Where is Here?

Unit Topic: Navigation
Grade Level: 7th grade (with suggestions to scale for grades 6 to 8)
Lesson No. 1 of 10
Lesson Subject(s): Grids, Latitude, Longitude, Compass
Key Words: Grids, Latitude, Longitude, Compass, Directions, Map, GPS

Lesson Abstract —

In this lesson, students are shown the very basics of navigation. The concepts of relative and absolute location, latitude, longitude, and cardinal directions are discussed, as well as the use and principles of a map and compass.

The activities include:

- Nidy Gridy – students individually make a map of the classroom using grids/coordinates and learn why having a common method of map-making is important.
- Northward Ho! – students, in teams of two, make a simple compass using magnets, needles and bowls filled with water.

Lesson Opening Topics / Motivation —

Ask students how we know where we are? (Possible answers: Because we can see we are in the school, we have maps, we just 'know,' use a compass.) However, that does not tell you *where* you are.) In a classroom, there are many ways to feel comfortable knowing where you are in relation to other places we know — this is called *landmark navigation.*

What if you were blindfolded, flown to a foreign country and dropped off in the middle of a city. How would you know where you are? (Possible answers: Ask someone? Purchase a map?) Now there are no familiar landmarks! If you do not speak the language, your best chance is to purchase a map, and see if you can match the new landmarks around you to the map.

What if we were in the middle of the ocean? All you can see is water all the way to the horizon in every direction! How do we know where we are now? (Possible answers: Maps? Perhaps a savvy student will say stars!) Draw a box on the chalkboard and put a few waves in it. Ask the students if this map would be helpful to them. (Answer: No.) Is there anything around you that you can see and recognize? If no student has mentioned it yet, suggest *stars* to help determine where they are. Next, draw another box on the chalkboard and put a few stars in it. Ask how helpful is this map? Tell the students that even if they recognize patterns in the stars, there is another problem: almost all of the stars move throughout the night! If students know that the North Star is fixed, tell them that that is a good start because you can always find the direction north. However, you can see the North Star from *anywhere* in the Northern Hemisphere, so you have only actually narrowed your location down to half of the earth! Tell the students that before modern technology, people did navigate using the stars, but it was not easy. The students will learn more about navigating with the stars — but today they just need to learn to navigate in their own classroom (cannot see any stars right now!).

Lesson Desired Student Outcomes —

Students will understand the concept of coordinates, cardinal directions, and the importance of using common symbols and methods when making maps.

Science: Students should be able to:

- Predict (hypothesize). (1)
- Evaluate data from other students to formulate conclusions. (1)
- Describe how using and understanding maps and compasses can help determine your location. (5)

Math: Students should be able to:

- Use numbers to count, measure, label, and indicate distances on a map. (1)
- Identify grid coordinates. (2)
- Scale graphs. (4)
- Simplify fractions. (1)
- Create a bar graph. (3)
- Know compass directions and that there are 360 degrees in a circle. (3)
- Measure (or estimate) angle measurements in 45 degree increments. (5)

Colorado State Standards Met

http://www.mcrel.org/compendium/search.asp

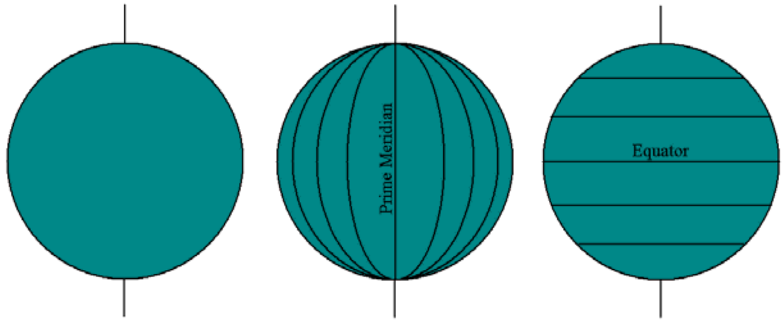
- Science Standard 1, 5
- Math Standard 1, 3, 4, 5

Lesson Background & Concepts for Teachers —

Overview

The following topics will be discussed:

- Latitude and Longitude,
- Degrees, Minutes and Seconds,
- Compass and Maps,
- The Earth's magnetic field (how a compass works), and
- Global Positioning System (GPS).



Imaginary lines of longitude (center) and latitude (right) help geographers pinpoint locations on Earth.

Image created by: Matt Lippis, University of Colorado, Boulder

Latitude

The measurement that tells you how far you are north or south is called *latitude.* On a globe, latitude lines appear as parallel rings that wrap the earth.

In the map below, the surface of earth has been flattened out and stretched at the top and bottom so that it is rectangular. Here, latitude is shown as horizontal red (bold) lines, and the equator is shown as a thicker red (bold) line. All points on any one latitude line are the same distance from the equator. Latitude lines are also called *parallels* because on a globe, latitude lines never touch each other — they are parallel to each other.

