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The project represents the efforts of Highline Public School s during 1967-68 to develop an integrated curriculum in mathematics and science for the primary grades. This project prepared teachers to develop scientific attitudes and student understanding of mathematical and scientific concepts. The curriculum was based upon an inquiry system utilizing eight concepts and seven processes which served to unify mathematics and science. The authors discovered that significant student learning occurred and both students and teachers exhibited greater interest in and enthusiasm for mathematics and science. (RR)

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FINAL REPORT

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Integration of Mathematics and Science Curriculum

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INTEGRATION OF MATHEMATICS AND SCIENCE CURRICULUM

CHARLES N. HARDY

Highline Public Schools
Seattle, Washington

June 1968

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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PREFACE

The project, "Integration of Mathematics and Science" was an attempt, by the personnel of the Highline Public Schools, to provide a new direction in curriculum design. The difficulty of such an undertaking is obvious, for example to provide a setting where elementary children can view Mathematics and Science as one. The key to the success, allowed through this study, was a complete change in teacher attitude.

The teachers, involved in the project, were most enthusiastic. Their effort made possible the first stage of what will be a continuing developmental program. The enthusiastic response can be gauged by the fact that eighty percent of the teachers will continue the program next year.

CONTENT:

INTEGRATION OF MATHEMATICS AND SCIENCE
CURRICULUM

SUMMARY:

Integration of Mathematics and Science Curriculum (I.M.S.) is an attempt to provide a unified sequence of materials for the primary grades. Twenty five elementary teachers were involved in testing district designed integrated materials with 750 students grades K-3 for a period of one year.

The scope of the study was developed around eight concepts. These were: Matter and Energy, Sets, Numeral. Geometry, Location, Measurement, Timing, and Volume. Materials were written for six of the eight concept areas and evaluation schemes developed to test the effectiveness in classroom situations.

Two evaluation methods were utilized for this I.M.S. program.

Four hypotheses were formulated for the study. These were:

1. There would be an increase in student learning using this method of approach.
2. Materials tried would be commensurate to grade levels.
3. Increased interest would be developed by combining Mathematics and Science.
4. I.M.S. materials could be adequately taught by elementary teachers.

Student performance was evaluated in light of the four hypotheses.

It can be reasonably stated, from the study, that significant learning can be accomplished through an integrated approach. Students can conceptualize science ideas more easily when the quantitative aspects of mathematics are used in conjunction with science activities. In turn, science can act as a viable motivation for mathematic activities.

SUMMARY: (Cont.)

The teachers, teaching this program, have become highly motivated as to the value and feasibility of the approach. Revision of the I.M.S. materials will take place this summer and an expanded district program will commence in the fall.

INTRODUCTION:

The work of designing acceptable integrated programs in Mathematics and Science, for elementary students, involves two ingredients. One is instructional material containing sound principles and concepts basic to both disciplines. The second is a teacher willingness to lead students into experiences encompassing the percepts of both areas. The Integrated Mathematics and Science Curriculum Project was attempted to provide a setting necessary to accomplish these goals. As stated: This is a project designed to provide teachers with knowledge, training and means for presenting classroom situations in the primary grades which would allow children to learn Mathematics and Science concepts and attitudes in an integrated way.

To do this job the teachers, in the I.M.S. project, were responsible to try materials based on an inquiry system with emphasis on observing, measuring, recording, manipulating, visualizing and predicting. These techniques were deemed to be vital in gaining an understanding of the processes of both Science and Mathematics and in the acquisition of fundamental knowledge inseparable from both disciplines.

The problem of this study became one of devising materials, and implementing their use. Furthermore, these had to meet the following requirements:

1. Contain sound accurate Science and Mathematics principles and concepts.

2. Applicable to a typical primary grade.

3. Result in beneficial experiences according to concept formation and attitude development.

In recent years there has been much effort by various groups, both national and local, to improve Science and Mathematics teaching at the secondary level. More recently attention has been turned to

INTRODUCTION: (Cont.)

elementary programs. Educators are now becoming concerned that the programs at both levels be developed upon a smooth transition from grade to grade with continuity in learning. Thus the student must have a strong foundation in Science and Mathematics in the elementary school.

At the elementary level most projects have developed and tested material of a quantitative nature. Two such programs are: AAAS and MINNEMAST. Both programs have made a concerted effort to devise materials which could utilize principles of Mathematics and Science. The basic premises for both projects have differed; however Mathematics and Science are developed throughout. AAAS has developed around process skills. Topic areas have not been structured according to factual information or Science concepts. Rather, the authors have attempted in a heirarchy of process skills using Mathematics and Science. MINNEMAST has attempted the correlation of Mathematics and Science materials. Units have been developed, of some length, which potentially will allow for a coordinated understanding.

This is by no means an exhaustive review, however it should suffice to make the point.

METHODS:

The Study

The hypotheses formulated from the defined problem of study were:

1. There will be a significant increase in student learning in Science and Mathematics, more specifically selected concepts and principles in Science and Mathematics as shown by the differences in student scores on the pre-test and post-test.

2. The material tried is commensurate to the specific grades attempted.

3. Learning Mathematics and Science as one, increases interest, as judged by teacher evaluation.

4. The material can be adequately taught by the primary teacher as judged by teacher evaluation.

The basic assumption to the four hypotheses listed is that a teacher will be able to evaluate student performance. In order to gain insight to actual performance each teacher was asked to rank each student as to existing abilities. These ranks were then compared periodically against the continuing evaluation. Several assumptions which must be recognized are:

1. Whether students can learn and utilize the selected Scientific concepts included in the materials.

2. Attainment of predetermined objectives.

3. The efficacy of the material to a particular situation.

The final analysis of these assumptions rests on the professional judgement of the writers and teachers.

The study utilized twenty five primary teachers from four schools. Schools were selected to give a wide cross section of student background. The number of primary classes are as follows:

Kindergarten	3
First Grade	8
Combination 1-2	1
Second Grade	5
Third Grade	7
Combination 3-4	1

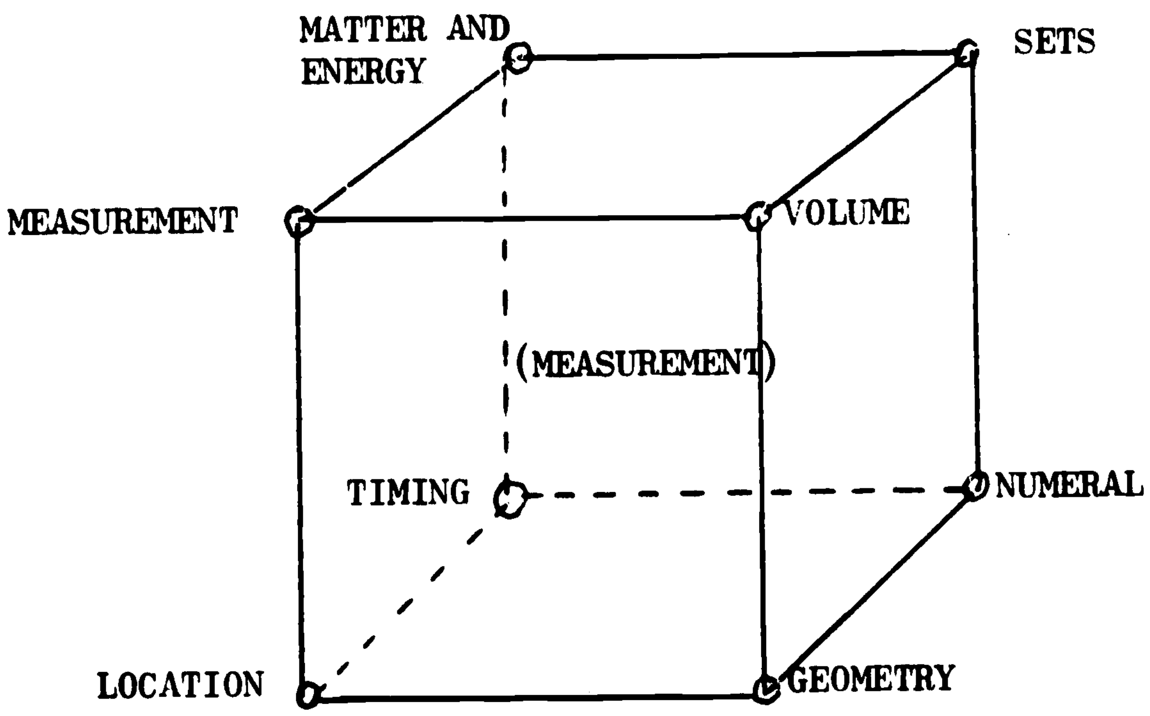
No elementary teacher had a strong background in Mathematics or Science. The mean teaching experience was eight years. Teaching experience ranged from one year to fifteen years.

Prior to the inception of each unit, the unit was given to the classroom teachers in an in-service program. The teachers carried out key parts of the experiments and suggestions were levied concerning potential use in the classroom. Teachers were instructed in the method of scientific inquiry. The term "scientific method of inquiry" as used in this study refers to two ways of teaching: one of these methods uses a set procedure, and the second uses involvement of students in experimentation.

To accomplish this, the classes were divided such that students worked on experiments as teams of two or three. Teachers were instructed to let the students be challenged by experiments and to guide student learning through the experimental stimulus. During discussion periods the teachers became more involved as a central coordinating figure.

