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ABSTRACT

This monograph is a handbook, consisting of twelve lesson plans based on the inquiry skills, to be used by substitute teachers for science classes. For effective use of the program, materials needed to implement the various lessons must be available and the substitute teachers who will be using these materials must be trained. The objective for each lesson is presented as well as the materials needed and the procedure to be followed. Where deemed necessary, special Teacher Notes are provided to help the substitute teacher maintain student interest and attention and make the lesson a worthwhile learning experience. Lessons presented include such concepts and/or scientific processes as observation, classification, measurement, graphing and mapping. (EB)

MANUAL FOR SUBSTITUTE SCIENCE TEACHERS

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By BARBARA LOGAN
Field Agent, Science

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FOREWORD

During the past three years, the Del Mod System conducted release time in-service programs for middle school science teachers, involving some thirty-five regular substitute teachers. Several plans for effective substitution were tried with varying degrees of non-success.

In a Cooperative Plan, involving teacher cooperation in planning with and preparing the substitute teacher, time became a prohibitive factor. A Unit Plan, whereby the substitute was responsible for a specific core of material, was found ineffective due to the time lag between lessons. The use of "Contingency" plans (simulation games, puzzles, etc) afforded little relevance to the regular science program and the lack of follow-up minimized their value as a learning experience for the student. Discipline emerged as a number one problem.

What was needed, it seemed, was a program which would be simple enough for the non-scientist to handle, different enough to give some status to the substitute, interesting enough to maintain student attention and relevant enough to be a worthwhile learning experience.

This handbook, consisting of twelve lesson plans based on the inquiry skills, is an attempt to provide such a program. The plans were field tested during the '72-'73 school term and revisions made on the basis of the critiques submitted by the users. Feedback on their success indicates that this is a workable approach to the substitute situation.

Those working with the lessons attest to the interest generated in the class. Student-substitute rapport increased and discipline ceased to be a major issue. The substitute teachers felt as though they were making a positive contribution to the classroom.

Those intending to use the program in their school districts should be aware of certain elements which contributed to their success during field testing.

To ensure success, I strongly support that the following procedures be followed:

1. The use of these lessons be restricted to substitute teachers and not incorporated into the regular science program.

2. A packet of materials needed to implement the various lessons be kept with the printed sheet.

3. Those substitute teachers who will be using these materials be trained to do so effectively. The materials packets can be prepared at this same time.

ACKNOWLEDGMENTS

Lesson 1 — Adapted from Dolmatz, Malvin S. and Wong, Harry K., Ideas and Investigations in Science; Prentice Hall, Inc. Englewood Cliffs, New Jersey, page 2

Lesson 2 — "Hamburger Harry" adapted from Activities in Science, Los Angeles City Schools, 1971
"Detective Game" Science and Children, December 1971

Lesson 3-4 — Adapted from Matthews, Charles; Phillips, Darrell; and Good, Ronald; Student-Structured Learning in Science Wm. C. Brown Company Publishers, Dubuque, Iowa

Lesson 5 — Idea taken from Interaction of Man and the Biosphere, Rand McNally and Company, Chicago, 1970
"Wee Beasties" adapted from Creature Cards, Elementary Science Study. McGraw-Hill Book, 1971

Lesson 6 — Adapted from Learning By Investigating, Bk. 6, Rand McNally and Company, Chicago, 1972

Lesson 11 — Adapted from Mapping, Elementary Science Study, McGraw-Hill Book Company, Webster Division, New York, 1971.

LESSON 1

OBSERVATION

OBJECTIVE:

To describe an object so a second person can identify the object in a collection of similar objects.

MATERIALS NEEDED:

Birthday candles (one for each student)
Metric rulers
Lunch bag for each student
Items for bags (items may vary according to content area)
3 x 5 cards

PROCEDURE:

1. Distribute birthday candle and ruler to each student. Ask the students to write as many observations of the candle as they can within the time limit. (Give the students about five to seven minutes to make their observations)

2. Ask various students what they observed and note their observations on the board. When inferences are made instead of observations, draw attention to this fact by asking questions such as "Could you really observe that?"

3. Note which of the senses were used in each observation and discuss some of the limitations when just one sense is used to make an observation.

4. Collect candles and distribute bags. The students may look in the bags but should not show the contents to anyone else. Instruct the students that one person will be asked to reach into the bag and describe an object in such a way that the other students will be able to identify that object in his own bag. When the description is finished the student should say "show". The rest of the class then holds up the object that was described. Repeat several times -- watch interest level.

5. Distribute 3 x 5 cards. Have each student describe one object on one side of his card without naming it. On the reverse side of the card he should place his name and the name of the object he described.

6. Exchange cards -- have partner read description and try to name the object described.

NOTE TO TEACHERS:

Collect bags and save for lesson 3 -- collect 3 x 5 cards.

The cards should be reviewed, appropriate comments made on each and then returned to the students at the next session.

Suggestions for bag items.

One round button
One square button
One round piece of white paper
One round piece of colored paper
One square piece of white paper
One square piece of colored paper
One marble or bead
One cube (wooden, plastic or sponge)
Bottle cap
Paper clip
Wooden splint
Toothpick

LESSON 2

SHARPENING OBSERVATION SKILLS

OBJECTIVE:

To identify, compare and classify samples of similar figures.

MATERIALS NEEDED:

Word puzzle sheet (one per student)
Set of "Hamburger Harry" pictures (one per student)
Class sets of "Detective Cards"
"Detective Game" Response Sheet (one per student)

PROCEDURE:

1. Distribute word puzzle. Have students locate and circle as many words as possible in 10 minutes.

2. When the 10 minutes has passed, check on the number of words found. Discuss systematic procedures for searching, e.g., use of a cover sheet to expose one line at a time.

3. Allow a few more minutes for trying the new procedures. Suggest that they work on the puzzle during their free time.

4. Distribute "Hamburger Harry" pictures. Ask the students to find the two that are exactly alike. Warn them not to shout out their answers, but to raise their hands. The teacher should move about the room, responding to those who offer a solution. Most will be wild guesses during the first few minutes.

5. After five minutes, suggest that there are ways of finding the solution without guessing, e.g., listing the numbers of the dogs that have similar noses then examining these groups for other similarities or differences. Advise them to consider the hamburger platter as well.

6. Require the student to review the steps he took in arriving at his choice.

7. If time permits, group the students into teams of three to play the detective game.

NOTES FOR "DETECTIVE GAME"

Preparation of Materials

The Problem Cards should be composed with original copies since duplication tends to introduce distortion. If students are grouped then fewer sets of problem cards are needed.

Directions

Each typewriter has a distinctive style which can be distinguished by careful observation. Be on the lookout for such clues as freshness of ribbon, cleanliness of the type, slight uneveness of successive letters or length measurement of a sentence. Record your answers on the response sheet.

Puzzle Solutions

Word Puzzle (possible words)

anteater	eel	koala	seal
ape	elephant	lemur	shrew
baboon	elk	leopard	skunk
badger	fox	lion	sloth
bear	giraffe	monkey	squirrel
bee	goat	pig	tiger
caribou	gorilla	platrypus	walrus
cow	horse	porcupine	whale
deer	hyena	possum	wolf
dog	kangaroo	rat	wombat
			woodchuck

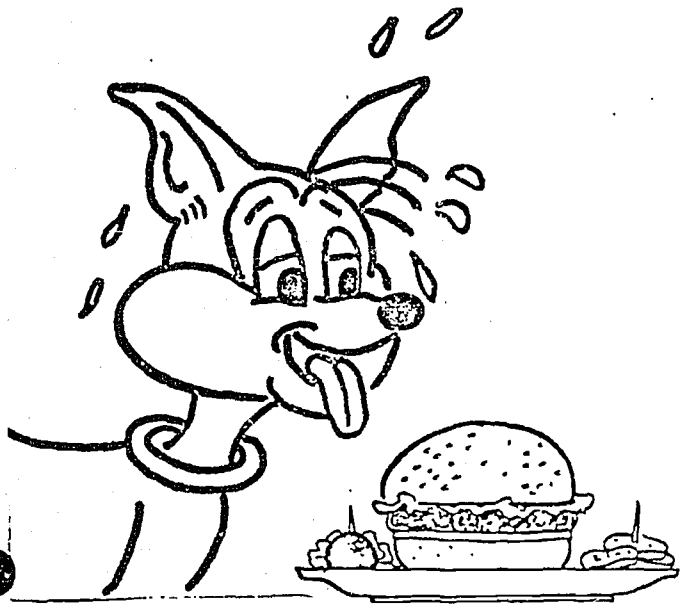
"Hamburger Harry" - 2 and 7

Detective Game - Problem Card I - 1 & 7, 2 & 8, 3 & 6, 4 & 5
Problem Card II - C, B, D, A
Problem Card III - C

ANIMALS

A E M A R T E N L A B W D W C P D
N E E P B F G H I M C H I O J O K
T T L L I E M W O M B A T L G R A
E A M E S G A L N P K L M F S C R
A N N O P N E V R E C E O E P U M
T A O A N H A Q E S A S A S L P A
E M R R L K A M G R L L S Q S I D
R W T D V L E N I O A V U U W N I
E L O X V B I Y T H A T P I M E L
S S E O W A L R U S I T Y R B T L
I L S O D T R Y O B R A T R A O O
O O F K P C Z K B G A E A E B Y S
P T B O U A H A C D D E L L O O H
R H F G X N R U R A E B P K O C H
O L E M U R K D C H Y E N A N I J
P K O O R A G N A K C A R I B O U
G I R A F F E L M N O R E G D A B
R A E B R A S H R E W B O S E A L

WHICH 2 ARE JUST ALIKE?



