



Received: 26 June 2014
Accepted: 01 October 2014
Published: 20 October 2014

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TEACHER EDUCATION & DEVELOPMENT | RESEARCH ARTICLE

Defining culturally responsive teaching: The case of mathematics

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Abstract: Elementary classroom teachers in eight school districts across Colorado, United States, share the knowledge of their students' home and community life, define culturally responsive mathematics based on the children they instruct, and give examples of how students learn math through culture in their classrooms. Findings from two interviews, classroom observations, and student artifacts reveal that teachers have an intimate cultural knowledge of the students in their classrooms, define culturally responsive mathematical practices consistent with research, use culturally responsive mathematics teaching for authentic learning, and express a need for additional professional development and curriculum support for culturally responsive mathematics instruction. Culturally responsive mathematics is important in elementary classrooms because it allows students to make personal connections to mathematics content.

Subjects: Mathematics, Mathematics Education, Teacher Education & Training, Teachers & Teacher Education

Keywords: culturally responsive mathematics, teachers classroom practice, qualitative research, teacher development, elementary level math teaching

1. Introduction

This is initial research of observing and analyzing teaching practices in the classroom that make a connection between classroom mathematics and mathematics in the real world. This is where teachers intentionally create mathematics learning opportunities with an explicit connection to



ABOUT THE AUTHOR

Jenni L. Harding-DeKam is a former elementary school teacher and instructional technology specialist. She currently coordinates the Master's of Arts in Teaching: Elementary Education Licensure Program working with multiple Partner Schools across Colorado. She is passionate in several areas of education including mathematics instruction, quality instruction for children, improving teacher education, diversity in classrooms including ethnomathematics, culturally responsive classrooms, STEM learning for English Learners, doctoral advising, and doctoral ethics. She had been awarded *Outstanding Advisor Award* in 2012 and 2008 by the College of Education and Behavioral Sciences.

PUBLIC INTEREST STATEMENT

United States elementary classroom teachers of children (5–11 years old) bring in the cultural background of their students in order to teach mathematics in ways children can understand. These ways include: (1) food for recipes (fractions, measurements, mathematics teaching connections, and shapes), (2) diverse languages encouraged in the classroom (solving of math problems, learning math vocabulary, and parents participating in math learning), and (3) cultural community connections (beads in hair connection to patterns, farm unit to teach area and perimeter, and money currency from other countries). These teachers for urban, rural, and suburban communities bring culture into the classroom in order to make explicit mathematical connections from what the children know at home to what is being taught in school.

students' background knowledge and cultural experiences. This is the account of eight elementary classroom teachers in eight school districts across Colorado who have shared the knowledge of their students' home and community life, defined culturally responsive mathematics based on the children they instruct, and given examples of how students learn math through culture in their classrooms. A narrative of each school is created to provide a physical description of the school (inside and out), illustrate how mathematics is displayed around the classroom, show how the environment is conducive to the culture of the students represented in the classroom, and provides a description of the teacher. The research question addressed is: How can cultural knowledge be incorporated into the learning and teaching of mathematics in United States elementary classrooms?

2. Literature review

Students come into the classroom with knowledge and understanding filtered through their cultural lens. When teachers access this cultural lens, mathematics can be comprehended based on the prior knowledge the student brings with them into the classroom. This literature review will define culture, cultural responsive mathematics, and how culture may be used in the mathematics classroom.

Culture provides a natural means for students to access a framework for conceptual understanding in mathematics. "Human development is a cultural process. As a biological species, humans are defined in terms of our cultural participation" (Rogoff, 2003, p. 3). Each student's cultural reference, worldview, and history are unique to the experiences this child has encountered. Furthermore, these experiences can be incorporated into the classroom to help students learn mathematics. "Culture determines how children will view the world, where they will focus their attention, and how they will value learning" (Tileston & Darling, 2008, p. 40). Researchers now recognize mathematics as a "cultural product ... with all of its complexities and contestations ... an important aspect of mathematics education" (Presmeg, 2007, p. 435).

This structure of teaching mathematics through culture is an awareness that integrates the prior knowledge of students in a way that builds upon what they already know leading to mathematical understanding. Culturally responsive teaching, "encompasses curriculum content, learning context, classroom climate, student-teacher relationships, instructional techniques, classroom management, and performance assessment" (Gay, 2010, p. 33). Nuri Robins, Lindsey, Lindsey, and Terrell (2006) posit to be a culturally proficient teacher one needs to teach "in a manner that builds understanding of the teacher's and learner's world that engenders a value of diversity" (p. IX). The National Council of Teachers of Mathematics (2005) takes this one step further by sanctioning that "... all students need the opportunity to learn challenging mathematics from a well qualified teacher who will make connections to the background, needs, and cultures of all learners." Culturally responsive teaching is necessary for all students, not just particular groups.

Culture should be the approach used to teach mathematics in the elementary classroom. This is "contrary to the cultural deficit paradigm ... recognizing the knowledge, skills, and rich cultural experience that students from diverse backgrounds bring to school" (Taylor & Sobel, 2011, p. 22). This is where culture "embodies a professional, political, cultural, ethical, and ideological disposition that supersedes mundane teaching acts" (Howard, 2010, p. 67). Furthermore, Gay (2010) explains "culturally responsive teaching is a means for unleashing the higher learning potentials of ethnically diverse students by simultaneously cultivating their academic and psychosocial abilities" (p. 21). Incorporating culture into mathematics instruction permeates all areas of teaching and learning including: dialog and interaction. This paper investigates how culturally responsive teaching is being utilized in these eight elementary mathematics classroom.

