Scaling The Field
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Scale - the ratio between the size of something
and a representation of it.

Purpose:

We are going to make a replica of the Botball game board. It is going to be to scale. We will use a piece of foam board. After creating the model we will use it to plan strategy for our game plan.

Assignment:

Make the largest Botball board model possible on our foam board. The dimensions of the full size board are available from the Botball website, http://www.botball.org/. You find it by logging into the 2010 Team Home Base, 2010 Botball Tools, 2010 Workshop Files, Documents, Game_Documents, and then choose Botball_2010_Table_Construction_1.1.pdf.

Materials:

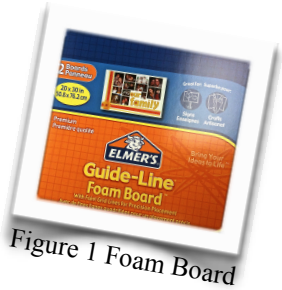

Figure 1 Foam Board

1. A large board made of cardboard, tagboard, or foam. We used a 20 x 30 inch foam board. The name of the foam board we used is Elmer's Guide-line foam board. It came from Walmart and two of them cost approximately $10. (See Figure 1)
2. Box cutter, scissors, or knife to cut the board.
3. Pencils, markers.
4. Materials to represent the game pieces. These will depend upon the final size of your model.

Step One:

Study the dimensions of the full-size game board.
The game board is made up of five 4 x 4 ft. pieces arranged in a rectangular pattern. This creates a rectangle 8 feet by 12 feet. (See Figure 2) This gives us a proportion of 8 to 12.
Reduce this: $\frac{8}{12} = \frac{2}{3}$ We will use this to scale our model board.

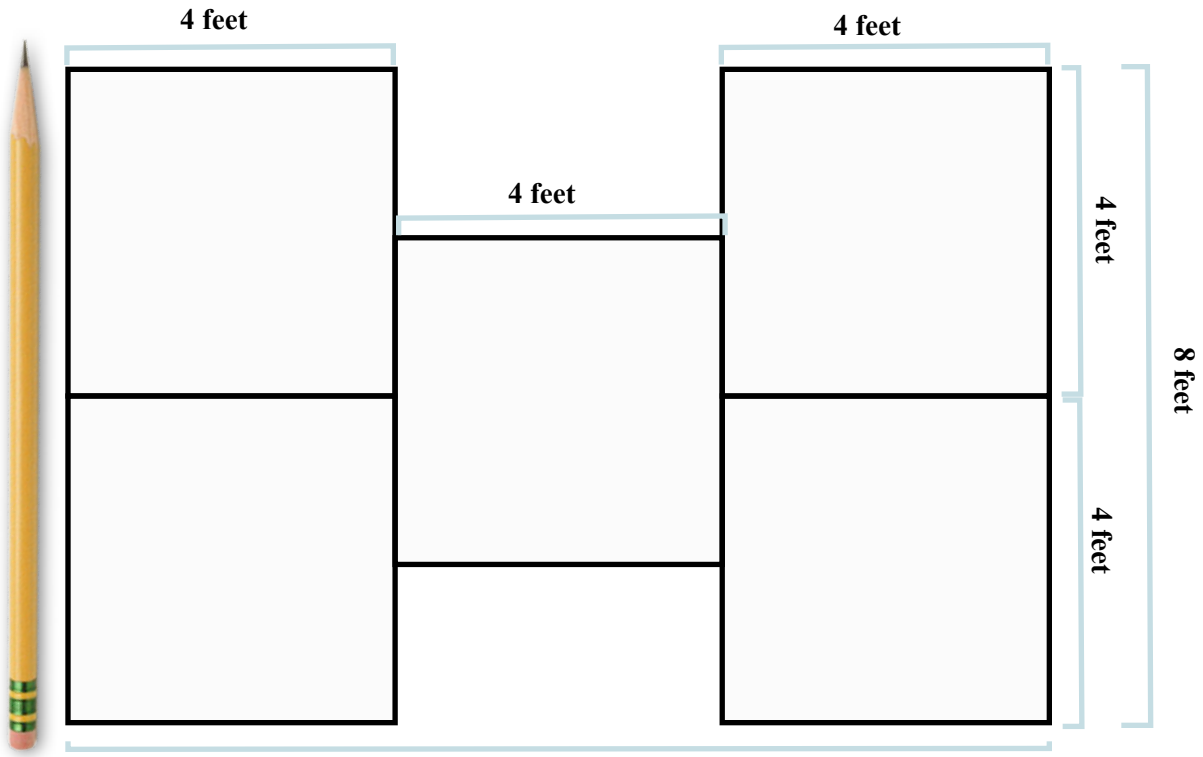

Figure 2- General Dimensions of the full-size Botball game board

Step Two:

Measure the piece of board that you are going to use to make the model. You can use different methods to figure out how big your model can be. Our assignment was to make the largest model possible for the size of our board. Here are some ways to figure it out:

To keep the scale of $\frac{2}{3}$ our model must also have the same scale. Another way of saying that is the board needs to be 2 units wide and 3 units long. It doesn't matter what the unit is as long as it is 2 by 3.

