SOCIAL JUSTICE STANDARDS

- I can explain the short and long-term impact of biased words and behaviors and unjust practices, laws, and institutions that limit the rights and freedoms of people based on their identity groups. (Justice 13)
- I will join with diverse people to plan and carry out collective action against exclusion, prejudice and discrimination, and we will be thoughtful and creative in our actions in order to achieve our goals. (Action 20)

MATHEMATICS ESSENTIAL CONCEPTS

- Geometry—Recognizing congruence, similarity, symmetry, measurement opportunities, and other geometric ideas, including right triangle trigonometry in real-world contexts, provides a means of building understanding of these concepts and is a powerful tool for solving problems related to the physical world in which we live. (SAPM.1)
- Geometry—Experiencing the mathematical modeling cycle in problems involving geometric concepts, from the simplification of the real problem through the solving of the simplified problem, the interpretation of its solution, and the checking of the solution's feasibility, introduces

LESSON 8.3: MAKING MATHEMATICAL SENSE OF FOOD JUSTICE

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HEALTH INEQUALITY

Students in this lesson identify the social injustice of those who suffer from food insecurity in Austin, Texas. Food Justice is a grassroots movement to democratize access to nutritious and affordable foods in response to the socioeconomic, ethnic, and racial disparities that exist in food deserts. Though this lesson begins in Austin, students begin to examine potential food injustice in their own communities. A food desert is defined as a geographic area with severely limited affordable, healthy food choices (especially fresh sources of protein and fresh fruits and vegetables). Students use creativity to determine supermarket placements that will declassify an area as a food desert. Students' use of mathematics in a modeling context to "read the world" raises their consciousness of the injustice of food insecurity. Students gain insights to just how difficult it is for some people to access healthy foods.

DEEP AND RICH MATHEMATICS

Students are challenged to develop a generalizable procedure for determining if a community qualifies as a food desert. Given the map of a town embedded in a coordinate plane, students use their geometric knowledge to develop mathematical procedures. Students are then asked to determine the optimal location for a new grant-supported grocery store in a food desert so that the area is no longer classified as one.

ABOUT THE LESSON

The lesson is a launch–explore–summarize instructional model and is intended to take approximately 180 minutes to complete.

Resources and Materials

- Student Resource sheet, *Democratizing Access to Healthy Foods* (1 per student)
- Worksheet, *The USDA Problem* (1 per student)
- 3 × 5 notecards (1 per student)

geometric techniques, tools, and points of view that are valuable to problem solving. (SAPM.2)

MATHEMATICAL PRACTICES

- Model with mathematics.
- Use appropriate tools strategically.

LESSON FACILITATION

Food Insecurity

Launch (25 minutes)

- Have students read the food insecurity facts on Austin provided in the Student Resource sheet, *Democratizing Access to Healthy Foods*, and review the map provided in the activity.
- Afterward, engage students in reflective group discussion. Consider questions like these:
  - *What do you notice?*
  - *What do you wonder?*
- Write the following quote from Rosa Flores in Austin, Texas, and the prompt on the board.
  - *"It's a great deal of trouble just to feed a family."*
  - *How do you characterize what "trouble" might look like when it comes to feeding a family?*
- Ask the class to consider the statement and prompt. Record responses on the board to engage the class discussion and keep it going.
- Next, have students respond to the following privilege survey and then together construct a dot plot.
  - Have students divide the card in half and draw a line labeling one side +1 and the other –1. Read the following prompt out loud: *Now that you know more about real food injustice in Austin, let's examine how this injustice can be present in our daily lives. I am about to read a series of statements. If the statement applies to you, please make a tally accordingly. Do not write your name on your notecard.* If this activity is being conducted in an affluent classroom where the statements may

not apply, consider assigning half the class to imagine they are individuals from the featured quote. Then they are to mark tallies as they would think Rosa Flores and her family members would.