Conceptual Schemes

A conceptual scheme utilizing skill processes was devised for each grade level. A chart of this scheme follows: (Also see Appendix A)



Topic units were written for six of the eight areas shown above. Time prevented development of all areas. A "thread" pattern was developed around each topic area. Two typical scope and sequences are listed below: (Also see Appendix B)

SETS (K-1)

(Properties of Observation)

↓

Attribute Blocks

↓

Sets of Different Things

Attribute Blocks (Greater than) (Less than) (Equivalent)	Sets of Plants and Animals (Greater than) (Less than) (Equivalent)

↓

Sets - Physical and Chemical Reaction
(Sulfur and Iron)
Magnetism

↓

Conductors and Non-Conductors

↓

Review and Evaluate
(Termite Family)

GEOMETRY (2-3)

↓

Attribute Blocks
(Shapes)

↓

Geometry Boards

← Area (Perimeter)
← Graphing

↓

Three Dimensional Factors of Shapes

Recognizing Shape →

↓

Contour Maps - Spatial Relations

← Angles - Scaling
← Map Reading

↓

Three Dimensional Biology

↓

Patterns
(Paper)

↓

Symmetry
(Patterns in Nature)

Each topic, as listed above, was expanded into one or more lessons. (See Appendix C)

FINDINGS AND ANALYSIS:

Data was collected and analysis made according to three separate methods: (1) Anecdotal Evaluation; (2) Objective tests; (3) Proficiency Measures. These were analyzed as separate components and then compared. Professional judgement allowed testing procedures one and three to be sufficient for the program. Examples of the proficiency measures are described below:

I. Proficiency Measures:

Evaluative measures were devised to assess whether the behaviors identified as instructional objectives, were met. The tasks involved called for testing of content utilization. This in turn required of the student, understanding of the concept promoted in the laboratory experience. No fixed number of student tasks were required by a single proficiency measure.

Teachers were asked to make a random distribution, of students, for evaluation purposes. A description of the tasks together with acceptable responses, for each task, was provided the teacher. A check system was used for evaluation purposes. However teachers were encouraged to write comments after each question given. Three students were tested individually for each proficiency measure.

A. Example Measure - Sets - Similarities and Differences (K-1):

1. Show the child the following collection of objects:

Brown Leaf
Brown construction paper
Brown covered book
Red Cuisenaire rod
Yellow crayon

a. Ask the question: "Which of these are of different colors?" (Check according to acceptable or unacceptable)

2. Add to the collection the following:

   Brown Cuisenaire rod

   Yellow colored ball

   a. State: "Sort these objects into sets according to color." (Check according to acceptable or unacceptable)

3. Show the child the following objects:

   Piece of crayon

   Orange rod

   Pencil

   Rubber ball

   a. State: "Sort these objects into sets according to shape." (Check according to acceptable or unacceptable)

4. Use the same materials (#3)

   a. Ask the question: "Which objects are most alike?" (Check according to acceptable or unacceptable)

   b. Ask: "Which of these are most like the rubber ball?" (Check according to acceptable or unacceptable)

   c. Ask: "Which of these are least like the rubber ball?" (Check according to acceptable or unacceptable)

5. State briefly any comments you feel pertinent to the student's responses.

II. Anecdotal Evaluation:

Teachers were asked to develop a continuum of student response during the school year. These were matched against the proficiency measures and professional judgement levied as to whether the objectives outlined were being met. Along with student comments the teachers were asked to list in sequence the following items:

1. Approach
2. Childrens' Reaction
3. Follow-up
4. Teacher's Reaction

A. Example Measure - Spatial Relations (3):

1. "The water level is even all the way around"
2. "The lines are closer together in some spots"
3. "I spilled the water - where is a towel?"
4. "Boy! It takes a lot of water"
5. "This was the most fun of all" (Pertains to changing three dimension to two dimensional plane)
6. "I've got it! The river flows this way" etc.

CONCLUSIONS AND RECOMMENDATIONS:

From the analysis and professional judgement it can be stated that the material utilized in this study apparently will result in significant learning on the part of the student. A concept - process scheme of Science and Mathematics is entirely feasible and learning activities can be developed with progressive sophistication. This study indicates that provision of materials used in a new context develops greater interest and enthusiasm in students. Utilization of materials in a laboratory setting does result in greater student interest. These contingent factors must be assumed basic to causing increased learning of students.

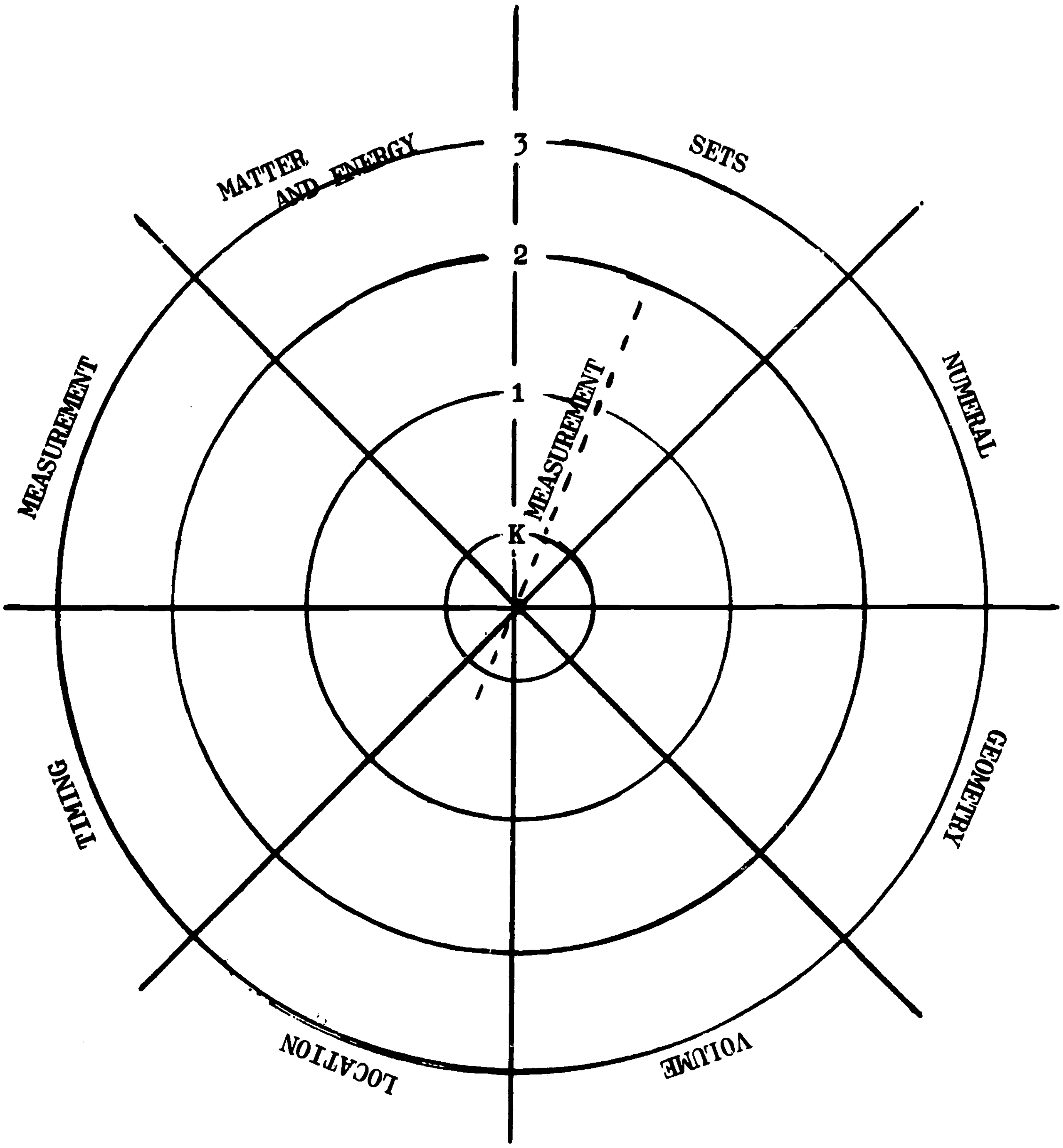
The hypothesis of this study demonstrates the fact that teachers with minimal Science and Mathematics background, when using well designed materials, can very satisfactorily teach correlation of Science and Mathematics. Because of the nature of the program the teachers continually strove to gain greater background in Science and Mathematics.

The teachers found that the material used in this study was readily adaptable to several grade levels. The question was then raised as to whether or not the material used in the study could be adapted to the regular curriculum. The answer to this question is that teacher in-service programs must be established to help implement the I. M. S. material. Such an in-service program is not needed to provide factual information of Science and Mathematics as for the integration of Science and Mathematics. This requires developing the new processes and attitudes on the part of teachers. For example, it is estimated that it took three months before teachers began to look at Mathematics and Science as one.

It was stimulating to experience the eagerness shown this project, on the part of students and teachers. This enthusiasm can be shown by the fact that an enlarged group of teachers will carry on with the integration of Mathematics and Science, with district support, during the 1968-69 school year.

