INTRODUCTION

As competition for land uses continues to increase, so must our understanding of land utilization, spatial relationships, proper zoning, and land measurement. The activities and tasks in this lesson plan provide some simple tools to involve students in land and space measurement. Although the instruments used are relatively primitive, the principles are the same as those used in the most sophisticated surveys.

Participants receive immediate feedback and the satisfaction of seeing how the maps they have constructed reflect the area they have "surveyed." Compass bearings and distances become personalized.

THE ACTIVITIES	TIME REQUIRED
Measure the Length of your Step	20 minutes
Learn to Use the Silva Compass	20 to 30 minutes
Use the Compass and Pacing Skills	30 minutes
Construct and Use the Instant Mapper	60 minutes
Construct and Use a Cardboard Box Plane Table	60 minutes

COMBINING THE ACTIVITIES

The activities in this unit are displayed singly. Depending upon the time available, and the skill of the participants, you may choose to do only one activity, or the entire series. For maximum learning, the activities should be experienced in the order listed in the unit, however, other suggestions are:

Title: Measure the Length of your Step/Learning to Use the Silva Compass/Use the Compass and Pacing Skills

Introduction: A map is a representation of a portion of the face of the earth. The features displayed on a map bear the same relationship to each other in terms of direction and distance (although at a reduced scale) as the features on the face of the earth that they represent. In order to use or make a map, it is necessary to have some means of determining distance and direction. In these activities, participants will learn to measure distance by "pacing" and use the compass to determine direction. This is followed by a practical exercise to reinforce the acquired skills.

Activity: Measuring the Length of your Step

Transition Statement: Now that you are able to measure the distance between points what else do you need to do to determine the relationship of one point to another?

Activity: Learn to use the Silva Compass

Transition Statement: Now that we have the skills to determine both distance and direction let's combine the two.

Activity: Using the Compass and Pacing Skills

CURRICULUM RELATIONSHIPS

Social Studies

1. Research and report on the history of the compass. What does the term "mariner's compass" mean? How did the very first compass work? For what was it used? What effect did it have on exploration and discovery? What important historical events, explorations, and discoveries have resulted because of the compass? Draw a time line and correlate it to improvements in different kinds of compasses.
2. Find where the magnetic north pole is located on a globe of the world. (75 N. latitude and 100 W. longitude; off SW corner of Bathhurt Island in the Parry Islands). Run a strip of adhesive tape from your city to the magnetic north pole. Now run a strip of adhesive tape from your city to geographic north pole. Measure the angle. Repeat the above activity for Cincinnati, Ohio, and New York City. What are the angles created from these cities? This is called the angle of declination.
3. Find out what occupations require a knowledge of the compass and navigation. What economic gains have been made because of the improvements in the compass? Will the compass someday be obsolete? What recreational interests require a knowledge of the compass?
4. Read about incidents of people getting lost and even dying in the woods because they did not know how to use a compass properly. Discuss how this could have been prevented.
5. Find out if the compass and magnetic needle could have had any effect on boundary disputes between nations.

Science

1. Make your own compass by magnetizing a needle and floating it in oil. Many elementary science books will give you detailed instructions on how to do this.
2. Find out how space travelers navigate. Create a display or report of your findings.

Mathematics

1. Read about the history of measurement.
2. Measure the distance from home to school by pacing. Measure the perimeter of the schoolyard using "chains" (66 feet of plastic clothesline will do). Measure other distances by pacing and chains.
3. Find out how many laps around the schoolyard equal a mile. Is the schoolyard more or less than an acre? What is the average length of blocks in your neighborhood? What are isotonic lines, bearings, azimuths, and degrees?

Language Arts

1. Develop spelling and vocabulary words such as azimuth, bearing, degree, and declination.
2. Write a paragraph defining and explaining the difference between magnetic north and true north.
3. Write a creative story using the following questions as starters: Do you think the compass will someday be obsolete? If so, what other methods of navigation do you think will take its place?
4. Write a specific set of directions for measuring activities such as learning your pace, using a compass for the first time, or measuring the perimeter of the classroom!

Creative Arts

1. Sketch an early mariner's compass or other measurement instruments.
2. Draw true north and magnetic arrows on classroom maps.
3. Using your skills, create a map of the classroom, the school, or the schoolyard.
4. Invite a landscape architect into class to demonstrate how they create maps of the areas they landscape.

MEASURE THE LENGTH OF YOUR STEP

CONCEPT Quantification, Scale

PRINCIPLE Relatively accurate measurements can be made without measuring tapes.

OBJECTIVE

- The student will be able to determine the distance between two points by counting the number of steps taken between the two points.
- The student will be able to walk a predetermined distance to locate a given point.
- The student will be able to compute the length of his/her average step given a premeasured 100-foot distance.

PREPARATION Place a stake in the ground or make a mark on the sidewalk with chalk. Using a long tape measure, make another stake or mark 100 feet from the first mark. Be sure to measure in a straight line. Make one course for each five people to reduce delays.

MATERIALS NEEDED

- chalk or wooden stakes, two stakes per course
- bright-colored paper or ribbon so stakes can be seen
- 100-foot tape measure
- paper and pencil for calculations
- copy of Activity Sheet A: Determine Length of Step, A-1: Determine the Number of Steps in Distances for each participant
- step foot conversion chart for each participant

PROCESSES USED

- Measure
- Use numbers

TIME 20 minutes

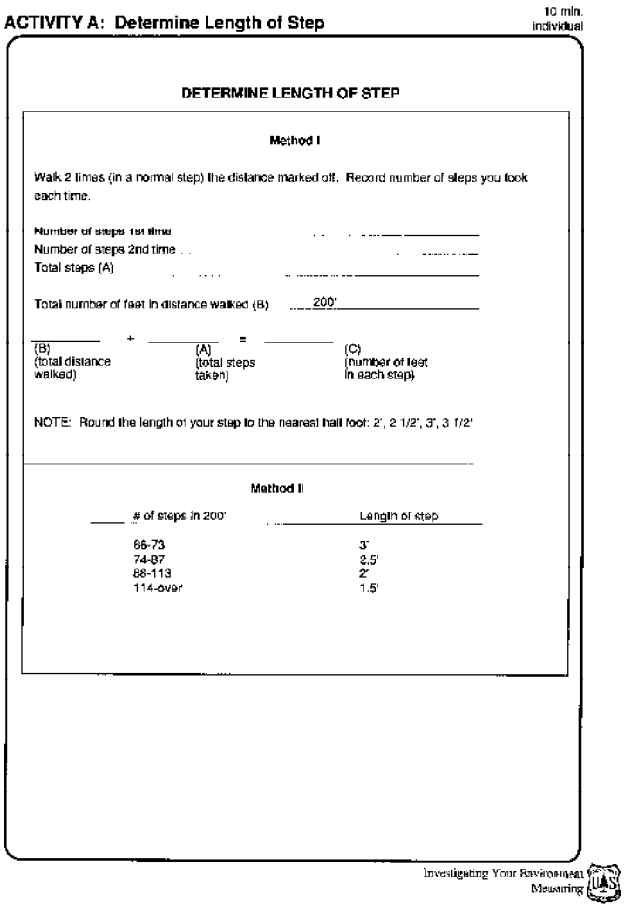
DOING THE ACTIVITY (outdoors preferred, can be done in a gym or large hall)

A. Set Stage

We haven't always had tapes to measure distance. Earliest methods used the length of one's own stride or pace as a unit of measure.

B. Procedure

1. Distribute Activity A



ACTIVITY A: Determine Length of Step — 10 min. individual

DETERMINE LENGTH OF STEP

Method I

Walk 2 times (in a normal step) the distance marked off. Record number of steps you took each time.

