CHAPTER 1

Problem-Based Mathematics Learning in Urban Spaces

Exploring Mathematical Circles in Youth's Community Circles

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"What do you have today, *vegan*?" asked Jalen, a sophomore, somewhat critically but with jest. I sit down at the lunch table with him and a few others.

"Well, today I thought I would bring in some BBQ chick'n strips with some chips."

"What's it made out of? *Tofu*?"—again, critical.

"Kind of. Technically it's soybean protein, but not quite the same process as you use to make tofu." He, along with a few other students, hold their forks in anticipation of me offering up some. I take a strip, turn my lunch container to face them, and watch them divvy up some of it, leaving me with about half of what I brought.

When I first told my students I was vegan last year, they often asked what I ate, whether all I could have was just salad, whether or not I ate dirt, and, one time, what I put on my cheese pizza. They are curious as to what I am "allowed" to eat, though I often tell them that it's what I

choose to eat. So over time I decided to bring in food during lunch to share. But one question that comes up over and over again is, "Where did you even get that?" Leon, a sophomore who instantly fell in love with the BBQ chick'n strip, immediately asked where I got it.

"Well, I got this at the Walmart on the east side, but they also sell it at Kroger."

"I'm going to get me some," he said as he reached for another strip. He took it and I told them that I was done sharing for the day, but, since this one was more popular, next time I might bring more. I've learned that if I bring something sufficiently foreign-sounding enough, like tofu rendang or anything with Brussels sprouts, I will have plenty to eat for lunch, but the chick'n strips, tacos, and pizza are all too tasty for me to bring without expecting to share a good amount of it.

"You know what? I was in Cincinnati this past weekend, and I went to a giant grocery store, and they sold scorpions there," I said as I got up, ready to move onto another table to bug more students. "I thought of you, but decided against getting it."

"Like, to eat? Why didn't you?" said Quinton, a sophomore who claims he will eat anything.

"I didn't think you would actually eat it . . . and I'm vegan, so buying it is weird. Plus, it was $10 for just one."

"Come on, Musgrove, you had one job . . . you let down the team," he said, shaking his head.

"I know you're a lame vegan, but you can buy it for us," said Aniah. "So you need to go back there and get it!"

"Yeah, what she said!" I heard, to the agreement of pretty much everyone at the table.

"Fine! But, it won't be anytime soon, since it's all the way in Cincinnati."

"We don't want excuses, we want scorpions!" said Jalen.

Making a Commitment to Access and Equity

Gloria Ladson-Billings (1995) argues that one likely reason for the difficulty that children of color, or poor children, experience in school is that "educators traditionally have attempted to insert culture into the education, instead of

inserting education into the culture" (p. 159). While more and more mathematics teachers agree that children's cultural knowledge and lived experiences matter in mathematics learning—and must not be ignored—the widespread implementation of culturally relevant pedagogy remains elusive, especially at the secondary level (Leonard, Napp, and Adeleke 2009). To us, the authors of this chapter, culturally relevant mathematics teaching begins with the inspiration provided by the students, as well as their unique, youthful perspectives and lived experiences. Rarely are these resources adequately harvested, compiled, and understood; as a result, it is exceedingly difficult to craft mathematics teaching and learning experiences within this cultural context.

Setting

The vignette above is narrated by Mr. Musgrove and showcases the ease with which he engages youth and his commitment to understanding them as children and community members, both critical first steps in maximizing students' cultural and community knowledge bases for the sake of learning mathematics (Turner et al. 2016). It took place at Llave Academy, a K–12 magnet school in the Central School District, where Mr. Musgrove has taught for six years. When it opened in 1987, the founders of the school decided that children's multiple intelligences would serve as a foundation from which curriculum and instruction would emerge. Drawing from Howard Gardner's (2006) theory of multiple intelligences, which assumes that children need opportunities to build on and showcase their various intelligences (e.g., kinesthetic, logical-mathematical, linguistic, intrapersonal) and strengths, the school created a theme-based multiple intelligences program that used projects as a central aspect of instruction and assessment. Each semester, students would create individual projects tied to a theme intended to remain authentic and meaningful to the students, as a way to merge a multiple-intelligence curriculum with a project-based one.