If you

1. travel ten miles or less to get to the nearest grocery store, mark a +1 tally.
2. were ever worried whether your food would run out before you got money to buy more, mark a –1 tally.
3. have never used SNAP coupons (a.k.a. food stamps), mark a +1 tally.
4. have more corner stores (a.k.a. bodegas) in your neighborhood than grocery stores, mark a –1 tally.
5. have eaten more fresh food than processed food in the past week, mark a +1 tally.
6. have ever gone to school hungry because there was no food in your house, mark a –1 tally.
7. ever had to choose to eat fast food over fresh fruits and vegetables because of price, mark a –1 tally.

- Tell students to write the total sum on the back of the notecard and think about what the sum means. Collect the notecards and make a dot plot using the notecards for students to reflect on.
- Facilitate a discussion using the dot plot to connect to what students in different spaces experience. Consider the following prompts:
  - *What would it feel like to be in different points of the dot plot?*
  - *How do you think this experience compares to the food insecurity reality that Latinxs face in east Austin?*
  - *Why do you think there is such a huge disparity in the number of grocery stores on the two sides of Interstate 35?*
  - *Are there multiple grocery stores to choose from in your neighborhood? How do you determine which one to go to?*
  - *Fighting for those who experience an injustice means listening to their needs and acting with them on their behalf. How can you take a stand against injustice if you yourself have not experienced that injustice?*

Explore (120 minutes)

- Organize groups of three or four maximum. Consider forming groups that are heterogeneous in sociocultural ways (e.g., by race, socioeconomic status, home language) to ensure a diversity of ideas and experiences are brought to bear on students' problem solving.

- Distribute the worksheet *The USDA Problem* and have students begin the activity. The problem calls on students to develop a solution to an authentic problem posed by a "client," the US Department of Agriculture (USDA). A solution looks like mathematical ideas represented in some way, such as formulas or graphs.
- Some students may struggle with developing a single way to determine if a geographic region is a food desert, noting that urban areas are too unlike rural areas. This should be allowed.
- Have students use mathematics to develop two procedures for the USDA, one that they can use to determine if a geographic region is a food desert and one that they can use to locate a grocery store within a food desert so that it no longer qualifies as one.
- Have each group of problem solvers engage in modeling cycles where they iteratively refine their model to make it applicable to a variety of situations to develop procedures that the USDA can apply to locate food deserts and optimize the locations of grocery stores.
- Give groups an opportunity to clearly and precisely communicate their ideas and defend their decisions in the form of a letter written to the USDA.
- Have each group present their solution to the class.
- Have students use Google Maps to search for grocery stores in the local area and create a quick visual of your own community. As students work through this idea, consider some of the following questions to facilitate learning:
    + *What factors have played a major role in determining the number of grocery stores in a certain area?*
    + *Why do you think this is the case?*
    + *How could things be different?*
    + *Think back to the food injustice situation in Austin and the dot plot activity. Moving forward, what steps can we take as a school community to stand together against food injustice?*

Summarize (35 minutes)

The summary should be a time for students to clearly and precisely communicate their ideas and defend their decisions while providing the rest of the class an opportunity to engage with those ideas and critique the group's reasoning.

- Use students' solutions in selecting, sequencing, and connecting for mathematical and social justice objectives. Here are some ways students have gone deeply with mathematics when teaching this lesson:
    + They used the "distance formula"—an application of the Pythagorean Theorem—to compute the distances from each home to the grocery stores. Then they averaged those distances and compared them with

an agreed-upon average distance above which a region qualifies as a food desert.

  - They created threshold distances along with some percentage of homes located beyond that threshold distance.
  - They averaged the x- and y-coordinates of each home to find the "average location" of a home; they then computed the distance from that average home to the grocery store and applied their threshold criteria.
  - They averaged with consideration for outliers to determine a central location among the homes where the grocery store can be placed.
  - They determined the central location using circles with radii equal to their chosen threshold distance, polygons and a strategy for finding their centers, and ellipses with grocery stores located at their foci and some percentage of homes within their perimeter.