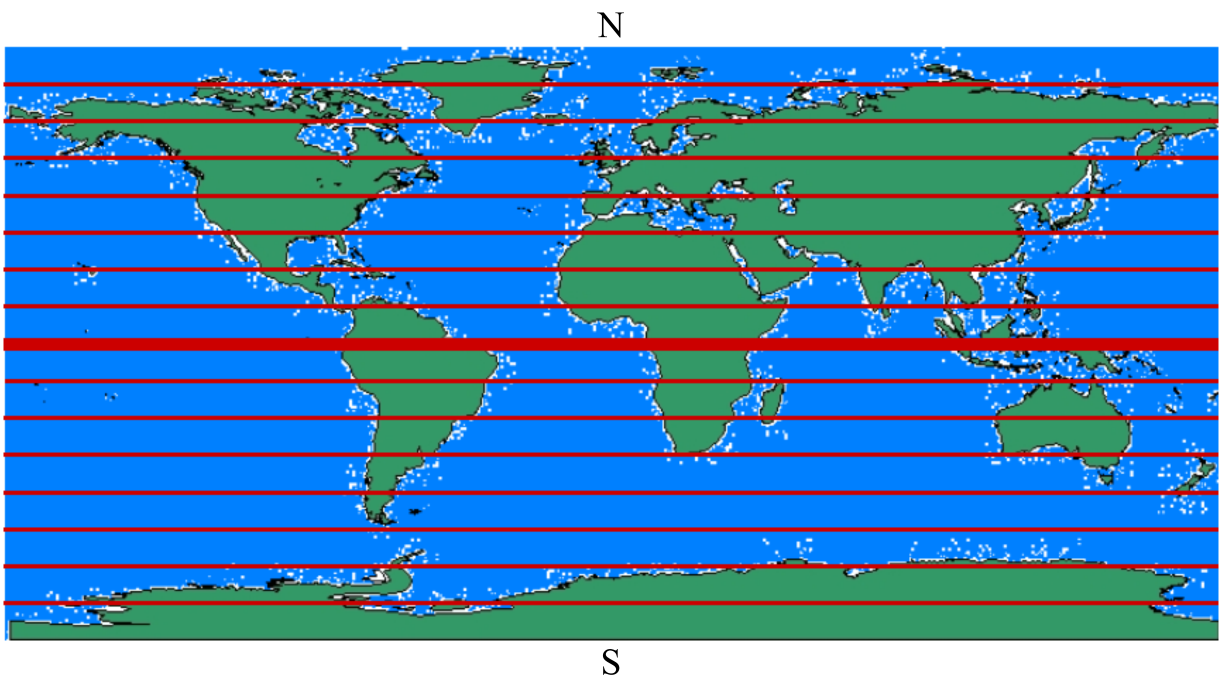
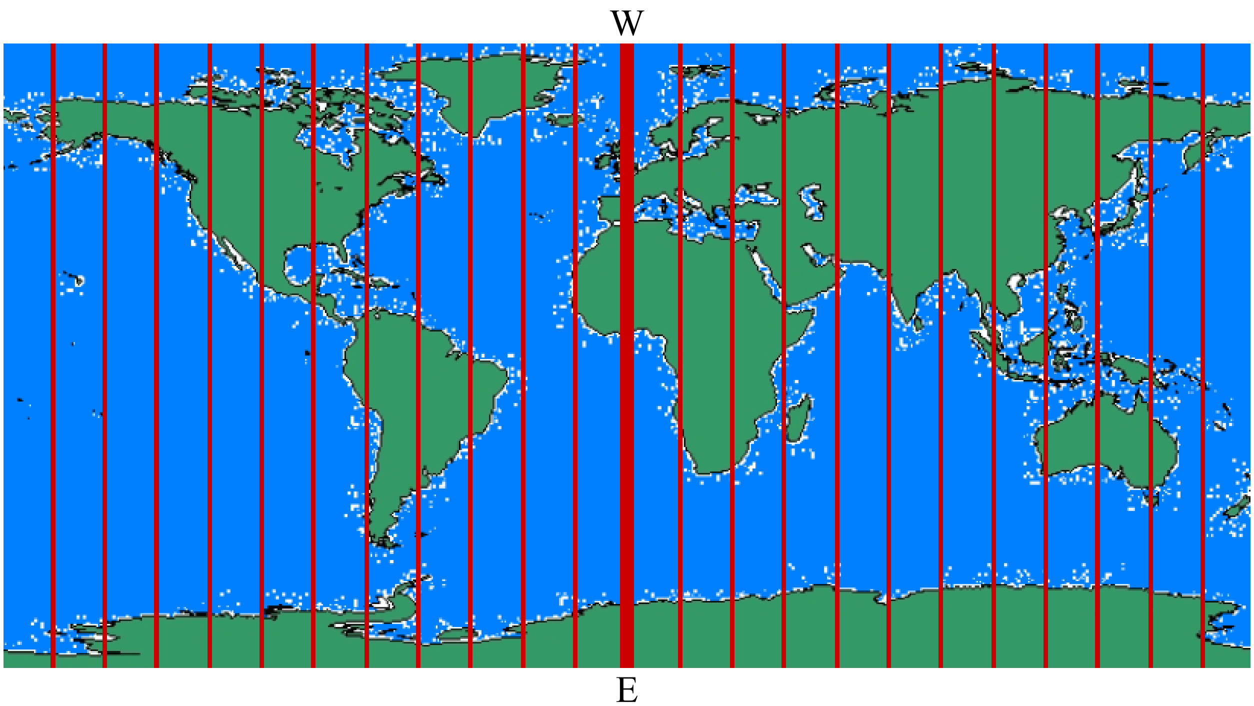


Image created by: Matt Lippis, University of Colorado, Boulder

Longitude

The measurement that tells you how far you are east or west of the Prime Meridian (the thick line that passes through Greenwich, England and part of Africa) is called *longitude.* On a globe, longitude lines appear as vertical bands that meet each other at the North and South Poles. They are not parallels (like latitude lines), since they actually all touch each other on the north and south ends of the earth.