This approach to mathematics learning provides many benefits for authentic student learning, broadens what counts as doing mathematics, and supports learners' development of positive mathematics identity. The method effectively goes against mathematics' historical role of sorting children into two clear categories of "can" or "cannot" do math well in favor of an activity system (i.e., doing mathematics) in which students can see themselves as integral participants. The episode above, as well as those that follow, represent real access to mathematics activity, as described in *Principles to Actions* (National Council of Teachers of Mathematics [NCTM] 2014): "Our vision of access and equity requires being responsive to students' backgrounds, experiences and knowledge when designing, implementing, and assessing the effectiveness of a mathematics program" (p. 60).

The challenge of creating and sustaining a project-based curriculum while maintaining high test scores is a cause for uncertainty among teachers today. Mr. Musgrove shares that the teachers at Llave were not entirely anchored in project-based learning, especially as they struggled and were pressed to raise students' test scores to meet academic mandates set by the district. At times, Mr. Musgrove acknowledges that he was unwilling to take the risks necessary to create mathematical work that was responsive to students' experiences outside of school because he felt he needed to create lessons, or use lessons already made, that aligned with state tests. He also did not feel that he had the support of the administration to develop new projects, given that teachers with more experience in project-based learning were leaving the school and there was increased scrutiny over students' test scores. Mr. Musgrove also feared that going outside of a traditional curriculum and into one that engages students' lived experiences could lead to projects that were not mathematically rich, whereas Civil (2007, p. 5), in her work supporting mathematics educators in building from community knowledge, advocates for "problem-solving situations that call for different approaches, tasks that require offering a mathematical justification, [and] activities that cut across different areas of mathematics (to highlight the connections)." Mr. Musgrove worried about leaving students unequipped to take standardized tests, but the more he engaged with the knowledge his students were bringing to the classroom, the more he noticed the students were willing to engage in the mathematics he was leading them toward.

In reference to the opening vignette, Mr. Musgrove continues the narration:

> One major thing that the students would ask is where I bought my food, and I realized that, just as I needed to go to different parts of the city to buy groceries, so did my students. This inspired me to plan the next unit in which the class would explore circles. Grounding this exploration in the context of food deserts, we would use maps to investigate how neighborhoods in our city have varying levels of access to grocery stores and convenience stores, use circles to represent access, and explore how streets intersecting with the circles connected to concepts in a traditional unit of circles in a geometry class. In particular, this project, by using properties of circles, identified and examined vast areas of the city where one would find it difficult to find the nutrient-rich foods typically found at larger grocery stores. [See chapter 2 for more about projects that connect with the students' experiences.]

The goals of this project reflect an effort to promote equity in mathematics learning. From our perspective, equity comes from rethinking the roles and

responsibilities in mathematics teaching and learning, as well as the sources of mathematical knowledge. Hence, a teacher focused on achieving equity necessarily (1) repositions students as competent generators of mathematical knowledge, rather than simply passive recipients, and (2) helps students not only make connections among mathematical ideas (a traditional, albeit not-always-well-accomplished goal) but also make connections between mathematical knowledge and systems of oppression or injustices. These dual fundamental roles (among others) share the spirit of how equity is encapsulated in *Principles to Actions* (NCTM 2014): "Promoting student engagement . . . , framing mathematics within the growth mindset, acknowledging student contributions, and attending to culture and language play substantial roles in equalizing mathematics gains between poor and non-poor students" (p. 65).

Advancing Access and Equity

In conceptualizing this project, Mr. Musgrove had the benefit of teaching this particular group of students for three years, so his relationship with them was well established, which led to more informal questioning to gather information and learn about the background of the students, and which enabled him to take more risks in potentially politically charged topics. (See chapter 9 in this volume for more about how teachers can connect to the students' lives.) In the sections that follow, Mr. Musgrove takes over the narration of what happened with this group of students in his efforts to advance access and equity.

Creating the Project

In my high school geometry class, one student was White, seven were African American, and two were Latina/o. One student lived on the southeast side of Indianapolis, six students lived on the west side, and three lived on the east side.

Before I asked my students to begin investigating food deserts in Indianapolis, I found a clip from *The Nightly Show with Larry Wilmore* that showed one of their correspondents being challenged to find an heirloom tomato in Camden, New Jersey. I choose this clip because of its comedic value, relying on absurdity to make a point, and its presentation of the concept of a food desert. The correspondent was positioned as a middle-class African American food snob who thought a food desert was the newest trend he must experience. After watching him struggle to find a tomato in a New Jersey city and getting laughs from the students, I played a local news report detailing how our city is actually ranked worst in the nation for food access.