3. Methodology

Eight elementary teachers from across the state of Colorado were interviewed twice for this article on culturally responsive mathematics teaching. There were two kindergarten (5-6 year old) teachers, two first grade (6-7 year old) teachers, two third (8-9 year old) grade teachers, and two

fourth grade (9–10 year old) teachers. These participants are dedicated educators who make mathematical connections for the children in their classrooms. The combined years of teaching are 62 years with a range from 2 to 19. There are two teachers with bachelor's degrees, five teachers with master's degrees (one in English as a Second Language), and one teacher with a doctorate degree.

This was a purposeful sample of elementary teachers who were known by peers, principals, parents, and faculty to be using culturally responsive mathematics teaching; furthermore, this instruction was making a difference in content understanding for diverse students in these classrooms. Elementary level teachers were chosen because of their students' recent ties to learning within their homes and communities prior to entering school and their level of cognitive development. These teachers teach a variety of students in public and private school classrooms. Classroom sizes averaged 20 students. Teachers self-identified their classroom diversity as cultural (seven schools), English learners (seven schools), ethnic (six schools), socioeconomics (four schools), and religious (two schools). The free and reduced lunch count average was 50% with a range from 0 to 90.

There were two interviews conducted using a semi-structured protocol with each teacher: one interview was prior to the teaching of a culturally relevant mathematics lesson and one interview was subsequent to the teaching on the same day the lesson was taught in the classroom. Interviews averaged 15 min in length. This is a case study design wherein holistic portrayals of educators who use culturally responsive teaching in their mathematics teaching were researched (Creswell, 2009; Merriam, 1998; Yin, 2009). Both interviews were audiotaped and transcribed verbatim (Creswell, 2009). The analysis was performed at two levels: within each case and across the cases (Yin, 2009) using INVIVO, qualitative software for data storage, coding, and theme development. Steps in qualitative analysis included: (1) preliminary exploration of the data by reading the transcriptions and memo writing (Charmaz, 2006); (2) the coding processes used for first cycle coding were attribute coding, value coding, and holistic coding; furthermore, the coding process used for the second cycle coding was pattern coding (Saldana, 2009); (3) codes were used to develop themes at two levels: within each case and across the cases (Yin, 2009); and (4) constructing a case study narrative composed of descriptions and themes. The data collection took place from September to November 2012.

Credibility of findings was secured by triangulating the following different forms of data: (1) two interviews (before and after lesson); (2) observation and video recording of lesson; (3) student math work artifacts; (4) rich and thick description of the cases; and (5) member checking through asking the teachers to review and respond to the transcripts, school narratives, and final manuscript (Charmaz, 2006; Mears, 2009; Rubin & Rubin, 2005).

4. Findings

This paper focuses on two semi-structured interviews where the teachers define culturally responsive mathematics in their classroom, give examples of learning math through culture, and elucidate knowledge of their student's home and community life. These questions were directly asked in order to understand the nuances present in the teaching pedagogy that are unseen by an observer. Bringing culture into mathematics instruction is a fairly new practice because previously numbers were seen as a culture free subject (D'Ambrosio, 2002; Gay, 2009). The teachers were located in eight school districts where the following classroom narratives were created: Urban Elementary School, Private Christian Academy, Mountain Elementary School, Modern Agricultural Elementary School, International Baccalaureate Elementary School, Community Elementary School, Residential/Retail Elementary School, and Small Town Elementary School (these are all pseudonyms).

4.1. Urban Elementary School

The first school, Urban Elementary School, is located in the city and draws children living in apartment buildings, the Mobile Home Park, townhomes, condos, and small houses. Many yards are unkempt with weeds, dirt, and children's toys completing the landscapes. The school itself is an

older brown-brick building with orange doors and only a few windows. There are two pine trees, grass lawn, and a flagpole out front. The playground consists of a blacktop with tetherball poles, four-squares, basketball hoops, metal climbing structures, swings, a new plastic playground structure, and a weed, grass, and dirt baseball field. The playground can be accessed from all around the school with openings in the fence; rules for playground use are posted and it is made clear “trespasses and violators subject to arrest and prosecution.”

As you enter the school, the sofa, loveseat, coffee tables, chairs, and a red Persian rug give the feeling of being in someone’s home. There are many welcome signs in both English and Spanish. Posters are targeting parents to get involved in their child’s learning: these students are “college bound” and a signed poster by parents agreeing to “join us on our journey to your child’s successful future: attendance, homework and read to help your child succeed.” This full-day kindergarten classroom has students grouped in threes at trapezoid tables facing the interactive whiteboard. All students wear uniforms to school. Mathematics is displayed around the room with a calendar (days in school – hundreds, tens, and ones), shapes and names of the shapes, numbers with dots and names 1–20, 10 apples student assignment, and student-height math manipulative and game shelves. The environment is conducive to the culture of the students represented in the classroom with a friendship pizza poster (where each child drew a picture of what they bring to their classroom), counting in Spanish and English, relatable technology items like Batman and Dora, and a world globe.

Mrs Roten has a musical voice as she chants and sings mathematical concepts with her students to help them learn greater than, less than, and equal. She models being nice to your friends because we are all friends in this kindergarten class. She gives clear directions so students know what is expected of them for each activity.