APPENDIX

A



3
2
1
K
MATTER AND ENERGY
SETS
NUMERAL
GEOMETRY
VOLUME
LOCATION
TIMING
MEASUREMENT
MEASUREMENT

APPENDIX

B

PROGRAM SCOPE AND SEQUENCE:

UNIT I - SETS

Properties of (observation)

Attribute Blocks

Sets of Different Things

Attribute Blocks
- Greater than
- Less than
- Equivalent

Sets of Different Things
- Greater than
- Less than
- Equivalent

Sulfur and Iron

Conductors and Non-conductors

Magnetism

Review - Termites

UNIT II - NUMERAL

Cuisenaire Rods

Measurement of Room

Measurement of Table with Cuisenaire Rods

Counting Money → ← Time

Plant Seeds

Cuisenaire Rods - Stair-step

Bar Graph

ESS film

Platform Balances
(Wt. relations of rods on # line)

Equivalences
Inequalities

Metric Rule
(Student Hts.)

Bar Graph - Stair-step

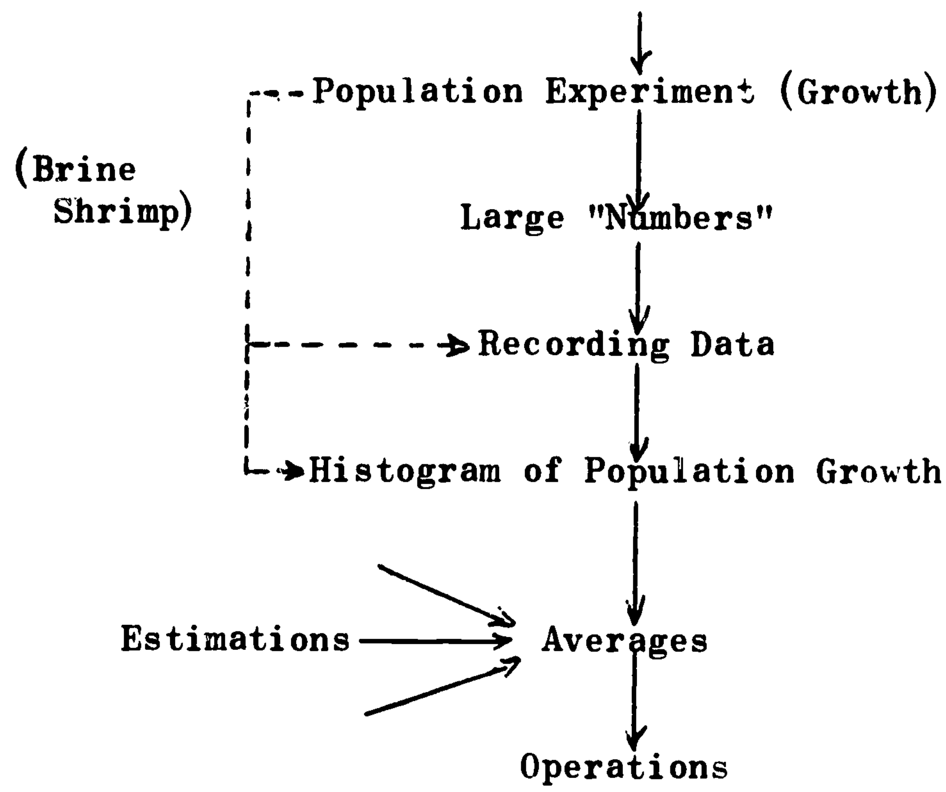
Number Line on Floor

Frog jumping contest →

Operations
(Addition, Subtract, Multiply, Division)

Cuisenaire Rods
(Arrow Game)

UNIT II - NUMERAL (Cont.)



UNIT III - GEOMETRY

Attribute Blocks (Shapes)

↓

Three Dimensional Factors of Shapes

↓

Contour Maps

↓

Recognizing Shapes →

Three Dimensional Biology (NSTA)

↓

Patterns (Paper)

↓

Symmetry
(Patterns in Nature)

↓

UNIT IV - GEOMETRY

Attribute Blocks (Shapes)

Geo-boards

← Area (Perimeter)

← Graphing

Three Dimensional Factors of Shapes

Recognizing Shapes →

Contour Maps

Three Dimensional Biology (NSTA)

Patterns
(Paper)

Symmetry
(Patterns in Nature)

UNIT V - VOLUME

Styrofoam Balls In Jar

Beans

Estimation

Rods

Sand In Jar

Water In Jar

Beans In Jar
Add Water - Close!

Standard Units of Measure
(Metric System)

Balances
(Which weighs more)

Ratios

Graphing

Density

UNIT VI - LOCATION

Graphing Game
(Line Segments)

Rubber Band Scale → ← Battleship

↓

Geo-board

↓

Relative Position

↓

Optical Illusions
(Both Black and White and Color)

↓

Senses
(Quantitative)

Sound etc. →

↓

Prisms and Color Chart
(Relate to Human and Material Objects)

UNIT VII - TIMING

Review of Fractions
(Concept and Notation)

— eg., 1, $\frac{1}{2}$, $\frac{1}{4}$, ... $1/10$

Calibrate Water Time

Beat of Heart → ← Candle in Can
Beat and Rhythm →

Metronome

Number Line in Circle →

Clock

History of Clocks → ← Science Center

Graphing

APPENDIX

C

Example Unit (For the teacher)

Concept:

To learn techniques and basic understanding of Special Relations.

Rationale:

An understanding of where we are in space and time is baxic to a child's understanding of his universe. In the following series of exercises students will have the opportunity to develop magnitude of position and direction utilizing mapping techniques.

Background Information:

Mapping involves, among other things, the scientific term, "vector", as opposed to "scaler". The terms are relatively easy to understand if you consider the following examples:

1. If you are driving a car and you are traveling at a speed of 60 miles per hour (mph), the scientific term used would be the scaler quantity speed.

2. On the other hand, if you are driving a car and you are traveling at a speed of 60 miles per hour east. the scientific term to use is velocity, which is a vector quantity.

From the above, it should be clear that a scaler quantity requires only magnitude (60 mph) a vector quantity requires both magnitude (60 mph) and direction (east).

Contour maps are relatively easy to read with a little practive. Essentially all you need to know is that lines of equal elevation are drawn on the map. Most contour maps are drawn on a scale having elevation differentation of 20 ft. or 100 ft. intervals.

Student Worksheet #____

In this experiment, you will be using colored rubber bands to show the direction and distance traveled by a boy at play.

As you read the directions, stretch a colored rubber band to show the direction and distance traveled. The distance between any two nails will represent one block. Let's see how you do. One last thing before you begin. When both direction and distance are given, the word we use is DISPLACEMENT. You will need to know this as you work the experiment.

Questions:

1. John walks from his home to the drug store. In doing so he travels 3 blocks east. See if you can show this using the geo-board. (Start with the peg in the upper left corner of the board). When you have done this compare your geo-board with your neighbor, both right and left.

2. Just to make sure you understand try this. John walks from his home to Mike's home. In doing so he travels 4 blocks south. Try to show this. Again check with your neighbors to see if you all agree.

3. Mike and John walked back from Mike's home to John's home. Can you describe their direction and distance?____________
____.

4. From John's home the two boys then went to the drugstore. Can you describe their total displacement?_______________
____.

New Problem:

1. Mike and John walked from John's home to the drugstore. In doing so they traveled 3 blocks east. Take a colored rubber band and show their displacement.

2. Instead of going straight home from the drugstore, Mike and

and John decided to visit their friend Bill. Bill lives south 4 blocks and east 3 blocks from John's home. Stretch a rubber band to show this. What would be the direction and distance of Bill's home from the drugstore?______________

____.

3. After arriving at Bill's home the three boys decide to play at John's home. They walk the following route to get there: 1 block north; 1 block west; 2 blocks north; 1 block west. Put different colored rubber bands on your geo-board to show this displacement. Raise your hand when you are ready to show your teacher.

4. Think of a new problem of displacement. Be sure to write out what you are doing. Then show your teacher after you have completed the problem.

(For the teacher)

Materials:

Plastic Container with Lid

Water

Grease Pencil

Styrene Contour Model

Graduated Cylinders

Beaker

Procedure:

1. Pass out the equipment to teams of students. Pass out student worksheets.

2. Read student worksheet introduction and procedure aloud in class. Ask the students to answer the questions asked. (Note if the graduated cylinder is less than 200 ml. the students will have to fill it the appropriate number of times.)

3. After the students have completed the first part of the experiment, have them pass in the model of the mountain. The students will be asked to draw the mountain from their contour map, therefore, unless you want them to have the models, put them away.

Student Worksheet #____

CONTOUR MAPS

In this laboratory experiment you will be using a plastic box; a model of a mountain; a grease pencil; a graduated cylinder; a beaker; and water. Since water is easy to spill, be careful. After you are through with the equipment your teacher might want you to put it away. Be sure and take paper towels and wipe off the grease pencil marks and water. There is no need to rush through the experiment. Scientists work slowly and accurately.

Procedure:

1. Place the model of the mountain in the plastic box.
2. Fill your beaker with water.
3. Pour the water from the beaker into the graduated cylinder until the level is 200 milliliters (ml.)
4. Pour the water from the graduated cylinder into the plastic box.
5. Don't jar the plastic box. Mark the level of the water by drawing a line around the mountain.
6. Repeat the same steps, marking each 200 ml. level, until the mountain is covered with water.
7. Take the plastic box to the sink and pour all the water out.
8. Take the plastic box back to your desk and place the plastic lid on top (mountain will be inside).
9. Look down through the top. On the lid redraw the lines that appear below.
10. Take the lid off.
11. Look at the mountain from the side. Draw lines on the side of the plastic box to match the lines you see on the side of the mountain.