Number of steps 1st time _____
Number of steps 2nd time _____
Total steps (A) _____

Total number of feet in distance walked (B) 200'

_____ + _____ = _____

(B) (total distance walked) | (A) (total steps taken) | (C) (number of feet in each step)

NOTE: Round the length of your step to the nearest half foot: 2', 2 1/2', 3', 3 1/2'

Method II

# of steps in 200'	Length of step
66-73	3'
74-87	2.5'
88-113	2'
114-over	1.5'

Investigating Your Environment
Measuring

2. Refer to the stakes: The distance from the first to the last stake is 100 feet
3. Walk an even, normal step all the way down, then all the way back.
4. Count the total number of steps you take on the way down and on the way back.
5. Using Activity A, determine the length of your step. Take 10 minutes.

C. Retrieve Data

In a discussion, ask:

1. What is your length of step?
2. How did you determine your length of step?
3. How many steps would you have to take to go 100 feet?
4. What might make it difficult to determine the number of steps between one point and another?

Hand out Activity A-1 (alternate method)

ACTIVITY A-1: Determine the Number of Steps in Distances handout

Find the column for the length of your step and determine the number of steps for the distance you want to walk in the distance column.

Distance column	Length of step columns			
If you want to walk this distance:	1 1/2 feet Then take:	2 feet	2 1/2 feet	3 feet
1 foot	1/2 step	1/2 step	1/2 step	1/2 step
2 feet	1 step	1 step	1 step	1/2 step
3 feet	2 steps	1 1/2 step	1 step	1 step
4 feet	2 1/2 steps	2 steps	1 1/2 step	1 1/2 step
5 feet	3 steps	2 1/2 steps	2 steps	1 1/2 steps
6 feet	4 steps	3 steps	2 1/2 steps	2 steps
7 feet	5 steps	3 1/2 steps	3 steps	2 1/2 steps
8 feet	5 1/2 steps	4 steps	3 steps	2 1/2 steps
9 feet	6 steps	4 1/2 steps	3 1/2 steps	3 steps
10 feet	6 1/2 steps	5 steps	4 steps	3 steps
20 feet	13 1/2 steps	10 steps	8 steps	6 1/2 steps
30 feet	20 steps	15 steps	12 steps	10 steps
40 feet	26 1/2 steps	20 steps	16 steps	13 steps
50 feet	33 1/2 steps	25 steps	20 steps	17 steps
60 feet	40 steps	30 steps	24 steps	20 steps
70 feet	46 1/2 steps	35 steps	28 steps	25 steps
80 feet	53 1/2 steps	40 steps	32 steps	27 steps
90 feet	60 steps	45 steps	36 steps	30 steps
100 feet	66 steps	50 steps	40 steps	33 steps

Investigating Your Environment
Measuring

This is another aid to help you quickly convert distances into steps or vice-versa.

CLOSURE Ask:

1. What is the range of steps in this group?
2. What does it mean to have a step of 2 or 3 feet?
3. Who would you like to go hiking with and why?
4. Does everyone walk the same step all the time? Why or why not?

TRANSITION Now that you are able to measure the distance between points, let's determine what else we need to determine the relationship between one point to another?

LEARN HOW TO USE THE SILVA COMPASS

CONCEPT Quantifications, Order, Field Replication

PRINCIPLE A compass may be used to find direction and your way around.

OBJECTIVE

- The student will be able to determine the direction a given object is, from a given point, using a compass.
- The student will be able to go from one point to another when given the compass bearing.

PREPARATION Place a series of numbered stakes in a straight line at one end of an area. Easily identified landmarks such as trees, building corners, fireplugs, etc. should be visible from each stake. Using a compass, determine the direction of a number of landmarks from each of the stakes. Record this information. Be sure that each stake has a number or other means of identification (color, letter, shape). Apply scotch tape with declination marked on each compass.

MATERIALS USED

- one silva compass for each student
- scotch tape with declination marks on each compass
- record of bearings from stakes or spots to each previously identified landmark
- illustration of difference between true and magnetic north
- identified stakes or spots on the ground

PROCESSES USED

- Observe
- Measure
- Use numbers
- Define operationally

TIME 20 to 30 minutes

DOING THE ACTIVITY (outdoors)

A. Set Stage

By the time you are finished with this activity, you will be able to use the compass to determine the direction to object, or point from where you are and given a compass bearing, determine what is located on that bearing. You will also be able to locate a point given only the compass bearing.

B. Procedure 1: Parts of the Compass

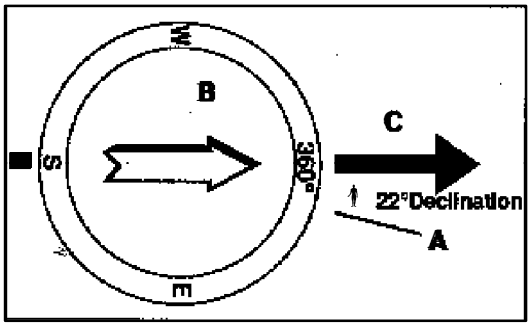
1. Give everyone a Silva Compass and have them stand facing you. Make sure the compass has a piece of write-on scotch tape with a pencil mark on it opposite the declination for your area. Do not let the participants do this sitting down.
2. The Silva Compass is used. It is one of the least expensive, most dependable, and one of the easiest to use.
3. Ask. What do you notice as you look at the compass?

COMPASS DECLINATION

Baseplate

Magnetic needle

Azimuth ring



A = Pencil Azimuth Line

B = Orienting Arrow

C = Direction of Travel Arrow

4. Discuss the major parts of the compass with the students. Make sure they are locating these parts throughout the discussion.
   (a) Base Plate - What is on it? Direction of Travel Arrow—always pointed directly away from you. (Clear plastic, has direction of travel arrow and two different scales.)
   (b) Azimuth Ring - a dial with degrees marked on it. Also called a compass housing, it has an orienting arrow inside the bottom of the housing. (The orienting arrow makes the Silva Compass different from other compasses and easy to use.)

(c) Magnetic Needle - red and white needle. Where does it point? (magnetic north) What makes it point there? (earth's magnetic field) The magnetic needle pivots freely within the azimuth ring and the red end always points to magnetic north.

Transition: Now that you are familiar with the parts of the silva compass, let's look at how you can use the compass.

C. Procedure 2: Holding the Compass

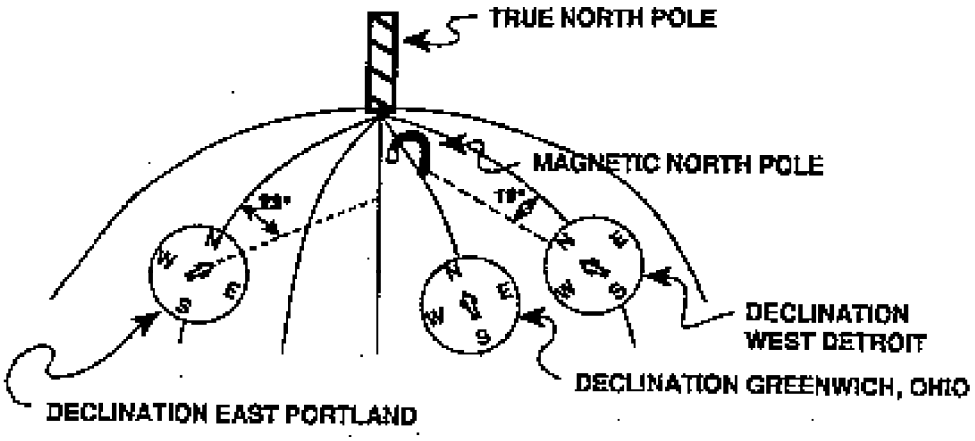
Describe these steps to the group by saying:

Holding the compass correctly is necessary for an accurate reading.