4.1.1. Knowledge of student’s home and community life

We have lot of Hispanics and African Americans, and English is not their first language so I really need to watch that. Some of my friends [students] have a really rough home life. I have four Dads this year, raising girls, and Mom is not in the picture for different reasons. A lot of socioeconomics, definitely lower for them. To be able to do their homework, I actually supplied their tools that they needed: the crayons, the pencils, the markers. And you know, we have this expectation for them to complete this stuff, and you’ve got to make sure they have the tools to do it. And for those families there are avenues, just the unfortunate thing is a lot of them are too proud or they won’t take advantage of it. (Mrs Roten)

4.1.2. Defining of culturally responsive mathematics

Definitely with a demographic like we have here you need to know where they [the students] are coming from and what they get. All my teaching career has been down here in this district, so the biggest thing is I have had a lot of “aha” moments when I have sat up there and was like they have no idea what I’m talking about. So just really paying attention to that and making sure they are grasping what I’m taking about and if not, stop, and give them that background knowledge that they need. (Mrs Roten)

4.1.3. Example of students learning math through culture

We had a one hundreds day so we were stringing beads and we were making groups of ten. But you know, a lot of m.y girls they have beads in their hair and they know beads. So, we got some really cool beads that we were doing and people were making the connection, ah look, there just like the ones in so and so’s hair. It’s a culture thing as much as a background thing, just of what they know. (Mrs Roten)

Mrs Roten incorporates cultural knowledge into mathematics learning and teaching by prioritizing the creation of background knowledge for students, remembering English is not the first language for many students, and sending classroom supplies home for students to complete their homework. Mrs Roten's cultural example is the connection of mathematics place value concepts to the hair beads of her students.

4.2. Private Christian Academy

The second school, Private Christian Academy, is housed in an industrial area where students must be driven to school or ride the bus because there are not any residential homes around the school. The building itself is not flashy, but looks modern with two picnic tables and a flag out front. There is newer looking plastic playground equipment fenced in at the back of the school with basketball hoops and tetherball available in the parking lot. Past the construction filled parking lot where trestles are being constructed is a large grass area where a soccer field is set-up.

The school environment was inviting with comfortable leather furniture in a salon like atmosphere. This half-day kindergarten classroom has colorful items on the walls, many bookcases with children's literature, and student cubbies. Three tables of student groupings were set up with six students at each table and a large carpet world map with world flags as a border that had students' names taped to each flag creating a permanent spot for them to stand around the rectangle. Mathematics is displayed around the room with a calendar, hundreds chart, coin money (quarter, penny, nickel, and dime), and a plastic analog clock. The environment is conducive to the culture of the students represented in the classroom with the Christian flag, Bible, religious children's literature, Bible verses, and a bulletin board with farm animals and vocabulary that reads: We Thank God for Farm Animals.

Mrs Randazzo is full of energy as she guides her students through their mathematics learning opportunities of more, less, and plenty. Her relationship with her students is one of caring, loving, joy, and respect. She cares about the whole child and teaches both moral and academic ideas to her kindergarteners.

4.2.1. Knowledge of student's home and community life

The majority have very active, involved parents with enriched lives. They go to museums, they are in athletic sports programs, they have church communities. There are some that have more struggles and those are harder because they are in the minority. One student from a struggling family and she just needs some extra love and support. Well educated, usually one family incomes that are affluent family incomes. Extended families are important and larger families with many siblings. We've had several grandparents come in. Larger families-I only have three that are only children, so they have siblings ... rich in that way. (Mrs Randazzo)

4.2.2. Defining of culturally responsive mathematics

It is essential because putting "math in a box" that is separate from culture is making it a distant and abstract tool for a few instead of a way that they [students] can be mathematical like God created them to be. So, I really like in this setting that everyone is a mathematician because our creator was a mathematician. God is the creator of mathematical knowledge, and his mandate to us is to be good stewards of his creation. We use mathematics to fulfill his Biblical mandates, so I would say just that constant reminder of why math works, how it works, why we study it, how we study it, how we use it. Our responsibility, kind of that call to action, mathematical piece comes from biblical worldview. (Mrs Randazzo)

4.2.3. *Example of students learning math through culture*

... it's mostly been arranged cultural learning versus authentic cultural learning. During lunch, some of them [students], and snack time, an example would be when the mom's cut their sandwiches into shapes. They had a cute conversation about the shapes of their food, early on in the year. So, that was bringing in their own food and the textures and the comparison of the shapes 'cause of a mom cutting a sandwich like a dolphin, and then there were other shapes, too. (Mrs Randazzo)

Mrs Randazzo incorporates cultural knowledge into mathematics teaching and learning through the awareness her students have enriched lives because of extended family and church community support, employing the biblical worldview philosophy where God created math, and viewing students as mathematicians. Mrs Randazzo's cultural example is the connection of geometric mathematics with the shapes created with sandwiches.

4.3. **Mountain Elementary School**

The third school, Mountain Elementary School, is situated on a hill with mountain views all around it and one side has a lake view. The school is in a neighborhood where residences (condos, townhomes, and a few single homes) look like log cabins with well-kept yards. A few businesses are off of the side street from the school, but each of them looks like residences. The high school, middle school, and elementary school all share the same geographic area. The school looks like a newer building nestled in pine trees with a flagpole and a Statue of Liberty in front of the school as well as park benches and a rock seating area to the right. There are two playgrounds: the wooden and metal structure below the school reminds one of a castle fort and the plastic structure, grass field, and rock wall are above the school.

There is a large welcome sign as you enter the building with a black and yellow divider that directs visitors into the office to check in before you continue down the hallway. This large first-grade classroom has plenty of unique areas for students including: a reading corner, computer corner, teacher corner with kidney table, and a carpet area. The desks are set-up in groups of five with four students in each group. Mathematics is displayed around the room with a number grid, coins (pictures, names, and amounts), calendar, graphing question of the day chart, children's math work display, frog rulers hung on white board, math manipulatives on a lower shelf where students may access them, and a number line. The environment is conducive to the culture of the students represented in the classroom with Spanish children's books, maps of the world, globe, and a world mobile where children of many different ethnic groups are represented.

Ms Axtell is well organized as she guides her students through the mathematics learning opportunities of money currency from around the world. She knows her students personally and has good eye contact while she listens to them.