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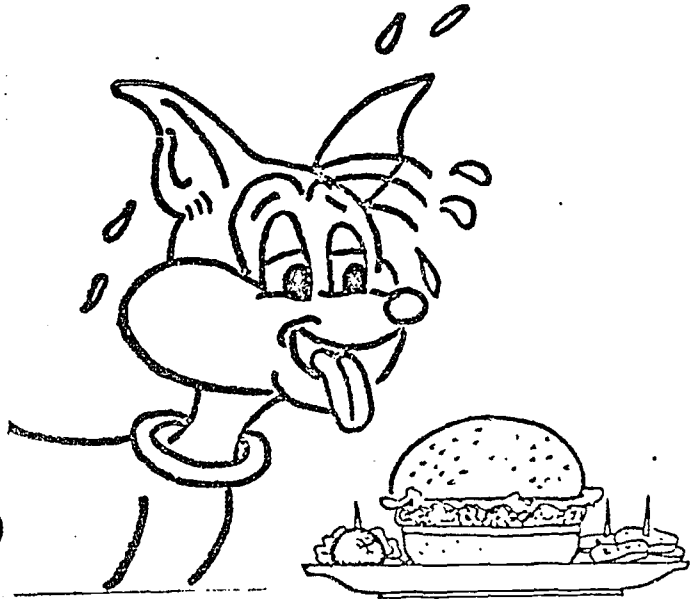

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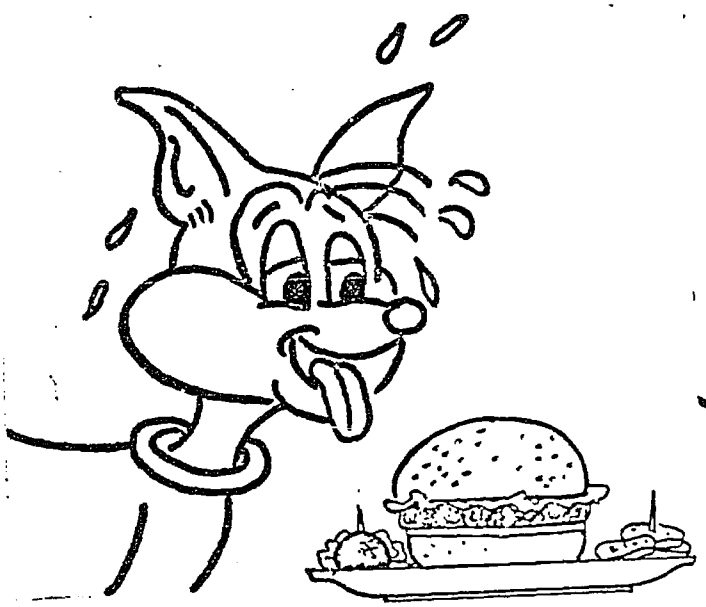

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DETECTIVE GAME

PROBLEM CARD I (Sample)

These sentences were typed on four different typewriters, two on each typewriter. List the pairs by sentence number on the record sheet.

1. The quick black dog barked at the croaking frog.
2. The quick black dog barked at the croaking frog.
3. The quick black dog barked at the croaking frog.
4. The quick black dog barked at the croaking frog.
5. The quick black dog barked at the croaking frog.
6. The quick black dog barked at the croaking frog.
7. The quick black dog barked at the croaking frog.
8. The quick black dog barked at the croaking frog.

DETECTIVE GAME

PROBLEM CARD 2 (Sample)

Shown here are an original and three carbon copies. Can you put them in order? Place the letter corresponding to the original, first copy, second copy and third copy in the space provided on the record sheet.

C. **An original and three carbon copies**

B. **An original and three carbon copies**

D. **An original and three carbon copies**

A. An original and three carbon copies

DETECTIVE GAME

PROBLEM CARD 3 (Sample)

A stewardess received this note during the highjacking of an airplane.

Bring the money in a brown bag. Hurry!

After some investigation the police had three suspects, all with typewriters. On which of the typewriters had the note been typed?

A. Bring the money in a brown bag. Hurry!

B. Bring the money in a brown bag. Hurry!

C. Bring the money in a brown bag. Hurry!

DETECTIVE GAME

PROBLEM CARD 1

1. List the pairs by sentence number.

Typewriter	Sentence pairs	
A	_____	_____
B	_____	_____
C	_____	_____
D	_____	_____

2. What features were most helpful?

_____

_____

_____

_____

PROBLEM CARD 2

Original copy _____

First copy _____

Second copy _____

Third copy _____

PROBLEM CARD 3

1. On which of the typewriters (A, B, C) had the note been typed? _____

2. What is your evidence?

LESSON 3

CLASSIFICATION

OBJECTIVE:

To construct a classification system whereby items can be identified on the basis of their observable properties when given a number of common substances.

MATERIALS NEEDED:

Envelope containing four paper clips - 2 copper clips of different sizes and 2 silver clips of different sizes - (one envelope per student)

Classification Scheme - (one per student)

Bags used in lesson 1 - (one per team)

Large sheet of newsprint paper (one per team)

Felt marking pen or crayon (one per team)

PROCEDURE:

1. Distribute a copy of the Classification Scheme to each student. Draw a sample on the board.

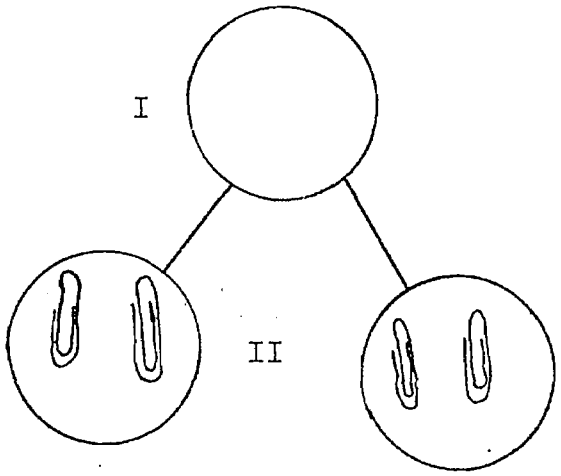
2. Introduce the day's objective with a brief discussion of every day encounters with classification. E.g., If your mother sent you to the supermarket for a dozen eggs, where would you look for them at the store? (dairy case) Would you find a can of peas in that same place? (no) Where? (on the shelf with canned vegetables)

   We often group things that are alike in some way. Today we are going to attempt to classify (group) a set of items on the basis of some observable characteristics. Let's try a sample scheme before attempting the big set.

3. Distribute envelopes containing clips. Ask the students to empty the contents into the circle at the top of the page. Label that circle with a Roman numeral one. Demonstrate at the board.

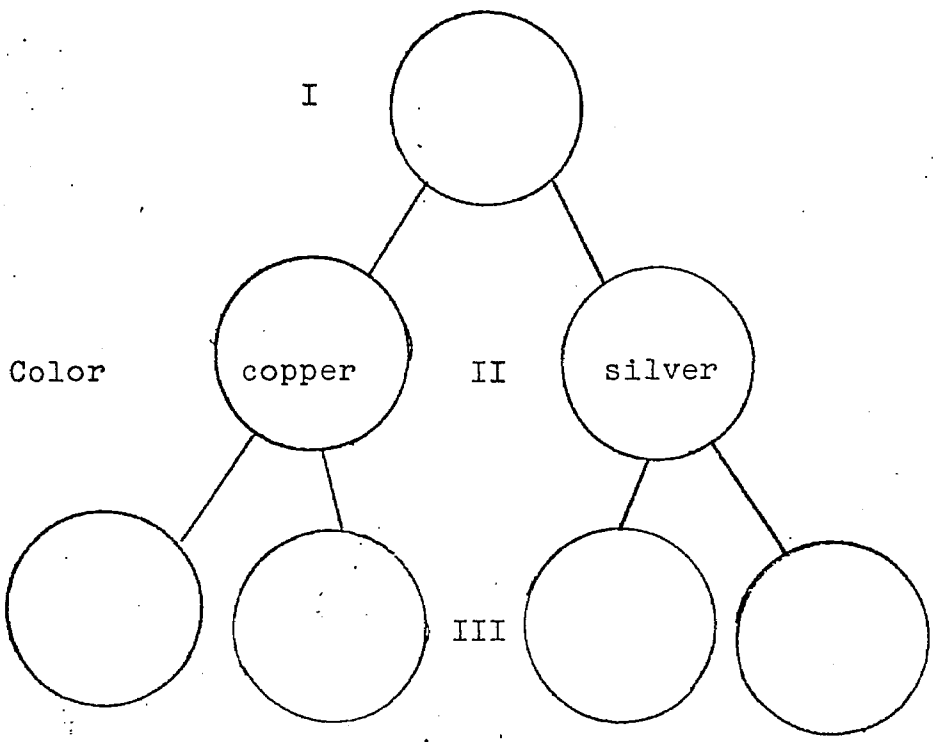
4. Ask the students to separate the clips into two groups using any criteria they wish. Indicate at the board that the groups should be arranged in the second row of circles. (Some students may need help. This should be given through careful use of questions - e.g., Are any of these objects alike in some way?)

5. There should be nothing in circle I at this time. Label the new Circle II. Demonstrate at the board. (The student's paper should now look like this.)



6. Ask one student to describe his two groups and to tell why he separated them as he did.

7. In the left hand margin, write the property used for his groupings - size or color. Ask the students to write cue word for their groups.
(The sample on the board may now look like this.)



8. Ask the students to divide each of these groups again using another property. Remind them to write the cue word in the margin. Complete the scheme on the board.

9. Point out that the classification scheme is now complete. Each item of the original set is now in a separate circle. Ask if anyone separated his differently from the scheme on the board. Discuss the possibilities.

10. Collect envelopes containing paper clips.

DO NOT START THE NEXT PROCEDURE UNLESS THERE IS AT LEAST TWENTY MINUTES REMAINING. SEE "NOTES" AT THE END OF THIS LESSON.

11. If time permits assign teams for work on the sorting bags, three students per team. Students should push their desks together, be stationed at a table or find floor space.

12. General instructions: These items were fairly easy to classify. Now we are going to do the same thing with different materials. You will have more items in the bag, so you will need to subdivide a greater number of times. You are to try to sort until each item is in a circle by itself.

13. Distribute large sheets of newsprint, crayons or felt pens and the bags.

14. The students should work on their own. If a group has difficulty getting started, the teacher should suggest that they separate the set into two groups, then ask why they put a certain group together.