1. Stand up: rest base plate on your index fingers; hold the edges with your thumbs. Keep your arms close to your sides for better stability and point the direction of travel arrow directly away from you.
2. Hold compass level. Tilt the compass up and down and from side to side to see what happens when it is not level.
3. You and the compass are a UNIT — TOGETHER. When you turn, the compass turns with the direction of travel arrow, always pointing away from you. Turn your whole body and compass, including feet, don't just twist around. Practice this as a group.

D. Procedure 3: Orienting to North

1. Turn dial and set 360° on Direction of Travel Arrow.
2. You and the compass turn as a unit until the red part of the magnetic needle and the pointing part of the orienting arrow go together.
3. Where does the magnetic needle point? (North—magnetic north)
4. Are you facing the same direction as the magnetic needle? (Yes, you should be, anyway.)
5. Which direction are you facing? Magnetic north, same as the magnetic needle.
6. Is magnetic north the same as the North Pole? (No—North Pole is called Geographic North or True North).
7. Refer to chart of North Pole and magnetic pole. (Magnetic north is located somewhere north of Hudson Bay, Canada in the Gulf of Boothia.)



8. If you are here (point to your location), and facing the North Pole, then magnetic north is at a degree angle to the right of you, in parts of western Oregon and Washington. Find your declination. In Portland, Oregon, it's about 22°.
9. If you're in Greenwich, Ohio, and facing the North Pole, then magnetic north and the North Pole would be in the same line of sight.
10. Most of the maps we use are drawn according to the North Pole or true North.

E. Procedure 4 Correcting for the Declination which is the difference between true and magnetic north.

1. On your compass is a piece of tape with a pencil line on it at _____degrees. (22° in Portland, Oregon)
2. Turn dial and set 360° on the pencil line.
3. Now turn yourself and the compass until the magnetic needle and orienting arrow go together.
4. Which way does the magnetic needle point? (Magnetic north—it always points there)
5. Are you facing the same direction as the magnetic needle? (No—you shouldn't be, anyway)
6. Which direction are you facing? (True North)
7. You and the Direction of Travel Arrow should be facing true North. The magnetic needle should be pointing to magnetic north, at a 22 degre angle to your right, or left depending upon location in the U.S.
8. From now on we will SET and READ all degree readings at the pencil line.
9. Continue to hold the compass so the Direction of Travel Arrow is pointing directly away from you.

F. Procedure 5 Practice Orienting to the Four Cardinal Compass Points

1. N=O°, E=90°, S=180°, W=270°
2. Set 90° on the pencil line and orient yourself to it. This means you and the compass move as a unit until the red part of the magnetic needle and pointing part of orienting arrow are together.
3. Before proceeding, answer these questions:

   (a) Which direction are you facing? (true east)
   (b) Which direction is the magnetic needle pointing? (magnetic north)

NOTE: To explain the difference between magnetic and true North: Extend your arm in the direction of true north. With your arm, make a 90° swing to the right. That should be the direction you are facing. Extend your arm in the direction of magnetic north. Now make a 90° swing with your arm at the right. That should be magnetic east, which should be at a 22°angle to the right of where you are facing.

4. Now set 180° on the pencil line. Orient yourself to that degree reading. Extend your arm in the direction the magnetic needle is pointing — (magnetic north). Now extend your arm directly opposite which would be magnetic south. Which direction are you facing? (magnetic south) Which direction is the magnetic needle facing? Which direction does it always face?
5. Repeat for 270° and 360°.

G. Procedure 6 Following a Predetermined Azimuth Bearing

1. INSTRUCTOR: Before class, pick a point, and sight on several objects (up to 10). Give the group bearings to set and then objects to sight on, until you feel they are confident using the compass.
2. Set_____degrees on pencil line.
3. Orient to that degree reading. Remind them to hold compass correctly.
4. Select a landmark in the line of sight found by you and the Direction of Travel Arrow. To do this, look down at direction of travel arrow, then jerk your head up. Whatever you see on the horizon, in line of sight of the travel arrow, is your landmark.
5. Repeat this several times to make sure you are sighting on an object directly in line of sight of the direction of travel arrow.
6. Now that you have selected a landmark, you could put your compass away and walk toward that landmark, always keeping your eyes on that landmark and walking straight toward it.

7. Why wouldn't you keep looking at your compass as you walk along? (You could wander all over the place)
8. Orient yourself to_____degree reading.
9. Select landmark. Repeat previous instructions on selecting landmark, if necessary.

CLOSURE Practice using the compass to follow a bearing as the closure activity. The steps are:

1. Work with a partner. Give that partner a degree reading.
2. Check to make sure they oriented to that degree reading.
3. Check: did she/he set the degree reading on the pencil line? Did she/he hold the compass level? Is the direction of travel arrow pointing away from him/her?
4. Check to make sure that person can select a landmark.
5. Is the person looking directly in line with the direction of travel arrow? (Most people tend to look either to the right or left, so watch them select the landmark.)
6. Is the person holding his/her head straight and in line with rest of his/her body and the compass?
7. Repeat, having the other person check you this time.

TRANSITION You have learned two skills: pacing, and using a compass. Now you are ready to put them together and practice another skill.

USE THE COMPASS AND PACING SKILLS

CONCEPT Quantification, Replication, Perception, Time/Space

PRINCIPLE The skills of pacing and using a compass can be used to move within an area. These skills are helpful in making a map.

OBJECTIVE

- The student will be able to follow a prescribed course using the compass and pacing to go from point to point.
- The student will be able to record the identifier for each point.
- The student will be able to demonstrate proper use of the Silva compass by sighting on an object, setting the correct bearing, and following that bearing for a short distance.

PREPARATION Set a row of numbered or lettered stakes about four feet apart. From each stake run a course with measured distances and bearings that lead back to one of the other stakes in the row. Use at least three distances and bearings. Record the information and reproduce it for the students. Leave off the identification of the last stake on student copies. If you are uncomfortable laying out a course, use the Boy Scout Compass and Pacing game. An example of the game is included at the end of the lesson.

MATERIALS NEEDED

- One compass for each participant
- 20 stakes
- Score card for compass course
- Pencils
- Boy Scout compass and pacing game

PROCESSES USED

- Measure
- Observe
- Use numbers

TIME 30 minutes

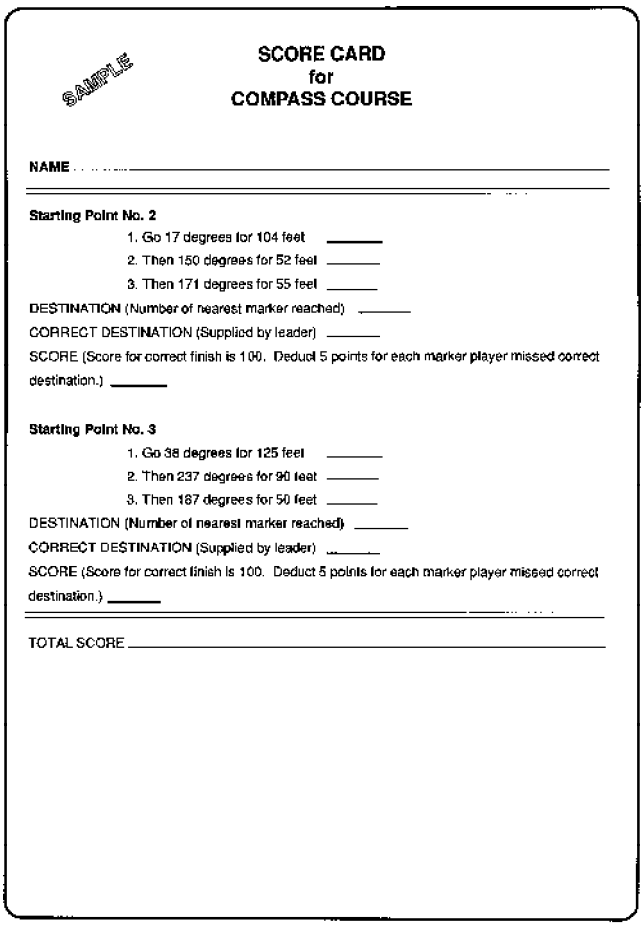
DOING THE ACTIVITY (outdoors)

A. Set Stage

The skills of pacing and using a compass can be used to move from point to point and keep track of where you are. They are also useful in making a map.

