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ABSTRACT

The emphasis of this instructional module is inductive reasoning, using the concept of graphing as a convenient means to record observations for subsequent mental operations. Performance objectives are: (1) construct a prediction from a point graph by applying the rules of extrapolation and interpolation; (2) demonstrate a test of prediction; (3) order a set of predictions or inferences based on a level of confidence; (4) construct inferences from a set of observations and identify which observations support the inference; (5) demonstrate a test for an inference by describing what additional observations are needed; and (6) given a set of observations, describe alternative inferences and distinguish between the certainty of these inferences. The general pattern of this module is one of presenting the situation with as little instructor-direction as possible. After the participant has generated data, then the sequence provides illustrations of how the instruments could guide the discussion toward a meaningful interpretation of the data gathered. The format includes: materials needed, suggested time period for each activity, pre-appraisal, activities, and post-appraisal. Because of the diagnostic data available in the pre-appraisal experience, it is possible to determine which instruction sequence appears to be most appropriate for which student. (BR)

REASONING ABOUT OBSERVATIONS

1st Experimental Edition

The Research & Development Center
For Teacher Education

THE UNIVERSITY OF TEXAS
AUSTIN

REASONING ABOUT OBSERVATIONS

1st Experimental Edition

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REASONING ABOUT OBSERVATIONS

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Science Education Center
and
The Research and Development Center for Teacher Education
The University of Texas at Austin

I. PERFORMANCE OBJECTIVES:

At the end of this session the participants should be able to:

1. Construct a prediction from a point graph by applying the rules of extrapolation and interpolation.
2. Demonstrate a test of a prediction.
3. Order a set of predictions or inferences based on a level of confidence.
4. Construct inferences from a set of observations and identify which observations support the inference.
5. Demonstrate a test for an inference by describing what additional observations are needed.
6. Given a set of observations, describe alternative inferences and distinguish between the certainty of these inferences.

II. RATIONALE:

To reason about our observations requires that we do more than merely describe those perceptions gained through our five senses.

We have a basic belief that nature is not capricious. If we see water change to ice at a certain temperature today, we believe that water will change to ice at that same temperature tomorrow. This belief in nature's regularity is the basic assumption which makes possible all reasoning about the real world. With this assumption we can predict what we expect to see happen in a new situation, and we can construct explanations which help us to interpret patterns of events and interrelationships between observations.

In this module, which emphasizes inductive reasoning, the concept of graphing is used as a convenient means to record observations for subsequent mental operations.

Note: When we connect the points of a graph to form a line, we expect to find some sort of pattern. This expectation is justified only by our basic assumption that nature operates in a regular way.

Two types of mental operation are made possible by our assumption that nature is regular. We construct a prediction when we expect to see event X occur when conditions A and B are present. The logic of human thinking, however, is to go beyond prediction to ask the question, "Why?". What reasons connect these conditions to this event? The trial explanation is an inference, the second type of mental operation made possible by our basic assumption.

New observations may require us to modify both our expectations and explanations. Thus the tentative nature of the results of our reasoning must always be kept in mind. We must be open to new observations that seem not to fit our conclusion rather than change our observations to fit the expectations we have!

The art of investigation requires this open mindedness--as well as the belief in the regularity of nature. It requires a mind prepared to look both for regular patterns and for observations that don't fit the expected pattern. This module,"Reasoning About Observations," is intended as a beginning in the preparation for these two tasks.

It may be relevant to indicate that it is possible to reason without observation. Such reasoning is called <u>guessing</u>. Making statements of what one expects to see without observational evidence upon which to base it or statements of how one explains events with no observations upon which to base them are guesses. This might be briefly pictured as:

	Statements Based on Observation	Statements Based on No Observation
What I Expect to See	Prediction	Guess
Why It Happened	Inference	Guess

Although intuitively the term "educated guess" may seem to be a useful way of communicating the idea of either prediction or inference, you are cautioned that it will help participants and the children in their classes to keep a consistent distinction between reasoning based on observation (inference or predictions) and reasoning based on no observation (guesses).

Ability of the participants to construct and interpret point graphs is necessary for success in this module. Therefore, this module should be preceded by "Describing Observations", in which graphing conventions are introduced.

The instructional activities for this module are based on the sequence in Figure 1.

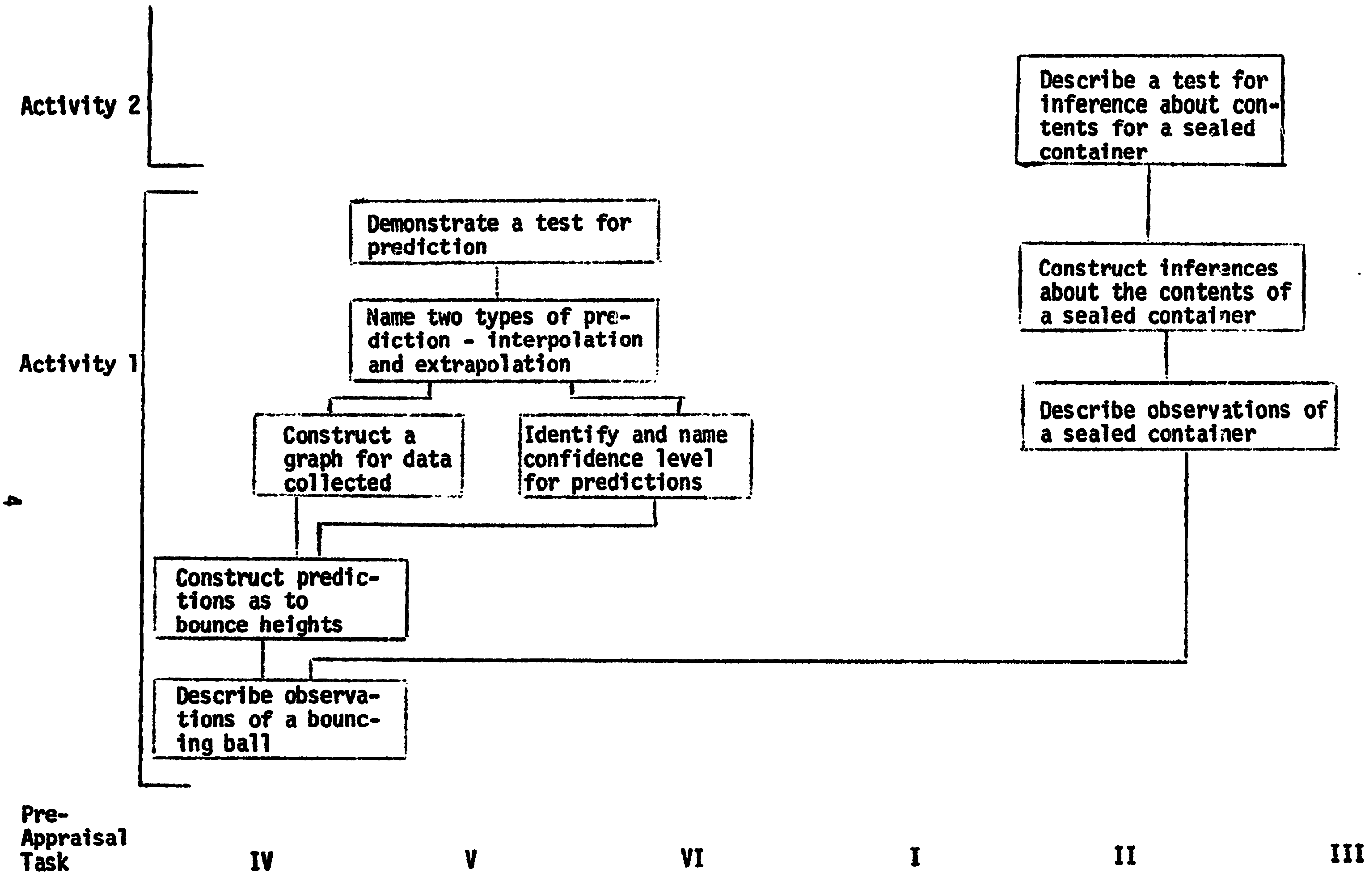
The general pattern of instruction in this module is one of presenting the situation with as little instructor-direction as possible. After the participant has generated data, then the sequence provides illustrations of how the instructor could guide the discussion toward a meaningful interpretation of the data gathered.