Ground Rules for Teachers:

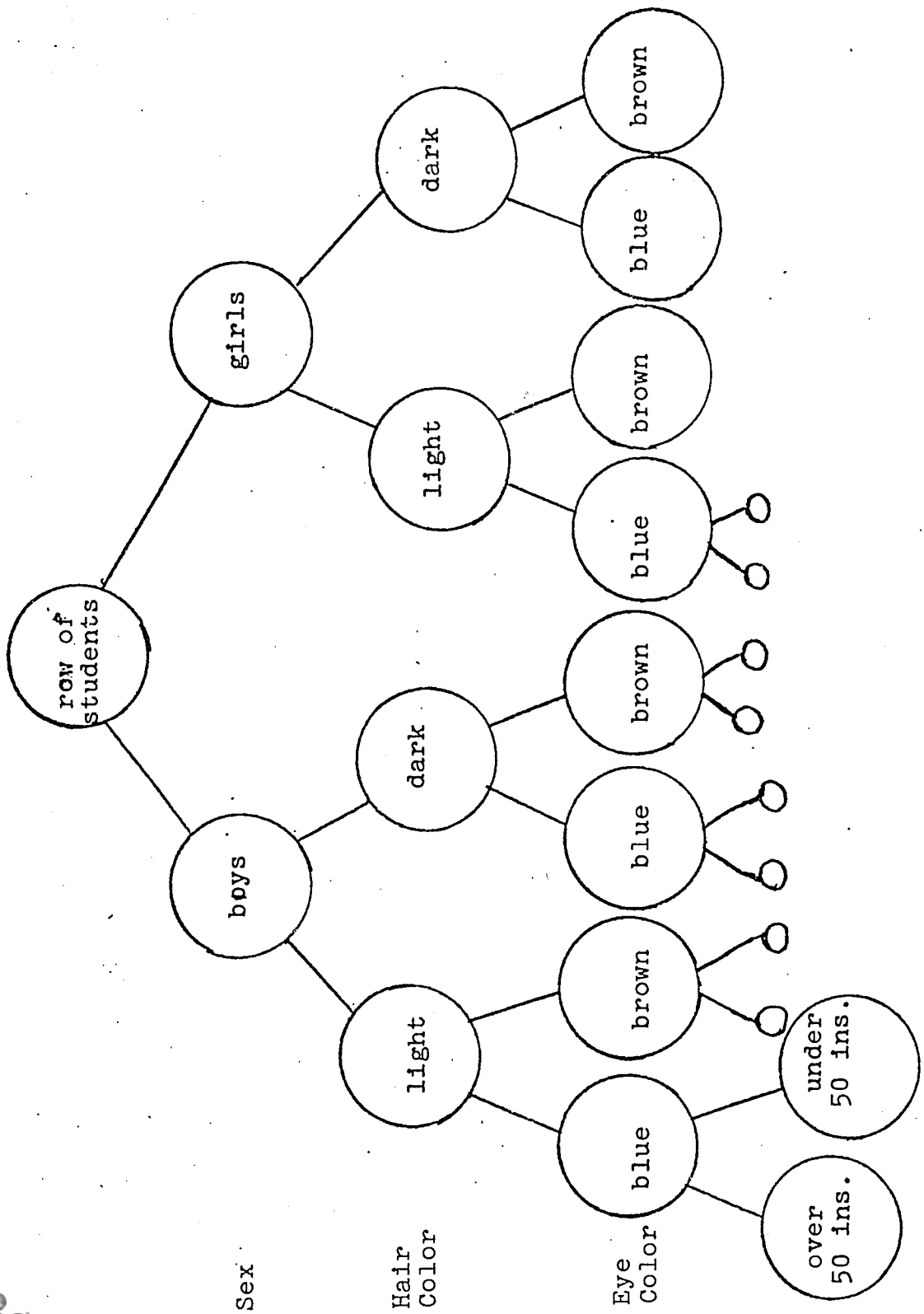
1. Any arrangement of articles is permissible as long as the students have a reason for their selection.

2. The correctness of the child's selection should be accepted for what it is -- a child's perception of the object. If the perception is invalid, it will be made apparent when the scheme is tested.

3. Watch the time. Allow at least five minutes for clean up. The objects should be put back into the bag and saved for next time. The papers should be folded to a convenient size (classification scheme in) and the name of the team members printed on the outside. Collect bags, crayons (if distributed) and papers.

NOTE:

If the students have difficulty with the classification of the paper clips, it would be wise to try the procedure again, e.g., select one row of students.



LESSON 4

CLASSIFICATION

OBJECTIVE:

To defend a classification scheme based on observable properties.

MATERIALS NEEDED:

Bags of sorting materials, papers, crayons or pens used in Lesson 3.

PROCEDURE:

1. Have students reassemble into teams at their respective work stations. (See Lesson 3, Procedure 11)

2. Distribute materials.

3. Allow time for teams to complete their classification schemes. Fifteen minutes should be ample time but this will depend upon progress made in Lesson 3.

4. If some groups finish before others, they can be directed to check their scheme and then to write a concise classification key using the numbers and cue words from the large picture.

5. When all teams have completed their work choose one scheme and tape it to the board for all to see. The team should then choose one article and another member of the class should try to trace it through the posted scheme. This may take a little practice and the teacher should help the students for the first few.

   Change schemes each time, until every team has tested his scheme once. Encourage the class to offer suggestions if the scheme tends to break down.

LESSON 5

USE OF A CLASSIFICATION KEY

OBJECTIVE:

To use a classification key to identify pictures of imaginary creatures.

MATERIALS NEEDED:

Copies of key
Copies of "Wee Beastie" creatures.

PROCEDURE:

Introduce the use of the key with a discussion such as:

How many of you have gone to the beach and collected shells? Did you know the names of each of them? What might you do to find the name of those you don't know? (Students will probably suggest looking them up in a book.)

Very often we can use a simple identification key to find the name of these shells, or flowers, or animals or rocks. Today I thought it might be fun to use a simple key to identify some imaginary creatures.

You will need a clean sheet of paper to record the names. Number straight down the sheet from one to fifteen. (Distribute identification key while students are preparing their answer sheets.)

When everyone is finished say:

"Look at the key that has been distributed. Notice that there are three columns. On the left side there is a series of numbered choices. The right hand column has either numbers or the name of one of our imaginary creatures. The big column in the middle states the characteristic. You start at the left with choice one and move down the column. If the creature has the characteristic listed for number 1 (two feet present) this leads you to another key number, number 3. You would then go to number 3 under the choice column. You here have a choice of 3a (with legs) or 3b (without legs). If your choice leads to a name instead of a number, you have found the name of your creature.

Let's take a look at our "Wee Beasties" and try identifying one together. (Distribute "Wee Beasties" pictures) Take a look at picture number 9. We begin by looking at our key and choosing between characteristic 1 or characteristic 2.

Which of those best describes our creature? (Students will answer #2 - one foot present) What does this characteristic lead to? (Students will answer #4)

We now move down the choice column to number 4. We must decide on 4a or 4b. Which of those best fit our creature? (Students answer 4a) To what does this lead us? (Uniped) This is the name of creature #9 and we will write the name UNIPED on our record sheet next to number 9.

See if you can identify the rest of the 14 "Wee Beasties". If you are having difficulty raise your hand.

Teacher will need to walk around, help students with reading, etc. Questions regarding characteristics should not be answered directly.

NOTE:

At the end of the period, collect pictures, keys and answer sheets. Answer sheets should be reviewed and returned at the next session.

IDENTIFICATION KEY FOR "WEE-BEASTIES"

CHOICE	CHARACTERISTIC	NEXT MOVE (OR IDENTIFICATION)
1.	Two feet present	3
2.	One foot present	4
3 a.	With legs	5
3 b.	Without legs	6
4 a.	With leg	UNIPED
4 b.	Without leg	BABELUCH
5 a.	With hair	7
5 b.	Without hair	8
6 a.	With hair	9
6 b.	Without hair	10
7 a.	One hair only	SWAMPSTOMPER
7 b.	More than one hair	11
8 a.	Thin neck	SERPENTOG
8 b.	Fat neck	DREWELLA
9 a.	Hair on head only	12
9 b.	Hair on head and tail	CHICKAWORM
10 a.	With ears	AURILOBBER
10 b.	Without ears	13
11 a.	No marks on body	DUOPUSS
11 b.	Has body markings	14
12 a.	Body rounded or curved	DUFFNUT
12 b.	Body angular or sharp	SNORKELESE
13 a.	Feet attached to body	15
13 b.	Feet attached at neck	ROADRUNNER
14 a.	Freckled body	GORKEL
[illegible].	Striped body	EL STRATO

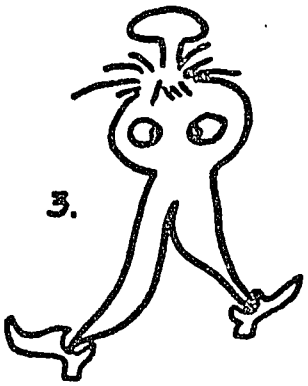
CHOICE	CHARACTERISTIC	NEXT MOVE (OR IDENTIFICATION)
15 a.	Freckled body	GUZZLELOT
15 b.	Unmarked body	SCHMOOMAN

ANSWER KEY

1. Duffnut
2. Swampstomper
3. Duopuss
4. Aurilobber
5. Guzzlelot
6. Gorkel
7. Snorkelese
8. Dwella
9. Uniped
10. Schmooman
11. Roadrunner
12. Chickaworm
13. El Strato
14. Serpentog
15. Babeluch


1.


2.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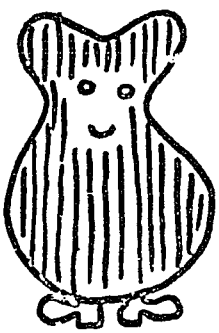
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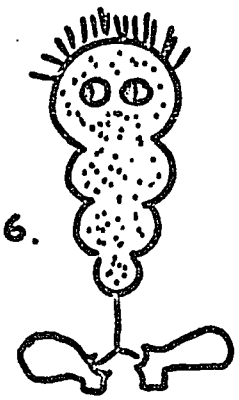
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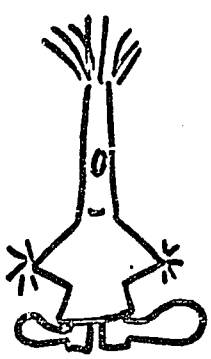
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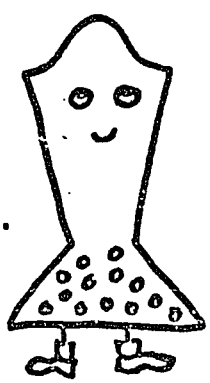
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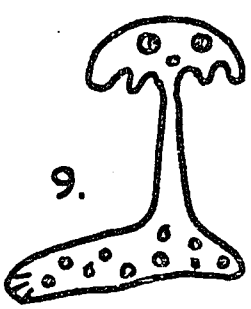
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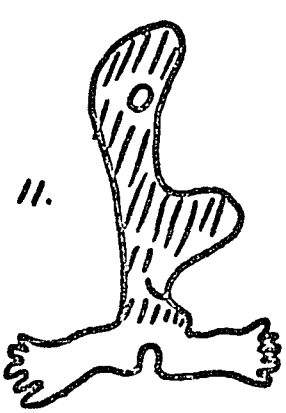
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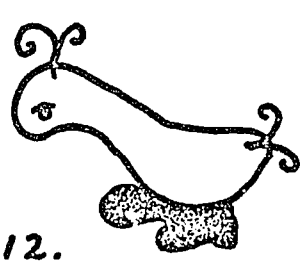
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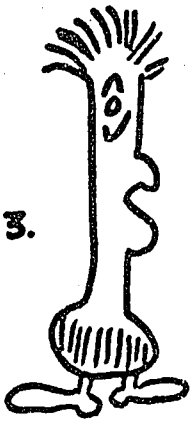

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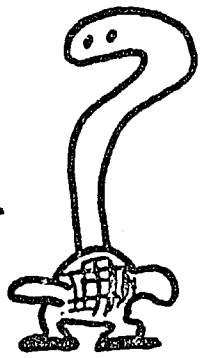

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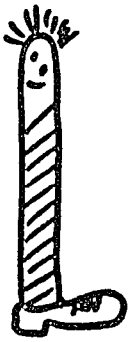


LESSON 6

MEASUREMENT

OBJECTIVE:

To demonstrate his skill in using a metric rule by measuring a line of a given length and reporting the answer in mm. and cm.