B. Procedure

1. Distribute score cards for game from the Boy Scouts Compass and Pacing Game.



SAMPLE

SCORE CARD
for
COMPASS COURSE

NAME _____

Starting Point No. 2

1. Go 17 degrees for 104 feet _____
2. Then 150 degrees for 52 feet _____
3. Then 171 degrees for 55 feet _____

DESTINATION (Number of nearest marker reached) _____

CORRECT DESTINATION (Supplied by leader) _____

SCORE (Score for correct finish is 100. Deduct 5 points for each marker player missed correct destination.) _____

Starting Point No. 3

1. Go 38 degrees for 125 feet _____
2. Then 237 degrees for 90 feet _____
3. Then 187 degrees for 50 feet _____

DESTINATION (Number of nearest marker reached) _____

CORRECT DESTINATION (Supplied by leader) _____

SCORE (Score for correct finish is 100. Deduct 5 points for each marker player missed correct destination.) _____

TOTAL SCORE _____

Investigating Your Environment
Measuring

2. Participants write down the number of steps they need to take for each distance given, using the Step-Foot Conversion Chart from the Measuring Your Length of Step lesson.
3. When most people have finished, select a volunteer to demonstrate the game.
4. Take his/her score card and call instructions while the group watches. Try to get the group to tell him/her what to do.

5. Starting place_____
6. Degree reading_____
   Set degree reading on pencil line.
   Orient to that degree reading.
   Select landmark.
   Put compass away.
7. Distance to walk
   Tell the group the distance, the length of volunteer's step, and have them figure out how many steps she/he needs to take.
8. Repeat for the second instruction.
9. Repeat for the third instruction.
10. Ask the volunteer to which stake the directions led. Where were they supposed to lead.
11. Explain how the scoring works.
12. Give volunteer his score.

NOTE: Anything above 70 is good!! If they get below 70, they should do over.

B. Procedure 2

1. Group follows their individual instructions. Let them know you have the answers.
2. Help individuals. If someone in group finishes first and did well, ask them to help others. Or give him/her the answer sheet, then you are free to help others.

C. Retrieve Data

1. Ask: What things did you have trouble with in solving the problem?
2. Point out that practice increases accuracy. If you lose your landmark when following an azimuth (line of sight), sight back toward your starting point, then check your compass to see if you are still on the line. This requires sighting a back azimuth which is in the opposite direction from the azimuth.

TRANSITION Tell participants that they will use their compass skills to find a line of direction.

D. Procedure 3

Select an object everyone can see and face it. Ask:

1. How do you find the direction of that object?
2. What do you have to do now? You need to line up the magnetic needle and the orienting arrow lines. How will you do that? (turn the dial).
3. Now read the degree reading. Where will you read it from? (the pencil line, not the direction of travel arrow).
4. Why do people on one side of the group have different degree readings than people on the other side? (everyone is at a different angle)
5. Practice taking bearings on other objects.

CLOSURE Ask the group:

1. What have we found out about pacing today?
2. What have we learned about using the compass?

CLOSURE If you have time, let them do this activity, which takes about 15 minutes.

(ALTERNATIVE ACTIVITY)

1. Start at a given point (A). Take a reading (azimuth) on an object. Proceed to that point (B). At Point B, set your compass so you can return to Point A. Then, do so.
2. Ask: What sort of hypothesis would apply to the shooting of a back azimuth?
3. Possible answer is that if the original bearing is less than 180°, add 180°. If it is more than 180°, subtract 180°. Reverse the red arrow so that the tail of the red arrow is superimposed over the head of the black arrow in the compass housing.

TRANSITION Let's use the skills learned to make a map.

CONSTRUCT AND USE THE INSTANT MAPPER

CONCEPT Quantification, scale, Perception

PRINCIPLE The instant mapper is a way to make a map.

OBJECTIVE
- The student will be able to construct and use the instant mapper to make a map of a specific area.

PREPARATION Assemble the materials listed below. Locate an area, relatively free of obstructions, with easily identifiable features (i.e. trees, buildings, flagpoles). School playgrounds or parks are good sites.

MATERIALS NEEDED For each person:
- One piece smooth cardboard (both sides) 8 1/2 x 11 inches
- One piece graph paper 8" x 10 1/2" with azimuth printed on it (attached)
- Piece clear "contact" paper (one side adhesive) 8 1/2"x 11"
- 40" scotch or masking tape, 1" or 2" wide
- 1 - 7/16 brass fastener
- 1 - 7" acetate disc, frosted one side
- Scissors
- Compass
- Drawing
- Vis-a-vis or dry erase pens

PROCESSES USED
- Measure
- Observe
- Use numbers
- Interpret data

TIME 60 minutes

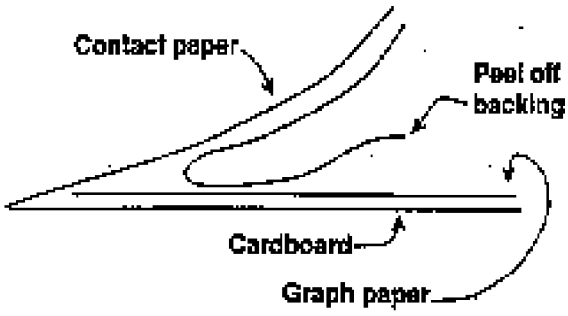
DOING THE ACTIVITY (construction indoors; using mapper outdoors)

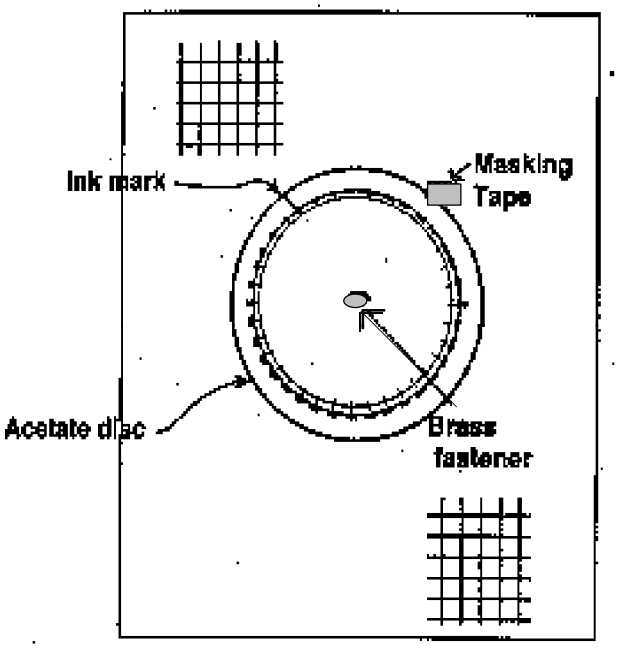
A. Set the Stage

There are many ways to make maps. One of the easiest and most fun is to use the instant mapper. You can easily make and learn to use the instant mapper.