4.3.1. *Knowledge of student's home and community life*

This is a very supportive community in terms of the kids. I know the ones [students] that are in soccer, the ones that do dance, and a lot of those different activities. Just being a small town, I guess, I see them around. I see them at the thrift stores in the weekends. I think 30% are on free and reduced lunch and it might even be higher than that. I have six ELL's [English Language Learners] in my class of twenty. So a little less than a third are ELL. So it's surprisingly poor for the town, I mean being a resort mountain town. The young families here are lower on the income level, and that's pretty representative for the class. Relatively low income. (Ms Axtell)

4.3.2. *Defining of culturally responsive mathematics*

I think bringing culture into anything is good. I've been talking to my other first grade teachers ... and we talk about our social studies curriculum and none of us really use it a whole lot because we feel like, especially at this age, a lot of the social studies is getting along with each other and integrated into other things. So, we feel like the culturally responsive teaching and getting all that stuff into other subjects is more beneficial than following our social studies curriculum. My kids that are from different backgrounds, love it if I say words in Spanish or ask them what certain words mean. I think it helps engage them when I bring their cultural backgrounds into it. (Ms Axtell)

4.3.3. *Example of students learning math through culture*

In calendar, we do the days of the week in English and Spanish. We do a lot of things just bilingual, like counting, things like that, in Spanish as well. Last year I had some of the Spanish-speaking parents that were able to come in and help out and do things related to math. Birthdays we celebrate and sing in Spanish and include all the families in different cultures that way. (Ms Axtell)

Ms Axtell incorporates cultural knowledge into mathematics learning and teaching through understanding student interest outside of the classroom like soccer and dance, inviting families to become part of the classroom community, and acknowledging the lower socioeconomics of her students. Ms Axtell's cultural example is speaking Spanish to enhance mathematics academic vocabulary for the third of her class who are English Language Learners.

4.4. *Modern Agricultural Elementary School*

The fourth school, Modern Agricultural Elementary School, is a brand new contemporary building with metal, bricks, and large windows. There are flowering plants, bushes, and newly planted trees along the sidewalk. The walkway into the building has a flagpole and three benches lining both sides with a cement star-design that reads: Your Journey Starts Here! The school is located on two sides by cornfields and newly developed natural colored homes on the other two sides. The new playground has a double-sized grass field with soccer goals set-up, swings, plastic playground structure, and basketball hoops on a blacktop. The playground is hidden and protected behind the school and parking lot.

Actual flags from all over the world with country information plaques next to them hang in the school's hallways. This first grade classroom is vivid with learning opportunities available in every corner of the classroom: reading corner, seating on the carpet, and group-directed teaching. The desks are organized in five table groups with four to five students in each group. Mathematics is displayed around the classroom with a number corner (days in school, odd or even, temperature), all the ways to create the number 28 poster, calendar, how many days in school (straw bundles—hundreds, tens, and ones), number line (0–100), tubs with math manipulatives, numbers with objects 1–10, tooth graph, math problem grid, and math objective on the board. The environment is conducive to the culture of the students represented in the classroom with words in English and Spanish, multicultural children's literature, map of the world, character attributes (creativity, independence, and integrity), and three-column poster (The Keep Quilt Traditions, School Traditions, and Our Family Traditions—each child has one represented by their name).

Mrs Lyons is vibrant and enthusiastic as she guides her students through their mathematics learning opportunities of quilt patterns and counting by fives. Her relationship to her students is one of caring deeply by knowing her students academically and socially. She takes the time to listen to her first-grade students in order to understand them and guide instruction.

4.4.1. Knowledge of student's home and community life

We have like a small town background in here because this is a farming community. Its close knit, parents in this community are very vocal about religious beliefs and it's a very church going community. We just did a unit on who we are that involved kids' family traditions that they all shared and they brought "Me Bags" in. We learned about their likes, their dislikes, what they like to read, so we basically spent from beginning of school 'til now really learning about our culture and who we are. So I feel like I have a really good idea of where kids are coming from in here and where their families are coming from. (Mrs Lyons)

4.4.2. Defining of culturally responsive mathematics

It's a very new concept to me, I think that naturally the way that I teach fits in to that category because I try to tie all learning to students prior knowledge and what they know. So, I feel like it's something I do intuitively, but other than that I don't know that I've ever been trained in it or really heard that much about it prior to maybe my last year in the master's program. (Mrs Lyons)

4.4.3. Example of students learning math through culture

We do in fact a huge farm unit in math to tie to that to teach them the economic principles. So we actually build our own farms, we plot the land, we do area and perimeter, and deal with fake money. Buying stuff and buying crops and putting animals on our farms and then we do like a thing where we sell what our goods are to tie into the community. Every year I've got a parent that brings in a small petting zoo of farm animals from around here for us to learn about it and have that as an experience so we tie into that a lot, too. (Mrs Lyons)

Mrs Lyons incorporates cultural knowledge into mathematics teaching and learning through recognizing the close knit farming community with religious underpinnings and creating units of instruction that connect to her students' prior knowledge. Mrs Lyons's cultural example is having the students create their own farm focusing on the mathematics of area, perimeter, and money with a connection to economics.

4.5. International Baccalaureate Elementary School

The fifth school, International Baccalaureate Elementary School, is located in a residential city area surrounded by large homes with oversized landscaped yards. The red-brick school building has a rounded entry way with two story windows. The well-manicured lawn has two picnic tables on each side of the entry way as well as bicycle filled racks with bikes and helmets. Out front is a flagpole, a wooden pole that reads, "May Peace Prevail on Earth" in several languages, and Energy Star plaques from 2002 to 2010. The playground behind the school has mulch under a large plastic playground structure, three smaller playground structures, well-kept grass field with chalk to mark off a soccer field, and nine basketball hoops on the blacktop.