MATERIALS NEEDED:

Worksheets (one per student)
Metric rulers (one per student)
Metric stick

*Teacher should do some background reading on the history of measurement. Suggestion for quick, easy reference: Think Metric by Franklyn Branley.

PROCEDURE:

1. Before class place the following chart on the board:

	chalkboard E-F units	window sill H units	paper T-W units	room width T-H units
1.				
2.				
3.				

2. Give a brief talk on the beginning of measurement systems. Hint at the idea that it was relatively simple because they always used some part of the body.

3. Let's measure a few things using this system.

Select: three students to measure the chalkboards using the length from the elbow to the end of the longest finger (E-F units).

Three students to measure the window sill using the width of the hand (H units). In so measuring the fingers should be kept close together.

Three students to measure the width of the room by pacing it off heel to toe (T-H units).

Three students to measure the width of a sheet of paper using the width of the thumb as a unit (T-W units).

4. As each student completes his measurement he is to record it on the chart and then return to his seat.

5. After the activity is finished discuss the results.

   a) Did each of the three students measure the same number of (E-F, H, T-W, T-H) units?

   b) Why do you think some of the measurements would differ?

   c) Do you think the (forearm, hand, thumb, foot) is a good unit of measurement? Why or why not?

   What was needed was some standard. Several systems of measurement were started. Several of these systems still used terms related to the body. For example, in America we often measure something that is a foot long. Do we mean the same thing as they did back in the days of the early kings?

6. Another system of measurement is based on a unit called the meter and is called the metric system.

7. Show the meter stick (distribute meter sticks to students if available) and introduce the terms meter, centimeter and millimeter. Activities such as follow may be used.

   a) Look at the space between 50 and 51 on the meter stick. How many spaces of that length are on the meter stick?

      We call each of those spaces a centimeter (cm). (Put word and abbreviation on board)

   b) Place the index finger of your left hand on the line marked 40 on the meter stick. Now place the index finger of your right hand on a line five centimeters away. (Spot check for those having difficulty.)

   c) Now look at the space between 50 cm. and 51 cm. again. How many spaces do you see between these two numbers?

   d) How many of these smaller units are on the meter stick?

      We call these millimeters. (Put word and abbreviation on board.)

   e) Put one finger on the line marked 40 cm. Place another finger on a line six mm away. (Spot check)

8. Have students place meter sticks on floor or collect them. Refer them to the metric ruler, a piece of the meter stick. Have them locate centimeters and millimeters again as above.

9. Distribute work sheets. Then say: "Before we begin to measure there are a few secrets that you should know." Free your hands. (Place everything down on the desk.)

   Touch the second fingers of your two hands together. Hold them out about 8 to 10 inches from your eyes. What do you see? Now look past your fingers at the wall. What do you see? What do we call this? (optical illusion)

10. Our eyes sometimes play tricks on us. So when we measure we must be careful that this doesn't happen. (Demonstrate the proper reading of the measurement tool.)

11. Have the students measure the lines on the work sheet and record their measurements in cm and mm.

1 

2 

3

4

5

6

7

8

9

10

NO.	CENTI-METERS	MILLI-METERS
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

LESSON 7

MEASUREMENT

OBJECTIVE:

To demonstrate skill in using a meter stick in metric units including meters and centimeters.

MATERIALS NEEDED:

20 pieces of adding machine tape cut to 2 meter lengths
Masking tape
Meter sticks.

PROCEDURE:

1. Prior to class time 4 or 5 of the paper strips should be attached to the wall making various stations around the room. At least one station should be in the front of the room. Each of these strips should be fixed with the lower edge flush with the floor and marks made on the paper at the one and two meter distances.

2. Select a student and have him stand in front of the class away from the tape. Ask the class to predict the student's height in meters. List the prediction on the board.

3. Check the prediction by having the student stand near the tape.

4. While student number one is still standing before the class, select another student from the opposite side of the room. Again have the class estimate his height in meters.

5. Check the estimate by having the student stand beside the tape.

6. Select a third student but ask him to remain seated. The class predicts his height in meters and the prediction is checked.

7. Instruct the students that in this activity they will be asked to predict a measurement and then to check that prediction using a meter stick.

8. Students will work in teams of 2 with each student recording his predictions on his own worksheet.

9. As the students work on the first section, the teacher should distribute the following to each team:
   1 strip of adding machine paper 2 meters long
   2 pieces of masking tape.

NOTE:

The teacher should be aware of the need to give reminders about measuring techniques as the teams are doing the activity. You might need to use some judgment as to whether or not the jumping exercise should be included.

Worksheet - Predicting

In this activity you are to predict a measurement and then check your prediction using a meter stick.

1. Predict and measure:

   a. your height in meters

   b. the length of your hand (longest point) in cm.

   c. the width of your hand (widest point) in cm.

   d. the length of your foot (remove your shoe) in cm.

1.

	Prediction	Measurement
a.		
b.		
c.		
d.		

2. Place the strip of paper on the floor. Start with the tip of one shoe at the edge of the paper. Take a step, have your partner measure it. Do this 2 more times. Record your results. Predict the size of your fourth step. Measure it.

   Using the same strip of paper repeat the activity but instead of taking a step, jump keeping both feet together.

2.

	Step	Jump
Measurement 1		
Measurement 2		
Measurement 3		
Prediction 4		
Measurement 4		

LESSON 8

GRAPHING

OBJECTIVE:

To name and plot coordinates on a two dimensional graph.

MATERIALS NEEDED:

Graph paper (2 sheets per student)
Large grid for class use (see "notes")
Transparencies

PROCEDURE:

1. Introduce graphs as a means of visualizing data by showing transparency of pictorial graph and circle graph. Read some information from each.

2. Refer to jumping exercise used in Lesson 7. Discuss ways to graph this kind of data. Show transparency of bar graph. Draw attention to the horizontal and vertical axes. Read some information from this graph. Ask questions such as: Which student was able to jump more than 130 cm? Which student jumped 85 cm.?

3. Show a line graph. Point out the same features. Introduce the skill to be learned today--locating points on such a grid.

4. Using a large block grid at the board demonstrate the proper procedure for labeling axes and locating coordinates. (By convention the first coordinate corresponds to the horizontal axis; the second coordinate to the vertical axis.)

5. Have students place coordinates on the graph. Dictate a few coordinates and have the students plot them. Then let the students locate a point and read back the coordinates for that point.
Include a few fractional coordinates, e.g., (3-1/2, 2); (4, 5-1/2).

6. Distribute individual sheets of graph paper to the students and prepare new grid on the board. (a number of 10 x 10 grids should be printed on the sheets distributed to the students)

7. Select one student to work at the board while the others work at their desks. Teacher calls out pairs of coordinates which students plot. If plotted correctly,

the coordinates will form a picture (see Teacher Notes). As the teacher moves about the room, she should watch for errors in locating the coordinates called.

8. Introduce the game GRAPHO - the bingo everyone wins. Students will plot coordinates called out by the teacher. If plotted correctly, GRAPHO will result. (See Teacher Notes)

   Warning: Everyone in the class should call "GRAPHO" simultaneously.

9. At each "GRAPHO", one student should be selected to call back the coordinates. Plot these on a board grid for proof.

10. Before the final game, review the plotting of fractional coordinates. Do a few samples at the board.

11. Final game is a mystery picture. Call out the coordinates. The student is to call GRAPHO when he can identify the picture.

NOTES:

Grids can be quickly drawn on the board if a music liner is used or several can be prepared before class using newsprint paper and a felt tip pen.

TEACHER NOTES

GRAPHO

Rules for GRAPHO (10 x 10)

1. Plot the pairs of co-ordinates that are called.

2. Call GRAPHO if the co-ordinates form a line consisting of at least 5 points. The line may be horizontal, vertical or diagonal.

3. Special games may also be played such as the L game, K game, N game, etc. See sample #3.

Co-ordinates -- Regular GRAPHO

#1 (2,3); (9,5); (2,5); (5,2); (2,9); (2,7); (0.2); (9,3); (2,0)

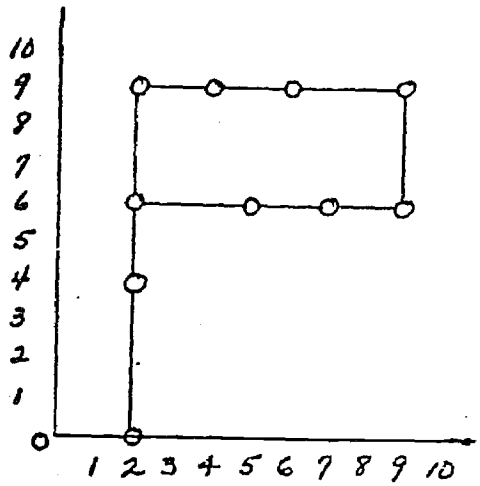
#2 (7,7); (4,4); (1,2); (3,7); (0,0); (10,10); (2,4); (4,9); (3,3)

#3 K game (1,10); (1,1); (5,1); (1,7); (3,3); (1,2); (6,5); (3,7); (1,3); (8,2); (1,5); (5,9)