Because of the diagnostic data available in the pre-appraisal experience, it is possible to determine which instruction sequence appears to be most appropriate for which student. Experience indicates that if 80 per cent of a group performs well on an appraisal task, the related instruction activities should be omitted. For this instructional module, this is illustrated as:

Objective	Appraisal Task	Instructional Activity
1	IV	1
2	V	1
3	VI	1
4	I	2
5	II	3
6	III	3 and 4

Evaluation Data:

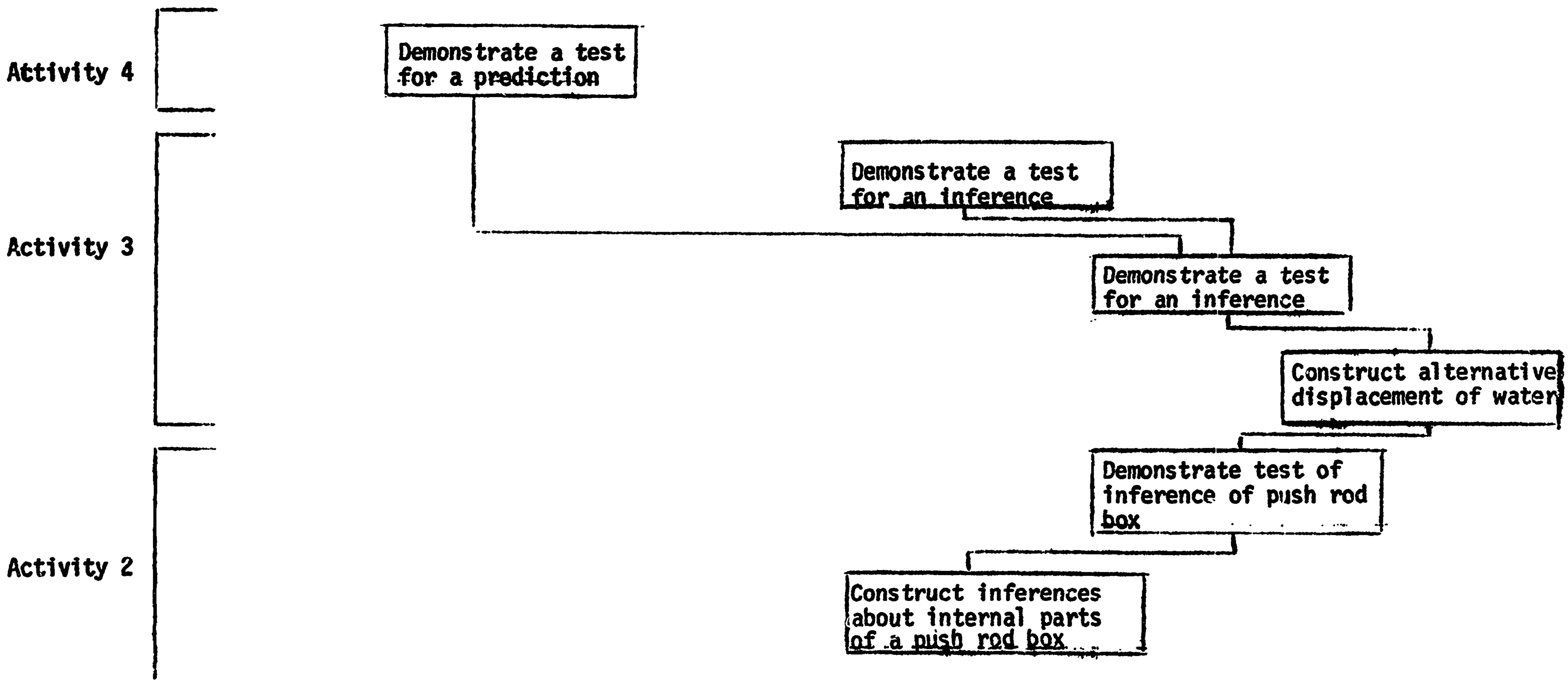
The population for this instructional program has been found to be effective includes pre-service and inservice elementary teachers who teach science.



Activity 2
Activity 1
Pre-Appraisal Task
Describe a test for inference about contents for a sealed container
Construct inferences about the contents of a sealed container
Describe observations of a sealed container
Demonstrate a test for prediction
Name two types of prediction - interpolation and extrapolation
Construct a graph for data collected
Identify and name confidence level for predictions
Construct predictions as to bounce heights
Describe observations of a bouncing ball
IV
V
VI
I
II
III

Figure 1

Objectives	Construct a prediction from a point graph by applying the rules of extrapolation and interpolation.	Demonstrate a test of a prediction.	Order a set of predictions or inferences based on a level of confidence.	Construct inferences from a set of observations and identify which observations support the inference.	Demonstrate a test for an inference by describing what additional observations are needed.	Given a set of observations, describe alternative inferences and distinguish between the certainty of those inferences.
Post Appraisal Task	IV	V	VI	I	II	III



The results of students involved in the instructional experiences as described in this module are as follows:

The time periods required for this instructional module include:

A. Planning for instruction: estimated 3 hours.

B. Teaching: estimated 120 minutes.

Suggested time periods for the module are as follows:

A.	Pre-Appraisal	25 minutes
B.	Activity I	25 minutes
C.	Activity II	20 minutes
D.	Activity III	15 minutes
E.	Activity IV	15 minutes
F.	Post-Appraisal	20 minutes
	TOTAL	120 minutes

III. REFERENCES

Commission on Science Education, Science - A Process Approach, Commentary for Teachers. AAAS Miscellaneous Publication 65-22, 1965, Pp. 141-160.

Commission on Science Education, Science - A Process Approach, A Guide for Inservice Instruction, AAAS Miscellaneous Publication 67-9, 1967, Pp. 18-31, 118-128.

IV. MATERIALS LIST

Pre-Appraisal	RO #1
Activity 1	Gclf Balls - 2 Ping Pong Balls - 2 Rubber Balls - 2 Super Balls - 2 Lined chart (horizontal lines 10 cm apart) - 1
Activity 2	RO #2 (Overview of Predicting) Sealed boxes containing <u>one</u> of the following: hexagonal pencil round pencil paper clip marble Push-rod boxes - 3
Activity 3	RO #3 One system for each group of four: Objects in the system: container of water Coke bottle (inverted) water in coke bottle straw scissors spoon eye dropper
Activity 4	RO #4 (Overview of Inferring)
Appraisal	RO #5 Graph paper

V. DESCRIPTION OF INSTRUCTIONAL ACTIVITIES

Pre-appraisal (Approximate time 25 minutes)

(Hand out RO #1.)

1. Growing seeds in the classroom has long been a favorite activity of both children and teachers. It provides the opportunity for several meaningful reasoning activities. On the sheets you have, take ten to fifteen minutes to check up on your reasoning behavior.

   After the ten minutes, you may wish to have the participants identify those tasks with which they had difficulty.

2. If you had three inferences such as:
   different kinds of lima bean seeds,
   1 plant had fertilizer,
   1 plant had more light,
   Circle Task 1

   If you name two obeervations for each of your inferences, circle Task II. For example: f Inference A above observations A and C sould support i.
   For inference B above Observations A and B would support it.

   If your test would have you holding contant the other variables, and varying only that one as describing your inference, circle Task III. For example: for A plant different kinds of seeds and compare the results in plants.
   For B. Observe the effect of fertilizer on other plants of the same kind, and
   For C. Observe the different amounts of light on other plants of the same kind.

   For Task IV your graph should include the labels for both axis and title. The answer to B, the manipulative variable was time. For C the responding variable was height of plant. D, the average height after ten days would be 20 centimeters, after 8 days would be 12-1.2 centimeters; after 15 days would be 36 centimeters, after 3-1/2 days would be 1/2 centimeter. If you had 8 of the nine possible points circle Task IV.

   If to test your prediction involved the height of the plant, on the day asked for, circle Task V. For example, to test the prediction the height of the plant will be 36 centimeters on day 15, measure the height of the plant on that day.

