Maps 3: Polar Coordinates

Imagine you're trying to hike to a mountain, and you have a compass. When you're hiking you don't need to know that the mountain is at 41.3099° N, 122.3106° W (those are GPS coordinates, and they are a lot like the coordinates we made a few weeks ago).

What you want to know is how far away the mountain is, and what direction to go – head forward, and a bit to the right, for five miles.

These are called "polar coordinates." They are different from the maps we made a few weeks ago, because you don't need to start off by making a big box. Polar coordinates are special because they are centered on you!

The direction and the distance to the mountain depend on where you are standing. For some people, the mountain is very far to the north. For other people, the mountain might be close by, and to the west. So everyone's polar coordinates are different.

Another name for a polar coordinate is a vector – a piece of information that has a distance and a direction.

For these activities, we are going to use polar coordinates to do some mapping. Get ready, explorer!

Maps 3: Polar Coordinates

Activity 1: Locating Items on a Polar Grid

Objective
Children will understand polar coordinates, and how to locate objects from a central point using direction and distance.

This activity is a nice follow up to the previous Map Making activities - but it is not necessary to complete it beforehand.

Ages: 3 - 9 years

Materials
- 3-5 random objects or toys
- masking tape or string
- paper
- marker
- pencil
- ruler/measuring tape (helpful but not necessary if you do not have one)

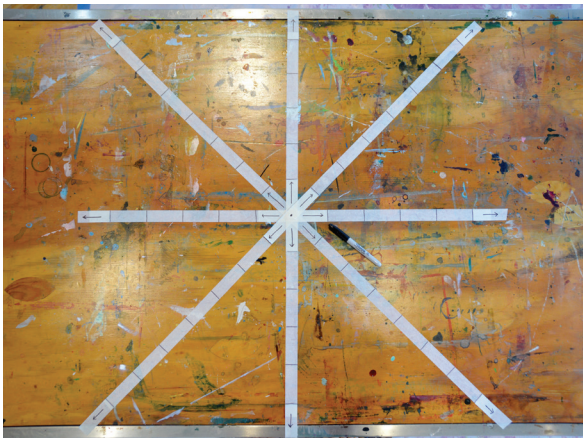
Process
1. Find a spot on the floor, or a large table. Depending on the age of the child, this step can either be completed ahead of time or together.

Using masking tape (string works too, if you don't have any - you can create knots to mark the units), map out a cross - that is, two axes that intersect in the middle, perpendicular to each other, like a cross.

Then bisect this cross, with two more pieces of tape so that you have a large 8-point star. The pieces of tape can be about the same size, and if you are plotting it out in a square shape, the diagonals will be slightly longer. No need to measure any angles, just roughly approximate these lines. Mark a dot in the center.

Create arrows along the pieces of tape, radiating from the center, and also at the end of each piece - so that the arrows show the direction that the tape line is going.

2. Mark the tape. For our demonstration, we created marks every 3 inches along the tape - but you can use whatever unit feels right for the space. The idea here is that we are using uniform units of measure, not necessarily a specific measurement, like an inch. Keep in mind the age of the child so that there are not too many loans to count, and that it is easy to follow for the child.



3. Explain.
If you were able to complete the Mapping #2 Activities, you may recall that we learned how to map using a grid. If you did this activity, review the key points and discuss how we located objects on the grid (i.e. we count how many steps across, and then how many steps up...)

Today we are going to learn a new way of locating things. Can you point to where your school is? (or church, or friend's house, or grandma's house, etc.) *And where is the park? Can you point which direction it is?* (or another known landmark?)

And how long does it take to get to the park? Is it far? Is it near?

The point here is not to get answers that are accurate, but rather to introduce the idea of locating places in relationship to a specific point (in this example your home) and using a direction and a distance. This is like a vector, which has a direction and a magnitude. When you point to a place, and tell me how long it takes to get there, do you think I could find it? Why or why not? We are going to explore maps today, and this idea of how far things are away from us, and which direction they are in.

4. Place an object (something small, like a Lego or toy, or rock, etc.) somewhere on the coordinates, at a line marked on the tape. Now point to the center where they intersect. Using your finger count how many lines between the center dot and the object. For example, say it is 3 units.

And what direction from the center is it? Point to the arrow on the piece of tape. Depending on the age of the child, you can attach language to this such as left, right, down, up or north, south, east, west - but for younger ones, the idea is that we are associating a length with a direction and so pointing to the arrow, and also pointing in the direction that the tape is going out from the center is good.