Questions:

1. Draw a small picture of these lines on your worksheet.

2. What do these lines tell us?______________________________

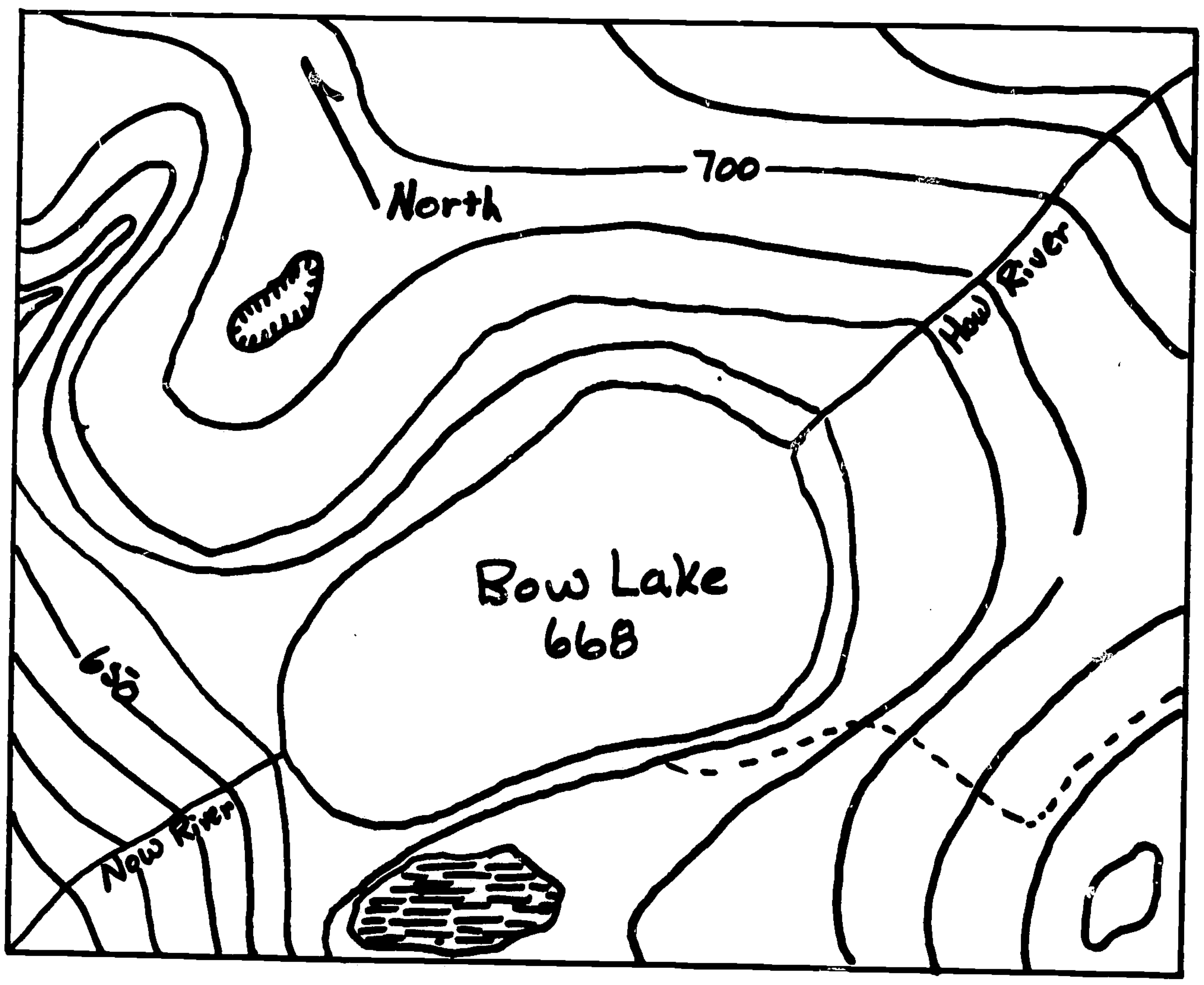
3. Draw a picture of the <u>side view</u> of your mountain.

Student Worksheet #____

CONTOUR MAPS #2a

Today you will have a chance to see how well you understood the laboratory exercise using the plastic model of a mountain. In this experiment you will be using a map drawn by scientists of the United States Geological Survey. However before you use this complicated map you will have a chance to review what you have learned, this time with another map. If you have questions as you do the experiment raise your hand and your teacher will help you. If you need the spelling of a word ask your teacher.

As you study the contour drawing answer the questions asked. When everyone has had a chance to finish, your teacher will discuss the answers everyone obtained.



Questions:

1. Show your teacher where the river is. Which way does the river flow?

    ____.

2. Find the lake on your map. Does the water flow into the lake or out of the lake?______________________.

3. List other features you see on your map.______________

    ____

4. Is there a mountain, ridge, or hill on your contour map?____ Which one?__________________

5. How high is it? (Refer to question #4)______________.

6. Draw a horizontal straight line across the contour map. In the space below, draw a picture of the side view.

7. On the back of the worksheet. draw a simple contour map. Have your neighbor try to guess what you have drawn.

Student Worksheet #____

CONTOUR MAPS #2b

At this point you are now ready to work with a real contour map. As you study the map, list as many features as you can find.

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

Student Worksheet #_____

TEMPERATURE LEVELS

In this experiment you will be measuring and recording the temperature at several places in your classroom. In measuring the temperature at different places in your classroom, you will be able to make a map of the room temperature. Do you think it is hotter on the ceiling than the floor? Is the temperature warmest at your desk? Where is the coldest spot in your room? Would temperature readings in your home be like those in your classroom? These are some of the questions you should be able to answer when you have completed this experiment.

1. You will be working at your desk during this experiment. Measure the temperature at the floor level.
2. The temperature at the floor level is____________.
3. Measure the temperature at the height of your desk.
4. The temperature reading at the height of the desk is_______.
5. Measure the temperature <u>3</u> meters above the floor. You may have to stand on your desk to make this measurement. <u>BE CAREFUL</u>!
6. The temperature reading 3 meters above the floor is_________.
7. Your teacher will want you to measure floor, desk, and 3 meter height temperatures in other parts of the room. Be sure to mark the positions where you made your temperature readings.
8. The temperature reading at____________________is_________.
9. The temperature reading at____________________is_________.
10. Once you have made all the temperature readings necessary, you will work in larger groups assigned by your teacher.
11. Make a map of the room temperature at each level (all around the room). Two of your members will be messengers to find out what temperatures the other teams recorded and where.

12. Once this is done, obtain a clear plastic sheet from your teacher. Place the plastic sheet over one of the maps and connect all the points of equal temperature with a smooth line.

13. Do this for each temperature value level.

14. Next, place the plastic sheets over one another.

These equal temperature lines are called ISOTHERMS; ISO meaning "equal", and THERM meaning "hot".

Questions:

1. Where is the hottest spot in the room?

2. Where is the coldest spot in the room?

3. What isotherm was hottest?

4. Would the temperature readings be the same tomorrow? Why not?

5. What things do you think cause the temperature to vary?

Student Worksheet #____

MAPPING THE CLASSROOM

Could you explain to your mother the shape of your classroom? Could you explain exactly where (the position) your desk sets in the classroom? Your teacher will call on one of you to try to explain these things. See how accurate the people are in describing the position of their desks. Could you do a better job? What things did they leave out?

One of the first things the explanation must show is the size of the room. Let's measure it.

1. Measure the distance from one corner to the door.______meters.

2. Measure the width of the door.______________meters.

3. Measure the other corner of the room.______________meters.

4. Measure the end of the room.________________meters.

Can you draw a picture of the measurements you made, in the space below?

Did you have trouble? Perhaps you found out you would need a piece of paper the same size as the room. There is another way to do this problem. You might already have tried it. The word we use to describe this is to draw the picture to SCALE.

See if you can draw the room to SCALE as you do the following things:

1. Obtain a piece of paper, with lines that go across the page and up and down the page, from your teacher.

2. The distance between each line is 1 centimeter (cm). Let the width of the paper represent the width of your classroom. Let the length of the paper represent the length of your classroom.

3. Next you must decide how many marks across the paper you want to represent 1 meter. Remember you must have at least 10 marks. Perhaps you will want to discuss this with your teacher.

4. After deciding the number of marks that will represent 1 meter, count off the number of marks needed for your picture. Then with a ruler and pencil draw a line to represent this.

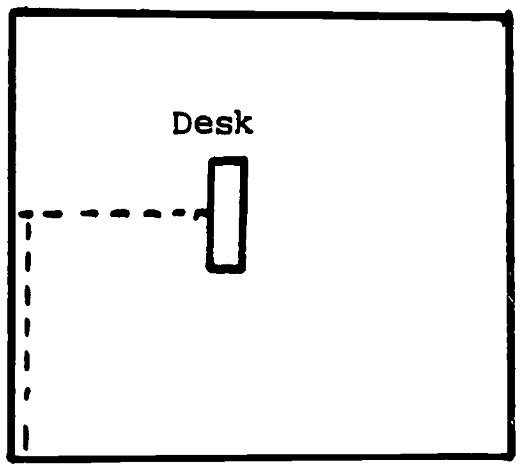
5. Repeat for the length of the room. Don't forget you have a door in your classroom.