2 For Task VI your order should have been 10, 8, 3, 15 or 8, 10, 3, 15. If you had either of these orders circle Task VI.

When class performance is at least 80% acceptable on any given task of the pre-appraisal, the instructional activity related to that task may be omitted. Correspondence of pre-appraisal tasks, instructional activities and behavioral objectives is indicated in the table.

Activity 1 - Predicting with Bouncing Balls
(Approximate time: 25 minutes)

Objectives:
1. Construct a prediction from a point graph by applying the rules of extrapolation and interpolation.
2. Demonstrate a test of a prediction.
3. Order a set of predictions or inferences based on a level of confidence.

3. If I hold this golf ball level with my eyes and drop it from that height, how high will it bounce? Write down your answer.

Secure the variety of responses from the group. Note that they will have to refer to various positions on you -- shirt level, shoe level, etc. -- in order to communicate the expected bounce height.

4. How many of you feel confident in your answer? For what reason do you feel either confident or not confident?

Here is your opportunity to begin the distinction between statements based on first hand experience and those based on little or no experience (guesses). By having each person describe his expectations, you have a 100% involvement in their interest in observing what will happen when you drop the ball. Now drop it.

5. Now write down your observation of the bounce height of the ball.

Compare results of the various participants. If they appear to have described the same event in different language (and that quite likely will happen) you may wish to pursue the reasons why they didn't all describe the same event in the same language (different points of reference).

6. What common frame of reference would make communication clearer?

A less cluttered backdrop is the answer that should be obvious. A lined chart in the room might also help to direct the attention of the group.

7. Write down the number of the line that is your best estimate of the bounce height of the ball if I drop it from line 6.

8. Do you know that it will bounce to the height that you have marked down? Why did you select that height?

Note here that although they have not specifically observed the bounce height they have identified, because of their experience in seeing the bounce height of the ball once, their expectations now are really predictions and not a guess.

(Directions: Drop the ball from line 6 while the participants observe.)

9. Now predict the bounce height if the ball is dropped from Line 4.

List the various predictions.

10. What makes this prediction different from the earlier one? (Item 7)

The range in the second prediction should be less because they are now constructing predictions using the same frame of reference (the chart) rather than transferring from you to the chart. You may also wish to explore the reason for predictions in which the bounce height was higher than the drop height.

(Directions: Arrange the participants into eight teams and distribute one ball to each team as follows:

Teams A and B:	golf balls
Teams C and D:	rubber balls
Teams E and F:	ping pong balls
Teams G and H:	super balls)

11. First, determine the bounce height of the balls when the drop height is line 2, 4, and 6. Second, share your results with the other teams -- without speaking. You have ten minutes to complete these tasks.

12. __________, (a member of Team C) describe verbally the results of Teams A and B.

This is an opportunity for practice in communication that is precise and concise. The member of Team C should be limited to describing only what is presented in Teams A and B's report. If the group is in agreement that this task has been done satisfactorily, proceed. If not in agreement, have other members of the group describe alternative ways for either presenting or using the information presented.

13. Using the report of Team A, write down your prediction of bounce height if the drop height is:

1. Level 3 __________
2. Level 5 __________
3. Level 1 __________
4. Level 8 __________
5. Level 19 __________

Check results of the group's agreement. When there is a lack of agreement, explore the reasons for different predictions of the same event from different people.

(Directions: If there is need, insert the optional activity on point graphing conventions here.)

14. Order your predictions according to your confidence in them.

It may be that those in which they would have the most confidence are also those in which there was the greatest agreement. The order will probably be:

3 and 5	Most confident
1	
8	
19	Least confident

15. What relationship exists between the range of our observation and the level of confidence?

It should be quite clear that those predictions that are within our range of observations are also those in which we have most confidence. As predictions of events move away from our observations, we are less confident.

16. Which predictions did we make that were within our range of observation?

Predictions of the bounce height from lines 3 and 5.

17. Which predictions did we make that were outside our range of observations?

Predictions for bounce height from lines 1, 8, and 19.

18. For those predictions that are made of events that are within our range of observations, we have a special label, "interpolation." Those which are outside our range of observation are called "extrapolations."

You may also wish to note that the greater the range of observation and the greater the number of observations, the more certainty or confidence we have in the interpolations and extrapolations we construct.

19. Describe the procedure by which you would test a prediction of bounce height.

The descriptions would essentially be a description of what they did to generate the data. If they were to generalize about constructing a test of a prediction, it would be to gather another set of observations <u>in the same way</u> that the observations were made from which the prediction was made.

20. At this point, let's define the skill in reasoning about observations by contrasting it with both observations and guesses. Write down your definitions in each team for these two terms, given this statement:

Observation -- Description of property of objects or events based on perceptions with five senses.

Guess -- ______________________________
____

Prediction -- ______________________________
____

Acceptable definitions should include the ideas of distinction, such as:

Guess -- statement about that which will happen which is not based on observation.

Prediction -- statement about that which will happen which is based on at least one observation.

(Directions: Depending on the group of participants, you may wish to follow this with an analysis of how predicting is introduced to children using RO #2, Overview of Predicting.)

Activity 2 - Reasoning with Inferences
(Approximate time: 20 minutes)

Objective: 4. Construct inferences from a set of observations and identify which observations support the inference.

(Directions: Hand out sealed boxes containing objects.)

21. Many times the event about which we wish to make statements is not readily observable such as with the bouncing balls. Each of you has an object. Write down what you think is inside the box and three reasons (or observations) as to why you have made those inferences.

Earlier the participants were introduced to inferences with the module on <u>Observing</u>. This activity is a brief diagnostic experience to help you identify those who at this point are still experiencing difficulty distinguishing observations from inferences. After a 4-5 minute period, put statements of the participants on the chalkboard.

22. As we code these statements, O = observation, I = inference, you code your paper.

If there is a lack of agreement on the acceptable code for a statement, first place a question mark beside it and then return to it.

23. If we were to check this statement out, what would we do?

For example, the statement "it is round" might be called an observation, but if we were to check out the statement we cannot observe the roundness of the object. We can listen to it rolling smoothly; we can "feel" the ease with which it moves in various directions; and because of our past experience (note this is not a statement of a guess), we can infer that the object in the box is round. If the statement is an inference, what we do to verify it is different from what the statement describes.

24. For each inference we have, state two observations that support it.

You may wish to have the participants do this as a group -- or do it in small groups on newsprint -- or do it individually.

(Directions: Hand out one push-rod box to each team.)

25. You have eight minutes to make and record whatever observations you wish (you may not open the box). Then you are to construct an inference as to how it is put together. That inference (but not your observations) you will then give to another team for them to decide how to test it.

If the participants are in teams of 4 or 5, this activity will provide much interaction. They will be both gaining information from this experience and reasoning about it.

(Directions: Be careful to call time. This aids people in getting promptly on with their tasks. You may wish to use RO #3 as a handout to help them.)

26. Now let's exchange boxes and inferences (or explanations) as to how the box works. You now have 10 minutes to describe (in writing) a test of the inference, without opening the box. Do it and then show what changes you would make in the inference, if any, of the previous group.

Here is a good opportunity for you to observe the precision of the communication levels of the various groups.

27. In what way was the second task similar to the first task? In what way was it different?

The frustration that one feels when he cannot see everything is closely akin to the scientist's feeling about many "black boxes" in nature. Both of these tasks were probably alike in this way. The difference is also like that of an investigator in science. When he builds on what others have done, he is able to feel much more confident about the results of his work. The relationship between certainty or confidence you have in an inference and the number of observations should be obvious.

Activity 3 (Approximate time: 15 minutes)

Objectives: 5. Demonstrate a test for an inference by describing what additional observations are needed.

6. Given a set of observations, describe alternative inferences and distinguish between the certainty of those inferences.

(Directions: Distribute systems [coke bottles, etc.] to groups.)

