noncontextual situation. When studying lines in the plane, for example, the context or world in which the problem is presented (if not an application problem) is simply the two-dimensional plane, which has no historical or present situational context; the two-dimensional plane is simply a mathematical concept. However, just because some pure math concepts can exist without any situational context, this does not mean that math is a neutral subject. Pure math, the abstract, ‘neutral’ tool set has been used by people and cultures in ways that are decidedly not neutral. The most obvious present example is the interpretation of statistical facts, which can be manipulated to seem like they suggest a variety of even contradictory things. In addition, math concepts have been developed and used in various ways by different cultures, so that these math concepts do exist within multiple and diverse contexts, which will be explored later.
 Thus, when one presents math as theoretical facts that are taken to be true, one also makes the choice not to present the complexities of how math is used by people and to what end. Ellsworth argues that people have positive or negative reactions to how things are presented based not only on how something is presented, but also on how something was not presented. One must always make a choice on how to present something out of a selection of possibilities, and choosing not to present something in a particular way can be just as significant as how one actually presents the subject (40). Ellsworth also says that what teachers present signals to students what s/he thinks it is possible for them to learn, or what is important for them to learn (41). In math, if teachers only present to students the bare bones of pure math problems, and not any ways in which math can be used to understand the world around them, perhaps this signals to students that they are not capable of understanding or entitled to knowing these tools to investigate their world. Thus, even if one presents pure math as a neutral subject, it cannot be because math exists in a world in which it is used for purposes that are not of a neutral nature. Also, no matter how one presents math concepts, it can never be neutral because a choice of how to present it, and consequently how not to present it, was made.
 One approach in teaching math through a multicultural lens is teaching math for social justice. This mainly takes the form of students learning how to use math concepts in order to investigate social justice issues around them, particular issues that may be relevant in their communities. This approach is also closely linked to the idea of teaching numeracy, that is, math literacy, which is becoming an increasing need in our society.
 Including social justice issues in one’s curriculum often seems the most doable in history or language arts classes, in which historical and present situations and contexts are often presented and can be viewed through a social justice lens. In math, how to investigate social justice issues seems unclear at first. However, math soon becomes an obvious choice for talking about social issues when one realizes that math is a tool used to investigate issues and happenings, so with the right curriculum, it is possible for students to develop math skills as tools to help them understand, question, analyze, and critique social situations around them. Eric Gutstein describes teaching math for social justice to be, in part, “reading the world through mathematics,” which he describes as using math to understand the inequities in different relations of power and access, as well as instances of discrimination, for example (45). Gutstein describes several activities he did with his middle school students in an urban, Latino school. These included projects such as looking at the distribution of wealth worldwide and analyzing SAT and ACT scores by race, gender, and social class (52).
 It is particularly important to note that these activities did not necessarily lead students to a ‘correct’ view of the world and its inequalities. Rather, data and the results of other mathematical analysis are interpreted in multiple ways by the students. This is important, as a piece of data can never be the end all explanation or evidence of something. It needs to first be interpreted and critiqued by the student, who must interpret what this number or process could be saying about the situation, and what factors are and are not taken into consideration when one does these certain calculations or gets this certain piece of data. Math is thus a particularly unique way to investigate social justice issues because it not only gets students thinking about social justice issues, but actually gives students tools with which they can investigate and these issues and develop critical thinking around them.
 Teaching math for social justice is closely linked to numeracy, or math literacy. The idea behind math literacy is that in our everyday lives, people are constantly inundated with numbers and statistics, yet most people do not have the math literacy or background to accurately interpret these numbers, or question how statistics are being used. In order to be critically informed citizens, it is necessary to have an understanding in not only basic mathematics, but how numbers work and can be manipulated. David Kung, in a lecture titled “Closer to Fair: Math and Social Justice,” describes two goals of math for social justice to be developing in students both the ability and the inclination to question numbers. Such skills are crucial when watching political debates, for example, or watching the news and all forms of advertisements that use numbers and statistics to sway the audience to feel or believe a certain way. Numbers often do not tell the whole story; they are not neutral. Students need to learn how to interpret numbers to not only understand what they do mean, but also what they do not mean. For example, Kung uses the example of mathematical correlations. Although two events may be highly correlated, this does not prove causation.