B. Procedure 1

1. Gather all the materials you will need to make the mapper.
2. To <u>construct the mapper</u>, position graph paper on cardboard, leave edge of cardboard exposed for contact paper to adhere to.
3. Peel back edge of paper covering the sticky part of contact paper and position the sticky part at the top of cardboard and graph paper. Now strip off rest of contact backing paper smoothing the clear part over the cardboard and graph paper.
4. Bind edges of instant mapper with masking or scotch tape.
5. Center the acetate disc over the circle on the graph paper with the rough side up.
6. Make a slit hole (with knife) through the cardboard and acetate at center of the circle.
7. Push a brass fastener down through the acetate disc and slit hole in the mapper. Bend back the fastener prongs.
8. Make one straight ink mark from any point on the edge of the acetate toward the brass fastener until it meets the circle on the graph paper. This is your map making orienting mark.
9. Attach a short piece of masking tape to the outside of the acetate disc to use as a handle.

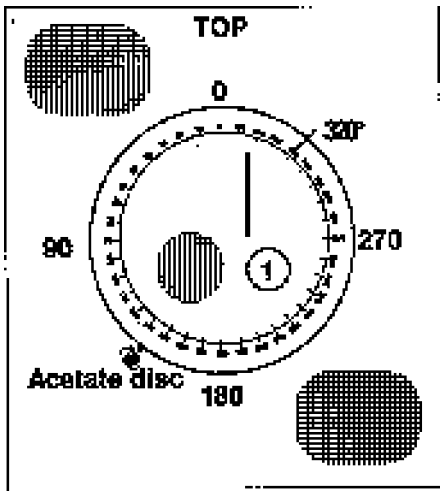


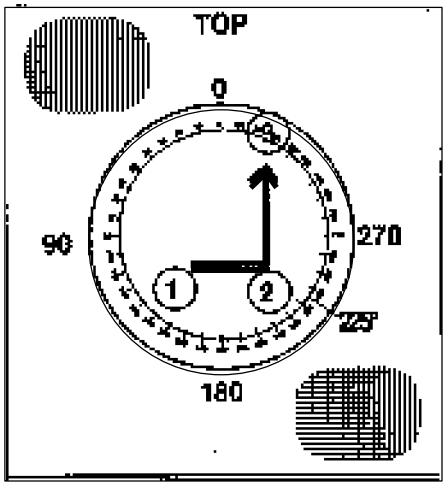


C. Procedure 2

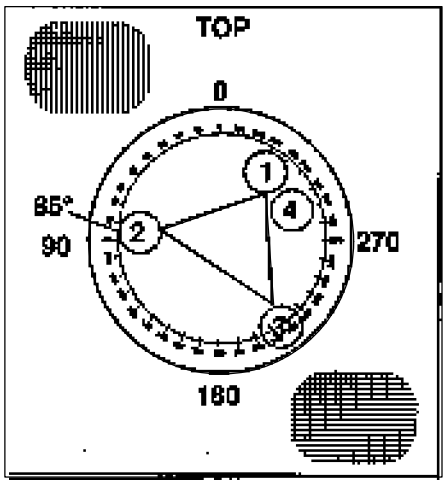
The instant mapper is designed to draw a map of your area as you determine the compass bearings and distances. It will be easier to learn to use if you already have the bearings and distance recorded of the area you want to map. You can map one of the Compass and Pacing Problems. Here is how to map an area with the following field notes.

Degree Reading			Field Notes			Dist.
320°	•	20'		5'	•	25'
225°	•	20'		10'	•	30'
85°	•	10'		25'	•	35'





3. To obtain the third bearing and distance turn the acetate disc until the ink line is directly over 85° on the dial.
   (a) Draw a line from point (3) toward the top of the instant mapper for 40 squares (40 ft.) parallel to the line on the graph paper. At the end of the line, make a dot and a (4).
   (b) Number (4) should coincide with the starting point (1).



D. Procedure 3

To draw land features on the map, stand at starting point #l, and face ground point #2.

1. Hold mapper waist high and turn acetate disc until the ink mark is on 320° on the inside dial. You, the instant mapper and the line from #1 to #2 should all be facing point number #2 on the ground.
2. Measure distances along the line by pacing. Put in any land features such as trees, fences, roads, or buildings that you want located on the map. Refer to hypothetical problem on page.
3. Repeat for other bearings and distance.

E. Retrieve Data

This step is accomplished throughout each activity since it is a skills activity and the participant can not proceed unless the previous skill is mastered.

CLOSURE Share with the group your feelings about this activity and where you think these skills might be useful or who might use these skills in their careers.

TRANSITION There is another way to learn to construct a map. It is called the plane table.

CONSTRUCT AND USE A CARDBOARD BOX PLANE TABLE

CONCEPT Quantification, Model, Scale, Perception

PRINCIPLE Many times it is not possible to learn to use a compass or an instant mapper. This cardboard box plane table provides a way to make a map without the use of the compass. The plane table is a device used for mapping that locates points by the intersection of two lines rather than by bearings and distances.

OBJECTIVE

- The student will learn to construct a plane table.
- The student will use the plane table to map a predetermined area and include at least three reference points.
- The advanced student will be able to use a plane table to measure a non-paceable distance.

PREPARATION Assemble materials needed. Locate an area to map. The area can be a school yard, park, or any relatively open area that contains some easily identifiable features, such as trees or flagpoles.

MATERIALS NEEDED For each group of two to five (four preferable):

- Cardboard cartons (3 per group), stout, like empty liquor boxes
- Pencil with eraser
- Plastic flagging - 2 colors
- Unlined paper 8 1/2" by 11"
- Heavy twine
- Wooden 12" ruler (one per table)
- 2 stakes
- Map tacks (4 per group, small nails will do)
- Sacking needle
- Roll of duct tape

PROCESSES USED

- Measure
- Observe
- Define operationally
- Interpret data
- Formulate model

TIME 60 minutes

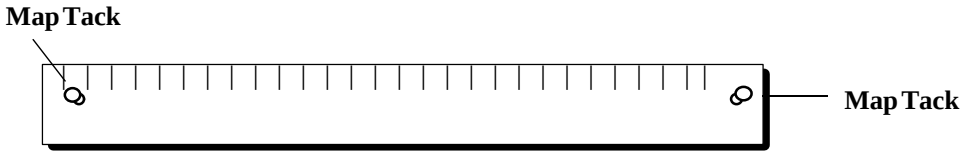
DOING THE ACTIVITY (construction indoors, use plane table outdoors)