28. Identify the objects in your system.

An acceptable description is:

container of water
water
Coke bottle (inverted)
water in Coke bottle
straw
scissors
spoon
eyedropper

29. The event or question for your thinking is: In what way can you remove the water from inside the Coke bottle without removing the bottle from the water. Note three rules:

1. Bottle may not be taken out of the water.
2. Water may not be drunk.
3. Water may not be taken away.

After the teams have placed their inferences and supporting observations on chart paper, display the results for the group to share. Select one or two of them for further discussion.

30. When you have completed the task, take two alternative inferences about what happened to the water. For each inference, list two observations which support that inference.

You may wish to have the groups race to see who is the first to get the water out. When one group is successful they could serve as helpers in other groups providing they do not tell the group how to do the task.

31. For this inference (name it) what kind of a test would we make to check its validity?

Have the group describe the steps or procedures they would follow to test the inference.

(Directions: Assign an inference to each group.)

32. Working in your group, construct a procedure to test the inference assigned to you.

(Directions: Have them follow their procedure. Have them display their results along with the inference they were testing.

33. If you were to design a new test for the inference -- how would you do it differently?

34. Which inferences about where the water went will you accept? In what way is your feeling about the inferences now different than it was before they did some testing (secured more observations).

Those inferences which now have greater supporting observations are the ones in which we have the greatest confidence.

Activity 4 (Approximate time: 15 minutes)

Objective: 6. Given a set of observations, describe alternative inferences and distinguish between the certainty of those inferences.

35. Think back to those charts of the observations of the ball bounce heights. In each group construct an inference and describe a suitable test for it as to why the bounce height from level 6 was not the same for each group.

It may be quite apparent to the groups that different teams had different types of balls. One inference might be that the bounce height of the balls was different because of the different composition of the balls

or

because of the different sizes of the balls

or

because of the smoothness of the texture of the balls

or

because of the difference in the surface from which the ball was bounced.

Check carefully the procedure for testing these inferences.

36. When we compare the procedure for testing a statement of inference and a statement of prediction, how are they alike?

The common element to the test of either of these reasoning skills is that they require more observations.

37. In what way do the testing of an inference and the testing of a prediction differ?

In testing a prediction you make a new set of observations just like those upon which the prediction was based. In testing an inference you make a new set of observations that are different from those upon which the inference was based. For example, to test the prediction of the bounce height of a ball, you drop the ball from another height and observe its bounce. To test the inference of bounce height being dependent upon the size of the ball, you have to use different balls and compare their bounce heights.

38. Write down a definition of inference that will distinguish it from the earlier definitions of observation, guess, and prediction.

(Direction: You may wish to display the earlier definitions for the participants' benefit. If time and interest permit, you may wish to follow this with an analysis of how the reasoning skill of inference is introduced to children using RO #4.)

Appraisal (Approximate time: 25 minutes)

39. You have 15 minutes to complete the 9 tasks of the Appraisal.

When finished, review acceptable responses. You may wish to have the participants construct a quickie profile of their improvement by comparing their performance on the pre-appraisal with the post-appraisal.

40. If for Task I you had such inferences as
   (a) more water poured into the jar at the front of the room;
   (b) jar on sill was spilled;
   (c) more evaporation from jar near window,
circle Task I.

If in Task II you used observation 1 to support inference A, observation 2 to support inference B. observation 4 to support inference C, or some reasonable way in which the observations were used to support the inferences, circle Task II.

If in Task III you listed such observations as questioned the people involved for inference A; or for inference B, how much water in puddle; or for inference C, compare evaporation at window and desk experimentally, circle Task III.

If for Task IV your point graph of the data had on the x axis the time period and on the y axis the water height of the jar and a label for the graph, circle A. If you had time of the day, circle B. If you had height of water as the responding variable, circle C. If you had 0 cm, 17.5 cm, 16.5 cm, 10 cm, 20 cm, and 0 cm (or near that), circle D. If you had three of the four letters circled, circle Task IV.

In Task V, if you had something such as place another glass of water in the window sill and observe the water level at exact times, circle Task V.

For Task VI, the order should be 9:30, 11:30, 10:30, 12:30, 8:30, and 3:30. If you had that order, circle Task VI.

Correspondence of Tasks

Performance Objectives	Pre-Appraisal Task #	Instructional Activity	Post-Appraisal Task #
1	IV	1	IV
2	V	1	V
3	VI	1	VI
4	I	2	I
5	II	3	II
6	III	3 & 4	III

Duplicated Materials -- Without Answers

RO #1

Code ________

Pre-Appraisal

Three children planted several lima bean seeds and then measured the height of the bean plants at selected intervals.

TASK I:

As the seeds germinated, the three children made these observations:

A. One plant had larger green leaves than the other two.
B. The color of the leaves of the other two plants was light green to yellow.
C. The stems of the light green leafed plants were longer than the dark green leafed plants.

Write three inferences that would explain the differences between the plants:

Inference A ______________________________

Inference B ______________________________

Inference C ______________________________

TASK II:

Name the observations upon which your inferences were based:

For Inference A ______________________________

For Inference B ______________________________

For Inference C ______________________________

TASK III:

Describe how you would test one of the inferences you constructed in Task I.

A ____________________

B ____________________

C ____________________

TASK IV:

They recorded their observations:

Days After Planting	Average Height of Plants at Tallest Point
4	1 cm
5-1/2	5 cm
7	10 cm
11	23 cm
12-1/2	28 cm

A. Construct a point graph of their data.
B. The manipulated variable in this activity was________.
C. The responding variable in this activity was________.
D. What was the average height of the bean plant:
10 days after planting?________
8 days after planting?________
15 days after planting?________
3-1/2 days after planting?________

TASK V:

Describe how you would find out if one of your predictions in Task IV was correct.

____

____

TASK VI:

You made four predictions in Task IV. List them in order of greatest confidence you have that they are correct.

Most Confident Least Confident

____________ ____________ ____________ ____________

Overview of Predicting

(Taken from Parts C and D of Science - A Process Approach, 1967 Xerox edition)

Predicting 1: USING GRAPHS (Part C = grade 2 or 3)

Objectives:

1. CONSTRUCT predictions based on the data presented on a graph.
2. DEMONSTRATE a test of the predictions.

Context:

The children work with data from spring scales and water displacement.

Vocabulary:

Record, data, pattern, extrapolation (on a graph)

Predicting 2: SURVEYING OPINION (Part C = grade 2 or 3)

Objectives:

1. DEMONSTRATE the method of collection and organization of simple data.
2. CONSTRUCT a bar graph to represent a given collection of data.
3. CONSTRUCT a prediction based on the examination of data presented in the graph.

Context:

The children collect and compare opinions of favorite animals in their own class, other classes, and of adults.

Vocabulary:

Prediction, survey, polling, data

Predicting 3: DESCRIBING THE MOTION OF A BOUNCING BALL
(Part D = grade 3 or 4)

Objectives:

1. CONSTRUCT a bar graph showing the relationship between the height from which a ball is dropped and the height to which it bounces.
2. STATE and APPLY A RULE that a ball's bounce height is directly related to its drop height.
3. CONSTRUCT a prediction of a bounce height, by interpolating on a graph, given two or more bounce heights, and two or more drop heights.
4. DEMONSTRATE the test of a constructed prediction.

Context:

The children collect and manipulate data from bouncing balls.

Vocabulary:

High, height, bounce, release, rebound

Predicting 4: THE SUFFOCATING CANDLE (Part D = grade 3 or 4)

Objectives:

At the end of this exercise the child should be able to:

1. CONSTRUCT predictions based on a series of observations that reveal a pattern.
2. CONSTRUCT a revision of a prediction on the basis of additional information.