Examples:

Board Width	*Board Length*	*One Unit*	*Two Units*	*Three Units*	*Largest Model*
24 inches	*80 inches*	*Using Width 24/2= 12*	*12 x 2 =24*	*12 x 3 =36*	*24 in by 36 in*
120 cm	*210 cm*	*120/2 = 60*	*60 x 2 = 120*	*60 x 3 = 180*	*60 cm by 180 cm*
Board Width	*Board Length*	*One Unit*	*Two Units*	*Three Units*	*Largest Model*
90 inches	*90 inches*	*Using Length 90/3 = 30*	*30 x 2 = 60*	*30 x 3 = 90*	*60 in by 90 in*

Solve for X:

Another way to figure out the model board dimensions is to solve for x. The x can represent either the width or the length of the model board. The problem looks like this:
Board size: 24 in by 80 in

x = length	Cross multiply		Largest Board	Possible
$\frac{2}{3} = \frac{24}{x}$	2x = 72	Length x = 36	24 in by 36 in 2 units 3 units	Yes
x = width				
$\frac{2}{3} = \frac{x}{80}$	3x = 160	Width x = 53.3	53.33 in by 80 in 2 units 3 units	No

Each unit represents the 4 x 4 ft. section in the full-size board. To discover the scale you take the length of one unit and divide by 4. In the example above one unit equals 12 inches. Divide by 4 and you get 3 inches equals 1 foot.

Our Board

The board that we chose had a grid printed on one side. The width was 40 squares and the length was 61 squares. One unit equals 20 squares. The largest board we could make was 40 squares by 60 squares. The scale was 5 squares = 1 foot. We measured the square and came up with 13 mm, but when we measured the length on the board it didn't fit. We went back and remeasured the square and realized it was only 12 mm. We needed a more accurate ruler to get the measurement more precise. This gave us a scale of 60 mm = 1 foot. (See Figure 3) We also did the solve for x on the board to make sure we had the right dimensions. (See Figure 4/5)

Next we drew out the board placing the center 4x4 in the middle of the two sets of 8x8 squares. Then we cut the board out. We used a box cutter and a pair of scissors. Mrs. Gundlach helped with the box cutter. Always remember: Safety first. (See Figure 6/7)