Before the students watched the video, they did not know what the term *food desert* meant. In a survey I gave after showing the videos, one student wrote,

"I thought it was a fluke, but actually it's a real problem," while another responded by saying, "I feel that when I first heard of food deserts I thought it was just randomness but now I see the real problem." The majority of the class said that they did not currently deal with any issues of accessing food, but two mentioned that, in the past, their families had troubles. We began talking about where we bought our groceries from; some of the students said they would either buy from a Kroger near their house, or go to another part of the city because the grocery store was cleaner and nicer there, or their parents would buy groceries at a store near their jobs instead of near where they lived. Some students immediately identified their neighborhoods as lacking good grocery stores, but they were able to make up for it by being able to drive to better ones. We then identified parts of the city we wanted to investigate in more detail, which lead a majority of the students to pick the areas where they lived.

The goal of the project was twofold: I wanted the students to create a model using circles that could be used to investigate areas of specific neighborhoods. The circles could then form a foundation for how to identify and describe relationships among radii and chords using streets, as suggested in Common Core State Standard HSG.C.A.2 (National Governors Center for Best Practices and Council of Chief State School Officers [NGA Center and CCSSO] 2010). Their investigation would lead toward discussions of (in)equities and proposals of how to instigate change within the communities. We kept our focus on the relationship between the location of stores that fit our definition of a grocery store and the location of stores that fit our definition of convenience stores and how those locations related to a neighborhood's overall distribution of house values. As we created circles with intersections and circles centered along streets, we could abstract them and consider how to represent sections of the neighborhoods as sector areas and create a process for finding the measurement of any sector area (HSG.C.B.5; NGA Center and CCSSO 2010). In the next sections, I describe three phases of the project and how they relate to these goals.

Phase 1: Investigating House Prices

One of the first tasks that the students worked on was to fill out printed maps from Google with house values found on Zillow.com. Later, students would draw circles around food stores to see if they could make any connections between house prices and access to food. To aid my students, I tried to zoom in at a level that would allow students to easily find intersections of major streets, have a good view of the neighborhood as a whole, and not have too much to fill out. I settled on a zoom that made 1,000 feet (four blocks) approximately one inch. Students worked methodically by zooming into the maps on Zillow.com until they could see the estimated house prices, blocking off an area on their paper map, and

assign it a value based on an average they saw online. During this time I was able to differentiate my instruction by having discussions about measures of central tendency with the different groups of students based on what they thought was a fair way to represent the area. For example, one group found the statistical mean and believed that it was the fair way to represent the areas, but others settled on labeling their maps with the price that appeared the most (i.e., the mode). One group decided through our conversations that excluding the highest and lowest prices would remove the outliers and that they then could find the median to represent the area. We also talked about how we could separate the areas using the streets to make different polygons and plan ahead to use shapes that would make it easier to find the areas. By doing so, the students would be able to find the area of the map for different price ranges and calculate the percent of the neighborhood that fell within certain ranges.

One group that faced a particular challenge was the east side group. This group was composed of three students, two boys named Brandon and David, who lived slightly north of the area on the map, and a girl named Arlina, who lived right in the middle of the map. They were familiar with most of the streets but were not sure about streets that were not close to where they lived. As they started, after curiously checking out their own house on Zillow as a comparison to other houses, they ran into two challenges. First, they found several lots listed at prices under $10,000. They asked me why the price was so much lower than the others, and I suggested clicking on the house to find out. At first, they thought the houses were just really good deals, saying things like "It wouldn't take too long to save up to buy" and "It might be on a bad street, but at least it's cheap." When they clicked on the house, however, one of two things became clear: The properties were empty lots, to which they replied, "Well, that's a trick," or the houses were listed as foreclosed, which the students said meant that they were boarded up and "full of weeds and homeless people." Other groups had these listings as well, but when they compared their areas to others, the east side group realized they had a lot more of them. As they worked through the map, they decided to represent these areas using lower prices in an effort to acknowledge the fact that a house or property had value, or unrealized value, while also distinguishing between those that had a more real, or immediate, value. After they had mapped out their areas in different shapes, they used the scale to find the measurement of the areas. With this data, they calculated the total area of their map and created a table that broke down the percentage of their map that had specific price ranges. This table, along with other information about the area, was turned into a poster that they used to show their findings.