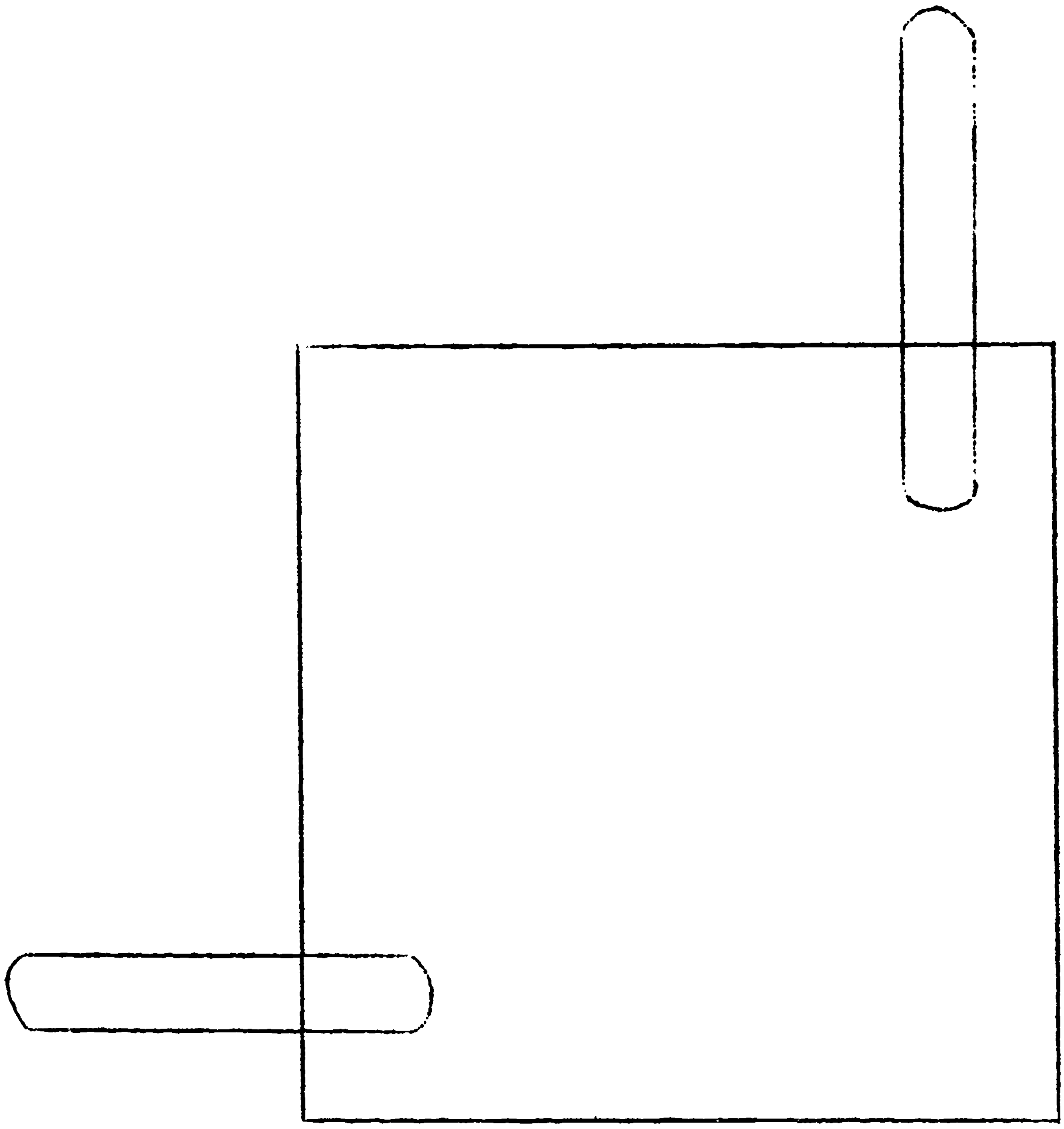
Context:

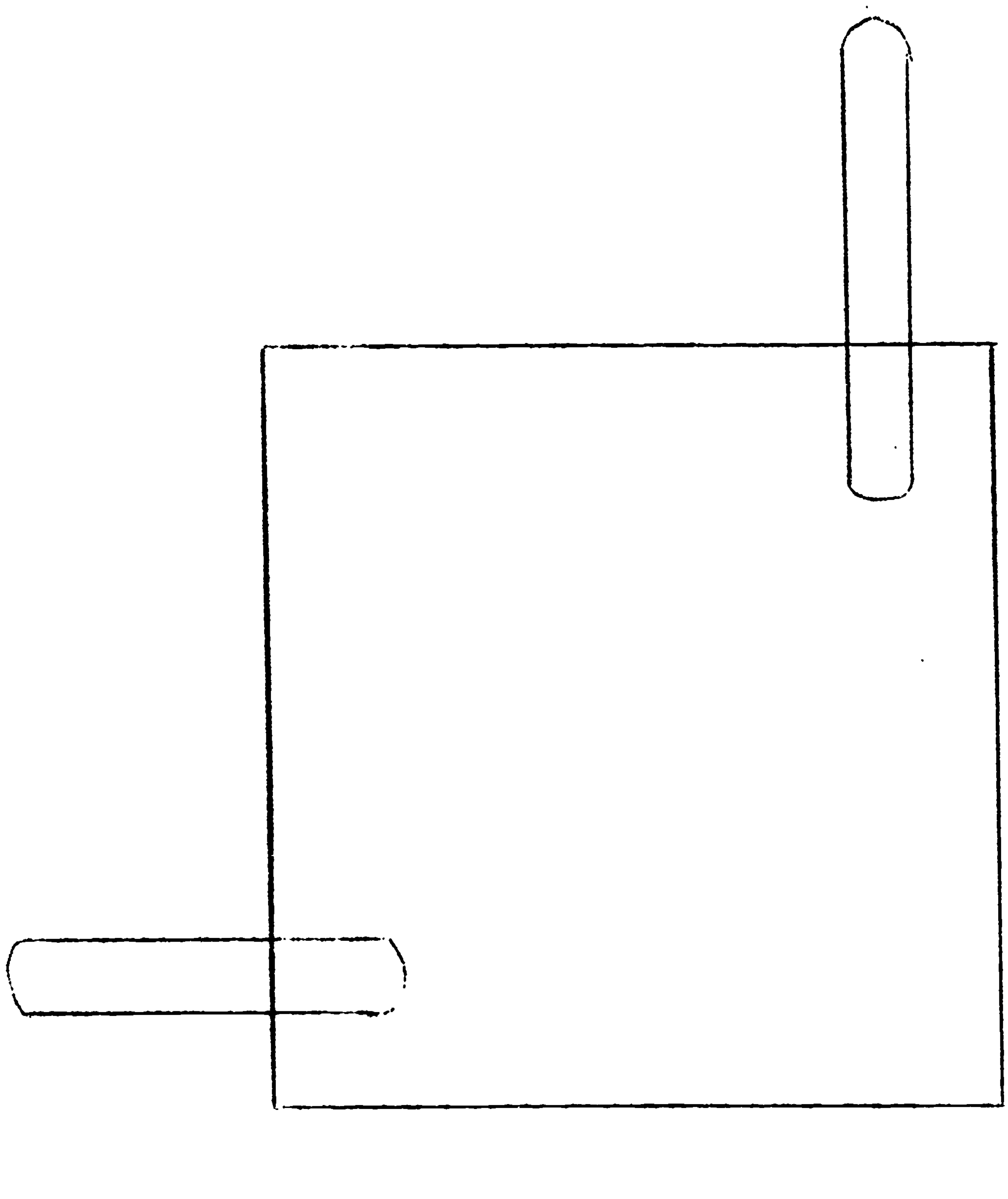
The children investigate relationships of burning time of candles and volume of jars placed over the candles.