← negative longitude **positive longitude →**
Western Hemisphere **Eastern Hemisphere**

Image created by: Matt Lippis, University of Colorado, Boulder

In the map above, longitude is shown as vertical lines, and the prime meridian is a shown as a thicker red (bold) line. Longitude measures how far east or west along the equator something is located. See diagram on page 3.

Putting Latitude and Longitude Together

Putting the latitude and longitude together, we now have a nice grid and can identify any point on the earth.

- North/South of the Equator **- East/West of the Prime Meridian**

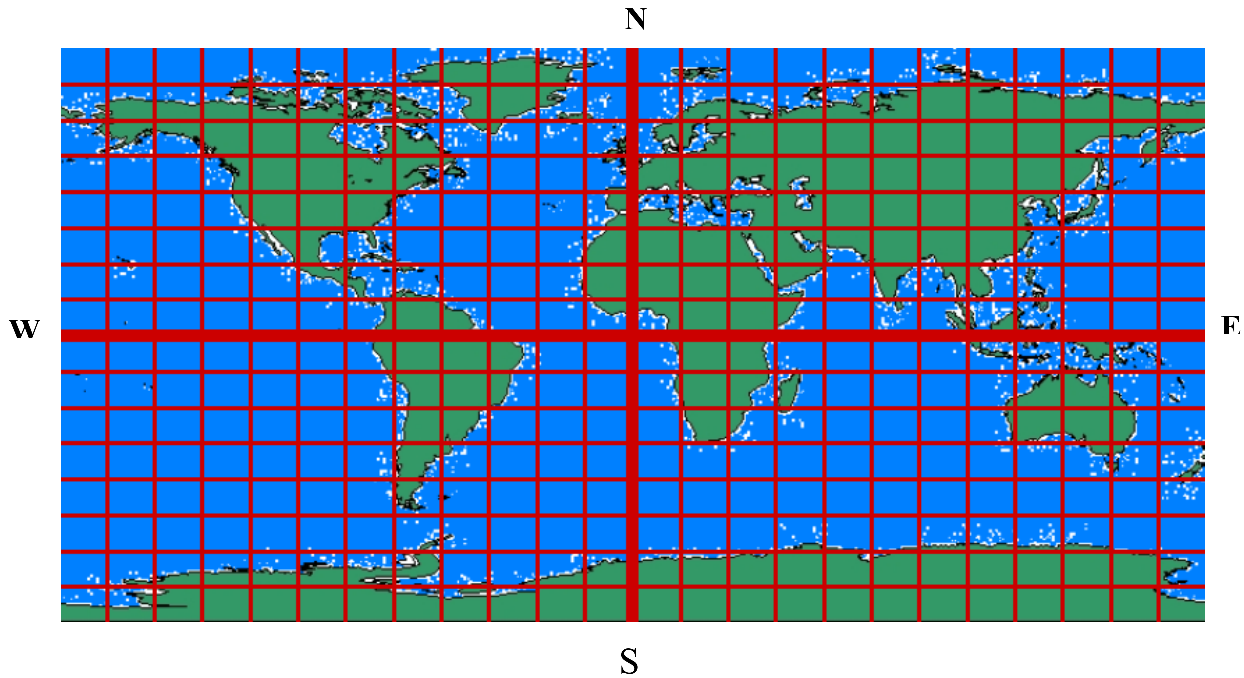


Image created by: Matt Lippis, University of Colorado, Boulder

Degrees, Minutes and Seconds

How do we measure latitude and longitude?

Longitude: Just like a circle, any longitude line (or ring) on the earth is separated into 360 degrees. It is easiest to visualize along the equator. Looking at the longitude map above there are 24 sections (divided by the red lines), 12 each for the west and east sides. Taking 360 degrees and dividing by 24, we know that each section is 15 degrees across. The reference point (or zero degrees) is from prime meridian, which is located at Greenwich, England. From here you can measure 180 degrees to the west, 0 to –180 degrees. You can also measure 180 degrees to the east, 0 to 180 degrees. Western degrees are always negative, and eastern degrees are always positive. As an example, Boulder, Colorado is at –105 degrees longitude.

Latitude: Starting from the equator, you can measure 90 degrees northward and 90 degrees southward. As an example, Boulder, Colorado is at 40 degrees N (north). The South Pole is at 90 degrees S (south), and the North Pole is at 90 degrees N.

The distance covered by a single degree is too large for practical use, so the system of minutes and seconds was developed. A degree is divided into 60 minutes. For even more detailed use, a minute is divided into 60 seconds. One second of latitude corresponds to about 30meters on the surface of the earth.