Another challenge that the east side group encountered was that they had a wider variety of house prices separated by single streets. Brandon pointed out two

streets in particular: Tecumseh and Woodruff Place East Drive (see fig. 1.1). He said that if you lived a block away, "Your house is three times as much!" He was shocked that the houses could be so close to each other and yet so different in price. While he was talking with his group, I again urged them to click on the houses once in a while to see what they looked like. When he did, he started going on and on about staircases, the number of bedrooms, the "fanciness," and how he would love to live there. He said, "It makes sense now that the houses are so much because they have so many rooms." Arlina also noted that many of the houses were being fixed up into "clean, perfect houses" that "are over 100K mixed in with all the others." Because of this mix, the group settled on zoning off the area using wider price ranges to reflect the mix of the house values, as seen in figure 1.2.

Fig. 1.1. Zillow.com image of Woodruff Place prices vs. Tecumseh

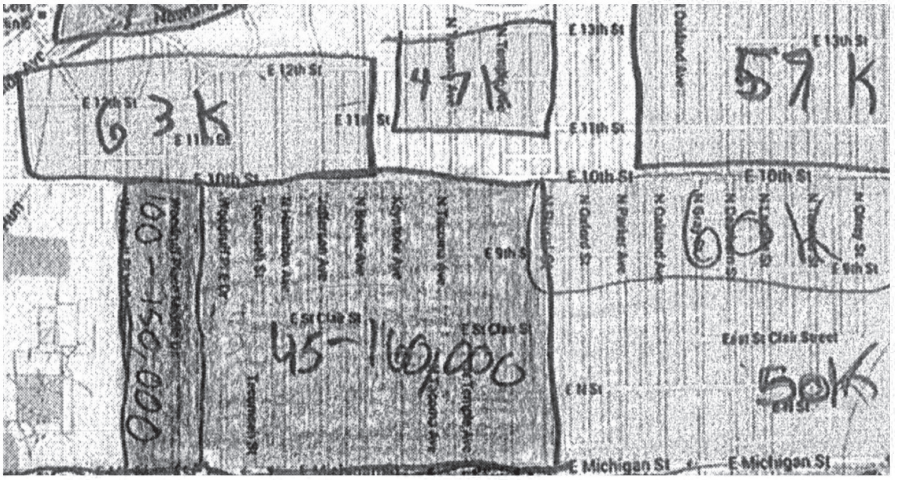

Fig. 1.2. The neighborhood in the lower left was listed with a wide house price range to represent the mix of house values on the same streets.

Later in the week I showed the students the map at https://demographics.virginia.edu/DotMap/index.html. The east side group was happy because they felt that their part of the map represented a mix of all the different dots with only a few spots being predominantly one color, as compared to the maps for the other groups that were more segregated (see fig. 1.3), with the west and northeast side group mostly black and the southeast mostly white. I brought the students' attention back to Tecumseh and Woodruff Place East Drive and asked if viewing the racial dot map had changed what they had thought earlier. They said the houses probably weren't expensive just because there were white people there but instead were expensive because the houses were bigger than in the places with a mix of people.