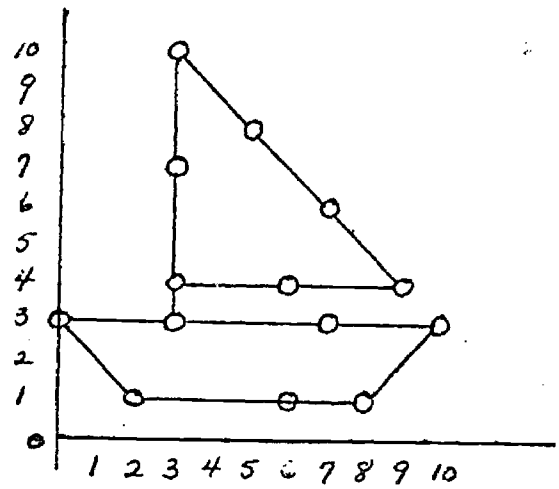
4. Mystery picture:

(6,9); (5,8); (6,7); (4-3/4,7); (4-1/2, 6-1/2); (3-1/2,6-1/4); (2-1/2, 6); (2-1/2,5-1/2); (4-1/2,5); (4-1/2,4-1/4); (5,4); (4-1/2,3); (5,2-1/2); (4-1/2,2); (4-1/2,1-1/2); (5-1); (6-1/2,1); (8,1-1/2)