Now you can show your mother at least the size of your room because you have a SCALE drawing of the room. But just where is your desk? See if you can place it exactly where it whould belong on the SCALE drawing.

Student Worksheet #____

USING ANGLES IN MAPPING

Did you have success in determining where your desk was to be placed on your scale drawing? Perhaps you measured from the corner of the room until you came to your row and then measured from this point to your desk. An example of this is shown here:



There is another way to determine where your desk is in the classroom. Later you will be asked to locate your desk using this method. First, however, let's learn how it works.

By this time you all are familiar with the directions of North, South, East, and West. You know, for example that is, you are facing North, the direction East will be on your right. O.K. so far. But what if you are out hiking and you are not hiking in a direction of North or East, but exactly between?

Questions:

1. In what direction would you be going if you were heading between North and East?________________.
2. In what direction would you be going if you were heading between North and West?________________.
3. In what direction would you be going if you were heading between South and East?________________.
4. In what direction would you be going if you were heading between South and West?________________.

As you measured your classroom you measured both the width and length of the room. You were measuring lines. This is called LINEAR MEASUREMENT.

Actually you were also making another kind of measurement too. This measurement is called ANGULAR MEASUREMENT. Let's see what this means.

When you measure from the corner of the room you were measuring from an angle, therefore you were making ANGULAR MEASUREMENTS too.

Let's take another look at Angular Measurement using the geometry boards.

Remember your boards should be marked with North (N), South (S), East (E), and West (W). If not take a pencil and mark them. Be sure East is on the right of North.

Begin in the middle of your board.

1. Stretch a rubber band over 3 pegs along the North-South.
2. Stretch a rubber band over 3 pegs East from the North end of the first rubber band.
3. Stretch a rubber band over 3 pegs East from the South end of the first rubber band.
4. In what directions would the fourth rubber band be heading?

   ____

Another Figure:

Begin in the middle of the board.

1. Stretch a rubber band over 3 pegs along the Northwest-Southeast line.
2. Stretch a rubber band over 2 pegs North from the Northwest end of the 1st rubber band.
3. Stretch a rubber band over 2 pegs East from the Southwest end of the 1st rubber band.
4. Stretch the 4th rubber band to close the figure. What are the directions for the last rubber band?______________

Make a drawing using both North, South, East and West and Northwest, Northeast, Southwest, and Southeast.

Student Worksheet #_____

COMPASS READINGS

There is an instrument which can be used to make angular measurements. Perhaps several of you have used this instrument. The instrument used to measure angular measurement is the COMPASS. In this experiment you will have a chance to use a compass as you study angular measurement.

1. Your teacher will pass out compasses. When you receive yours, place it on your desk and watch it spin. In what directions did it finally stop?____________________

2. Why did it stop in the position it did?____________________

   ____

3. Are "True North" and "Magnetic North" in the same place?

   ____

4. Obtain a small magnet from your teacher. Place the magnet at the top center of your desk so that the North end (N) of the magnet points toward you. Place the North (N) symbol of the compass so it points toward the magnet. Which direction does the needle point?____________________

   ____

5. Place the compass on the right side of your desk half way between the top and bottom of your desk. Place the North (N) symbol of the compass so it points straight up the edge of the desk. In which direction does the needle point?______________________________

6. If you look close you will see numbers going in a circle around the compass. Which number does the needle point to?

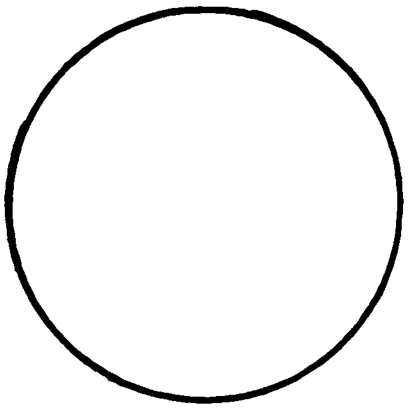
   ____

7. The numbers, along with the letters, are both used to find direction. The compass markings would add up to 360 if you were to add them together. Every compass is divided into these 360 equal parts. Each part is called a DEGREE. We use a special symbol to represent a DEGREE. It looks like this°. So if you write 25 degrees you would write it as 25°.

Student Worksheet #____

ANGULAR MEASUREMENT

1. Place your compass in the circle shown below. Place the letter N on the top mark.
2. Mark East, South, West, and North on the circle.
3. Make a mark where the compass needle points.
4. Now move the compass.
5. Draw a line from the middle of the circle to the letter N.
6. Draw a line from the compass needle mark to the center of the circle.



7. What angle have you drawn?______________________________

Any portion of the curved surface of the circle is called an ARC.

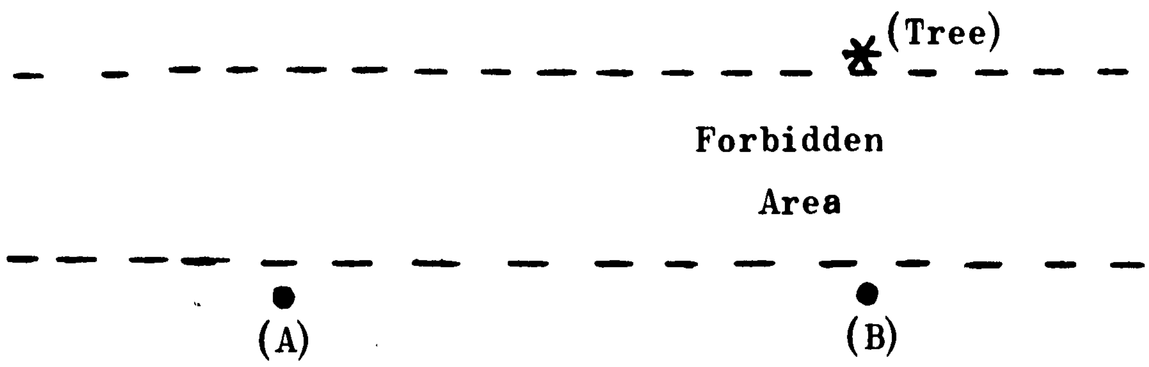
8. How many degrees have you drawn in your ARC?____________
9. There are two arcs in your circle. How many degrees do you have in the other arc?____________________

Student Worksheet #_____

LOCATING THINGS USING ANGULAR MEASUREMENT

In this experiment you will locate the distance of an object some distance away using <u>Angular Measurement</u>. Imagine you are on one side of a river and you want to swim across. You know you can swim 50 meters, but the river may be farther across than 50 meters. How could you easily find out the distance across the river? We will come back to this problem but first we will work a problem closer to school. Your teacher has already marked off several distances to be determined on your playground area. You will be dividing up into groups to solve the problems given.

Before you go outside, look at the example problem. Suppose you wanted to find the distance to a tree, but could not measure the distance directly. One procedure you could use follows:



1. Mark a position you wish to start from. Mark this position A.

2. Use a tape measure and measure from position A until you are directly across from the tree. Call this position B. This should be about 6 meters.

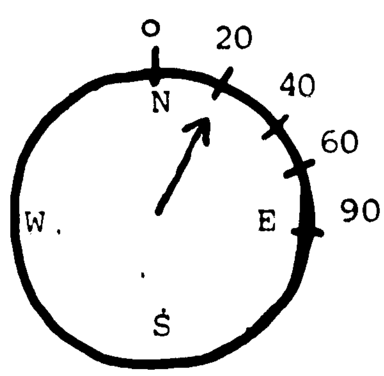
3. Draw a line between A and B. This will be called the <u>BASE LINE</u>.

4. Place the compass in a cardboard slot and place the N marking so it makes a 90 angle with the compass needle.

8. Place the compass on the left side of your desk, half way between the top and bottom of your desk. Place the North (N) symbol of the compass so it points straight up the edge of the desk. In which direction does the needle point?____________________

9. Again look for the number of degrees the needle points to. How many?________________________________

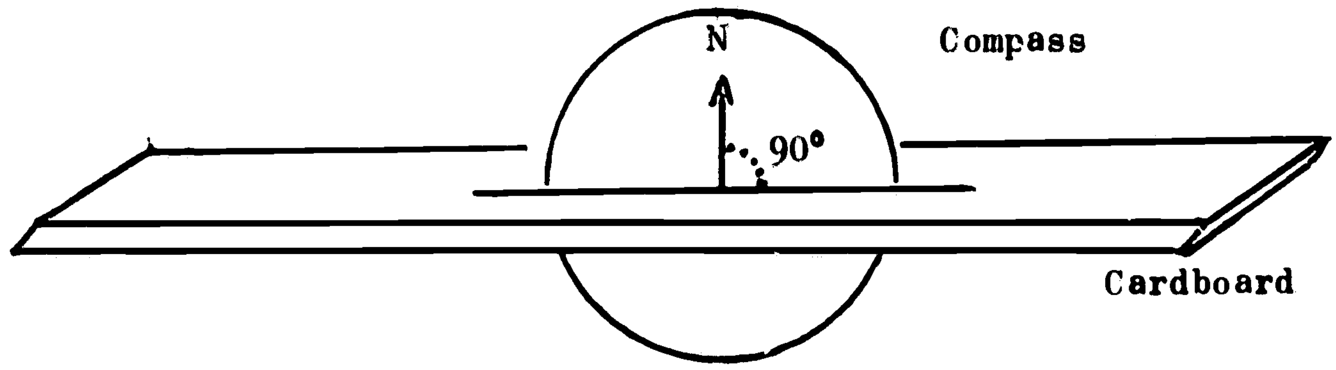
10. Now let's put the degrees and direction together as it would look to the scientist. To do this, you first write the number of degrees, then the direction from the North or South. For example:



20 East of North

11. Now look back to step 8 and 9. Write these two readings together.________________________________

12. Place your compass anywhere on your desk. Again take the reading.____________________. Don't move your compass. Raise your hand and your teacher will check to see if you are right.