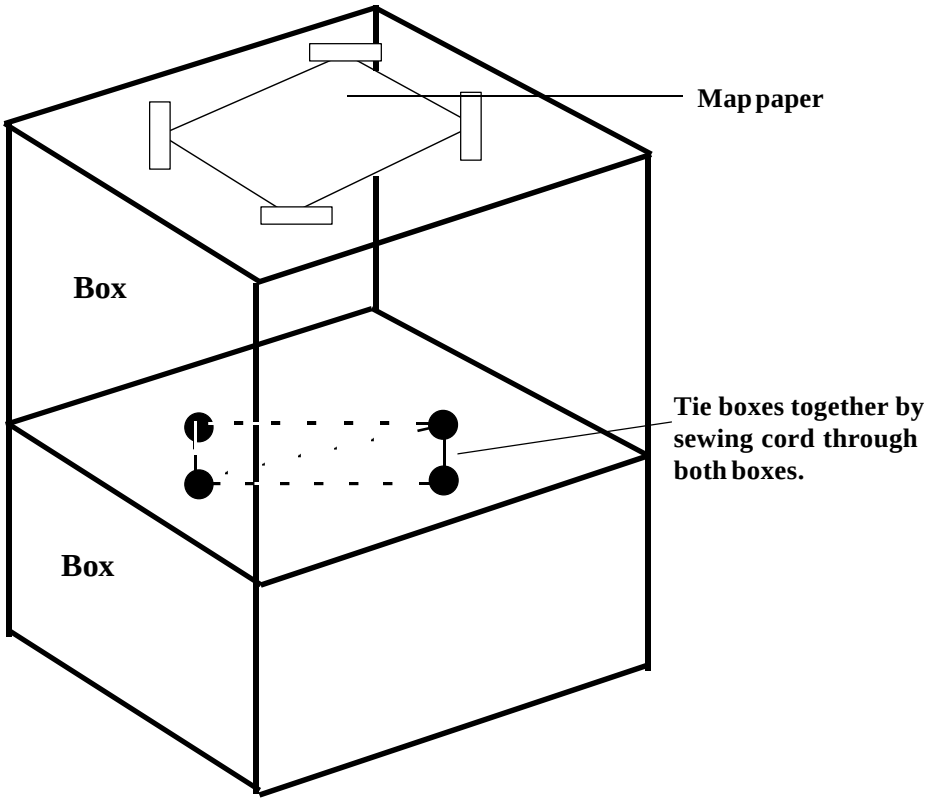
A. Set Stage

Many of our early maps, including some still in use, were made using plane tables. Surveyors would carry them to mountain tops and draw lines to other peaks and features. Then they would move to another mountain top, whose bearing and distance from the first was known, and draw lines to the same features. The location of the feature was at the point where the lines intersected.

B. Procedure 1 Construct a plane table

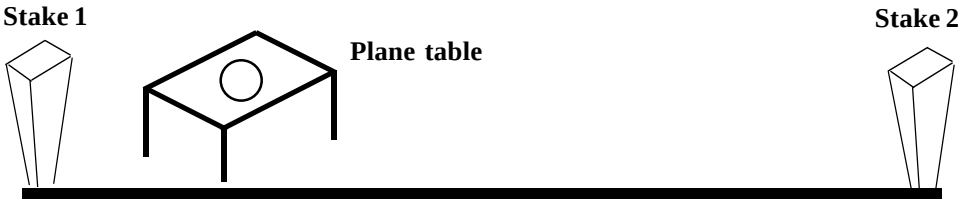
1. Place cardboard boxes one on top of the other. Thread boxes together with a sacking needle and stout cord. It may be easier to sew if boxes are on their sides. Duct tape may be used to fasten boxes together in lieu of "sewing".
2. Tape paper to the top of the box.
3. The 12" sight ruler will be used as a sighting guide. Drive map tacks into the ruler making sure tacks are equidistant from the edge of the ruler.





C. Procedure 2 Use the plane table to establish a base line:

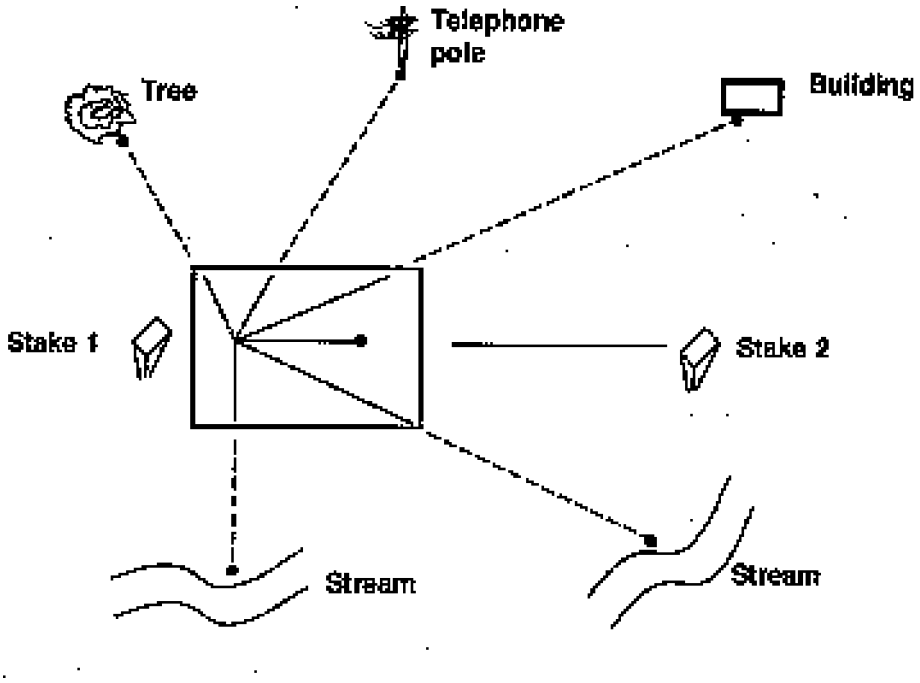
1. After you determine the area to be mapped, pick two objects to be included in the map, that are the farthest apart. Set up your plane table near one of these objects.
2. Drive a stake at the base of the plane table. Now pace the longest distance that must be mapped and drive in the other stake. On the way back to the plane table measure the distance. This is your base line and the only measurement needed.



3. Choose a place on the paper for a starting point.
4. Stick a pin in the paper at the starting point. Put the edge of the sight ruler against the pin.
5. Get your head down toward the plane table so you can sight over the pins of the sight ruler toward Station 2, the second point on your map.
6. Keep the edge of the sight ruler against the pin. Line up the tops of the two pins on the sight ruler so they are in a direct line with Station 2.
7. Draw the first line on the paper, from Station 1 toward Station 2. Don't shift the ruler while drawing this line.

D. Procedure 3

1. To locate map features, draw lines toward all the other features you want to include on your map. It is done the same way you drew the line toward Station 2. The theory behind the plane table is to locate points of intersecting lines.
2. Do not move the plane table. Keep the edge of the ruler against the pin. Line up the tops of the two pins on the sight ruler so they are in direct line with the object you wish to include on your map.
3. Keep the ruler still. Draw a line from the pin along the edge of the ruler to the end of the ruler.
4. Label each line with the name of the object.



E. Procedure 4

To measure the base line and determine scale, pick up the plane table and walk to Station 2. Count the number of steps between Station 1 and 2. This is your base line.

1. The size of the area to be mapped determines the map scale.
   Using 8" wide paper: 1" = 100' will map a space 800'
   1" = 40' will map a space 320'
   1" = 20' will map a space 160'

2. Since we are using standard rulers with inches and quarter inches, the scale is best divisible by 4'. Thus if l" = 40' then 1/4" = 10'. If l" = 20' then 1/4" = 5'. If 1" = 80', then 1/4" = 20'.
3. This must be determined by observation and estimate, or by actually measuring the greatest distance between two objects to be included on the map.