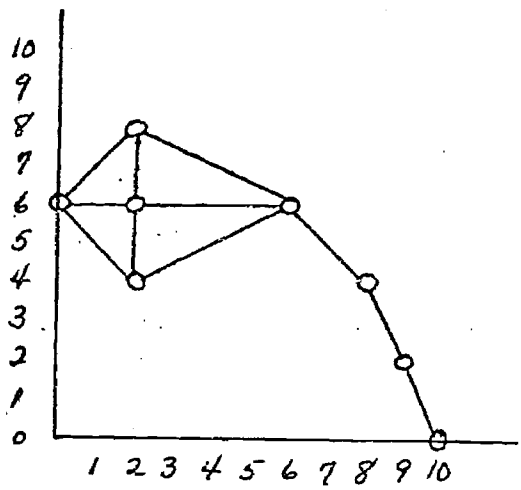
FORMING PICTURES



FLAG

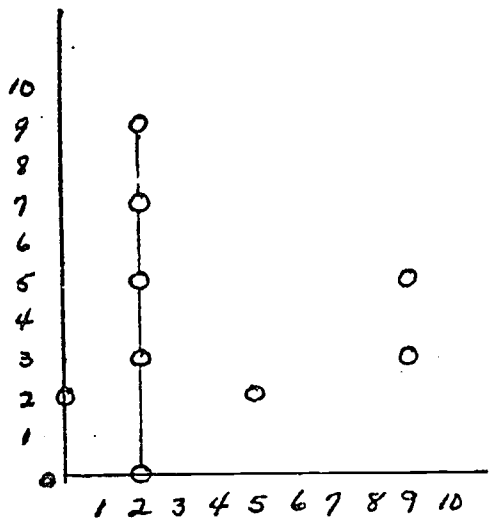


SAIL BOAT

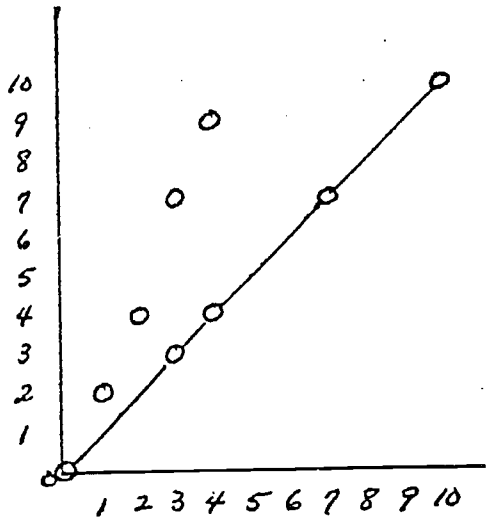


KITE

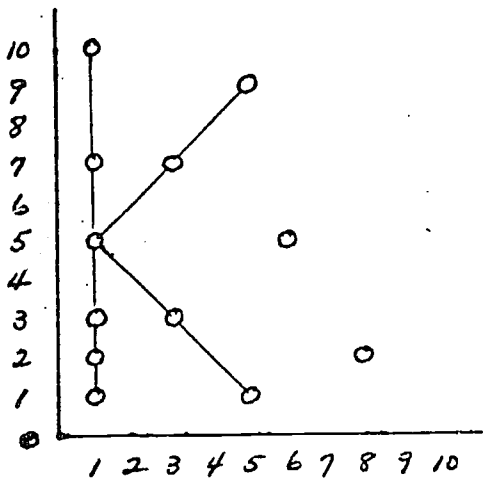
GRAPHO GAMES



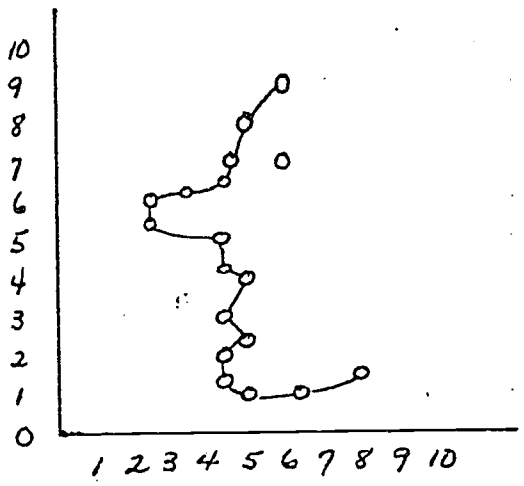
#1



#2

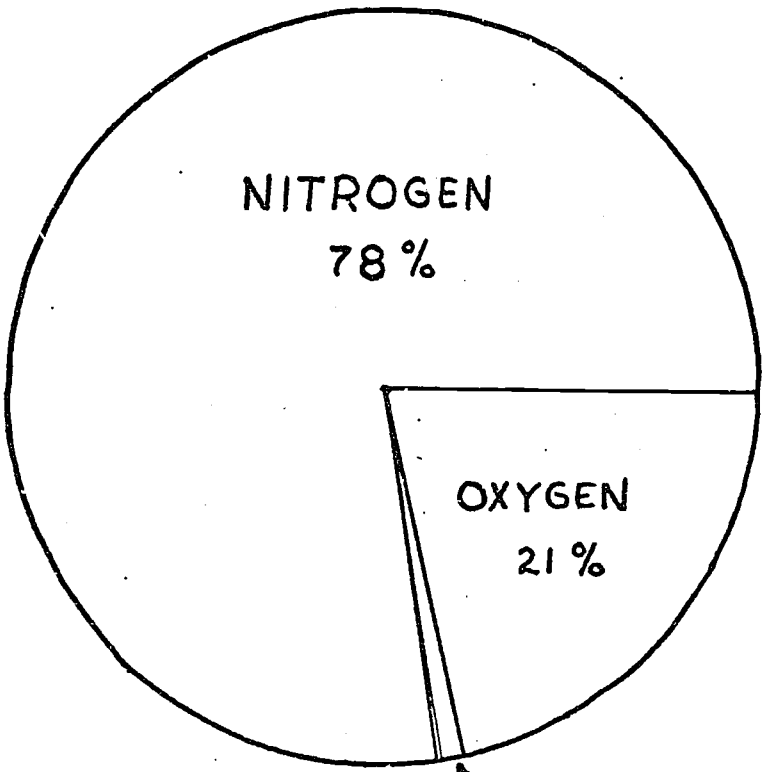


#3
LETTER GAME
SAMPLE

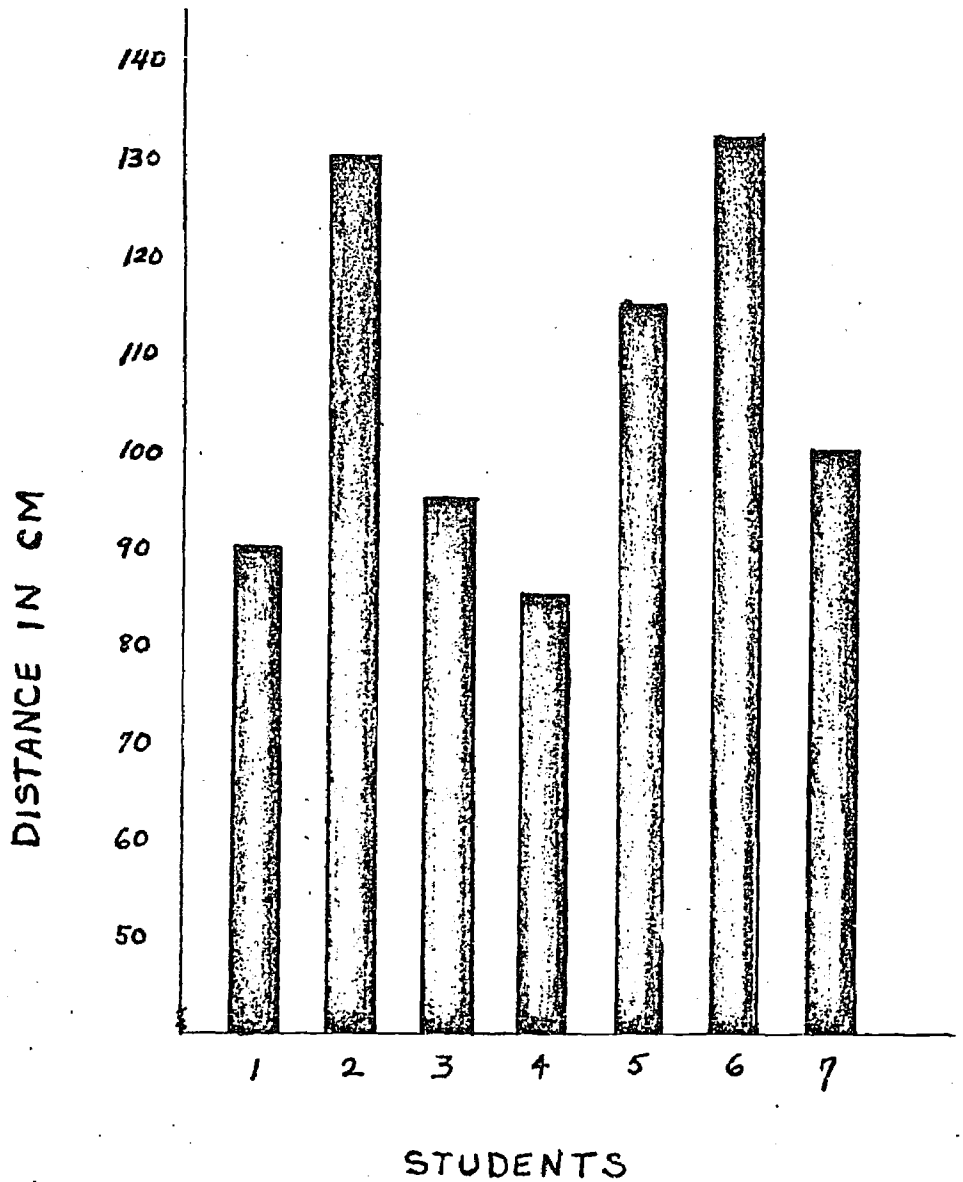


#4
MYSTERY
PICTURE

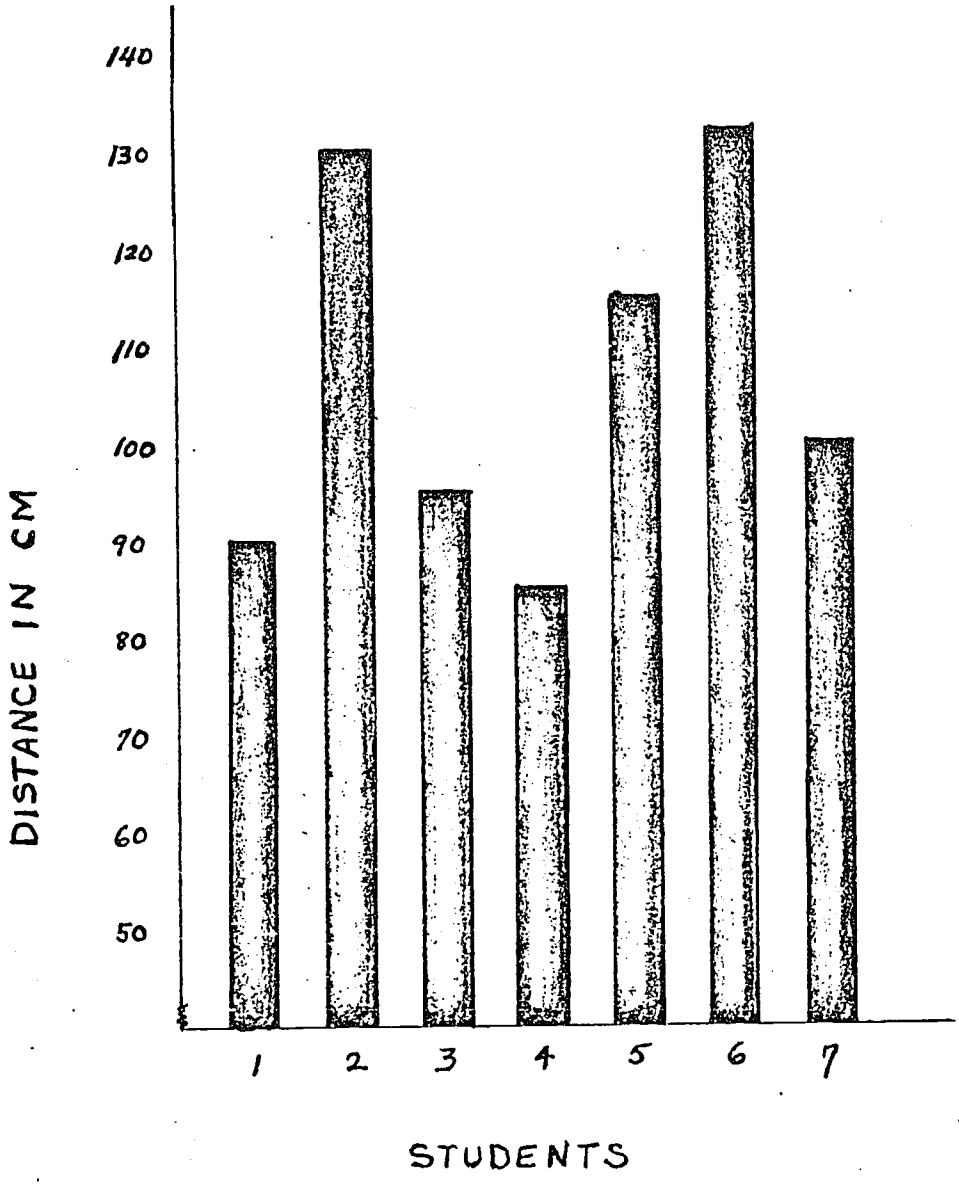
GASES IN THE ATMOSPHERE



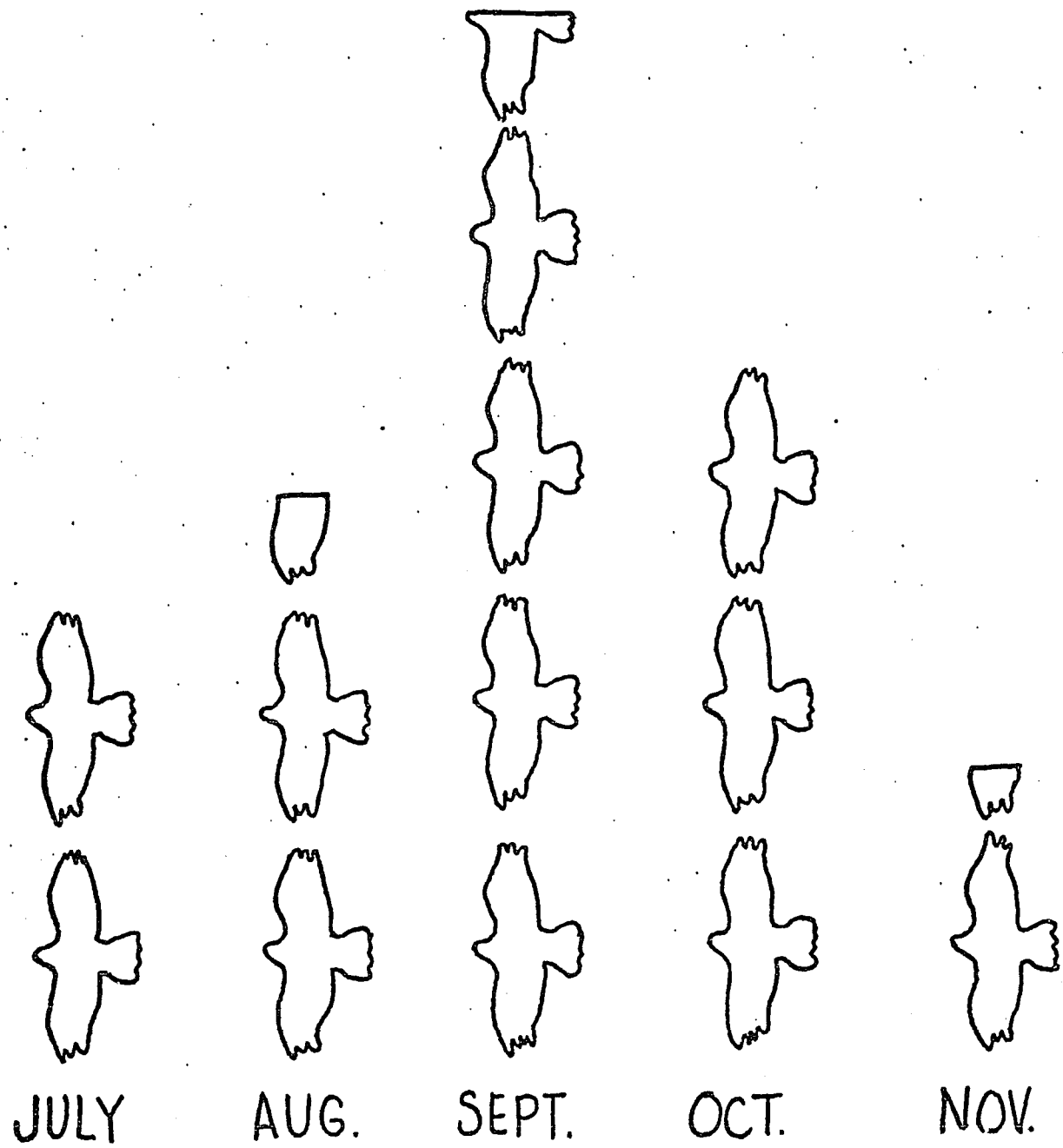
JUMP BAR GRAPH



JUMP BAR GRAPH



BIRD POPULATION OF A SMALL ISLAND IN MIGRATION PATH



Each  = 500 Birds

LESSON 9

GRAPHING

OBJECTIVE:

To construct a graph of the data obtained from measurement and describe verbally the relationship shown in the graph.

MATERIALS NEEDED:

Graph paper (one per student)
Large graph on board
Metric ruler (one per student)
Worksheet (one per student)

PROCEDURE:

1. Present a situation in which a measurement is taken, a record made and a graph of the data prepared.

   e.g. On the board I have copied a data chart which a student kept while performing an experiment. He heated a can of water for a few minutes and then recorded the temperature changes that took place for the eighteen minutes after the water was removed from the heat. He took a temperature reading every three minutes and recorded his data like this: (refer to chart on board)

	Time	Temperature °C
(when removed from heat)	0	100°
	3 min.	97°
	6 min.	95°
	9 min.	93°
	12 min.	88°
	15 min.	85°
	18 min.	81°

How could we plot this data on a graph? (Through questions and discussion lead the students to plotting the time along the horizontal axis and the temperature along the vertical axis.)

Label the grid on the board and plot the points. (This can be done by students.) Connect the plotted coordinates to form a line graph.

2. Tell the students that today they will be doing a similar task. They will be working with drawings of bean plants grown under different conditions.

3. Distribute pictures of two sets of plant sprouts. Tell the students that both sets of plants were grown in the same soil and received the same amount of light and water. The set marked A received an additional tablet of plant food but Set B did not. The pictures are of 1 plant from each set. (similar to time lapse photography)

4. Discuss the term sprout with students. Make certain everyone understands that once the plant has pushed its way through the soil it is a sprout.

5. Tell the students to measure each sprout in centimeters and to mark the height below the pictures. Spot check the students' work while they are measuring the sprouts.

6. Assist students in setting up data charts.

Set A		Set B	
Day	Height	Day	Height

7. Discuss graphing the data. One of the students will probably suggest putting the height on one axis and day on the other. Prepare the large graph on the board so that the height is on the vertical axis and time is on the horizontal axis.