5. From position B, sight the tree with the (N) symbol and at the same time sight toward position A with the compass needle. Position A might have to be moved.

6. From position A sight position B with the compass needle. At the same time, move the compass until the N symbol is sighted at the tree. Read the number of degrees.

7. Measure the distance from A to B.

If all of these steps were taken, the results might be as follows:

Distance from A to B ----------------6 meters
Angle from A to tree-----------------35°
Angle from B to tree-----------------90°

From this information a SCALE DRAWING could be made to find the distance from point A or point B to the tree.

APPENDIX

D

PROPOSAL

Highline Public Schools

King County, Washington

Application For A Research Grant

to

Bureau of Research

U.S.O.E.

Integration of Mathematics and Science Curriculum

November, 1966

PROPOSAL FOR RESEARCH AND/OR RELATED ACTIVITIES

SUBMITTED TO THE U.S. COMMISSIONER OF EDUCATION FOR

SUPPORT THROUGH AUTHORIZATION OF THE BUREAU OF RESEARCH

Title: Integration of Elementary Mathematics and Science Curriculum

Cooperating Agency: Highline Public Schools
253 South 152nd Street
Seattle, Washington 98148

Initiators: Charles N. Hardy, Coordinator of Science
206-CH 4-6100, Ext. 235

and

Frank M. Cline, Coordinator of Mathematics
206-CH 4-6100, Ext. 235

Principal Investigators: Charles N. Hardy
and
Frank M. Cline

Transmitted By: Dr. William Sorenson
Deputy Superintendent - Instruction

Contracting Officer: Horace Trimble
Assistant Superintendent - Business

Duration of Activity: July 1, 1967 to June 30, 1968

Total Federal Funds Requested: Direct....... $7471.00
Indirect..... 2500.00

Date Transmitted: November 21, 1966

OE Number assigned:

II. THE ABSTRACT

Project Title:	Integration of Elementary Mathematics and Science Curriculum
Principal Investigators:	Charles N. Hardy and Frank M. Cline
Contracting Agency:	Highline Public Schools
Federal Funds Requested:	Direct Costs......$7471.00 Indirect Costs.... 2500.00
Beginning and Ending Dates:	July 1, 1967 and June 30, 1968

This is a project designed to provide teachers with knowledge, training and means for presenting classroom situations in the primary grades which would allow children to learn mathematical and science concepts and attitudes in an integrated* way.

The integration of primary school mathematics and science curriculum would be based on an inquiry system of teaching and learning. This system would include emphasis on observing, measuring, recording, manipulating, devising, visualizing and predicting. These techniques are deemed to be vital in gaining an understanding of the processes of both science and mathematics and in the acquisition of fundamental knowledge inseparable from both disciplines.

This project would be accomplished in seven phases:

1. Research, writing of teachers' texts and development of laboratory materials. A team of five science and mathematics specialists would spend fifteen days synthesizing plans and preparing for the following six phases.

2. Introductory teacher workshop. A concentrated introduction to the task would be given to twenty selected primary teachers during a two-day workshop.

3. Initial classroom application. The twenty teachers would initiate the instructional component to approximately six hundred primary school children. This portion of the project would continue for a period of 180 days.

4. College course in integration of mathematics and science curriculum. The twenty teachers would form a complete college extension class offered by Western Washington State College of Education. Throughout the fourteen bi-weekly class sessions, the teachers would be directed in a continuation of curriculum development, the writing of textual materials and evaluation procedures.

5. Evaluation of accomplishments. Evaluation of the program would be under the Director of Research for the Highline School District, in cooperation with the elementary mathematics and science committees of the same agency.

6. Alteration and development. In accord with results of the evaluation, project revision and advisability of local expansion would be studied. The five mathematics and science specialists would contribute the necessary time for project redesign and in the introduction of recommended changes to curriculum and administrative specialists in the Highline School District.

7. Dissemination of results and recommendations. The scope of the distribution of findings will be determined by the positive results of the teaching-learning process. It would be desirable to be able to promote a successful project to local, regional and national educational agencies.

*Integration of curriculum takes place when school subjects are combined and presented as aspects of one unifying activity.

III. THE BODY

A. Objectives:

Integration of Elementary Mathematics and Science Curriculum is a proposal aimed at the development of a program for students and teachers, combining mathematics and science in an integral pattern. An initial program objective is to promote a move toward teaching for "learning as a whole", rather than for learning isolated subject matter.

When a student enters a classroom he becomes a part of that environment. His experiences in the classroom will determine to a large degree his future impact on a larger environment--society. As we plan the continuing curriculum we must be conscious of what things will most benefit the child in his world of the 1970's and beyond. To use a continuum of isolated subject areas, as has been the case to date, hampers the general learning process of the child. To activate a proper learning environment we must design environments whereby students can operate effectively with "doing activities" aimed at the commonality between subject areas.

The interdependence of Science and Mathematics is indisputable. Yet we seldom deal with these subjects in an integrated fashion in schools.

Young children view their world as one but before long they are learning mathematics, physics, chemistry--all separated from one another as if they are not aspects of the one world.

Not only do we contradict the basic psychology of the child, but we produce in the end too many students of the arts devoid of scientific aptitude or interest and scientific people who are artistically inept.

It is a curious commentary on our times that in what we call "the age of science and mathematics" we do not require that an educated man know science or mathematics. Yet it is understandable when considering the rate of growth of these disciplines. In just twenty short years we have passed through the atomic age and the space age. What implications do these points show when considering science and mathematics teaching in our elementary schools? They show that the world of our students is not our world. They show curriculum change which we have not yet dreamed of. They point out the urgency with which we must proceed in developing a framework of study. They point out the restructure which we must undertake in determining what mathematics and science be taught. And they point out the rethinking we must undertake in determining what environmental conditions are necessary for children learning for their adulthood of tomorrow.

Integration of Elementary Mathematics and Science Curriculum would be an integrated program based upon an inquiry system of teaching and learning. This system would include the skill processes such as observing, measuring, recording, manipulating, devising, visualizing, predicting, which lead to: 1) an understanding of the processes of science and mathematics and 2) an acquisition of fundamental knowledge in these two disciplines. Students learn that although "facts" accepted as true today may be modified or discarded tomorrow; general concepts such as the usefulness and limitation of a model; the process of building a hypothesis; the role of inductive and deductive reasoning have lasting value.

Two "national" programs have incorporated some mathematics and science materials together into a sequence for elementary children. The "Minnemast" program has attempted to coordinate the teaching of science with the teaching of mathematics. This approach is considerably different than the attempt at integration of materials from these areas. "AAAS--A Process Approach to Science" has incorporated mathematics and science to the end of achieving process skills. Again, material is not integrated toward the development of conceptualization.

Rationale: In proposing Integration of Elementary Mathematics and Science Curriculum, the initiators have agreed upon the following premises:

1. Textual material and laboratory investigations in both science and mathematics will not distinguish to the student the separate nature these two disciplines as are now taught. Text and lab should not be treated as separate entities. Furthermore, it is not enough to assume that they are interrelated; indeed, they are indispensable to one another.

2. An inquiry approach to the teaching of mathematics and science is essential if students are to develop skills in self-instruction and a realization of their own potential for deeper understanding of their environment.

3. Students are innately curious and eager to learn. They will learn if they are given an opportunity to develop the realization that a search for knowledge can be personally gratifying.

4. Science is not in itself more important than mathematics. Mathematics is not in itself more important than science. The two, however, are important parts of the education of future citizens.

5. Teaching science and mathematics at different times as if they are separate segments of the curriculum should be changed.

6. Process skills are but one of the important parts of the developmental scheme of the proposed project. Conceptualization is of equal importance. Teaching the skills necessary to explore mathematics and science intelligently are more important than the teaching of isolated facts. This is not to say, however, that the elementary school science and mathematics programs should, or could, exist in situations devoid of content, from which can follow conceptualization.

7. Other mathematics and science programs being developed align their philosophy to process approaches at the expense of concept formation or, as yet, have not integrated mathematics and science at the elementary level.

B. Description of Activities:

1. Writing Team
A team of five science and mathematics specialists would spend fifteen days synthesizing plans and preparing materials. This team would consist of the following individuals:

Mr. Charles Hardy, Coordinator of Science, Highline Public Schools
Mr. Frank Cline, Coordinator of Mathematics, Highline Public Schools
Mr. Russell Magnuson, Coordinator of Mathematics, Bellevue Public Schools
Mr. William Hunter, Coordinator of Science, Lake Washington Public Schools
Mr. Gary Tressel, Chairman of Mathematics Department, John F. Kennedy High School (Parochial High School)

2. Teacher Workshop
A concentrated introduction to the task would be given to twenty selected primary teachers during a Friday-Saturday workshop. Teacher selection would be from the Highline schools with no more than the faculties from four schools involved. The Highline School District would make all the necessary arrangements for substitute teachers to replace the workshop participants during the first day of the session.