1 degree = 60 minutes

1 minute = 60 seconds

1 degree = 3600 seconds (60 minutes x 60 seconds)

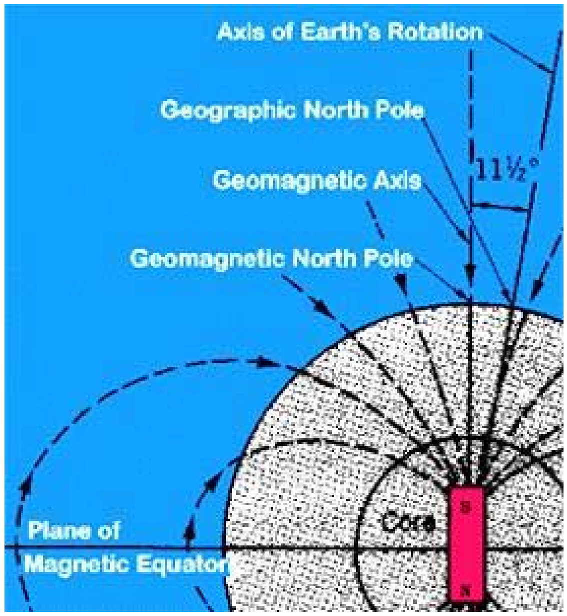


Image source: http://rst.gsfc.nasa.gov/Intro/Part2_1a.html

Compasses and Earth's Magnetic Field

The earth has a magnetic field that flows from the geomagnetic South Pole to the geomagnetic North Pole. It is this field that causes the alignment of a compass needle, which is magnetized. Luckily, the geomagnetic poles are close to the geographic poles. Therefore, when a compass needle points in the direction of the magnetic field (pointing towards the geomagnetic North Pole) it is pointing pretty close to the geographic North Pole (or, *True North*).

The slight deviation from the geomagnetic pole and the geographic pole is called the *declination.* On any good map, the declination for that area will be shown. This way you can calibrate your compass, which is pointing to geomagnetic north, to point at the geographic north, or True North.

The origin of the magnetic field is still a question that has not been fully resolved, but many geophysicists believe it is generated as the rotation of the earth causes slow movements in the liquid outer core. The magnetic lines of force resemble those that would be formed if there were an imaginary bar magnet extending through the earth's interior. At the present time, the geomagnetic pole is located 11 degrees of latitude from the geographic pole.

Global Positioning System

The Global Positioning System (GPS) is just as it sounds. It is a publicly available system that you can use to find your position anywhere on the globe. To use it, you need a device called a *GPS receiver.* More than 24 satellites constantly circle the earth and broadcast radio signals. A GPS receiver accepts these signals and uses them to determine its, or your, position. The great thing about GPS is that it is relatively inexpensive, user friendly and accurate. A "no-frills" receiver will cost around $100. To determine your position using a GPS receiver, all you have to do is turn it on, wait a few minutes, and the receiver reveals your latitude and longitude. A-top-of-the-line receiver will be accurate within approximately 20 feet of your actual location. Besides all the commercial/industrial uses, they are very popular for personal recreational activities. The GPS will not only tell you where you are, but will keep track of where you have been and help you return there. This is an invaluable device if you are hiking in mountainous areas — on or off trails, boating, or skiing, among other activities. GPS will be covered more in depth in later lessons.

Lesson Vocabulary List —

- **Navigation** – Following a planned course to and from known points.
- **Latitude** – Latitude is distance north or south of the Equator.
- **Longitude** – Distance east or west of the Prime Meridian.
- **Equator** – The line of 0 degrees latitude.
- **Prime Meridian** – The longitude line that runs through Greenwich, England, is internationally accepted as the line of 0 degrees longitude.
- **Cardinal Directions** – One of the four principal directions on a compass: north, south, east, or west.
- **Compass** – An instrument that uses a magnetized metal bar to indicate the direction of the earth's magnetic poles.
- **GPS or Global Positioning System** – This is a system that allows anyone with a receiver to determine their location. It is based upon a series of satellites that broadcast information down to the earth's surface. A receiver (available to the public) picks up these broadcasts to determine its location.

Activity Attachments —

Activity 1: Nidy Gridy – students individually make grids to locate points in the classroom. They learn that they must devise a system *together* for everyone to be able to use it.

Activity 2: Northward Ho! – students will learn how important magnetic directions are for maps. They will also make a basic compass to find North in the classroom.

Lesson Closure and Follow-up —

Ask students how they will get home after school. (Possible answers: walk, bus, parents pick up.) What form of navigation will they use to arrive at their house? (Hopefully they will be aware that they will use landmark navigation — navigation through places and things that they recognize, even if it is just to know when to get off the bus.) Ask if they know whether their house is north, south, east, or west from the school? How could they figure it out? (Possible answers: look at a city map, landmark they can see from the school and their house, draw a map as they go home, etc.) Ask them if they think their house has a latitude and longitude? (Answer: yes or no.) Because they know and recognize landmarks in their neighborhood, they do not need a grid and coordinates to find their house, but what about other people? Oftentimes people need a long list of directions to find a house, but every house has a specific latitude and longitude — all you need if you have a good map!

Lesson Extension Activities —

- Have each student bring in their address and look up their own — or alternatively, the school's — latitude and longitude (as close as possible with what ever maps are available).
- Find the distance between two locations if you know the Lat, Long! http://jan.ucc.nau.edu/~cvm/latlongdist.php

Lesson Assessment and Evaluation —

Pre-Lesson Assessment

- Discussion Question: Solicit, integrate, and summarize student responses.
  - How do we know where we are? (A: See Lesson Opening Topics/Motivation section above)

Post-Introduction Assessment

- Voting: Ask a true/false question and have students vote by holding thumbs up for true and thumbs down for false. Count the number of true and false and write the number on the board. Give the right answer.
  - True or False: How many people think a map is all you need to know where you are anywhere in the world? (Should be zero — a map alone is not enough.)