 John Allen Paulos, in his book *Innumeracy: Mathematical Illiteracy and It’s Consequences*, provides numerous examples of mathematical thinking that often involves only basic math skills, such as probability versus coincidence, the use of very large numbers, and expected values. *Innumeracy* is filled with examples of different ways in which numbers are presented to people, how people normally interpret them, and how, with a basic foundation in numeracy, one can affectively critique how the ‘facts’ are presented. Notice that this idea of math literacy requires a conception of math as being far from a neutral subject. Students must consider who is presenting these numerical facts and how they may be trying to spin the data. Students must also look at possible other ways to view this data, instead of just accepting it at face value. Numeracy requires students to also develop critical thinking about the ways in which numbers are presented. This is linked to math as social justice because it allows students to become critical thinkers about the numerical data that is constantly presented to them throughout the course of their day. It allows them students to think for themselves, rather than letting numbers automatically sway their perceptions.
 Yet, teaching math from a social justice perspective through teaching for social change and numerical literacy could potentially be developed so that students need to learn specific math skills before they can do the work of applying the math to issues that are of concern to them. This leads to the question of whether or not teaching math using a multicultural framework can only be done when talking about the application of math concepts. However, it turns out that one can teach the basic skills of math, its ‘pure’ concepts, in a way that is not neutral, and takes on a multicultural perspective. The following two sections will explore how one can teach pure mathematics using a multicultural perspective, specifically through using ethnomathematics and creating a curriculum is culturally responsive by exploring how math conventions are socially constructed.
 The term ethnomathematics used in this paper will refer to teaching mathematical concepts by presenting them through how different cultures have utilized and developed them. Ethnomathematics is another pedagogy that directly challenges the idea that math is a universal or neutral subject. Sleeter notes that when math is taught as a decontextualized subject, without any reference to history or culture, it reinforces the idea that math was a product of Western thinking (684), or, as Zaslavsky describes “dead white men” (29). However, math concepts have been developed by multiple cultures and used in a wide variety of ways. Ethnomathematics takes advantage of the rich history that math has within different cultures and provides students with the opportunity to explore math within different cultural contexts, instead of in a decontextualized pure math framework. Claudia Zaslavsky’s book *The Multicultural Math Classroom: Bringing in the World* presents many sample lesson plans and activities that teachers can use to present math topics from different cultural perspectives. For example, students may examine different numerical systems, such as Chinese rod numerals, the bars and dots system of the Mayas, Roman numerals, and our own Indo-Arabic numerical system, among others. Students can then review important numerical concepts such as place value, base, groupings, orderings to show value, and the concept of zero, by comparing these numerical systems amongst each other. For example, while our current Indo-Arabic numerical system, as well as the Chinese rods, are both base ten systems, the bars and dots system of the Maya is a base twenty numerical system. Other units in which Zaslavsky provides suggestions for ethnomathematic lessons include measurements and estimating, geometry and architecture, and recording and calculating data.
 One warning that Sleeter provides about developing an ethnomathematics lesson is that teachers need to have a strong knowledge about how math is or was used in other cultures, in order to avoid trivializing the people or contributions of the culture (692). The challenge that is always present in developing a multicultural lesson is that teachers do not want to inadvertently create a lesson that does not accurately or respectfully portray the cultures that are being learned about. A study done by Adams reveals how easy it may be to create an ethnomathematics lesson that does not accurately portray a particular culture. Adams gave an assignment to her pre-service elementary teachers to create a lesson that “reflected their understanding and value of different cultures and the way people in those cultures contributed to and participated in mathematics” (51). Most of these pre-service teachers created lessons that involved Native Americans, but did not actually address how the people of these cultures used or developed mathematical concepts. Instead, Native Americans were simply used as a backdrop to practice different mathematical skills. One teacher, for example, made a “Ten Little Indians” bulletin board, on which students matched a Native American cut-out marked with a number to the number word on canoes on the bulletin board (51). This is clearly problematic and does not meet the goal of presenting to the students how Native Americans uniquely developed or used mathematical concepts. Thus, it is essential that teachers do not simply add in figures from different cultures to their lessons, but take the time to learn and understand how math was used in the cultures. Despite this danger, if done correctly enthnomathematics can present math as being a contribution of many cultures and can show students in fact math is not neutral or universal, but has been developed and used in a variety of ways across many different cultures.