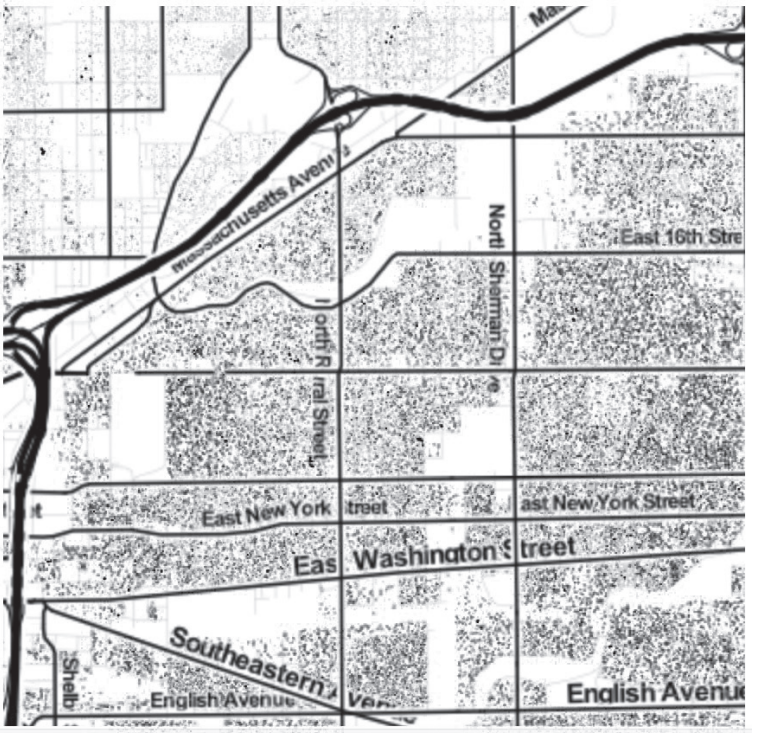

Fig. 1.3. Racial dot map of the east side group

Phase 2: Investigating and Classifying Grocery Stores

At the beginning of the second week of the project, the students began looking at the city as a whole in order to compare the prices of houses with their access to food. Nearly 900 stores were listed as grocery stores on the Food Establishments Inspections website, and although the website was full of useful information, it was not exactly student friendly. So instead of having the students struggle with the site's interface, I copied and pasted all the relevant data onto a Google Sheet that I shared with them. The students had one class period to sort through the list of stores, classify them as discussed below, and use easymapmaker.com to create an interactive map that showed locations of grocery stores, convenience stores, charities, and farmers markets. Using Google Sheets enabled the students to work together on one list in real time and avoid doing any of the work twice. This map would be cross-referenced with their neighborhood maps to look for any relationships between house prices and access to nutritious food sources. In the days that followed, this would be the bulk of the work, utilizing circles as a tool.

When I first showed the students the list, they were confused by what they saw. I told them that I made a list of all the grocery stores, but the first store was Village Pantry, followed by Catholic Charities, and then two more Village Pantries and a Speedway. A student called out, "I thought you said these were grocery stores?" I told them where the list came from, and that on the website we can see all the inspections that occurred at these stores, and I asked, "Why do you think they are listed as grocery stores?" One student responded that someone probably would check the refrigerators; another said that they sell chips, bread, and sometimes milk; and another student suggested that they prepare food to go, like fried chicken, in grocery stores.

As a class, the students decided to separate what they thought of as grocery stores from the gas stations and corner stores, thinking that it would be easier to have just two categories. The students were already working in pairs, so each pair picked an area of the city and began classifying each store on the Google Sheet as either a grocery store or a gas station. The five areas were north, south, east, west, and central, which closely corresponded with the areas they were already investigating. After some time, as the pairs were working and talking out loud, one pair began arguing about Family Dollar. One of the students told his partner that it should be a grocery store, because his family stops by there sometimes to get a few things for dinner. His partner was not buying it and said it was more like a gas station because they did not have "real" groceries, like fruits and vegetables, that you see when you first walk into a grocery store. After some argument, another group joined in the conversation and said that they were thinking about calling the gas stations convenience stores. The student who was insisting that Family Dollar was a grocery store said that it should still be a grocery store because he could get things for dinner. His partner said, "But you said your family stops there sometimes to get a few things for dinner, not grocery shopping—isn't that the point of a convenience store?"

Hearing this, I wanted to get the whole class in on the discussion. I asked them to repeat what they were arguing about, to make their case, and, as a group, we would all decide on a set of defined categories. The two students stated their case, and, as a class, we decided that Family Dollar, along with Dollar General and Dollar Tree, would count as a convenience store for our classifications. We became convinced of this when one student said, "Can I buy a bag of potatoes at Family Dollar? No. Then it's not a grocery store!" After the discussion, the students decided to add two other classifications, so we now organized our stores as one of the following: grocery store (if the place was likely to sell a bag of potatoes or exclusively sold food), charity (if the place offered food to the community), farmers market (if it seemed more like a farm stand kind of place), and convenience store (if it fell outside of one of these other categories).

Phase 3: Drawing Circles

HAUGHVILLE USA! The west side group, composed of two boys named Bradley and Jeffery, was the most vocal about their part of town being the best. They shouted out "Haughville USA!" when the west side was mentioned, skipping both city and state. But where there is pride, there is also frustration. Below are two images taken from their work: Figure 1.4 shows five- and ten-minute walking radii circled around convenience stores, and figure 1.5 shows them around the grocery stores. Before we began drawing circles on the maps, we discussed what would be the best way to represent access to food. After discussing it, the students decided it would be overly complicated to identify where a store was located and then measure distances from it only along streets. Instead, a student suggested we should mark where the store was and then mark a set distance away from it, thereby grounding the concept of a radius with a practical application. We wanted to know how far to draw the radii on the map in order to keep a five-minute walking distance, because the two videos we watched at the start of the project had defined good access to food as being within five or ten minutes of walking. I asked the students how far that would be. Their guesses were wildly different from each other, and Jeffery said, "Why don't we just time ourselves?" The students agreed with this idea, but when I asked where we could go where we knew the distance, they realized that we did not have a good spot already measured. After more discussion, a student suggested using the tiles in the cafeteria. We set two end points that were 50 tiles/feet apart, and the students walked for five minutes, counting the number of laps they made. For the sake of simplicity, we averaged out the distance traveled to settle on 1,000 feet, as that closely matched our results.