Post-Lesson Assessment

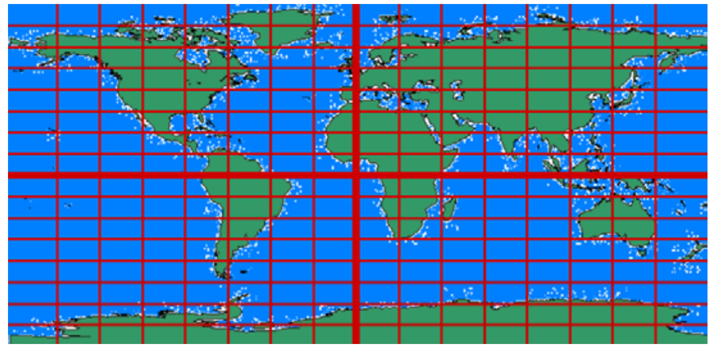
- Flashcards: Each student on a team creates a flashcard with a question on one side and the answer on the other. If the team cannot agree on the answers they should consult the teacher. Pass the flashcards to the next team. Each member of the team reads a flashcard, and everyone attempts to answer it. If they are right, they can pass the card on. If they feel they have another correct answer, they should write their answer on the back of the flashcard as an alternative. Once all teams have done all the flashcards, clarify any questions. Sample questions follow if you need to help students with ideas:
  - Name three things to find the north direction (Answer: compass, stars, GPS)
  - How many landmarks are needed to orient a map? (Answer: 2)
  - How many directions are needed to orient a map? (Answer: 1)
  - Is a car a good landmark? (Answer: No – it moves.)
  - How many coordinates do we need to map the earth? How about in space? (Answers: Two for Earth, because it is locally flat. Three for space because you can move up and down.)

Lesson References —

http://www.ars-grin.gov/ars/MidWest/Ames/Images/Eight_World Map.jpg

http://rst.gsfc.nasa.gov/Intro/Part2_1a.html

Activity: Nidy-Gridy



This activity is planned for 28 students working individually.

Activity Materials List —

- 28 How to Graph handouts
- 28 Blank Graph handouts
- 28 Grid Worksheet handouts
- 40-50 feet of string (two pieces long enough to reach from wall to wall of the classroom).
- Lat and Long cards

Activity Equipment and Tools List —

- Pencils
- Tape measure

Activity Cost Estimate —

Less than $5 total.

Activity Attachments —

Graph Paper Handout   Grid Worksheet

Relative Size Worksheet   Lat / Long cards

Activity Time Estimate —

40 – 50 min.

Activity Procedure —

A. Background:

Normally we find things using landmark navigation. When you move to a new place, it may take you awhile to explore the new streets and buildings, but eventually you recognize enough landmarks and remember where they are in relation to each other. However, another accurate method to locate things is using a *grid* and *coordinates.* If there was a huge grid with numbers painted on the ground throughout the city, and you knew the coordinates of your destination, you could just follow the increasing or decreasing number to your desired location. Unfortunately, there is not a grid painted all over the city (although sometimes numbered streets come close!), but if you have a map and know where you are on that map, you can easily find another location by moving the correct distances indicated by the grid on the map. The common system used for distances on maps all over the world is called *latitude* (distance North-South) and *longitude* (distance East-West).

In this activity, students will come up with their own system of a grid and coordinates for their classroom and then understand why it is good to have one common method of map-making.

B. Before the activity:

Read through all the steps of the activity and have some relevant questions ready. Check your room size using a tape measure and print Lat / Long cards.

C. With the Students:

Ask the students if they think they can find any spot in the classroom? (Yes!) Ask, where is the chalkboard? (Possible answers: right there, students may point, etc.) Ask where am I? (Same answers and pointing.) Ask, where am I in relation to other objects in the classroom? (Possible Answers: next to the board, next to that desk, etc.) Once several students have described your position, ask if you are a good landmark. (Answers: yes and/or no). Walk 5-10 feet (several meters) away. Uh-oh! I moved! Now where am I? (As students try to answer, keep moving.) Tell the students that good landmarks do not move. Now ask the students if they can find this spot in the classroom: (5,3) (write it on the board). Tell them that these numbers represent a spot in the classroom. Why can't they find it? They should know that they have no basis or reference for what the numbers mean. Say that it is obvious to you what the numbers represent. How could you convey that information to them? (Answer: draw a map.) Tell them a map is a great idea, and that they will have to come up with a system and draw their own maps.

Part I

1. Give each student a blank classroom graph sheet.
2. Tell them they have 5 minutes to draw the objects in the classroom into the box on the sheet. They should draw the walls first, and they should put a star on their desk when they have finished drawing it.
3. When the 5 minutes is up, have the students choose one corner of their drawn room, and mark one wall leading from that corner as "x" and other one as "y."
4. Have the students put a numbering system on the x- and y-labeled walls (any way they want: up, down, 3 numbers on a side, 25 numbers on a side, etc.)
5. Now have students note the x and y coordinates of their desk on the Grid Worksheet using the numbering system on their map. If their desk does not line up with an exact number on their x or y axis, they can round to the nearest value or estimate the best number between the nearest values (for example, if their desk falls between 1 and 2, they would write 1.5).
6. Have the students trade worksheets with their neighbor. Ask them to (physically) locate the x and y positions written on their neighbor's worksheet using their own map.
7. Using their own map, students will position themselves at the coordinates written by their neighbor. (Instruct students to do this quietly, as it may be confusing early on because some students may not have their neighbor's numbers on their

own map grid. If they do not, tell them to go to the closest number they do have written on their grid (i.e., if they receive a worksheet with an x value of 50 and the x axis on their map only goes to 20, they should just proceed to 20).