 A third way that math can be taught through a multicultural perspective is through making math curriculum culturally relevant through the explicit consideration of math conventions being a socially constructed language. While there are multiple ways in which the literature on multicultural mathematics suggests one can make a math classroom culturally relevant, such as through communication style, knowledge of the students and community, building trust and relationships with students, and constantly revising and reflecting on one’s teaching process (Bonner 29), these processes are not necessarily math-specific. However, one can expand the communication aspect to include something that is in fact unique to the math classroom, which is giving special consideration to math as a language, and teaching not only this language of math, but presenting it in such a way that students see that it is socially constructed, and giving them opportunities to construct it and innately understand the concepts behind the language themselves.
 Math is at its core a system of logic, with a specific language to explain the processes that happen when working within this logic system. While there are specific conventions to the language of math, one can see from the above discussion of ethnomathematics, that these conventions are not universal. Yet, teachers often teach math as if they are. Although revealing the conventional logic structure of math is crucial, Kress argues that there should also be room to question the conventionality of the system (49). The Algebra Project, started by Robert Moses in response to middle-school students’ lack of access to college preparatory mathematics, uniquely approaches the teaching of math as a socially constructed language.
 Algebra can be a difficult stepping stone for students on their way to higher math because they are being asked not only to think about what numbers represent, but also the question of “which way?” (Silva 51). For example, students are asked to perform different operations on equations and then asked to *undo* operations, for example, subtraction will ‘undo’ addition in an equation. However, this can be a conceptual leap for many students, so the Algebra Project uses a series of lessons that firsts gets students to connect to some physical event that they are already involved in which exemplifies the question of ‘which way’. For example, students may think about their experiences and knowledge of the public transportation system. Then, students draw pictures to represent the directionality of algebra concepts and are then asked to explain these concepts *in their own words* (Silva 380). So before students are taught the conventional language or representation of these concepts, they are first prompted to solidify their innate understanding of the concept by using the way of describing things that they are most comfortable with.
 In fact, the curriculum of the Algebra project is based on the idea that math and the language we use surrounding it is socially constructed, and it is necessary to illuminate this idea for students (Silva 382). The curriculum includes lessons to “demystify” the conventional language of math and highlights that these conventions are how scientists use mathematical language but leaves room for students to develop their own symbols or ways of representing these math concepts, to highlight its social construction (381). Thus the Algebra Project’s focus on the social construction of math conventions creates a curriculum that is culturally relevant in two ways: by first connecting math concepts to physical events and knowledge that students are familiar with when they enter the classroom, and by highlighting the fact that math conventions are something that is created by people and allowing them to explore the concepts first in their own words and allow them to explore the creation of their own conventions.
 The field of math at first seems to be incompatible with a multicultural perspective because, specifically pure math, seems universal and decontextualized. Applied math is more easily identified as a way in which a teacher can infuse a multicultural or social justice perspective into the curriculum. This is seen in the views of multicultural math education as teaching for social justice or for numeracy, where often statistics and data analysis are the subjects of study. However, concepts in pure math can also be taught from a multicultural perspective, specifically through ethnomathematics and by using strategies formed by The Algebra Project, in which students are taught to link their own physical experiences with math concepts and encouraged to view math conventions as socially constructed. Thus, even pure math can be culturally responsive and benefit from a multicultural perspective.

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