When we got back to class, I told the students that on one map they should draw circles around all the grocery stores and on a second map they should draw circles around convenience stores to represent estimates for walking. They nodded at me and did not seem to be concerned with the task at hand. They would use the map the class collaborated to make on EasyMapMaker to see where the stores were located, estimate where the stores were on their paper maps, and draw the circles around them using a compass. When they started working, Bradley protested: "What do you mean a circle around each one? Do you know how many gas stations there are?" I said, "Yes." He asked why we had to do it, and I told him I wanted us to explore proximity to see what connections we can make between where things are located and what people actually have access to. It seemed this was an acceptable answer to him, but he was not excited about drawing all the circles. His partner, who was busy color-coding the map, told him to just do it and it would not be so bad.

Later in the same class period, I came back over to see what the two students had accomplished so far. They had completed the color-coded map, and so both were working on the circles. I asked what they thought so far. Jeffery pointed

out that it was crazy that the majority of the convenience stores were north of the street (see fig. 1.4) while all the grocery stores were on or south of Michigan Street (see fig. 1.5), Bradley said that there were more grocery stores farther north closer to 38th Street—another student overheard this and said, "Yeah, we've got all the grocery stores"—and that you can get anything you want up there. The two students went back and forth about how there are Indian, Asian, Mexican, and "normal" grocery stores scattered throughout (the area itself is known as the International Market District). I asked if they could see anything on the maps that might lead us to understand why the stores could be located the way that they are. After looking at it for a little while, Jeffery pointed out that the convenience stores were in the places with cheaper houses, while grocery stores were located among more expensive houses and the veterans' apartments. He pointed out that even within the circles themselves, the closer you were to a grocery store, and the more likely you are to have a more expensive house.

Fig. 1.4. Convenience stores near Haughville

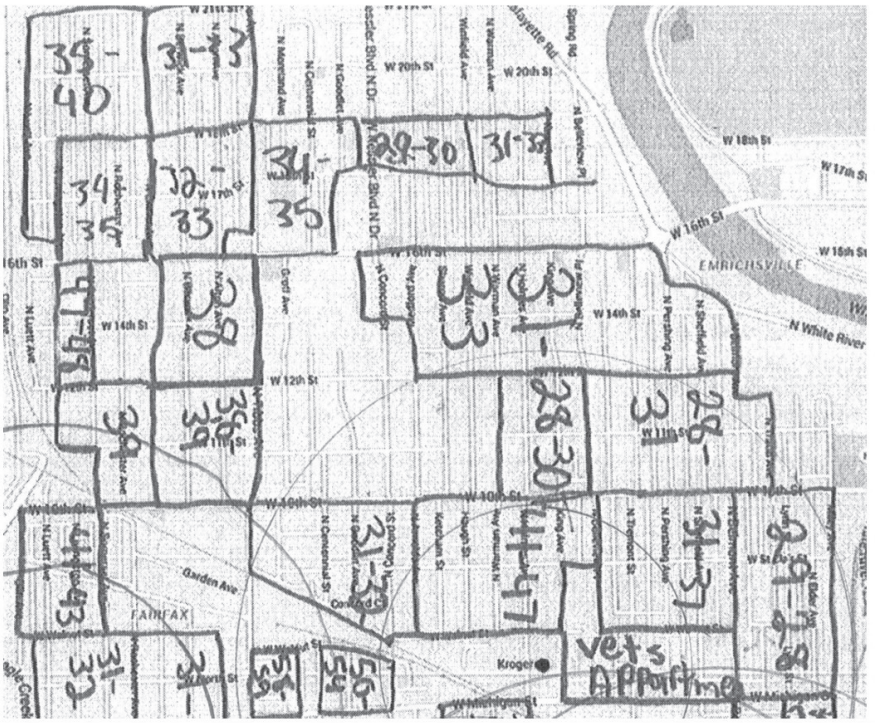

Fig. 1.5. Grocery stores near Haughville

I asked Jeffery what he thought the Haughville Community Organization would think if he showed them this information at a meeting, and he said, "I don't think they would care. No one shows up to those anyway." He said that the organizers might want to know, but that people who live there do not go to the meetings and so what would be the point? "People know there are problems, but they don't want to solve them." I asked the pair why they thought people would not want to solve these problems, and they mentioned that people are too busy today with their jobs, going to school, and other things to take the time to fix such problems. They recognized that people could theoretically change things by opening up their own grocery stores in different locations, but this would take time and people were not doing it. Jeffery said he wanted people to make changes, but if they do not show up to help, things are never going to change.