The atmosphere of the school is inviting. There is a mural, world map with dots on each place where students are from as well as a key identifying which country students are from geographically, a large textile art piece, five-sided bench seat with children from the world fabric pattern, bar like table with chairs and a TV, Colorado and American Flags, pictures of children for each month who are "international citizens," large Parent Teacher Organization News bulletin board with information table, school staff photos, and items labeled in Spanish and English. This third-grade classroom is in a modular building, called the Island, behind the school. The walls and ceiling are covered with learning posters and student work in this cozy classroom. Five students sit at the four table groups. Mathematics is displayed around the room with a number line (-15 to +115), manipulative cabinet with every type of manipulative, 100 number grid chart, lunch graph, and nametags (ruler in centimeters and inches; fraction examples with picture, fraction, and decimal—1/1, 1/2, 1/3,

1/4, 1/8, 1/10, place value from ten thousandths to hundred millions). The environment is conducive to the culture of the students represented in the classroom with Cultures of Our Class bulletin board and three world globes.

Mrs Kind smiles often at her students and demonstrates endless patience when she teaches them measurement (length, width, height, difference, circumference, and diameter) and weight concepts.

4.5.1. Knowledge of student's home and community life

A range of socioeconomic status from a medical doctor, but they are separated, divorced and then I've got ... yeah, you know, my other extreme where, we don't even have a car so we're taking the public bus to get here because they're choosing our school. The mom that helped with math she's from South Africa although they've been here for a long time. So I've got two Malaysia, two from Mexico, Saudi Arabia ... and Canada ... and one Native American. (Mrs Kind)

4.5.2. Defining of culturally responsive mathematics

So our first inquiry unit is on culture, so we talk about the different cultures, what culture is, we focus on traditions, customs, beliefs and values, and then I'll also throw in heritage. We talk about all those words one at a time because they're big words and we sent them home ... wrote the little definition of what it was, kind of gave some examples that was homework, and they were supposed to talk about with their families: traditions their family has. And then we gave them all just a brown lunch bag and they were supposed to choose something whether it be an actual item or a picture or drawing or a photo or whatever of a tradition that went into the bag with a little note card explaining the tradition. (Mrs Kind)

4.5.3. Example of students learning math through culture

You know, like [students] from Malaysia, who when we were talking about measurement we were talking about the US customary verses the metric and how much of the world uses metric ... I'm like yep and we talk about how, you know, we have to learn both here and ... with math it's pretty universal, and I think the kiddos that do struggle with language like math because it's something they can do. (Mrs Kind)

Mrs Kind incorporates cultural knowledge into mathematics learning and teaching by valuing her students' diverse cultural backgrounds, accommodating the mixed socioeconomic levels, and teaching an inquiry unit on culture (traditions, customs, beliefs, values, and heritage). Mrs Kind's cultural example is the universal language of mathematics present in all of her students' cultures including the example of the metric system.

4.6. Community Elementary School

The sixth school, Community Elementary School, is located in a politically active residential area in the city with nice sized yards that contain numerous election signs. The school is a one story red brick building with a pillar walkway sitting on a rolling hill with forest like trees around the school placed on green grass. On the building surrounded by copious American flags it reads, "Nationally Recognized," "School of Excellence," and "Veterans and Service Men and Women We Thank You"! Signs announce: "Area is Protected by the Neighborhood Watch" and "Drug Free Zone With Minimum of 5 Years in Prison." The park like playground consists of three large plastic playground structures, two tennis courts, two blacktops with basketball hoops, soccer field, and open space with mature trees and benches.

One pushes a call button to get into the school with these signs: "warning video surveillance" and "photo identification is mandatory when checking students out." Inside the entrance is a welcome

sign to come see the schools success, a world map rug on the floor, clocks with different times (Buenos Aires, London, Cairo, Moscow, and Tokyo), student sized bronze statues (girl and boy learning), and Blue Ribbon School plaque. A leather loveseat, four chairs, and two coffee tables sit on the edges of the office. The third-grade classroom is in a modular building behind the school called the “club house.” Teacher-created educational posters are displayed around the room to help students with content learning. There are separate areas for computers, a listening center, round teacher instructional table, and group space on the world map rug. Students sit at four tables with four or five at each table and two students at individual desks. Mathematics is displayed around the room with a number line (–13 to +103), place value poster in numbers (ten-thousand to thousandths) and base-ten blocks, number grid poster (–9 to +110), math vocabulary, number grid chart movement tips, math agenda and objective, shelf of manipulatives, math literature books, times around the clock, and name tags (100 chart, addition chart, and 3D shapes). The environment is conducive to the culture of the students represented in the classroom with RISE (Respect/responsibility, Independence, Safety, and Equity) and classroom pledge to care about each other signed by the students.

Ms Ness, an Asian American teacher, creates comfortable mathematics discourse in the classroom where students are eager to participate in their mathematics learning of decimal points to the thousandths place. She scaffolds her math curriculum to meet the needs of all diverse students in the classroom. These third graders attend a non-traditional school year schedule at this year round school.