F. Procedure 5

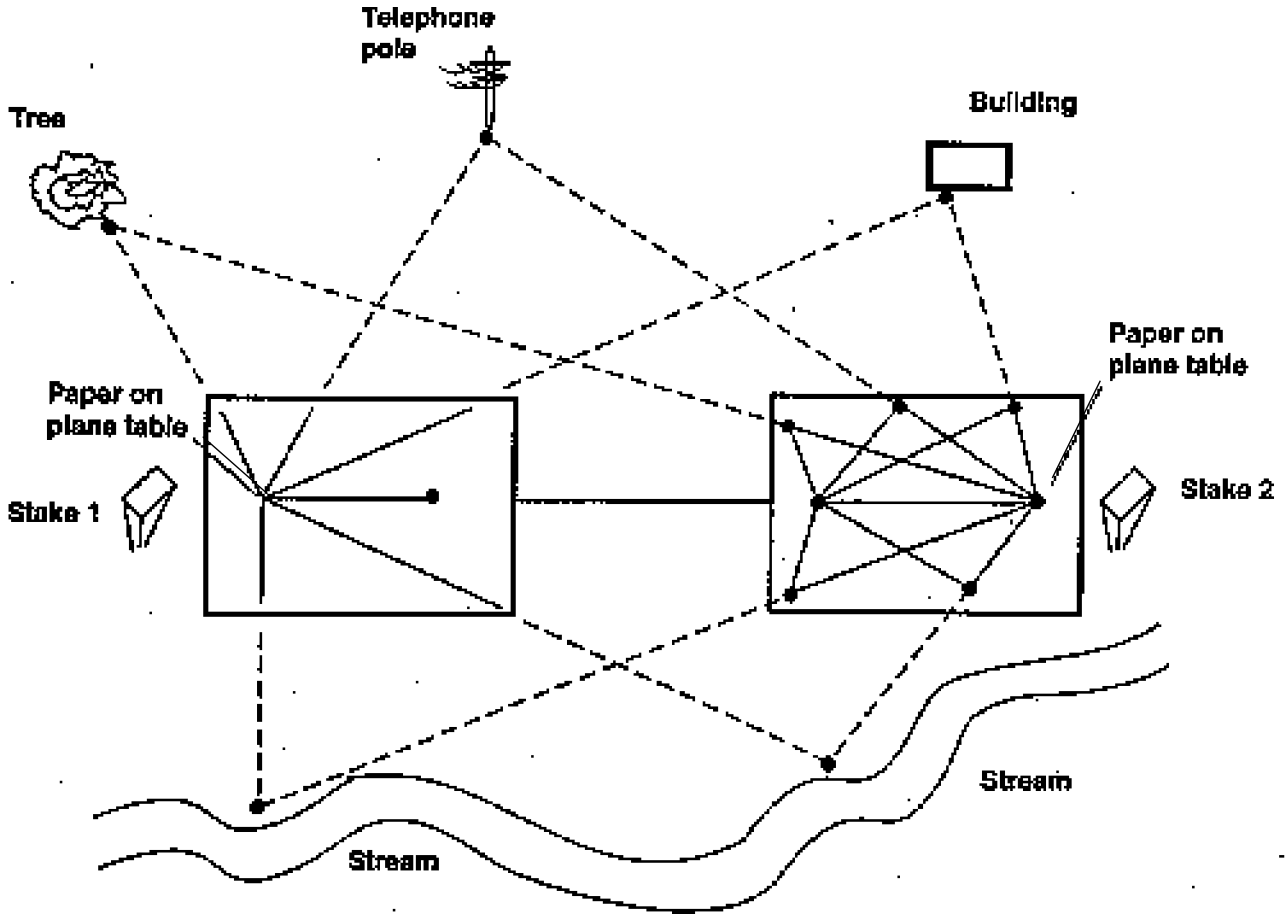
To orient the plane table between Station 2 and 1, measure and place a pin on your map at the point indicating Station 2. Position determined by scale.

1. Put the sight ruler up against this pin and sight backwards to Station 1, turning the plane table so that the edge of the ruler runs exactly along the line you just drew.
2. Your plane table is now oriented to Station 1. DO NOT MOVE THE PLANE TABLE AGAIN.

G. Procedure 6

To plot features on the map, you are now ready to locate the positions of those objects on which you sighted in Step 1.

1. Let's say one of the features you wanted to include on the map was a lone apple tree. WITHOUT MOVING THE PLANE TABLE FROM ITS ORIENTATION TO STATION 1, put the edge of the sight ruler against the pin indicating Station 2, and line up the tops of the two pins on the sight ruler so they are in direct line with the apple tree.
2. Without moving the ruler, draw a line along the edge of the ruler toward the apple tree. The line you are drawing now should cross the line you drew in Step 1. Where the two lines cross is the location of the apple tree on the map.
3. Repeat this procedure for all the other features you want to include on the map, and for which you drew lines in Step 1.
4. This procedure may be carried on indefinitely. You can set up a Station 3 beyond Station 2. This could be a prolongation of the base line 1-2 or it may be in another direction.

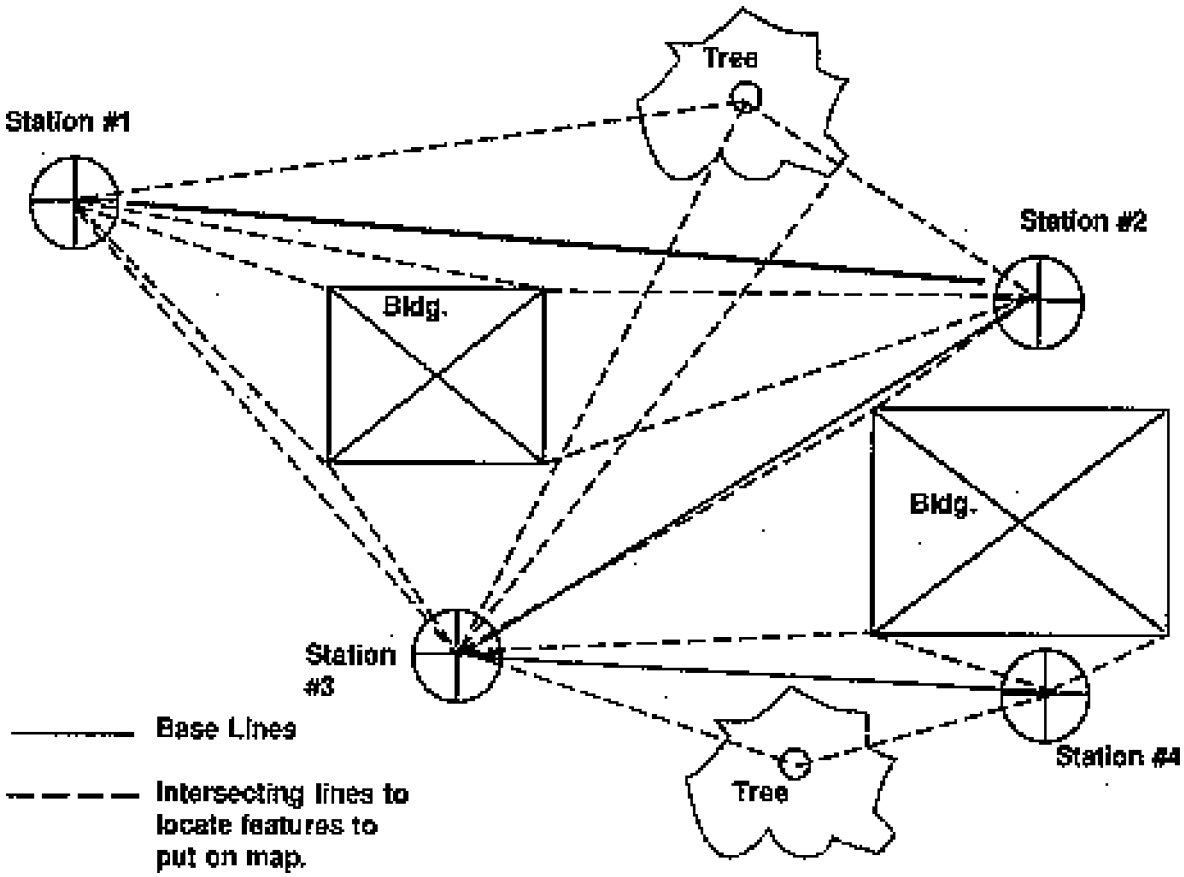


CLOSURE

Display maps and discuss the difficulties and procedures inherent in this process.