3. Classroom Application
Using ideas and materials developed by the planning team, the twenty teachers would initiate the program in their own classrooms and would be expected to add considerably to the rewriting of text materials and to help in the evaluation of the program. Approximately 600 primary school children, Grades K-3, would be affected by the study. This portion of the project would continue for a period of 180 days.

4. A college course in integration of mathematics and science curriculum would be offered to the program teachers. Western Washington State College at Bellingham has expressed its interest and support for this venture and two members of its faculty have been chosen to represent them. They are:

   Mr. James Hildebrand of the Department of Mathematics
   Dr. Arnold Lahti of the Department of Physics

   The inservice work with the twenty teachers would be sponsored for college credit purposes by the Office of Continuing Studies of the College under the directorship of Dr. F. R. Feringer, with Mr. Hardy and Mr. Cline as authorized instructors.

   Teachers participating in a two-day workshop and fourteen bi-weekly class sessions would be directed in a continuation of curriculum development, the writing of textual materials and evaluation procedures.

C. The Use To Be Made of Findings:

1. <u>Evaluation</u>
   Evaluation of the program would be under the Director of Research for the Highline School District in cooperation with the Committees for Science and Mathematics for the same agency.

   Western Washington State College, through Mr. Hildebrand and Dr. Lahti, would give support in evaluation and methodology.

   Evaluation would be an ongoing process throughout the term of the program. Since the pattern of presentation would be considerably different from present patterns, design and analysis of the testing vehicle will be important in determining success.

2. Alteration, Development and Dissemination

Advisability of local expansion would be studied at the end of the granting period. The five mathematics and science specialists would contribute the necessary time for project redesign and in writing the final report. The results would be available to those interested parties requesting the information.

If the program proves successful, local expansion would be sought.

Integration of subject material in mathematics and science would accomplish two important considerations facing elementary teachers: 1) Reduce the many different subject areas the teacher must now teach and 2) Present materials that children can view as part of "their one world". This would be a major contribution to education.

IV. PERSONNEL AND FACILITIES

A. Personnel:
(Refer to Section III, B-1, 4)

NAME: Charles Hardy

POSITION TITLE: Coordinator of Science, Highline Public Schools

EXPERIENCE:

Education: MAT in Physical Science

Teaching Experience:

8 years - Secondary
2 years - Coordinator of Science, Highline
NSF-CHEM Study - St. Martin's College
2 years - Inservice Classes, Central Washington State College
2 years - Professional Credit Classes

Professional Activities:

Past President, Puget Sound Science Teachers Association
Past President, Washington Science Teachers Association
Regional Director, National Science Teachers Association, 1964-1966 for California, Oregon, Washington, Idaho, Nevada, Alaska, Hawaii
Member, State Science Advisory Board to the State Department of Education
Past President, local Education Association
Outstanding Chemistry Teachers Award, American Chemical Society
High School Relations Chairman, Puget Sound Section of American Chemical Society
Articles in Washington Science Teacher

PERCENTAGE OF TIME COMMITTED TO PROJECT: 30%

NAME: Frank Cline

POSITION TITLE: Coordinator of Mathematics, Highline Public Schools

EXPERIENCE:

Education: MAT in Mathematics

Teaching Experience:

6 years - Elementary

3 years - Coordinator of Mathematics, Highline

4 years - Teaching Inservice Classes for University of Washington, Central Washington State College, Western Washington State College and summer courses on campuses of Central Washington State College and Eastern Oregon State College

Assisted in teaching a summer course at Oregon College of Education, Monmouth, Oregon

Taught off-campus classes for three summers for Seattle Pacific College

Adult Education classes for Highline Community College

Professional Activities:

Member, National Council of Teachers of Mathematics

Member, Washington State Council of Teachers of Mathematics

Member, Puget Sound Council of Teachers of Mathematics

Served on Committee for Undergraduate Program in Mathematics

In charge of three county and two state Mathematics Conferences

Acted as Consultant for University of Washington, Department of Community Services, under Dr. Edgar Draper

Acted as Consultant to many school districts in the States of Oregon and Washington

Acted as Consultant for Addison-Wesley Publishing Company, Science Research Associates, Encyclopedia Brittanica Press, Holt, Rinehart and Winston

PERCENTAGE OF TIME COMMITTED TO PROJECT: 30%

NAME: William Hunter

POSITION TITLE: Coordinator of Science, Lake Washington Public Schools

EXPERIENCE:

Education: B.S. and Graduate work at University of Washington

Teaching Experience:

8 years - Shoreline School District
- 3 years - Elementary
- 3 years - Junior High
- 2 years - Senior High

1 year - Science Coordinator, Highline

2 years - Science Coordinator, Lake Washington School District

Inservice Classes, Central Washington State College

4 years - Professional Credit classes

2 years - Adult Education classes

KCTS-TV, Interim Biology Series

Professional Activities:

Member, Pacific Science Center Advisory Committee

KCTS-TV Science Advisory Committee

State Science Advisory Committee

State Conservation Committee

Secretary-Treasurer, Washington Science Teachers Association, 1965

PERCENTAGE OF TIME COMMITTED TO PROJECT: 100% for fifteen days

NAME: Russell Magnuson

POSITION TITLE: Coordinator of Mathematics, Bellevue Public Schools

EXPERIENCE:

Education: MAT in Mathematics

Teaching Experience:

2 years - Junior High
7 years - Senior High
4 years - Mathematics Coordinator
Inservice classes - Western Washington State College, Central Washington State College, Washington State University
5 Workshops - Madison Mathematics Project
2 years - Adult classes
1 year - Bellevue Community College

Professional Activities:

Member, National Council of Teachers of Mathematics
Member, Washington Council of Teachers of Mathematics
Member, Puget Sound Council of Teachers of Mathematics
Chairman, Washington Council of Teachers of Mathematics Conferences
Published article in Arithmetic Teacher
Instructor, Madison Mathematics Workshops in Los Angeles, San Diego, Chicago

PERCENTAGE OF TIME COMMITTED TO PROJECT: 100% for fifteen days

NAME: Gary Tressel

POSITION TITLE: Chairman, Department of Mathematics, John F. Kennedy High School, Seattle (Parochial School)

EXPERIENCE:

Education:
- B.S. in Mathematics
- Graduate work in Mathematics

Teaching Experience:
- 8 years - Secondary
- 3 years - Junior college
- 1 year - Central Area Motivation Project (elementary)
- 1 year - Inservice classes, Western Washington State College
- 1 year - Adult Education, Mathematics

Professional Activities:
- Member, National Council of Teachers of Mathematics
- Member, Washington State Council of Teachers of Mathematics
- Member, Puget Sound Council of Teachers of Mathematics
- Member, Mathematical Association of America

PERCENTAGE OF TIME COMMITTED TO PROJECT: 100% for fifteen days

NAME:	Dr. Arnold Lahti
POSITION TITLE:	Professor of Physics Western Washington State College
PERCENT OF TIME COMMITTED TO PROJECT:	100% for three days

NAME:	James Hildebrand
POSITION TITLE:	Associate Professor of Mathematics Western Washington State College
PERCENT OF TIME COMMITTED TO PROJECT:	100% for three days

B. Facilities:

Facilities for the success of the curriculum program are dependent ultimately on the classroom environment. For this reason, teachers would be utilizing the project material in each of their classrooms. Inservice work will be handled in the same manner. Typical classroom parameters are 30' x 30'. Each room has storage, water, blackboards, movie screens and table space for children. District committment has been assured.

V. BUDGET SECTION

Budget Worksheet: Guide for Research Activities

Investigators: Charles Hardy and Frank Cline Duration of Proposed Activity: One year
Institution or Agency: Highline Public Schools Beginning date: July 1, 1967 Ending date: June 30,1968

Category	First 12 months Federal	Local	. . . .	Total Federal	Local
A. DIRECT COSTS					
I. Personnel					
a. Principal Investigator, Mr. Charles Hardy Time on project: 30% of yearly contractual time Duration of employment - July 1, 1967 through June 30, 1968 Per annum salary	$ 510#	$3300*		$ 510#	$3300*
b. Principal Investigator, Mr. Frank Cline Time on project: 30% of yearly contractual time Duration of employment - July 1, 1967 through June 30, 1968 Per annum salary	510#	3300*		510#	3300*
c. Member of Planning Team, Mr. William Hunter Time on project: 17 days Duration of employment: July 3 through July 24, 1967 and August 24 and 25, 1967 Per annum salary	510			510	
d. Member of Planning Team, Mr. Gary Tressel Time on project: 17 days Duration of employment: July 3 through July 24, 1967 and August 24 and 25, 1967 Per annum salary	510			510	

* Estimated salary. (Salary contracts for 1967-1968 not issued until April, 1967.)
#Salary for 17 days - July 3 through July 24, 1967 and August 24 and 25, 1967. (Not covered by local contractual period.)