- Consider using some of the following prompts to facilitate discourse during presentations:
  - *Explain why the mathematics you ultimately used (e.g., the Pythagorean Theorem) makes the most sense to you.*
  - *What were the most important considerations behind your mathematical procedures for determining next steps for the grant program?*
  - *Look across the models developed by other groups in the class. What are the key mathematical ideas underlying each of the models?*
  - *How are similar ideas represented in different ways?*
  - *What do you see differently in your own model now that you've explored other groups' models?*
  - *What new insights do you have?*

TAKING ACTION

To begin action, students research their own contexts, apply their methods, then start a letter-writing campaign, as follows:

- Research if their neighborhood is actually a food desert and compare it with their own conclusion.
- Utilize the procedure they developed to identify a food desert and apply it to their own neighborhood.
- Discuss whose procedure matched the actual classification of food desert, and whose did not, and why they think that's the case.
- Write a letter to their congressperson to encourage them to craft and support legislation that would establish a program to provide grants for the establishment and operation of grocery stores in underserved communities.

WORKSHEETS AND TEACHER RESOURCES

online resources *These downloadable resources can be found online at* **resources.corwin.com/TMSJ-highschool**

◀ *Student Resource*

Democratizing Access to Healthy Foods

"It's a great deal of trouble just to feed a family."—Rosa Flores, Austin, Texas

Consider these facts about Austin:

Austin stands out as the most economically segregated major metro area in the country, where minorities, especially Latinxs, lack access to affordable housing and healthy food.

- Rosa Flores lives in eastern Travis County. She is among those who must travel many miles to the nearest full-service grocery store to buy fresh food at a lower price. We consider Rosa and her family to be food insecure—that is, they lack consistent access to enough food for an active, healthy lifestyle. The Flores family lives in what is known as a "**food desert**," which is a geographic area with severely limited affordable, healthy food choices (especially fresh sources of protein and fresh fruits and vegetables).

Image Source: resat_dongel/iStock.com

Where are the majority of full-service grocery stores in Austin? ***In districts where most of the residents are white and wealthy.***

- District 2, where 69 percent of the 80,004 residents are Hispanic, has only two grocery stores. By contrast, there are nine such stores in District 10, where 9.3 percent of the 80,839 residents are Hispanic and 78.3 percent are Anglo. The difference in median household income is about $90,000 between districts, according to city data.

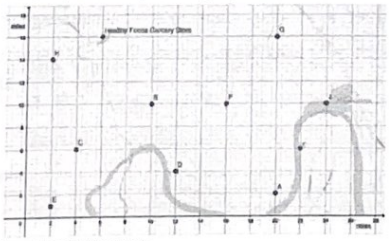
▶ *Worksheet*

The USDA Problem

"Food deserts" exist in areas where it proves to be extremely difficult for residents to access affordable, healthy foods. In order to expand the availability of healthy foods, the US Department of Agriculture (USDA) has developed a program to provide grants to states for funds to support the establishment and operation of grocery stores in underserved communities. In order to implement this program, the USDA needs a procedure for determining if a particular geographic region qualifies as a food desert.

The map below identifies the locations of ten randomly selected homes along with the grocery store that's closest to each of them.

1. What questions do you have when looking at this map?
2. How long does it take you to get from your home to a grocery store that sells fresh foods?
3. Would you say Home G has easy access to the grocery store? How far is it?



Source: Map Data © Google 2020

4. The USDA has asked you to help them with their grant program by doing the following:
   a. Develop a procedure for determining if this region qualifies as a food desert. Show how your procedure works for all ten houses shown on the map. Give details so that the USDA can check and employ your procedure to locate food deserts.
   b. Develop a model that will help the USDA identify the optimal location for a new grant-supported grocery store in this area so that it is no longer classified as a food desert.
5. Write a letter to the USDA officials that explains how your two procedures work. Make sure the officials will understand how to use your procedures not just for the map in this problem but also for any map of a geographic area they wish to investigate.