Figuring Out the Dimensions for Our Scale Model

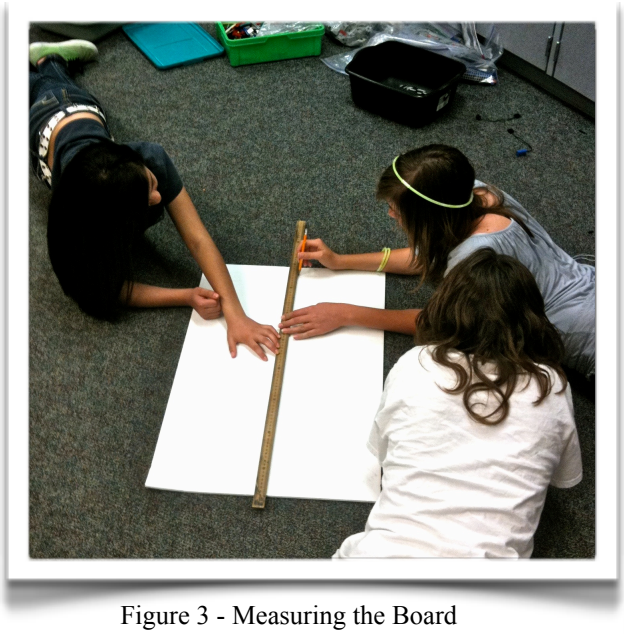

Figure 3 - Measuring the Board

Figure 4 - Figuring Out the Dimensions

Figure 5 - Solving for X

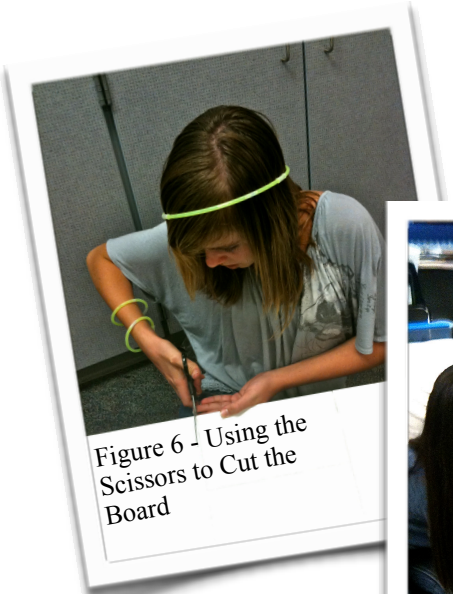

Figure 6 - Using the Scissors to Cut the Board

Figure 7 - Mrs. Gundlach Helping with the Box Cutter

Make It Big - Scale It Up

Another great activity is to do the opposite of the project. Instead of creating a scale model you can make a larger version of the Botball game board. This gives students an opportunity to combine their math skills and programming knowledge to participate in a fun activity. Mrs. Reynolds and Mrs. Gundlach worked on such an activity with the 7th grade math classes at John Glenn Middle School in Indio, CA. Here's what they did.

Assignment:

1. Create the largest Botball game board possible on the floor of the classroom.
2. Make all the game pieces to scale to fit the large board. The robots are played by the students themselves.
3. Develop strategy to play the game and write a program to score as many points as you can.
4. Each student must add up all the points their robots scored using the scoring chart in the Botball game documents. Their grade is based on being able to accurately add up the score.

Activities:

1. Students work in groups of four. Each group studies the full-size board using the game documents from the Botball workshop.
2. Measure the room and decide what scale to use for their board. The board has to fit in the room and be as large as possible. The desks and chairs can be moved but not taken out.
3. Each group goes to the Multipurpose room and practices making a large Botball game board on the floor. The board must fit in the available room in the classroom. The groups practice moving around on the board and scoring points.
4. The students recreate one board on the floor of the classroom at 2 1/2 scale.
5. Each group creates their own set of game pieces. They use stuffed animals for Botguy, small cereal boxes for the ducks, and crumpled paper for the frogs. (See Figure 8)
6. The groups plan strategy and write a program. The programmer calls out the commands and the student "robots" execute them. The programmer has to face the wall and not look at the game board. (See Figure 9) The students acting as "robots" are blindfolded to simulate being autonomous. (See Figure 10)
7. The teacher scores the points to use as a key for grading the students. (See Figure 11)

Figure 8 - Game Pieces

8. Each member of the group has to score the points at the end of the game using the scoring chart. (See Figure 12)

Results:

The students did a great job recreating the board and making the scale game pieces. The programs were good and the "robots" moved around the board well using different methods to sense where they were. (See Figure 13)

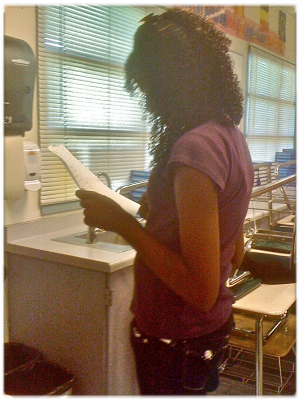

Figure 9 - The Programmer

Figure 10 - The "Robot"

The hardest thing was the scoring. On the first day of the activity none of the students were able to accurately add up the points by reading the score chart.

To help them understand better, Mrs. Gundlach had another lesson on how to read the chart. Reading and interpreting graphs is a very challenging 7th grade standard. There is not enough real life application problems that the kids can relate do. This activity forced the kids to read the chart in order to to play the game. When they got a grade for how well they could keep score, they did a much better job! Then the students did the activity again. This time they succeeded.

Figure 12- Each student figuring out the final score.

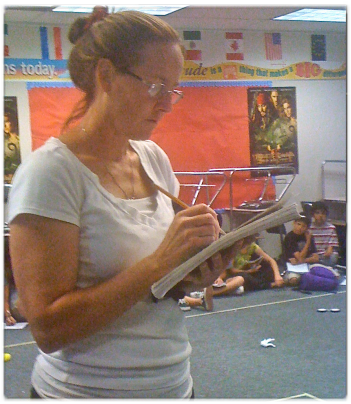

Figure 11- Scoring

Figure 13- Autonomous "Robot" sensing the game pieces.

The activity was a great success. The students loved the hands-on aspect of the game and they learned a lot about both math and programming. The students said, " Can we do this tomorrow", "We messed up, can we do it again?". When the robotic team came in after school for practice they all wanted to do the project themselves. They even got some of their friends who were not in the class or the robotics team to do the activity after school. They entertained themselves for over 45 minutes. Next year I plan to include even more activities that incorporate the Botball game and 7th grade math standards. The students love the projects and they really see the relevance of math to a real-world problem.