How many students ended up at the desk of their neighbor? (Probably not many.) What went wrong? (Possible answers: different numbering systems, different walls for x and y axis, not everyone marked the same landmarks on their maps, etc.)

8. Return to desks and trade back worksheets.

Part II

1. Hand out the Relative Sizes Worksheets and complete the exercise with the students.
2. Ask helpers who have been working quietly to measure the classroom walls using the tape measure.
3. Give each student a new blank Classroom Graph Sheet.
4. Decide as a class how the classroom dimensions will fit best on the graph paper.
5. Draw in the walls.
6. Decide as a class how to set the coordinates, and decide how many divisions you will make along each wall. (For a globe-like grid you will need 90 degrees north, 90 degrees south, 180 degrees east, and 180 degrees west. This puts the center of the room as 0 degrees. A simpler grid system would be to choose one corner as 0,0.)
7. Measure the divisions along the two walls moving away from 0,0, and mark them with a piece of tape.
8. Have each student stand next to a piece of tape and make a Lat or Long card to post there as appropriate.
9. Using two pieces of string (long enough to touch opposite walls of the class), have students take turns in groups of four measuring the Lat and Long of their four desks.
10. Each student should record on their Grid Worksheet what their desks' Lat and Long are for the common class map.

Math Skills Reinforced —

6th, 7th and 8th: Identifying grid coordinates, scaling, simplifying fractions, and reading and interpreting scales.

Activity Troubleshooting Tips —

If you are using a lat/long system, use the cards given and place the 0,0 in the middle of the room, and if you are using x and y, use a grid system with numbers on the wall. This could be a good way to make this two activities- do one map with x and y, and the next time a map with long/lat.

Activity Desired Student Outcomes —

After this activity, students should realize that landmarks should not be things that move, coordinate grids are useful for location and navigation, and that maps must be created using an agreed upon common format to be useful for other people.

Activity Assessment & Evaluation —

Pre-Activity Assessment

- Discussion Question:
    - How do we know where everything in the classroom is? (Answer: Please refer to the beginning of Section C, *With the Students.*)

Activity Embedded Assessment

- Map Making:
    - Students will each create their own map of the classroom and then try to use each other's maps. Upon realizing that everyone's maps are different, they will work together to make a common map of the class.

Post-Activity Assessment

- Bingo:
    - Using the common class map as a bingo grid for the student's desks, the teacher will call out coordinates and ask students questions. If a student answers correctly, s/he stands up as a bingo chip. Once a full desk row, column or diagonal is standing, the class wins.

Suggestions to Scale Activity for Grades 6 to 8 —

- 6th Grade: Conduct activity as is.
- 7th Grade: Have the students calculate the exact relative room size on their graph paper.
- 8th Grade: Have the students calculate the exact relative sizes for all large objects in the room for the room dimensions on the graph paper.

Relative Sizes — Classroom

Name: ___________________ Date: ____________________

To make an accurate map, you need to draw objects to scale. What does that mean? Well, a map is obviously not the same size as a room, or a city, or the world. It is much smaller. So every object on the map must be smaller, including the border, which is what we will focus on here. Pretend you have a room with the following wall lengths:

Wall #1: 12 feet Wall #2: 15 feet Wall #3: 12 feet Wall #4: 15 feet

The walls on our map will be smaller (our paper is less than 1 foot by 1 foot). We must *convert* the walls to a smaller size that fits on our paper.

For Wall 1, you could choose each square to be 1 foot. This is an easy conversion: one foot in real life is equal to one square on the grid. Draw a horizontal line 12 squares long in the upper left corner.

Alternatively, you could choose two squares to be one foot. One foot in real life is equal to 2 squares on the grid. How many squares do you need to represent 12 feet? ________
Draw a horizontal line the length answered, just below the 12-square line in the upper left corner.

Which line fits our paper the best (one square *or* two square per foot?)______________
What would happen if you chose three squares to be 1 foot? ______________________

Now use two squares equal to 1 foot as the conversion for wall #2. How many squares will it be? ___________. Draw a vertical line the length answered, starting from the right end of Wall 1.

What would happen if you changed the number of squares equal to 1 foot for the other two walls? _________________

Continue clockwise and draw the other two walls, using two squares equal to 1 foot as the conversion. Your room is done.

How do you know it is to scale? Relative sizes can be compared when written as fractions. For the real room, the comparison of Wall 1 to Wall 2 could be shown as:

$$\frac{12\,feet}{15\,feet}\text{, which is the same as }\frac{2*2*3\,feet}{3*5\,feet}.$$

In this fraction, you can cancel out the 3 from the top and bottom.

That gives you a real world fraction equal to $\frac{4}{5}$.