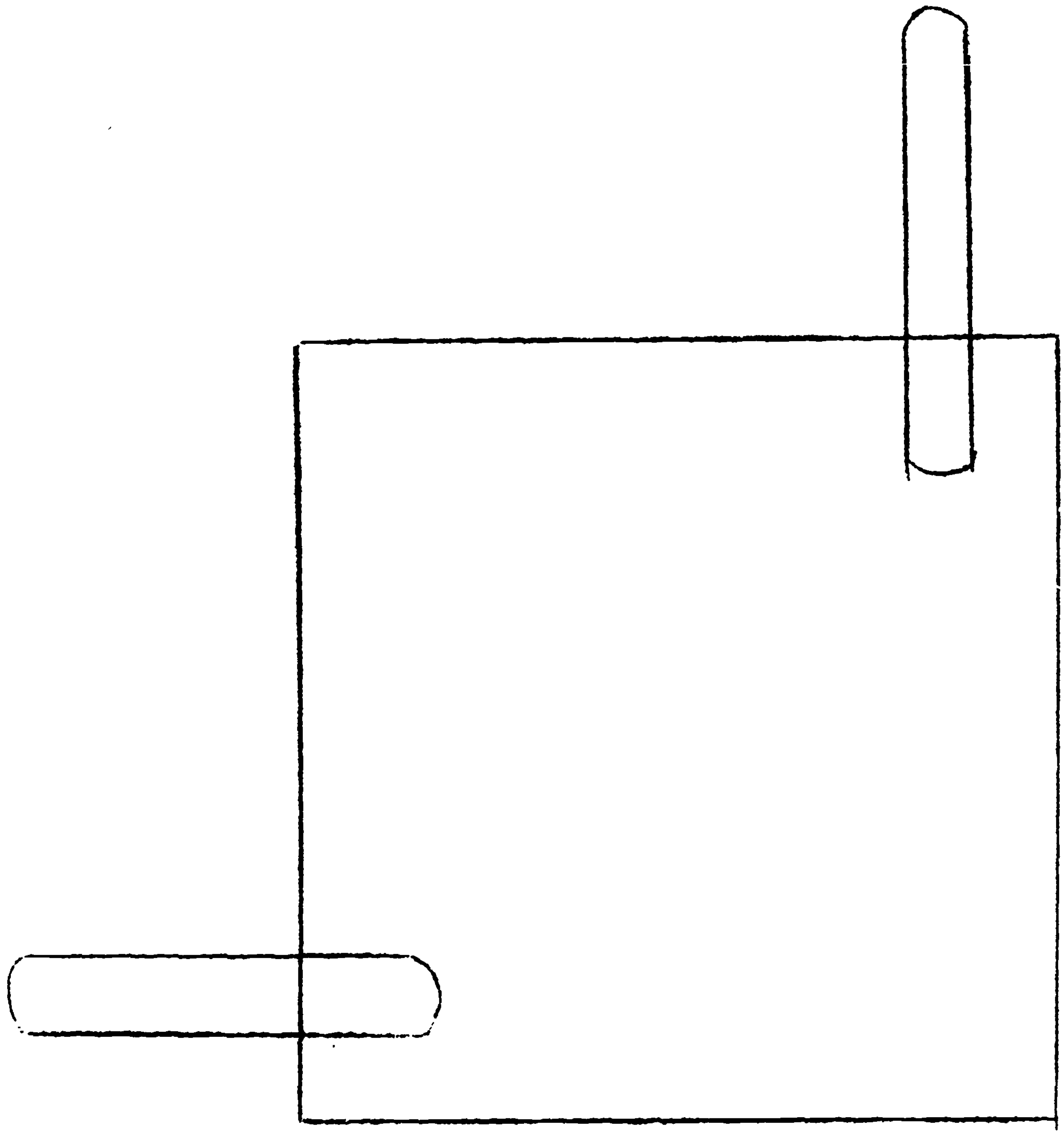
Vocabulary:

Experimental error, interpolation, extrapolation

RO #3







Overview of Inferring

(Taken from Parts C and D of Science - A Process Approach, 1967 Xerox edition)

Inferring 1: INFERRING THE CHARACTERISTICS OF PACKAGED ARTICLES (Part C = grade 2 or 3)

Objectives:

At the end of this exercise the child should be able to

1. DISTINGUISH between statements that are observations and those that are explanations of observations, and IDENTIFY the explanations as inferences.
2. CONSTRUCT inferences about packaged articles in terms of likelihood rather than certainty.

Context:

Children examine unknown objects which are concealed from direct sight or touch.

Vocabulary:

Inference, infer, likelihood, certainty, conclude, conclusion

Inferring 2: DIFFERENTIATING BETWEEN SIMILAR THINGS (Part C, grades 2 and 3)

Objectives:

At the end of this exercise the child should be able to

1. DISTINGUISH between observations and inferences.
2. IDENTIFY observations that support an inference.
3. DISTINGUISH between an inference that accounts for all of the observations and one that does not.
4. IDENTIFY the additional observations needed to distinguish between two or more similar objects, or to test an inference.

Context:

Children work with objects which appear alike in some ways, but which may or may not be actually identical.

Vocabulary:

No new words.

Inferring 3: OBSERVATIONS AND INFERENCES (Part D = grade 3 or 4)

Objectives:

At the end of this exercise the child should be able to

1. DISTINGUISH between observations and inferences in situations pictured in cartoons.
2. CONSTRUCT one or more inferences from an observation or a set of observations presented in one or more cartoons.

Context:

The children study and discuss cartoons.

Vocabulary:

Observation, senses, inference, to infer

Inferring 4: TRACKS AND TRACES (Part D = grade 3 or 4)

Objectives:

At the end of this exercise the child should be able to

1. DISTINGUISH between observations and inferences about animal tracks and traces.

2. CONSTRUCT inferences based on observations of an animal's tracks or traces and its characteristics or environment.
3. DEMONSTRATE that inferences may need to be revised on the basis of additional observations.

Context:

Children compare the effects of tools on materials with animal traces of similar activity, e.g. digging, piercing, etc.

Vocabulary:

Digit, trace

Inferring 5: THE DISPLACEMENT OF WATER BY AIR
(Part D = grade 3 or 4)

Objectives:

At the end of this exercise the child should be able to

1. DISTINGUISH between observations and inferences about the displacement of water by air.
2. CONSTRUCT an inference to explain the movement of liquid out of an inverted container when air moves into it.
3. DESCRIBE observations he can use to test his inferences about the displacement of water by air.

Context:

Children work with containers of water and air.

Vocabulary:

Displace, displacement

Inferring 6: LOSS OF WATER FROM PLANTS (Part D = grade 3 or 4)

Objectives:

At the end of this exercise the child should be able to

1. CONSTRUCT appropriate inferences about water loss from plants based on observations of investigations demonstrating water uptake and loss.
2. CONSTRUCT situations to test such inferences.
3. CONSTRUCT predictions from a graph about water loss from plants over a given period of time.

Context:

Children work with live plant seedlings and cuttings.

Vocabulary:

Transpire, transpiration, stomate (STOW-mate)

RO #5

Code________

Appraisal

TASK I:

In this room there are two jars. In addition to any observations you might make, I have observed the following:

1. The jar at the front of the room has a higher water level than the jar on the window sill.
2. There was a puddle of water on the window sill near the jar.
3. There was a trail of wet spots on the floor, leading from the door to the jar at the front of the room.
4. Earlier in the day, the window was open near the jar on the window sill.

Based on your own observations or those listed above, write three inferences that explain or account for the different levels of water in the two jars.

Inference A ____

____

Inference B ____

____

Inference C ____

____

TASK II:

For each of the inferences in your response to Task I, name the observations upon what that inference is based.

For Inference A______________________________________

For Inference B______________________________________

For Inference C______________________________________

TASK III:

Describe additional observations you might make that would test Inference A.

____

____

____

What is your reason? ________________________________

____

TASK IV:

Another child comes to you and says he has really been acting like a scientist. He has been measuring the water height all day (when you weren't looking). His results:

Time	Water Height of Jar on Window Sill
9:15 A.M. (You went to the Principal's office)	19 cm
10:10 A.M. (P.E. time)	18 cm
11:45 A.M. (Lunch time)	16 cm
1:10 P.M. (You were still in the teacher's lounge)	4 cm
2:15 P.M. (Music time)	1 cm

A. Construct a point graph of his data.

B. The manipulative variable in this activity was

____

C. The responding variable in this activity was

____

D. What was the water height in the jar in the window sill at:

9:30 A.M. __________
10:30 A.M. __________
11:30 A.M. __________
12:30 P.M. __________
8:30 A.M. __________
3:30 P.M. __________

TASK V:

Describe how you would test your predictions in Task IV.

____

____

TASK VI:

You made six predictions in Task IV. Order them in terms of greatest confidence you have that they are correct.

Greatest Confidence					Least Confidence
______	______	______	______	______	______

Duplicated Materials -- With Answers

RO #1

Code ________

Pre-Appraisal

Three children planted several lima bean seeds and then measured the height of the bean plants at selected intervals.