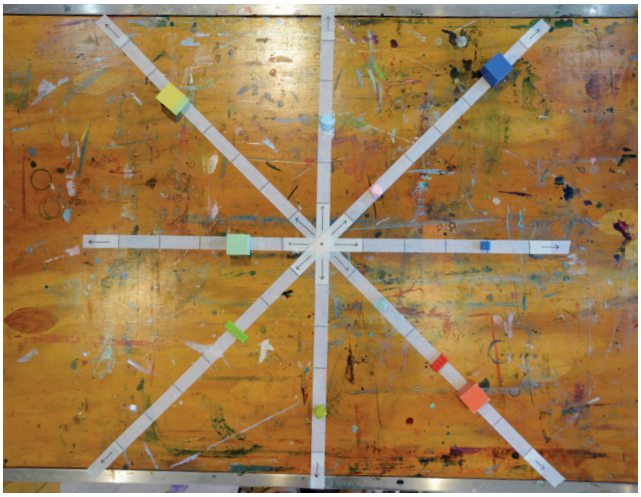
5. Place another object, and ask the child to tell you two things:

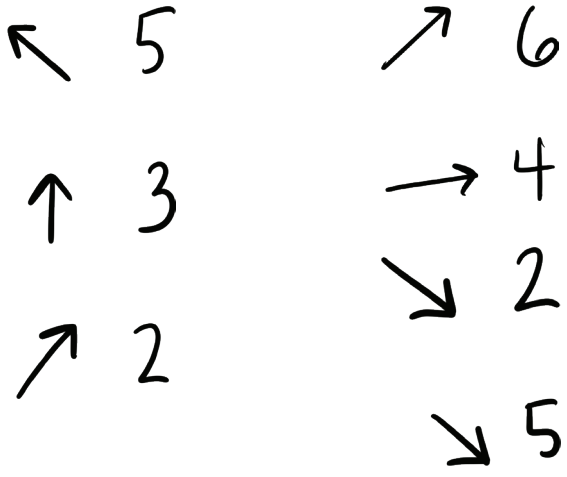
Which direction is this object from the center? Can you point which direction it is? Which arrow? And how many steps? Can you count with your finger?

Using a piece of paper, write how we can show this, like so:

6. Place another object, and ask the child again, and depending on the age of the child, have them say or write out the coordinate, using an arrow and a number. Remind them this is a direction and a distance.

7. Place 3-5 new objects on the grid and ask the child to say, or write out, their coordinates.





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Activity 2: Using polar coordinates to place items on the grid.

Objective
Children will understand polar coordinates, and how to locate objects from a central point using direction and distance.

Complete this activity after completing Activity 1.

Ages: 3 - 9 years

Materials
- 3-5 random objects or toys
- masking tape or string
- paper
- marker
- pencil
- ruler/measuring tape (helpful but not necessary if you do not have one)

Process
In the second exercise, we will use the same grid. Review the key concepts.

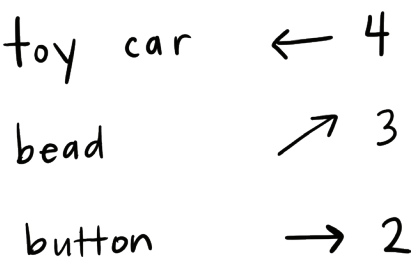
This time, we will start with information (a polar coordinate) and represent it in physical space.

On a piece of paper, write out a coordinate, such as:

Remember to use the direction first as an arrow, and then use the distance counting the marks on the tape.

Return to your grid. Ask your child to place an object at that location.

Now try assigning coordinates to a number of different objects. For example:



Ask the child to arrange the objects.

Maps 3: Polar Coordinates

Activity 3: Using a compass to locate polar coordinates

If you have an older child, and want to go further into the idea of polar coordinates and orienteering, Exercise 3 becomes slightly more complex. For this, we will leave behind the star we made before, and use a real compass instead.

1. Place an object on the floor. Explain that we are going to say where the object is using polar coordinates.

2. Have the child sit down nearby, holding the compass. Ask them to point to the object. Good!
Now, ask the child to look at the compass and see where the north arrow is pointing. Ask them to turn and sit facing north.

3. Now, point at the object again. Observe that they are pointing in a different direction now!

4. Ask the child, "Imagine that you are at the center of the star we made before. What are the polar coordinates of the object?" For example, if the object is to the right, within arms reach, it might be "West, 2 feet."

5. Now, ask the child to stand up and walk to a different part of the room. Sit down again, and turn to face north.

6. Now point to the same object again. What are the new polar coordinates? Point out how these coordinates are different than the last coordinates – even though the object hasn't moved at all!

7. Now try placing two different objects on the floor. Identify the coordinates of each. Stand up, sit down again, find north, and give new coordinates.

8. You can explain how polar coordinates are a useful way to navigate.