Relative Sizes — Classroom

Name: ____________________ Date: _____________________

On your graph paper, Wall 1 is 24 squares long and Wall 2 is 30 squares long. The length of Wall 1 compared to the length of Wall 2 is: $\frac{24}{30}$, which is the same as $\frac{2*2*2*3\,feet}{2*3*5\,feet}$ (multiply this out to verify). In this fraction, you can cancel out a 3, and a 2 from the top and bottom. What fraction are you left with? __________

Is that the same as the real world fraction? ____________
If it is, your drawing is to scale!

Relative Sizes — Classroom

Name: ____________________ Date: _____________________

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
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Map Your Class!

Name: ____________________ Date: _____________________

Nidy-Gridy Worksheet!

Name: ___________________ Date: ____________________

Part I

After you've drawn your classroom map and written numbers along your "x" and "y" walls – record the coordinates of your desk according to your map:

NOTE: a coordinate is the number that lines up with the spot you are interested in!

Using MY map:

X coordinate of my desk: ________ **Y** coordinate of my desk: ________

Part II

Using the Common Classroom map:

Latitude of my desk: _______ **Longitude** of my desk: _______

Using the Common Classroom Map would you be able to find your neighbors desk using their coordinates?

____

0º

Latitude

10º N

Latitude

20º N

Latitude

30º N

Latitude

40º N

Latitude

50º N

Latitude

60º N

Latitude

70º N

Latitude

80º N

Latitude

90º N

Latitude

0º

Latitude

10º S

Latitude

20º S

Latitude

30º S

Latitude

40º S

Latitude

50º S

Latitude

60º S

Latitude

70º S

Latitude

80º S

Latitude

90º S

Latitude

0º

Longitude

10º W

Longitude

20º W

Longitude

30º W

Longitude

40º W

Longitude

50º W

Longitude

60º W

Longitude

70º W

Longitude

80º W

Longitude

90º W

Longitude

100° W

Longitude

110° W

Longitude

120° W

Longitude

130° W

Longitude

140° W

Longitude

150° W

Longitude

160° W

Longitude

170° W

Longitude

180° W

Longitude

180° W

Longitude

0º Longitude	*10º E* Longitude
20º E Longitude	*30º E* Longitude
40º E Longitude	*50º E* Longitude
60º E Longitude	*70º E* Longitude
80º E Longitude	*90º E* Longitude

100º E

Longitude

110º E

Longitude

120º E

Longitude

130º E

Longitude

140º E

Longitude

150º E

Longitude

160º E

Longitude

170º E

Longitude

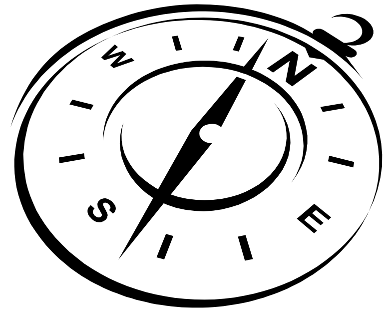
180º E

Longitude

180º E

Longitude

Activity: Northward Ho!



This activity is planned for 28 students working in teams of two.

Activity Materials List —

For each team:

- 14+ packing peanuts (the non-biodegradable / non-water soluble type, recycle or available at packaging stores)
- 14 plastic bowls or margarine tubs large enough to accommodate the “needle”
- 1 roll black electrical tape ($1.50 per roll)
- 28 common pins ($2.50 per box)
- A few strong magnets ($12.00 for three bar magnets)

Activity Cost Estimate —

$16.00 total (for 28 students in teams of two)

Activity Equipment and Tools List —

- Tap water
- 5 hand compasses (borrow compasses from friends, parents or teachers)

Activity Attachments —

Worksheet: Find Your Own Direction

Activity Time Estimate —

30 – 40 min.

Activity Procedure —

A. Background

- Earth’s magnetic field has a shape like a strong bar magnet placed near the center of the Earth with its S pole near the north geographic pole and its N pole near the south geographic pole.
- Earth’s magnetic field is inclined at about 11 degrees from its axis of rotation.
- A compass is just a magnet held on top of a pivot so the magnet can rotate freely.
- A compass points in a direction that lies along the magnetic field at the point.
- Earth’s magnetic field is three-dimensional. Using a common compass only indicates the magnetic field in a horizontal plane on the surface of the Earth. There is also a component of the magnetic field perpendicular to the surface of the Earth.