TASK I:

As the seeds germinated, the three children made these observations:

A. One plant had larger green leaves than the other two.
B. The color of the leaves of the other two plants was light green to yellow.
C. The stems of the light green leafed plants were longer than the dark green leafed plants.

Write three inferences that would explain the differences between the plants:

Inference A DIFFERENT KINDS OF LIMA BEAN SEEDS

Inference B ONE PLANT HAD FERTILIZER

Inference C ONE PLANT HAD MORE LIGHT

TASK II:

Name the observations upon which your inferences were based:

For Inference A A and C

For Inference B A and B

For Inference C A and B

TASK III:

Describe how you would test one of the inferences you constructed in Task I.

(A) PLANT DIFFERENT KINDS OF SEEDS AND COMPARE THE RESULTING PLANTS.

(B) OBSERVE THE EFFECT OF FERTILIZER ON OTHER PLANTS OF THE SAME KIND.

(C) OBSERVE THE EFFECT OF DIFFERENT AMOUNTS OF LIGHT ON OTHER PLANTS OF THE SAME KIND.

TASK IV:

They recorded their observations:

Days After Planting	Average Height of Plants at Tallest Point
4	1 cm
5-1/2	5 cm
7	10 cm
11	23 cm
12-1/2	28 cm

A. Construct a point graph of their data.

B. The manipulated variable in this activity was TIME.

C. The responding variable in this activity was HEIGHT OF PLANT.

D. What was the average height of the bean plant:

(Acceptable responses should be near, but need not be exactly):

10 days after planting? 20 cm
8 days after planting? 12-1/2 cm
15 days after planting? 36 cm
3-1/2 days after planting? 1/2 cm

TASK V:

Describe how you would find out if one of your predictions in Task IV was correct.

TO TEST THE PREDICTION THAT THE HEIGHT OF THE PLANT WILL BE 36 cm ON DAY 15, MEASURE THE HEIGHT OF THE PLANT ON DAY 15.

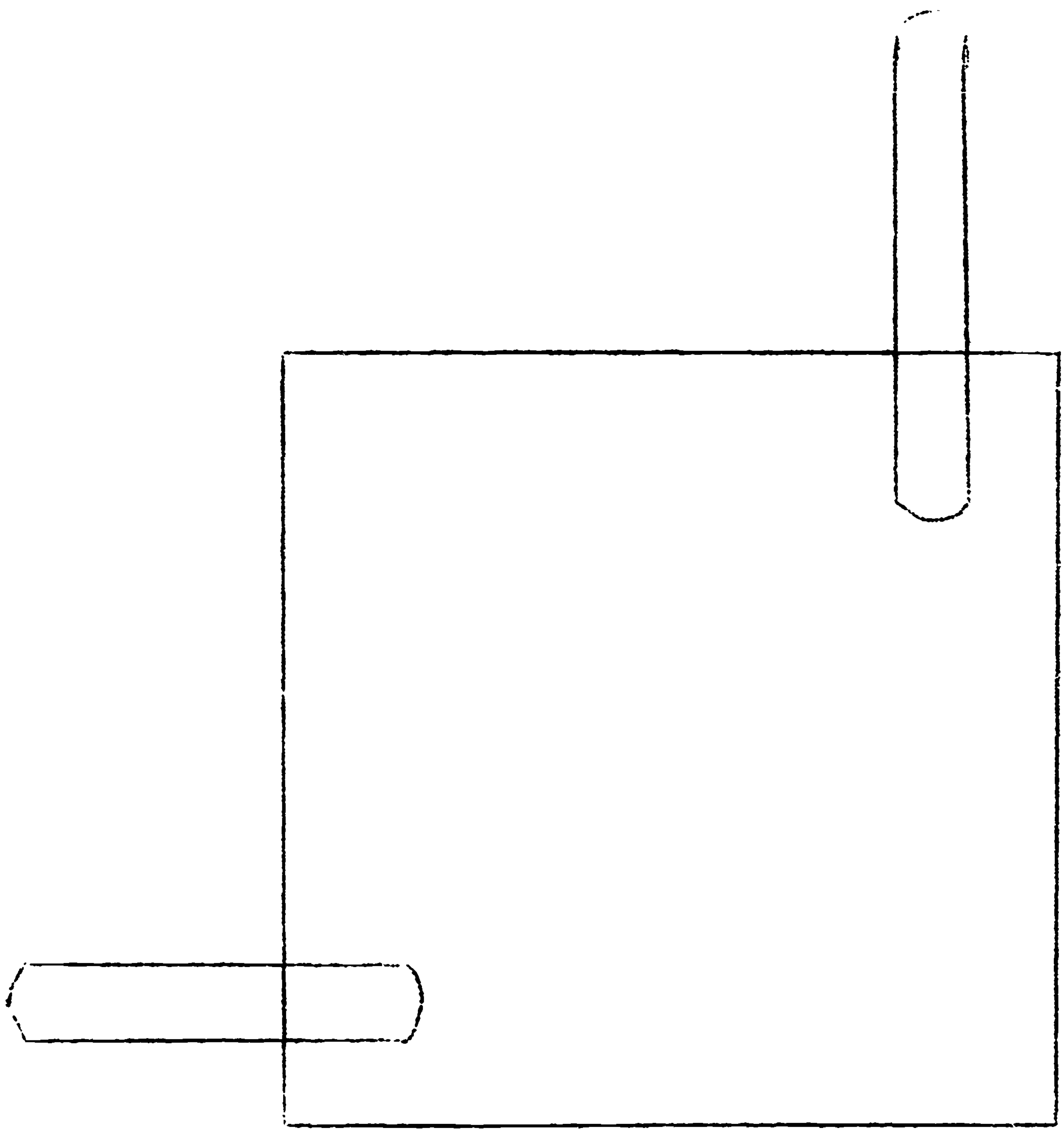
TASK VI:

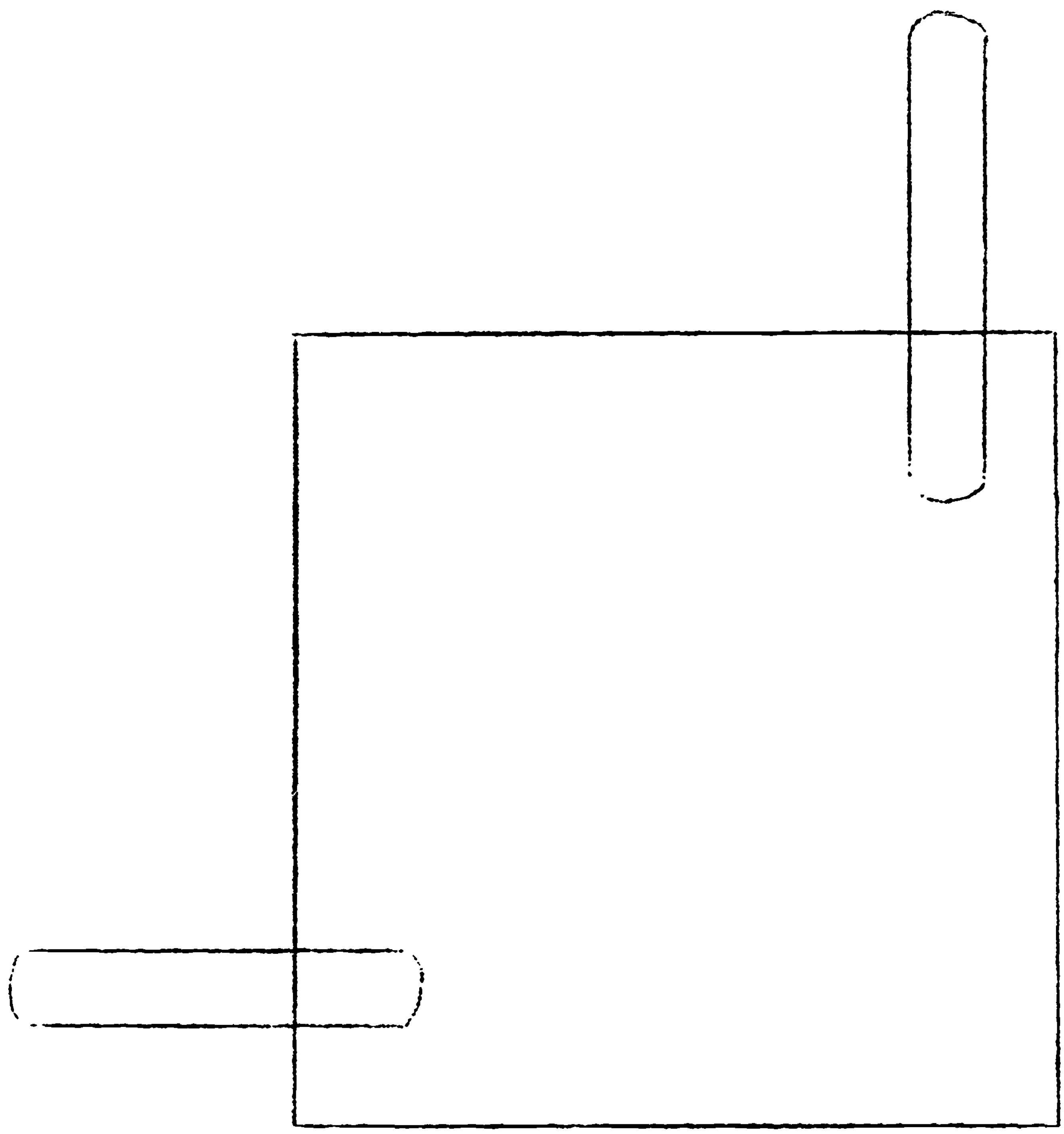
You made four predictions in Task IV. List them in order of greatest confidence you have that they are correct.