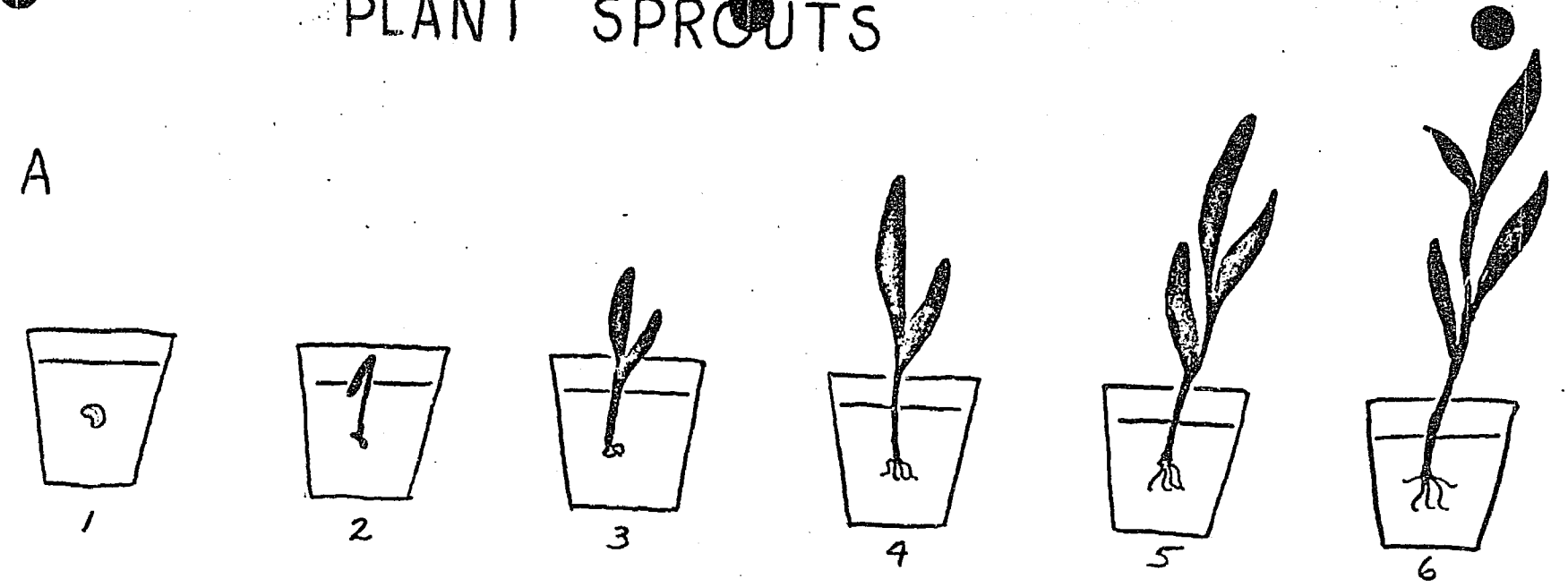
8. Distribute graph paper to students and have them prepare a grid similar to the one at the board. They are to graph the data for Set A in pencil and then Set B in ink using the same axes.

9. Discuss the reading of the graph. Does the graph tell us anything? What can it tell us? Does it show us any relationship between plants and plant food? From the data on the graph when does the plant food begin to have an effect on the growth of the sprout? What conclusion might be drawn after studying the graph?

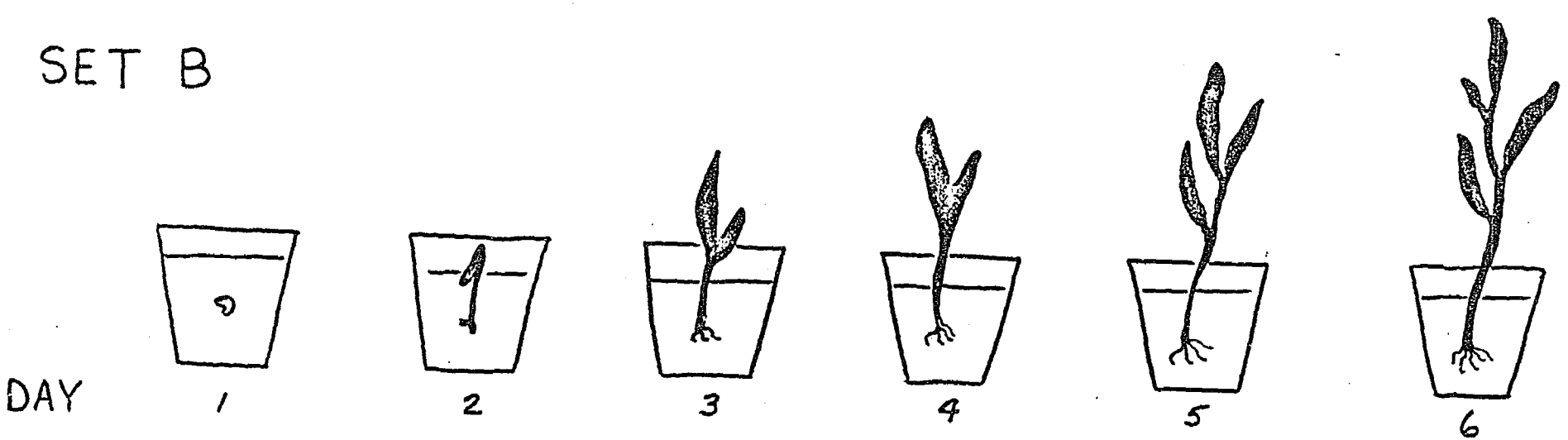
   Does the graph tell us what will happen if we continue to give Set A plant food? Does it tell us what might happen if we were to begin to give the plant food to Set B?

PLANT SPROUTS

SET A



SET B



LESSON 10

INTERPRETING A GRAPH

OBJECTIVE:

To demonstrate the ability to carry out an individual activity involving graph construction and interpretation.

MATERIALS NEEDED:

Graph paper attached to 4 x 6 card
Straws (large diameter) attached to 4 x 6 card
Meter sticks
Masking tape
Student worksheets.

PROCEDURE:

1. Review graph interpretation through the use of an inquiry such as:

Byron is a sixth grade student who has been working with a climbing bean plant. Once the bean had begun to sprout he measured the height of the plant each day. These are the results he recorded.

(Refer to chart which has been placed on board)

DAY	HEIGHT OF PLANT IN CM.	
1	1 cm.	
2	2 cm.	
3	3.2 cm.	
4	--	Saturday didn't measure
5	--	Sunday didn't measure
6	6 cm.	
7	7.5 cm.	
8	7.9 cm.	
9		

Then he plotted his findings on a graph.

(Have the graph axes on the board. And have a student graph the results. Connect points.)

Bryon thought he saw a pattern in his data. What pattern do you see?

How might we state this relationship in one sentence.

Suppose today were day 9. Could you predict how tall the plant may be today?

Today we're going to try a similar type of experiment. We will not use plants but a much simpler device. (Distribute work sheets and go over each step of the procedure with the students. Demonstrate each step using one of the students as a partner.

Assign teams and distribute other materials.

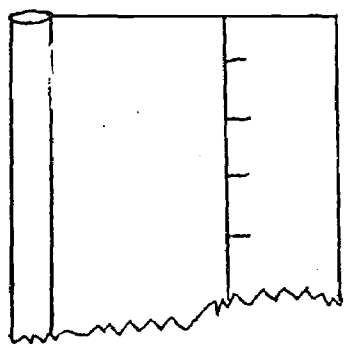
NOTE:

Collect worksheets at the end of the period.
Check to see if the interpretation is consistent with the data.
Return papers at the next session.

STRAW & GRAPH PAPER EXPERIMENT

PROCEDURE:

1. You have received a straw attached to a 4 x 6 card. Use masking tape to attach this to a meter stick. Be certain that the edge of the card is even with the edge of the meter stick as in the diagram.



2. Steady the meter stick across your desk. One team member holds the graph paper on the meter stick so that it is 10 cm. away from the edge of the straw.

3. Count the number of squares that can be sighted at this distance.

4. Count the number that can be sighted when the graph paper is 20 cm. away from the edge of the straw. 40 cm. away.

5. Repeat steps 2, 3 and 4 with the other team member doing the sighting.

6. Record all the data on your data sheet.

7. Graph the data

8. Answer the questions under <u>Interpretation</u>.

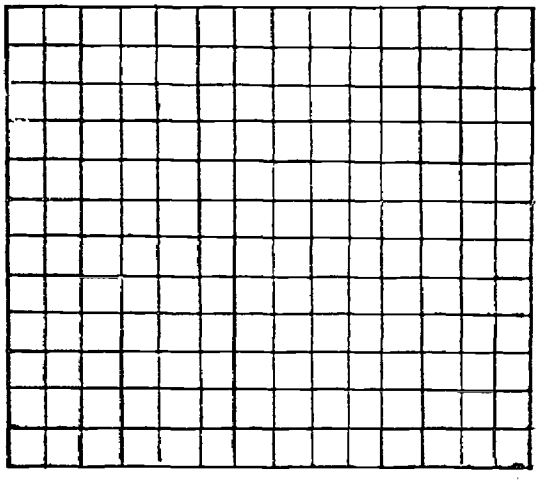
Name _____

I. Data Chart

Distance	Squares Sighted
10 cm.	
20 cm.	
40 cm.	

II. Graph of Data

No. of Squares



Distance

III. Interpretation

1. Is there a relationship between the number of squares seen and the change in distance?

2. If so, state this relationship in words.

LESSON 11

MAPPING

OBJECTIVE:

To identify position with reference to a stable background.

MATERIALS NEEDED:

Pencil or crayons
Paper
Transparency map of a classroom
Transparency picture divided into 4 quarters

PROCEDURE:

1. Divide the class into groups of four and number the members in each group 1, 2, 3, 4.

2. Put a transparency (frog sample) on the overhead and tell the students to take out a piece of paper and draw just the quarter of the picture that corresponds to their number.

3. After the students have finished drawing their sections tell them to match it with students who have completed the other three quarters.

4. Discuss how their picture compares with the original. How could they improve on their picture and still have each person in the group work independently? (Lead the students to identification of reference points.)