During this phase, I noted where students were drawing circles and asked all the groups which parts they thought were the most interesting. I scanned their maps later and used these areas as class examples. Using the circles and streets, I was able to create activities that had students find sector areas around a grocery store or convenience store based on the zones they already had made or on streets.

With these sector areas, we were able to compare grocery stores among the neighborhoods and determine whether there were any themes that we could draw from the data. Students often noticed that the grocery stores had more areas with higher house prices than the convenience stores did. When I gave mastery checks later in the week, instead of using images of circles from textbooks or worksheets I took images of their maps and created test questions from what the students had created. When they first saw the test, they said it was cool seeing their maps. After the test was over, they told me that it was not as intimidating as usual because they were working with something that was already familiar, even if the problems were just as difficult. Figure 1.6 is an image that was used on a mastery check assessing sector areas, with the different sectors being separated by different house prices.

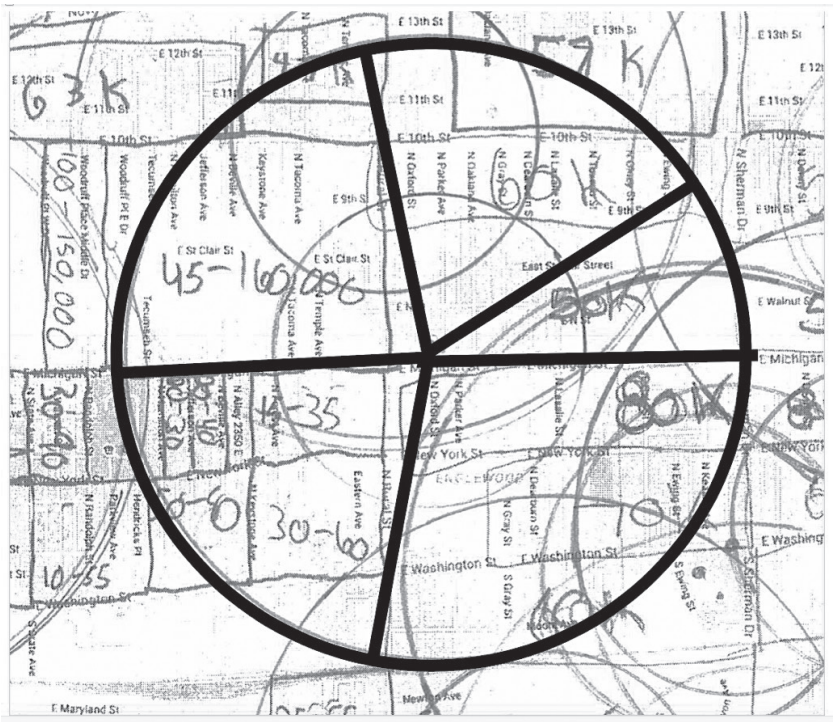

Fig. 1.6. Scanned image of student work that was later used for a class assessment

Reflection and Taking Action

A few months had passed after the initial scorpion lunch conversation, and after we worked through the food deserts project the end of the year was in sight. Quinton reminded me of my promise to bring them a scorpion, and I told them that

I was going to that store over the weekend. They said I had better, because the next week was the last week of school. Off I went, but I discovered that scorpions were sold out that day. Deciding not to come back empty-handed, I bought a few packs of BBQ-flavored crickets and worms at the store and also bought a scorpion on Amazon.com. I had it rush delivered to come on Wednesday.