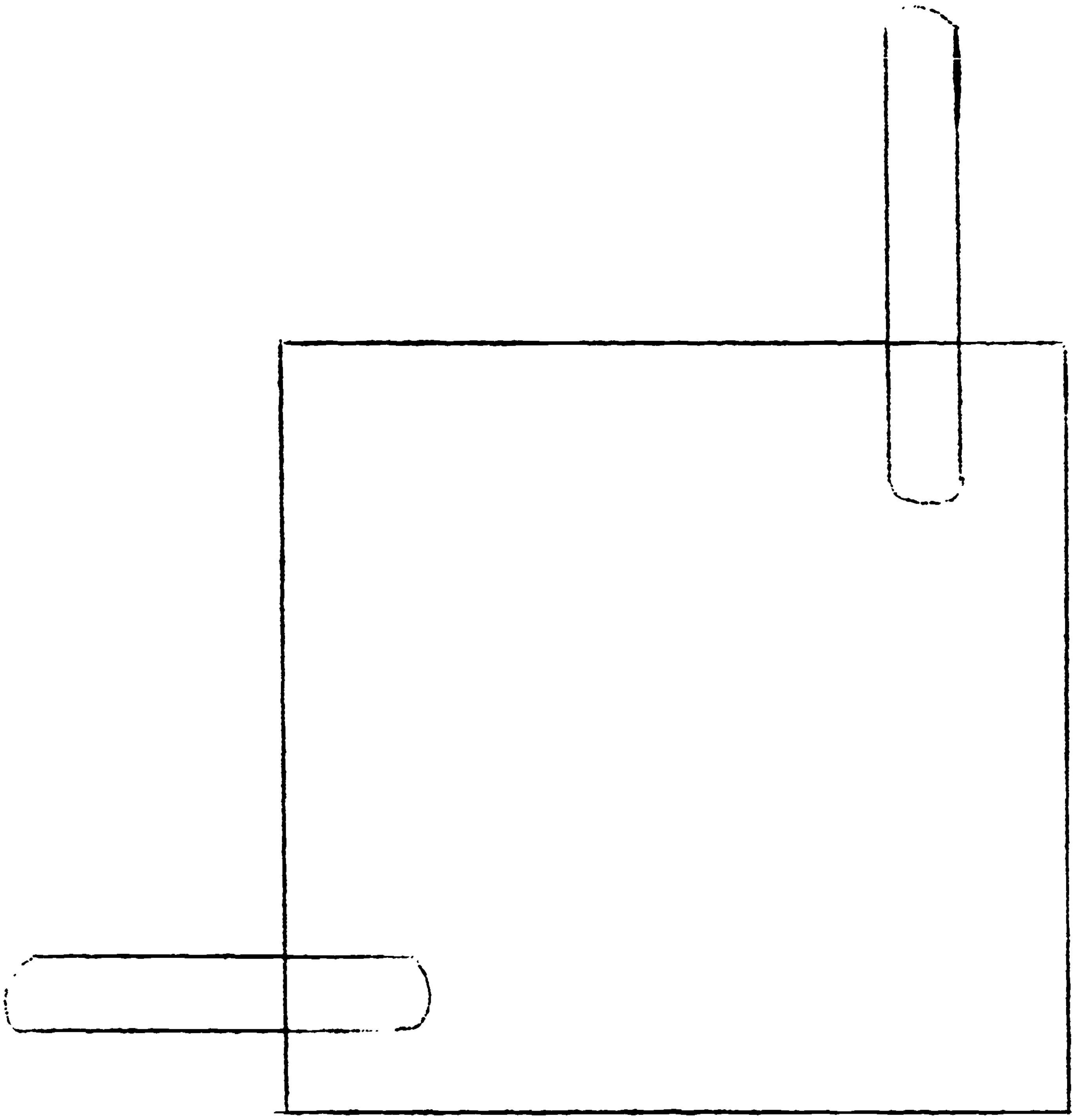
Most Confident			Least Confident
DAY 10	DAY 8	DAY 3	DAY 15

(interchangeable)

RO #3







RO #5

Code ________

Appraisal

TASK I:

In this room there are two jars. In addition to any observations you might make, I have observed the following:

1. The jar at the front of the room has a higher water level than the jar on the window sill.
2. There was a puzzle of water on the window sill near the jar.
3. There was a trail of wet spots on the floor, leading from the door to the jar at the front of the room.
4. Earlier in the day, the window was open near the jar on the window sill.

Based on your own observations or those listed above, write three inferences that explain or account for the different levels of water in the two jars.

(Examples)

Inference A MORE WATER POURED INTO JAR AT FRONT OF ROOM.

Inference B JAR ON SILL WAS SPILLED.

Inference C MORE EVAPORATION FROM JAR NEAR WINDOW.

TASK II:

For each of the inferences in your response to Task I, name the observations upon which that inference is based.

For Inference A 1

For Inference B 2

For Inference C 4

TASK III:

Describe additional observations you might make that would test Inference A.

(Examples)

A QUESTION THE PEOPLE INVOLVED.

B HOW MUCH WATER IN PUDDLE?

C COMPARE EVAPORATION AT WINDOW AND DESK EXPERIMENTALLY.

TASK IV:

Another child comes to you and says he has really been acting like a scientist. He has been measuring the water height all day (when you weren't looking). His results:

Time		Water Height of Jar on Window Sill
9:15 A.M.	(You went to the Principal's office)	19 cm
10:10 A.M.	(P.E. time)	18 cm
11:45 A.M.	(Lunch time)	16 cm
1:10 P.M.	(You were still in the teacher's lounge)	4 cm
2:15 P.M.	(Music time)	1 cm

A. Construct a point graph of his data.

B. The manipulative variable in this activity was TIME OF DAY.

C. The responding variable in this activity was HEIGHT OF WATER.

D. What was the water height in the jar in the window sill at:

9:30 A.M.	18.5 cm
10:30 A.M.	17.5 cm
11:30 A.M.	16.5 cm
12:30 P.M.	10 cm
8:30 A.M.	20 cm
3:30 P.M.	0 cm

(Acceptable responses should be near, but need not be exactly these.)

TASK V:

Describe how you would test your predictions in Task IV.

PLACE ANOTHER GLASS OF WATER ON THE WINDOW SILL AND OBSERVE THE WATER LEVEL AT THE EXACT TIMES.

TASK VI:

You made six predictions in Task IV. Order them in terms of greatest confidence you have that they are correct.

Greatest Confidence					Least Confidence
9:30	11:30	10:30	12:30	8:30	3:30