Ask:

1. What have we found out about mapping from our activities and discussions?
2. How could you use these skills to help plan for the future of a piece of land?
3. What are your feelings about the activities we have done?



ACTIVITY A: Determine Length of Step

DETERMINE LENGTH OF STEP

Method I

Walk 2 times (in a normal step) the distance marked off. Record number of steps you took each time.

Number of steps 1st time _____

Number of steps 2nd time _____

Total steps (A) _____

Total number of feet in distance walked (B) _____

200'

"

(B) (total distance walked) _____ (A) (total steps taken) _____ = _____ (C) (number of feet in each step)

NOTE: Round the length of your step to the nearest half foot: 2', 2 1/2', 3', 3 1/2'

Method II

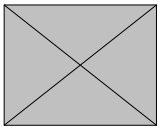
# of steps in 200'	Length of step
66-73	3'
74-87	2.5'
88-113	2'
114-over	1.5'

ACTIVITY A-1: Determine the Number of Steps in Distances

handout

Find the column for the length of your step and determine the number of steps for the distance you want to walk in the distance column.

Distance column	**Length of step columns**			
If you want to walk this distance:	1 1/2 feet **Then take:**	2 feet	2 1/2 feet	3 feet
1 foot	1/2 step	1/2 step	1/2 step	1/2 step
2 feet	1 step	1 step	1 step	1/2 step
3 feet	2 steps	1 1/2 step	1 step	1 step
4 feet	2 1/2 steps	2 steps	1 1/2 step	1 1/2 step
5 feet	3 steps	2 1/2 steps	2 steps	1 1/2 steps
6 feet	4 steps	3 steps	2 1/2 steps	2 steps
7 feet	5 steps	3 1/2 steps	3 steps	2 1/2 steps
8 feet	5 1/2 steps	4 steps	3 steps	2 1/2 steps
9 feet	6 steps	4 1/2 steps	3 1/2 steps	3 steps
10 feet	6 1/2 steps	5 steps	4 steps	3 steps
20 feet	13 1/2 steps	10 steps	8 steps	6 1/2 steps
30 feet	20 steps	15 steps	12 steps	10 steps
40 feet	26 1/2 steps	20 steps	16 steps	13 steps
50 feet	33 1/2 steps	25 steps	20 steps	17 steps
60 feet	40 steps	30 steps	24 steps	20 steps
70 feet	46 1/2 steps	35 steps	28 steps	25 steps
80 feet	53 1/2 steps	40 steps	32 steps	27 steps
90 feet	60 steps	45 steps	36 steps	30 steps
100 feet	66 steps	50 steps	40 steps	33 steps



SCORE CARD
for
COMPASS COURSE

NAME _____

Starting Point No. 2

1. Go 17 degrees for 104 feet _____
2. Then 150 degrees for 52 feet _____
3. Then 171 degrees for 55 feet _____

DESTINATION (Number of nearest marker reached) _____

CORRECT DESTINATION (Supplied by leader) _____

SCORE (Score for correct finish is 100. Deduct 5 points for each marker player missed correct destination.) _____

Starting Point No. 3

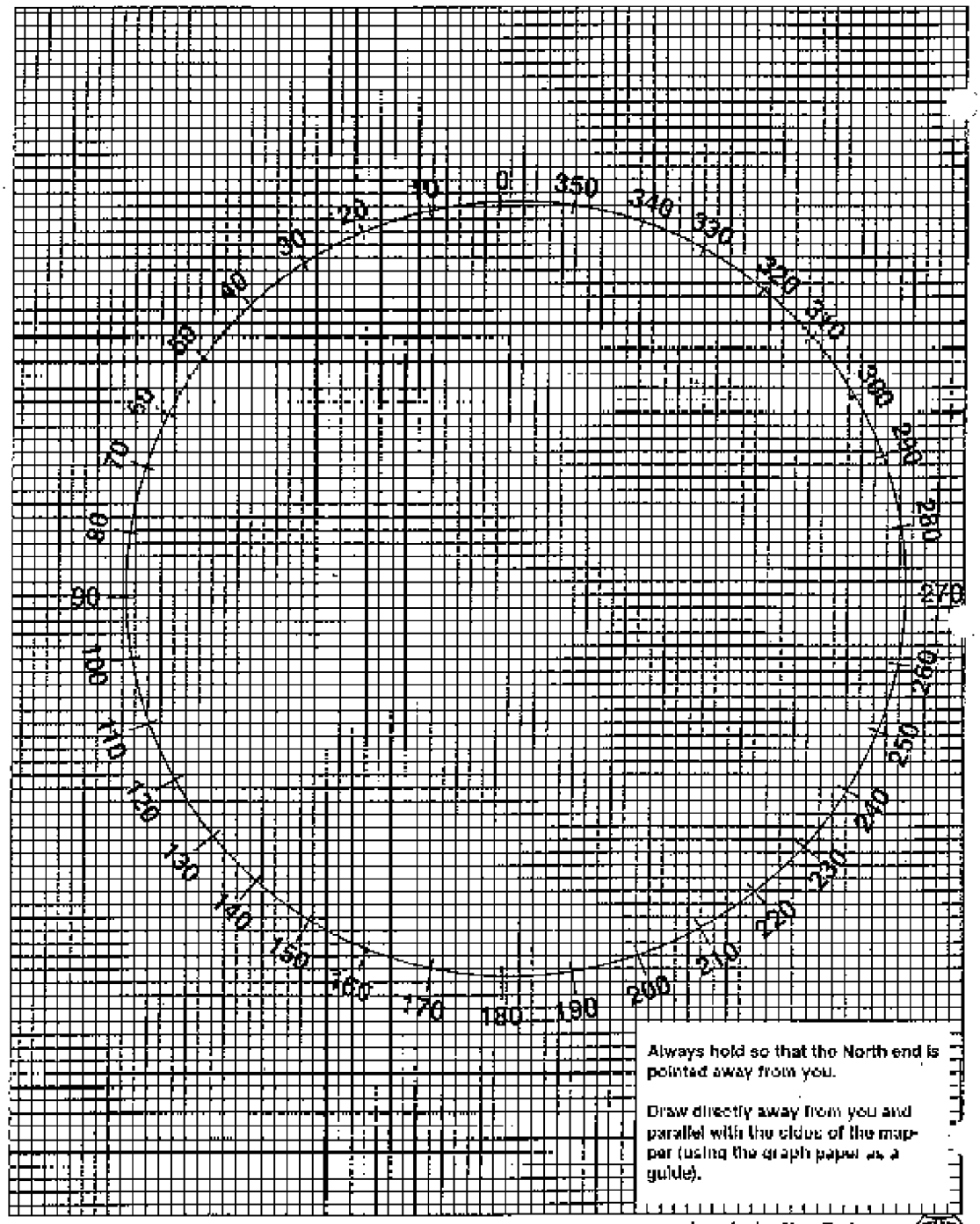
1. Go 38 degrees for 125 feet _____
2. Then 237 degrees for 90 feet _____
3. Then 187 degrees for 50 feet _____

DESTINATION (Number of nearest marker reached) _____

CORRECT DESTINATION (Supplied by leader) _____

SCORE (Score for correct finish is 100. Deduct 5 points for each marker player missed correct destination.) _____

TOTAL SCORE _____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Always hold so that the North end is pointed away from you.
Draw directly away from you and parallel with the sides of the map (using the graph paper as a guide).