4.6.1. Knowledge of student’s home and community life

I have four students who go to Arabic school on the weekends, one of my students is from Africa, and eight Spanish speaking students. Most of the parents of my students work like three jobs. We just had conferences and I only had nine show up for their original conference out of nineteen. A lot of our kids have brothers and sisters in other grades, so they have lots of family. A lot of our kids live with each other but they’re not related, so ... I think that their home life is very stressful. We do have Latino pass and Black pass, for the African American community and the Latino community [parent organizations]. So, they have their own groups for children succeeding since they are at a higher academic risk. (Ms Ness)

4.6.2. Defining of culturally responsive mathematics

I think it plays more into the math curriculum but, um, like across all cultures, you add and subtract the same way, it’s just, the vocabulary ... had to break it into smaller chunks. So I think we’ve done a really good job trying to simplify it because I have even noticed when we do the Smart Board and then we go to the journal, the journal sometimes is harder: we just use an easier vocabulary. (Ms Ness)

4.6.3. Example of students learning math through culture

I love when they all talk to each other in their Native language because I just think it’s so cute in a way that they feel comfortable bringing their culture in and we talked about, Eid, because we had a lot of students out for that. I think, you know again, one of the hardest things with teaching [our curriculum] is its made for an American culture, and none of our students have that. So, we’ll use like enchiladas, or we have them put things that are important to them like pistachios, things like that, so it’s not always like cats and dogs and cars. (Ms Ness)

Ms Ness incorporates cultural knowledge into mathematics teaching and learning by knowing her families work multiple jobs while living with each other, understanding the school support systems of the Arabic school and parent organizations, and breaking apart mathematics academic vocabulary

making it comprehensible. Ms Ness' cultural example is allowing students to discuss mathematics in their native language for understanding and by using mathematics food examples of what they are familiar with at home.

4.7. Residential/Retail Elementary School

The seventh school, Residential/Retail Elementary School, is located in a residential/retail area with businesses (strip mall, fast food, gas station, tire store, and restaurant) on one side, wooden fence lined street with well-maintained homes on small lots, and a magnet school on the other side of the school. The school itself is a traditional, one-story, brown-brick building with a two-story bell and a flagpole out front. There are portable buildings behind the school for additional classrooms. The yard is surrounded by grass with oak trees on both sides of the school and one pine tree on each side. The playground behind the school consists of an oversized grass field, plastic structure, metal structure, blacktop with basketball courts, and swings.

The school environment is welcoming with block letters on the building stating WELCOME TO OUR SCHOOL. Upon entering the school, there is a spacious entryway displaying assorted furniture: two round tables with chairs, a long cushioned bench seat, and an antique chair. The space is completed with a large fish tank and student-run post office. This fourth-grade classroom has every inch of wall and cabinet space covered with posters, learning materials, pictures, and expectations. Desks are in a horseshoe pattern with one horseshoe inside the other horseshoe. A purple carpet is in the middle of the horseshoe for student seating on the floor and a library area with pillows is outside the horseshoe. Mathematics is displayed around the room with a number line (-35 to 36), how to use numbers strategies posters, math vocabulary word wall (definition and pictorial representation), math and science non-fiction book tub, basket of math manipulatives, nametag ruler (inches and centimeters), and math posters: fractions, multiplication tables (1-12), and geometric shapes. The environment is conducive to the culture of the students represented in the classroom with rules and health information in English and Spanish.

Ms Walker is technologically savvy as she uses her interactive whiteboard to guide students through their mathematics learning opportunities of function machines by generating mathematical rules. She kneels down on the floor to be at the student level when working with groups. These fourth-grade students are in a safe environment where they are comfortable to say if they do or do not understand the math concepts.

4.7.1. Knowledge of student's home and community life

Most of my kids are Spanish speakers who have come from Mexico. And again, having worked with Mexicans for a year and a half, I didn't just get to know the country but even the different states. Like I could tell you the difference between someone from Puebla, Mexico as opposed to Chihuahua. I think I know a little bit about the culture and a little bit about what's important to the families and I mean it's not totally different than the values I was raised with. But it's just a little bit different in traditions and the way things are taught and brought up in their families. (Ms Walker)

4.7.2. Defining of culturally responsive mathematics

I think it's very important having learned Spanish. You know I learned it on the streets, so I know how frustrating it is to hear things and understand things and know that I'm smart in English, but can't express myself in Spanish. I know how frustrating it is to learn a language and I feel like math is one of those subjects where it doesn't matter what language you speak or where you come from. It's something that you can understand and it's something that a person can do. And so I want to make sure that these kids- and I think that's why I'm so heavy on the vocabulary. 'Cause if they understand what these concepts are in English and if they have that exposure and if they understand what the questions are asking:

numbers are universal. These kids can take these numbers and go once they understand what they're supposed to do with them. So I think definitely sensitive to language issues. (Ms Walker)

4.7.3. *Example of students learning math through culture*

The biggest thing I can think of is recipes. And again, I'll pull recipes from Mexico. A big thing in fourth grade is fractions. So as soon as we get to fractions I will be pulling recipes that they'll be use to. Last year I gave them recipes from Brazil, from Puerto Rico. I gave them a stir fry recipe (laughs) so all sorts of different recipes from around the world, so again, culturally for them it's comfortable, but then also, some other things that might be a little more unique. That's just one example of ways that I might try to pull in that culture into mathematics because food is a HUGE indicator of culture. (Ms Walker)

Ms Walker incorporates cultural knowledge into mathematics learning and teaching by knowing the details about her Mexican students (values, tradition, and culture), teaching in English and Spanish, and focusing on academic vocabulary because numbers are universal. Ms Walker's cultural example is the connection of learning fractions through cultural recipes defining food as an indicator of culture.

4.8. *Small Town Elementary School*

The eighth school, Small Town Elementary School, is located in a community with less than 2,000 people. The school is surrounded by a church, middle school, and an area for small homes. The school itself is a red and brown brick building with windows across the whole building and blue doors. In front, there are 10 trees, well-kept grass, and a flagpole. The playground consists of two plastic playground structures, swings, special needs swings, metal slide, metal climbing structure, blacktop with two basketball hoops, and a grass field connected to a dirt baseball field connected to a football field connected to two tennis courts.