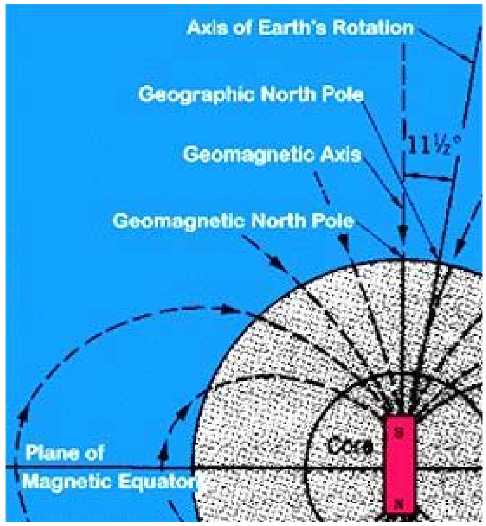


Image source: http://rst.gsfc.nasa.gov/Intro/Part2_1a.html

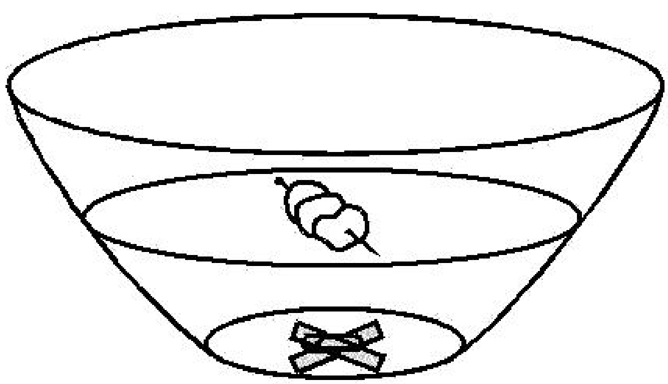
The first compasses were just lodestones — a naturally occurring magnetic ore — on small sticks placed in a bowl of water. The fact that this device pointed to the pole star was used for navigation by mariners. Probably very shortly after the first compasses were used, people discovered that an iron or steel needle that had been touched or rubbed with a lodestone would also align with the pole star.

B. Before the lesson:

Gather all necessary materials.

C. With the students:

1. Make an X in the center of the outside bottom of the bowl using electrical tape.
2. Fill the bowl with enough water so the compass needle will be able to move freely.
3. Magnetize the needle (pin) by stroking it two dozen times with the magnet.



Compass for measuring Earth's magnetic field in a horizontal plane.
Image created by: J. White and M. Lippis, CU-Boulder.

4. Stick the compass needle through part of one packing peanut. The best way to do this is to crush the peanut into a small ball, and stick the pin or needle through it so that the needle passes through the middle of the peanut. There should be only a small bit of the needle covered by the peanut. Remember, the peanut is only there to be used as a floatation device for the needle.
5. Place the whole needle/peanut assembly into the bowl of water. What happens? (The needle should rotate to be oriented north/south. Verify orientation with a real compass to make sure.)
6. Have students walk around the room with the compass. What happens to the compass needle as you move about the room? (Answer: it should always rotate so that it is pointed north/south.)
7. Use the tape on the bottom of the bowl to determine the four cardinal directions.
8. Bring the compass near the tops of any iron or steel objects in the room (the most common steel objects in a classroom are filing cabinets and garbage cans, but some rooms may also have small refrigerators or radiators). What happens? (Answer: the needle should point at the object.) Move the compass down to the bottom of the steel object. What happens? (Answer: the needle should flip around 180 degrees.)
9. Remove the needle and packing peanut assembly from the water.

Math Skills Reinforced —

- 6th: Show a chart of how various objects in the room affect the magnetization of their compass.
- 7th: Draw a compass on the board, labeling the degrees. Tell the students that there are 360 degrees in a circle. North is at zero degrees, east is at 90 degrees, south is at 180 degrees, and west is at 270 degrees. Also look at the compass in 45 degree increments.
- 8th: Draw a compass on the board, labeling the degrees. How many degrees are in a circle? If north is at zero degrees, then at what degrees is: south? (Answer: 180 degrees.) West? (Answer: 270 degrees.) East? (Answer: 90 degrees.) Also look at the compass in 45 degree increments.

Activity Troubleshooting Tips —

When magnetizing, students must stroke the needle in one direction only. Rubbing the needle back and forth will not magnetize it strongly. Also, if they do not stroke the needle enough, it will not be strongly magnetized.

Some alert students might also realize that the compass and needle point at a direction that is not true north. This is magnetic north. If students are interested, show a map and the change in inclination for the compass that can be made to compensate and show true north.

Activity Desired Student Outcomes —

After this activity, students will be able to explain how a compass works, understand that Earth's magnetic field has both horizontal and vertical components, and learn more about cardinal directions.

Activity Assessment & Evaluation —

Pre-Activity Assessment

- Prediction
  - Question: Ask students to predict what will happen if we float a magnetic needle in water.

Activity Embedded Assessment

- Worksheet
  - A worksheet entitled, "Find Your Own Direction" (please see *Activity Attachments* section above) is provided to allow students to record their observations during the activity — beginning when the compass is placed in the bowl of water.

Post-Activity Assessment

- Question/Answer
  - Question: Ask the students to point in the four cardinal directions. Use the compass to resolve any disagreement among the students.
  - Question: Why did you build a compass that floated on water?

Suggestions to Scale Activity for Grades 6 to 8 —

- 6th Grade: Do activity as is.
- 7th and 8th Grade: Do activity as is. Also have students draw a plan for the school building, playground, and any associated buildings, etc. Then have students walk different paths through the school using a hand compass to determine the direction they are walking at various points along the path. For example, students should estimate how many degrees west of south or east of north they are walking whenever they are not pointing in one of the four cardinal directions.
- 8th Grade (if more is needed): Have students conduct research to compare magnetic north and true north. Ask them to identify which they found, magnetic north or true north.

Worksheet: Find Your Own Direction

Group Name:___________________________________ Date:______________

What happens when you place the compass needle in the bowl of water?

Draw a picture of your compass in the space below.

Walk around the room with the compass. Describe what happens to the compass as you walk around the room?

Describe what happens when you bring the compass near the top of an iron or steel object in the room?

Describe what happens when you move the compass near the bottom of an iron or steel object in the room?