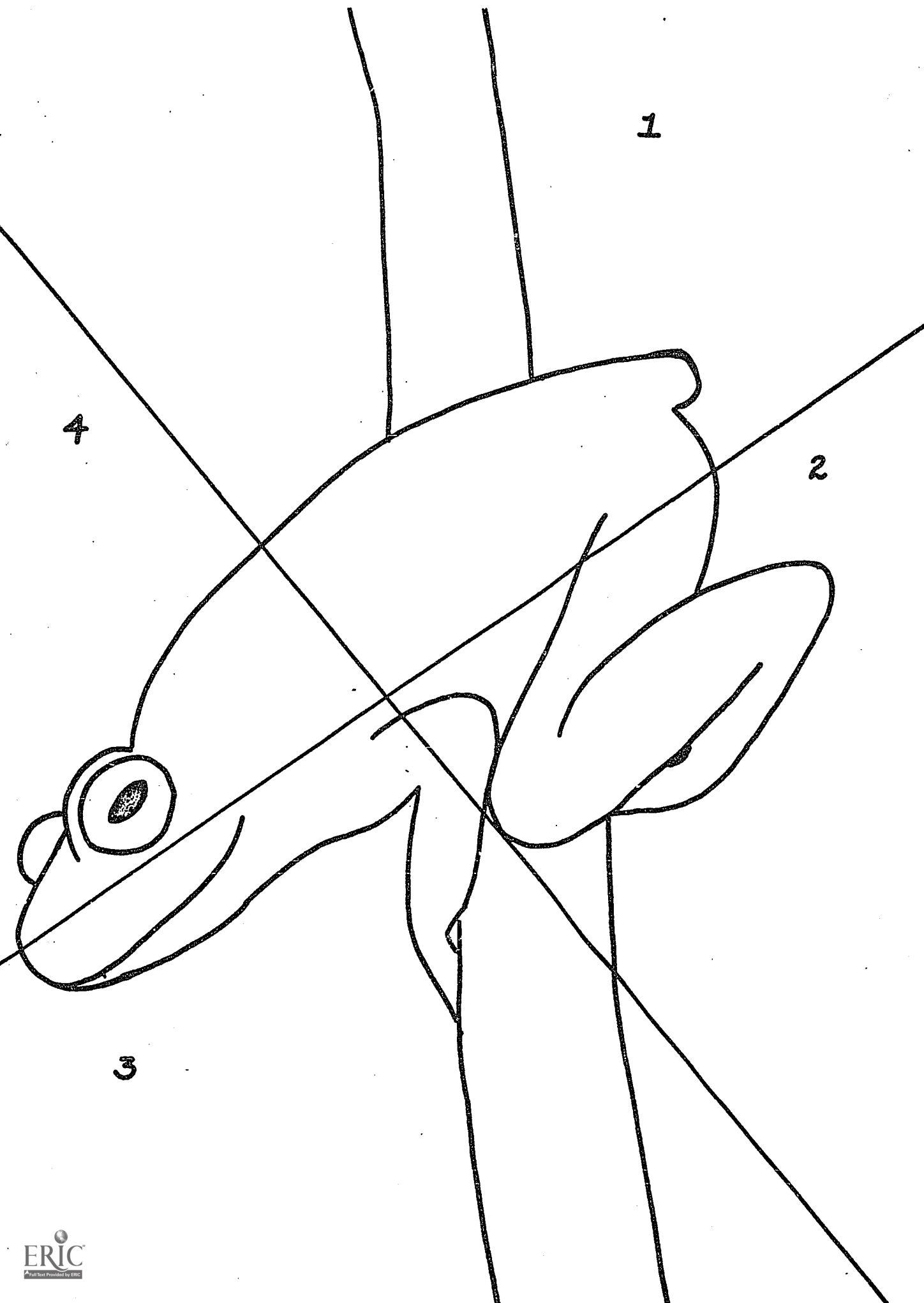
5. Try another activity without specifying reference points. Have each student draw a map of the classroom and mark his desk with an X. Allow only three to five minutes. No names on papers.

6. Collect the maps, shuffle them and redistribute them, random fashion. The student is to read the map handed to him and go to the desk indicated by the X.

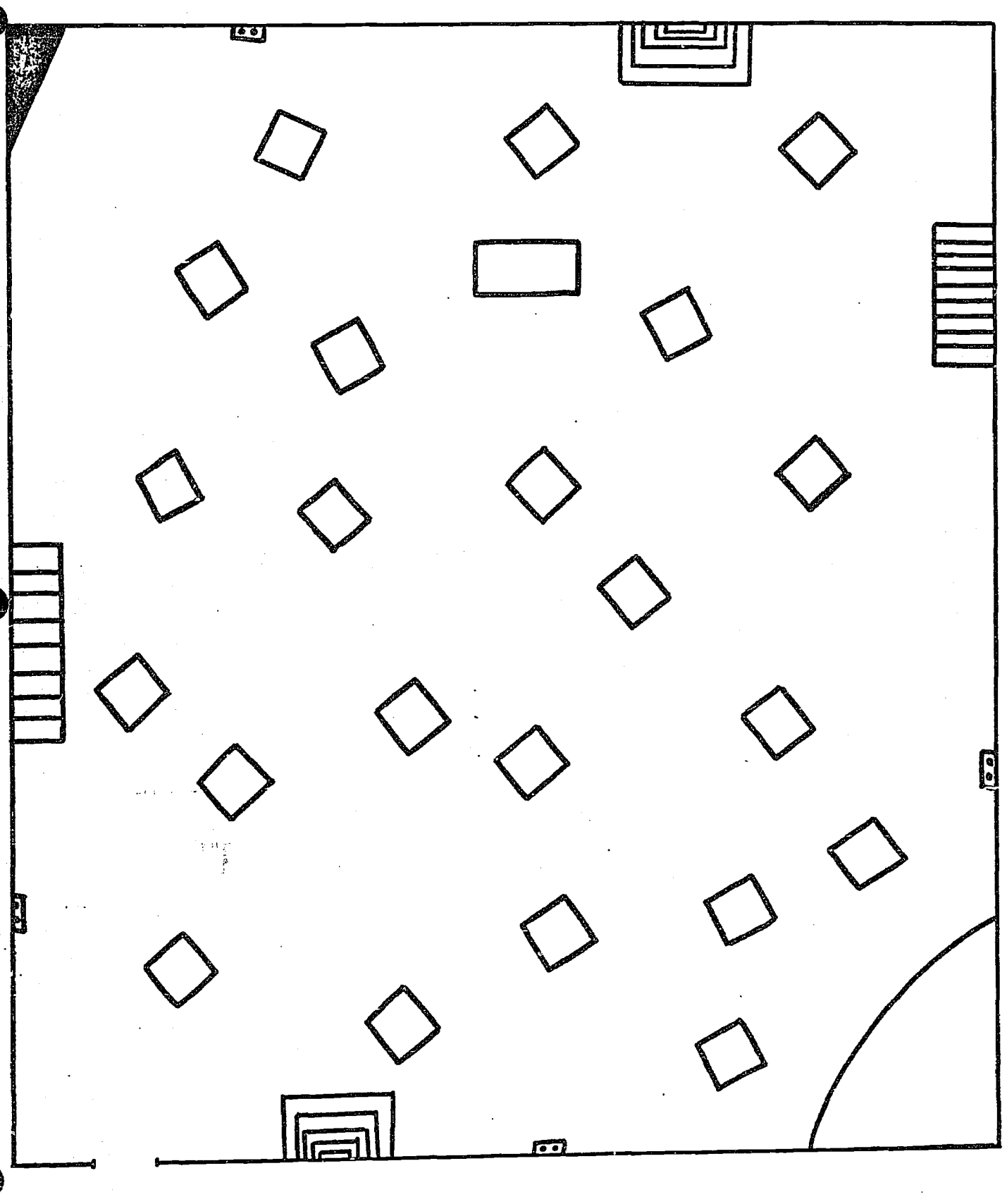
7. If a student is having difficulty in finding the desk which is marked on the map, call this to the attention of the class. Put a rough sketch of the student's map on the board and ask for interpretations of the map. Ask what improvements could be made to make the map easier to read.

8. Select several students who were able to locate the desk marked with an X and ask what feature of the map was most helpful (reference point).

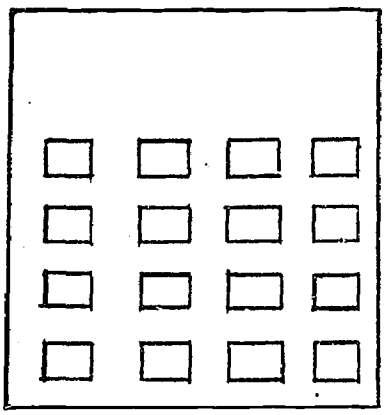
9. Put transparency #2 on the overhead. Explain that this is a map of a classroom in which the desks have been arranged haphazardly. Discuss the map; what problems would be encountered if you were trying to locate a desk in this room, what reference points are available.


1
2
3
4

#1 CLASSROOM MAP



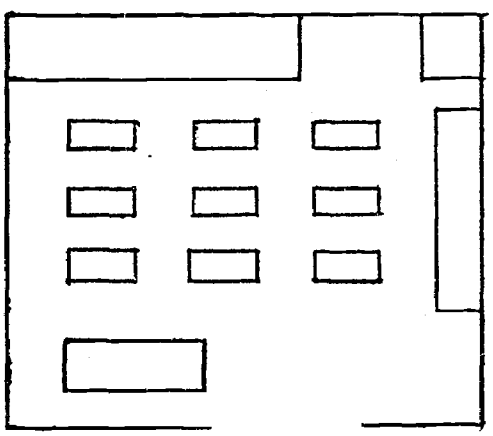
Mapping Worksheet

1. 

John sits in the second row the second desk from the front.

Is it possible to locate John's desk using the map at left? _____

2. Do something to the map to improve it. You may write on it or mark it in anyway.

3. 

At the left is another map of a classroom. As you come in the door the teacher's desk is to your right. There are three square cupboards that are used for experiments. Is this an accurate description? List all your reasons for your answer.

LESSON 12

MAPPING

OBJECTIVE:

To use information found on a road map to give directions to a given location.

MATERIALS NEEDED:

Classroom maps (one per student)
Road maps (one between every two students). These may be obtained free at gasoline stations.

PROCEDURE:

1. Distribute a classroom map to each student. Each map should have a different object or location marked with a letter or a number.

2. Ask each student to give directions to the others so that starting at the classroom door they will arrive at the location or object. Others are to follow along their map to the object and then to mark it with the appropriate letter or number.

   When interest level begins to wane stop the activity.

3. Distribute road maps. Allow students to handle the maps for a few minutes. Then discuss the various features, e.g., How are airports designated? Railroads? Bridges? Parks? Major highways? Smaller roads? Large cities, small cities?

4. How is mileage determined? Routes marked? Etc.

5. Ask the students to select two cities and map a route. If all students have the same map, one student should give the directions as the others try to follow his route.