On Monday, the students were disappointed to not have the scorpion yet, but ended up liking the BBQ crickets. Students from other lunch tables came over and tried some, to varying degrees of acceptance, along with some hesitation, disgust, confusion, and laughter. Two days later, the scorpion came; it was about two inches long, dried out, and fairly hard (figure 1.7). When I presented it to the students, they agreed that it was Jalen who wanted it the most, though he began to appear squeamish and caught off guard now that it was actually here. He put most of it in his mouth, began gagging slightly, saying it was hard and biting down softly. Everyone laughed, and several people took out their phones to take photos or videos (myself included) as we watched him try to eat it. After straining for what seemed like forever, he swallowed the last bit, showed his tongue, wiped away a tear, and said, "I'm still here!" Some kids clapped, while others said they could not believe someone would eat a scorpion. Jalen quickly unwrapped his PB&J sandwich, began to eat it, and said that he was not sure if the scorpion was worth it.

Fig. 1.7. Jalen and the scorpion

Ways to Take Action

When designing the project, one of the major goals was to engage the students in mathematics discussions while also investigating something unknown to them. Instead of starting with something abstract such as examining theorems about circles, seeing how they related to other properties, and only then applying them, the project attempted to "flip the script." We started with something in the lived realities of the youth, illuminating circles as a useful tool, using them, abstracting what we discussed, and exploring relationships that did not naturally lend themselves to the initial application in the project (Gutstein 2006). The students could then be positioned not as passive recipients but as competent generators of their mathematical knowledge (see Varley Gutiérrez, Willey, and Khisty 2011). By specifically focusing on food access, the students were exposed to injustices happening in their communities, and they became better informed citizens who can now use mathematics to argue for where stores should open in the future, all while making connections among traditionally abstract mathematical ideas (Gutstein 2006).

Throughout the project, we began class with a discussion of what the students discovered so far, made connections among some of the geometric concepts, and started the work for the day. Toward the beginning of the project, much of the time was devoted to the issue of food access, with less time spent on abstract mathematics concepts. Within the project, we were able to have discussions about and use the area of circles and sectors; consider theorems related to chords, secants, and tangents by using streets as the line segments; and construct concurrent and intersecting circles. Near the end, we began abstracting more and investigating other properties of circles that did not have useful applications to the project. Topics that were discussed but not used to drive the project included inscribed angles, arc lengths, and circumscribed angles. Trickier theorems related to chords, such as "If two chords of a circle intersect, then the products of the measures of the segments of the chords are equal," came from discussions within the project that were then further abstracted to include secants and tangents.

If I were to go back and do the project again, I would spend time at the beginning deciding what to do with the information once we gathered it. The project was designed with the end product being the interactive map, the color-coded maps with the circles drawn, and an overall summary of their findings. We did not, however, plan for a presentation of the findings to the community. On reflection, this would have been a powerful, memorable ending to the project and would have represented the hardest-to-incorporate component of culturally relevant pedagogy: critical consciousness, or social action (Ladson-Billings 1995). Because the project was done at the end of the school year, we faced multiple deadlines, and we did not have a chance to schedule community stakeholders to

come in to meet with the students. Such an activity would have been a good way to address some of the concerns brought up by the students, such as Jeffery's experience with his community's lack of participation at community meetings. While I had discussions with the students about the issues they raised, bringing in community members would add a layer of authenticity and expertise that we recognize was lacking when addressing issues in particular communities where the students live but we do not.

Another modification to consider would be to consider the amount of tasks necessary for the project to work and for connections to be made. Llave Academy has only one section of geometry; in larger schools, different classes could focus on various areas of a large city, investigate only one or two sections, or coordinate with other teachers to have groups of students work on specific areas and share their results with one another. While it was beneficial for the students to have multiple areas to compare, it put a lot of work on just a few students.

Questions for Reflection

In closing, we offer the following questions for teachers to consider as they examine the extent to which they engage youth in culturally relevant mathematics teaching and learning:

1. In what ways do you collect information about your students' cultural and community knowledge bases? Why does this matter? How can you compile and leverage these insights to create the frame within which all mathematics teaching and learning takes place?
2. What are the obstacles in your institutional context that prevent you from implementing a mathematics program that positions children as knowledge generators and centers instruction on the social realities that matter to youth? How might you overcome these obstacles?
3. How can you create mathematics activities that start with students' experiences but can then be further abstracted to include areas of mathematics that might not be readily evident in their everyday experiences?
4. In what ways can you foster relationships among students of different ethnic or racial backgrounds to create conversations that can inform your lessons?
5. When designing a project, how can you create it to be open-ended and flexible and yet still achieve the mathematical goals for which you are

aiming? Consider what it would look like to create multiple mathematical pathways that the students could explore during the project but to then provide opportunities for students to share along the way, thus exposing all groups to different mathematical dimensions within the same problem context.

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