One is greeted with a partition across the hallway that has a welcome sign and a poster: "Thank you for keeping your school safe! Please sign in at the office" as you walk into the building. In front of the partition are two blue chairs and an end table. The office continues the blue chair décor with a coffee table, bookshelf filled with books, fall decorations, colorful pumpkins window treatments, and parent information in Spanish and English. This fourth-grade classroom is spacious with five tables with four children at each table. There are six computers in the classroom for student use, a round table for teacher directed scaffolding, a teacher's desk, and a document camera. Mathematics is displayed around the room with a number line (0–100), extra large protractor, math manipulatives on the table, math vocabulary posters for area and perimeter (with chant words, numbers, and pictures), and a math learning objective on the board: I can solve for area and perimeter. The environment is conducive to the culture of the students represented in the classroom with pictures of the students, student created rules (say nice things to be respectful, be responsible for our things, be safe, listen to other when they are speaking), and a globe.

Mrs Shaffer, English as a Second Language certified educator, has a soothing demeanor with high expectations for her students to understand the concepts of area and perimeter as she guides them through a gradual release pedagogy of learning. The students are active participants where they are involved in mathematical discourse in pairs and groups with connections to their lives.

4.8.1. *Knowledge of student's home and community life*

... fifty percent [of students] are white and are from around here, and fifty percent are second generation from Mexico, so they were born here but they have a lot of family back in Mexico that they still visit or know about. Since I am ESL certified I have four or five in my classroom. Some parents are supportive, and I know for some kids they go home to no one,

so they have to do all the work on their own. Community life involves sports, so they get involved, but it's usually the families whose parents are home to give them that support. (Mrs Shaffer)

4.8.2. *Defining of culturally responsive mathematics*

I think it's important. I have a hard time always knowing how to bring it in I guess, especially in math knowing what part of their culture. I mean a lot of times if I know a word in Spanish I'll try to bring that in and I'll have it connect them in another way but with regards to where they're from originally like Mexico or other places, I could do better at that. I think that's something that I don't totally understanding what that concept means with math I guess. (Mrs Shaffer)

4.8.3. *Example of students learning math through culture*

We do nutrition on Fridays and we learn about different foods from different cultures like how to make salsa and how to make ... this hot punch that's like a Mexican punch. We do talk about different measurements of using like half cup and that kind of stuff, teaspoons, so I guess in that sense we do bring that in. We do a lot of talking in partners because I know for ELL kids talking is really important for them to practice all the time and being able to hear someone else say it. Then they can re-say it, so we do a lot with partners, we do a lot of discussion at tables, and ... just making it not so quiet (laughs) 'cause I know a lot of classrooms can vary- everyone's working on their own, nobody's talking, and to me that's not what kids do. So, to make it more of a community and collaborative, that's what my goal is. (Mrs Shaffer)

Mrs Shaffer incorporates cultural knowledge into mathematics teaching and learning through knowing her students (from community and from Mexico), understanding community life involves sports, and allowing students the space to talk and listen to mathematics language through discussions. Mrs Schaffer's cultural example is the connection of mathematics measurement and fractions to cultural food.

4.9. *Culturally responsive mathematics defined*

These teachers defined culturally responsive mathematics in ways that aligned to their philosophies, worldviews, and classroom experiences working with diverse children. The following five themes emerged through the multilayers of coding in the defining of culturally responsive mathematics: (1) as a requisite in the diverse elementary classroom because it is essential, focuses on every child being able to understand math, and instills the idea everyone is a mathematician; (2) as a medium for understanding where children are coming from in terms of culture, their worldview, experiences, beliefs, traditions, and the connections to their families; (3) as a foundation to build math content on what the children already know, their background knowledge, and their prior knowledge; (4) as a framework within the teaching and learning cycle through engagement, curriculum, vocabulary, using the child's home language, and assessments; and (5) as a area of professional development because there has been a lack of training in this area and it is hard to always know how to implement it effectively into instruction.

5. Discussion

These eight elementary teachers incorporated cultural knowledge into the learning and teaching of mathematics through the knowledge of the individual students' home and community life, the defining of culturally responsive mathematics, through specific examples of how students learn math through culture, and self-identification of diversity. These conversations give a glimpse into mathematics culturally pedagogy being implemented into instruction in a variety of classrooms in the United States.

5.1. Knowledge of students' home and community life

These eight teachers expressed an intimate knowledge of the students they had in their classrooms. They understood the cultural backgrounds of the children by referring to them as Hispanics, African-Americans, South African, Malaysian, Mexican, Saudi Arabian, Canadian, Native American, and African as well as the multiple languages these children spoke. Individual relationships were created with their students because teachers knew the extracurricular activities (sports, arts, and church) and family values these students brought with them. These teachers classified the children into socioeconomic status (high/low, free and reduced lunch, and working multiple jobs), family relationships (single parents, extended families, siblings, and love/support), location in the community (type of transportation and type of area they live in), and family involvement at school. This teacher expertise of their students demonstrates how they have intimate knowledge about the children they instruct beyond the academics (Ukpokodu, 2011).

5.2. Defining of culturally responsive mathematics

Previous research substantiates these definitions for culturally responsive mathematics articulated from the teachers. First, the ideology of culturally responsive mathematics as a requisite in the diverse elementary classroom is essential focusing on every child being able to understand math, and instills the idea everyone is a mathematician. Howard (2010) explains schools seek “to develop dynamic teaching practices, multicultural content, multiple means of assessment, and a philosophical view of teaching that is dedicated to nurturing student academic, social, emotional, cultural, psychological, and physiological well being” (pp. 67–68). These teachers have the belief that all children in their classrooms are capable of learning mathematics.

Second, the design of culturally responsive mathematics as a medium for understanding where children are coming from in terms of culture, their worldview, experiences, beliefs, traditions, and the connections to their families is substantiated through the research. Gay (2010) endorses “... teaching is most effective when ecological factors, such as prior experiences, community settings, cultural backgrounds, and ethnic identities of teachers and students, are included in its implementation” (p. 22). These teachers built upon the cultural capital their students bring to the classroom in order to enhance mathematics learning.

Third, the implementation of culturally responsive mathematics as a foundation to build on content on what the children already know, their background knowledge, and their prior knowledge is verified through research. Ukpokodu (2011) demonstrates “providing appropriate scaffolding through the use of familiar language, metaphors, examples, and hands-on learning, thereby tapping into the ‘funds’ of mathematical knowledge students bring to the mathematics classroom” (p. 17). These teachers believe that their students come to them with mathematics knowledge from their own lives and cultures; therefore, the teacher taps into this knowledge for mathematical understanding.

Fourth, the idea of using culturally responsive mathematics as a framework within the teaching and learning cycle through engagement, curriculum, vocabulary, using the child’s home language, and assessments identified by these teachers is supported in research. Taylor and Sobel (2011) contend culturally responsive pedagogy “involves teacher responding to students by including elements of the students’ culture and life experiences in their implementation of curriculum and instruction” (p. 16). These teachers view content as more than mere formulas to be memorized because they believe mathematics understanding should be created with real world personal connections.

These teachers defined culturally responsive mathematics in global terms concurring with previous research; however, these teachers also felt that there was a lack of professional development in order to have them become experts of tying cultural learning with mathematics instruction. This idea of needing culturally responsive mathematics professional development has been supported in the research (Barta & Orey, 2008; Gay, 2009; Ladson-Billings, 2009). Quality professional development

needs to be brought into the schools in terms of learning about culturally responsive practices, spending time in students' communities, bringing parents and community leaders in for conversations, and modeling how to teach culturally responsive lessons from effective teachers.

5.3. Example of students learning math through culture

These teachers bring in a variety of culturally responsive mathematics into their instruction allowing the mathematics content to come alive with personal connections (Aguirre, 2009; Averill, 2012). Food with its cultural connection seemed to be the main math learning activity mentioned though recipes for fractions (Brazil, Puerto Rico, and Mexico) and measurements (salsa, hot Mexican punch), bringing in food examples (enchiladas, pistachios), and cutting food into shapes (dolphin). Diverse languages are encouraged in these classrooms with bilingual communication (instruction, counting calendar, and birthday song), allowing students to use their native language discourse to enhance learning, and having bilingual parents help during math instruction. Community cultural connections were made through stringing beads for groups of 10 with the connection to braided hair with beads; teaching area, perimeter, and money through a farm unit connection; and using money and currency from other countries. Nasir (2002) confirms "the idea that good teaching practices help students connect their existing cultural identity with their experiences in the classroom" (p. 219). These teachers create collaborative learning communities in the classrooms where student cultures are embraced and used as examples to enhance mathematics learning.

5.4. Self-identifications of diversity

These eight teachers self-identified their classroom diversity as cultural (seven schools), English learners (seven schools), ethnic (six schools), socioeconomics (four schools), and religious (two schools). All eight of these teachers mentioned these diverse elements within knowledge of the individual students' home and community life, the defining of the culturally responsive mathematics, through specific examples of how students learn math through culture, and self-identification of diversity. How teachers identified the diversity in their classroom drove the mathematics scaffolding and differentiation they provided their students. Therefore, mathematics was comprehensible in ways students could access within their cultural worldviews.

6. Implications

These teachers have defined culturally responsive mathematics in agreement with current research in the field and are at the beginning stages of implementing learning activities into their classrooms. There is stillroom for growth and many of these teachers during the interviews expressed this personal need. Support needs to happen in terms of curriculum, professional development, exemplar classroom activities created and shared, and community connections. The mathematics curriculums these teachers are using are recommended by research and organizations such as the National Council of Teachers of Mathematics; however, most of these teachers in the interviews mentioned their curriculum did not meet the needs of the culturally diverse and language learning students as well as it did for native students in their classrooms. Culturally responsive mathematics teaching needs to be added to these curriculums to meet the needs of diverse children.

Professional development in culturally responsive mathematics should happen in a consistent and coherent manner to support teachers in their distinctive classrooms. This needs to be more than a one-day training allowing time to learn about, comprehend, digest, and understanding what this is and how you can implement it in the classroom. Exemplar classroom activities with mathematics and cultural connections need to be created and shared. This could be done through lesson plans on the internet, teaching videos, or coaches coming to present model lesson to a teacher's class. Furthermore, these activities should go beyond the stereotypical ways of classifying children into cultural categories, but seeing students as cultural beings whom bring background knowledge that needs to be built upon for mathematics learning to occur. Finally, community connections need to

be made between the school and the people who make up the community population in order to create an understanding between the two groups as well as brainstorming ways in which mathematics instruction can be enhanced based upon the culture of the students.

7. Importance of culturally responsive mathematics

Culturally responsive mathematics is important in elementary classrooms because it allows students to make personal connections to mathematics content. These personal connections should be based on what the children already know; furthermore, the mathematics connection can be the most meaningful when they are connected to the child's cultural background. Teachers can use culturally responsive mathematics in their classroom to create meaningful and distinctive real world understanding for their students. In a sense, mathematics comes alive for the students in the classroom and becomes more than just a problem in the math book ... it becomes personal.

8. Conclusion

These elementary teachers are addressing the same issues of working with culturally diverse children in their classrooms even though some are urban, within the city suburbs, industrial areas, near retail, the mountains, small town, or agricultural. Teachers' knowledge of culturally responsive mathematics informs their classroom teaching decisions as they are making real world learning connections for students. These eight teachers provide a glimpse into the knowledge of student's home and community life, defining of culturally responsive mathematics, and examples of student learning math through culture.

Funding

The author received no direct funding for this research.

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Citation information

Cite this article as: Defining culturally responsive teaching: The case of mathematics, J.L. Harding-DeKam, *Cogent Education* (2014), 1: 972676.

Cover image

Source: Author.

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