V. BUDGET SECTION (Continued)

Category	First 12 months Federal	Local	. . . .	Total Federal	Local
I. Personnel (continued)					
e. Member of Planning Team, Mr. Russell Magnuson Time on project: 17 days Duration of employment: July 3 through July 24, 1967 and August 24 and 25, 1967 Per annum salary	$510			$ 510	
f. Consultant, Mr. James Hildebrand Time on project: 3 days Per annum salary: (3 days at $45 per day)	135			135	
g. Consultant, Dr. Arnold Lahti Time on project: 3 days Per annum salary: (3 days at $45 per day)	135			135	
II. Employee Benefits Social Security - 4.4% of $2550.00	111			111	
III. Travel	--	--		--	--
IV. Supplies and Materials					
a. Project Materials	1200	--		1200	--
b. Office Supplies	--	--		--	--
V. Communications	--	--		--	--
VI. Services					
a. Duplicating and Reproduction	--	--		--	--
b. Statistical	--	--		--	--
c. Testing	--	--		--	--
d. Other	--	--		--	--

Category	First 12 months Federal	First 12 months Local	. . . .	Total Federal	Total Local
VII. Final Report Costs	--	--		--	--
VIII. Equipment	--	--		--	--
IX. Other Direct Costs					
a. Tuition for teachers attending training sessions 20 teachers at $40 per teacher	$800	--		$800	--
b. Teacher costs per diem for attending training sessions 20 teachers at $7.50 per class for 14 classes	2100	--		2100	--
c. Wages for substitute teachers 20 days at $22.00 per day	440	--		440	--
X. Subtotal, Direct Costs	7471	6600		7471	6600

B. INDIRECT COSTS

Established by John J. Fotheringham, Federal Programs Coordinator, Highline School District, on November 18, 1966, for the period July 1, 1967 through June 30, 1968.

Overhead is based on the contributions being made by the local school district for the following services:

I. 30% of time of one mathematics and one science coordinator spent on the project throughout the 1967-1968 school year.

II. Use of facilities, including two offices and twenty classrooms for development of the project.

III. Use of equipment, office and classroom supplies and materials that are now available for use to complement those items that would be supplied by direct federal funds.

IV. Secretarial and clerical time for preparation of materials and final report.

(continued on next page)

V. BUDGET SECTION (Continued)

Category

B. Indirect Costs (Continued)

V. Mileage payments for staff participants.

VI. Time spent by curriculum directors, coordinators and consultants who would work in supportive roles in project.

VII. Use of services provided by Instructional Materials Center, Business and Purchasing Offices.

	First 12 months . . . . Federal	Local . . .	Total Federal	Total Local
VIII. Subtotal, Indirect Costs	$2500	--	$2500	--
C. TOTAL COSTS	$9971	$6600	$9971	$6600

VI. APPENDED ITEMS

A. Other Information:

1. Amount and source of support other than from the transmitting institution.............None.

2. Whether this or a similar proposal has been submitted elsewhere ......No.

3. Whether this is a proposed extension of, or addition to, a previous or current project supported by the Office of Education...........No.

B. Revisions:
Not Applicable

C. Report On Other Projects:
Not Applicable

D. Instruments:
Not Applicable

E. Agreement With Contracting Agencies:
See letters attached.

WESTERN WASHINGTON STATE COLLEGE

BELLINGHAM, WASHINGTON

November 3, 1966

Extension & Correspondence Study Services

MEMORANDUM

To: U. S. Office of Education

From: Western Washington State College

Date: November 3, 1966

Subject: Integrated math-science project with Highline School District

This is to inform you that we have been in contact with Mr. Cline and Mr. Hardy of the Highline School District regarding the enclosed math-science project. It is our recommendation that the conception of this project is sound, and that Mr. Cline and Mr. Hardy are qualified persons to supervise it. As described in the project, we are planning a training program for their teachers in the event that it is eventually mounted. Please do not hesitate to contact us if there is further information you can provide.

F. R. Feringer, Director
Office of Continuing Studies

James L. Hildebrand, Associate Professor
Department of Mathematics

Arnold M. Lahti, Professor
Department of Physics

gf

STATE OF WASHINGTON

Superintendent of Public Instruction

Olympia

LOUIS BRUNO
STATE SUPERINTENDENT

November 21, 1966

TO WHOM IT MAY CONCERN:

It is my firm conviction that one of the ways in which educational programs can be made more effective is to emphasize the interrelations of the various academic fields rather than to perpetuate the interdisciplinary barriers that result from arbitrarily categorizing for scheduling convenience. Little effort has been made to impress students with the fact that the interdependencies of the sciences with one another as well as with the social studies and fine arts are far more significant than their differences.

In the belief that this proposal involving the integration of science and mathematics is a needed step in the desired direction, I heartily recommend your favorable consideration of this project. In the event that this project is carried through to a successful conclusion, exemplary materials might very likely result which the Office of the State Superintendent of Public Instruction could make available to other school districts throughout the State.

Respectfully,

James M. Garner

James M. Garner
Supervisor of
Science Programs

JMG:rh

APPENDIX

E

CRITIQUES

CRITIQUE ON
INTEGRATION OF MATHEMATICS AND SCIENCE
CURRICULUM PROJECT

Carried Out By

Highline Public Schools
Seattle, Washington

Sponsored by U.S. Department of Health, Education and Welfare

It has become my feeling that an integrated subject matter curriculum for elementary schools is mandatory if we are to meet the educational needs of elementary school children. With the tremendous amount of subject matter being placed in the elementary curriculum, teachers no longer have time during the day to teach in a fragmented manner all of the subject matter which is demanded. Also, students more often tend to disassociate concepts learned in the different disciplines when they are handled separately. It therefore is becoming increasingly necessary for those working in curriculum development to come up with integrated programs.

The IMS Program developed and tested by the Highline School District is a significant step in curriculum development towards integration of subject matter. This program has not only integrated Science and Mathematics, but has also integrated the process skills with fundamental concepts. That is, the IMS program has avoided one of the serious pitfalls of many of the popular programs which are now in use. Some of the outstanding features of this program are the in-service training which is provided for the teachers in order that they be well indoctrinated not only to the subject matter and methods of teaching, but to the general concept which is not at first easy to grasp. The teaching material is well planned and well written enabling each instructor to work in depth in the material according to the ability of the students. The program also had measures set up previous to the program's inauguration for evaluation.

In short, the program has met, to my thinking, the criteria which is essential for a good study program. I feel that the enthusiasm and the interest which was shown by both the teachers and the students in the material and in the manner in which it was handled is testimony that the purposes set down at the inception of the program, have been met. It would be my feeling, that this program should be carried on for another year or two years and that objectives for the program be stated in terms which were more measurable. This is a very worthwhile program and to end the work at this point would be unjust to the participating teachers and to the participating students. I know that there are many people in this area along with myself who will be watching the further development of the IMS material.

W Ray McConnell

W. Ray McConnell
Science Coordinator
Kent School District
Kent, Washington

STATE OF WASHINGTON

Superintendent of Public Instruction

LOUIS BRUNO
STATE SUPERINTENDENT

June 14, 1968

P. O. BOX 527
OLYMPIA 98501

TO WHOM IT MAY CONCERN:

This letter was written in regard to Project 7-I-029 entitled Integration of Mathematics and Science Curriculum. The proposal is being submitted by Mr. Charles Hardy, Science Coordinator for the Highline Public Schools in Seattle, Washington.

The premise upon which this project is based is certainly consistent with current curriculum trends, most of which reflect a variety of attempts to break down the arbitrary categorizations of the traditional disciplines into more relevant interdisciplinary experiences. The crucial importance of the first few years of formal schooling is well documented, and therefore programs such as this which are designed to make studies more meaningful to children are particularly desirable.

The introduction to the project proposal is plainly stated and the objectives are clearly defined. The provision for evaluation of student achievement includes reasonable assumptions, but the third of these, "the efficacy of the material to a particular situation" is disturbingly ambiguous.

A number of the terms and concepts incorporated in the materials for teachers may appear to be rather sophisticated for K-3 students, but this is a matter which should be decided at the discretion of the local educators who are most familiar with the abilities of their particular students.

The copy examined by this reviewer was in need of proofing, but assurance was given that this would be taken care of before materials were distributed. That portion containing information for teachers included some errors which could prove troublesome to elementary teachers lacking a science background. (See formula given representing reaction between iron and sulfur).

As Supervisor of Science Programs for the State of Washington, I am especially pleased that this effort is being made. It reflects educational insight and professional determination to meet real needs of real children living in a real world, and we will continue to cooperate in every way with the competent educators responsible for this project.

DIVISION OF CURRICULUM
AND INSTRUCTION

James M. Garner
Supervisor of
Science Programs

JMG:rh

APPENDIX

F

ERIC REPORT RESUME

(TOP)	
Resume Date: 06-16-68	Is document copyrighted: yes ☐ no ☒
	ERIC Reproduction release: yes ☒ no ☐

Title

INTEGRATION OF MATHEMATICS AND SCIENCE CURRICULUM

FINAL REPORT

Personal Authors: HARDY, CHARLES "and others"

Institution Source: HIGHLINE PUBLIC SCHOOLS, SEATTLE, WASH.

Pub'l. Date: 06-16-68 **Contract Grant #** OEG-1-7-070029-2823

Retrieval Terms:

Integration of Mathematics and Science Curriculum --
Primary Grades

Abstract: This is a project designed to provide teachers with knowledge, training and means for presenting classroom situations in the primary grades which would allow children to learn Mathematical and Science concepts and attitudes in an integrated (unifying) way.

The integration of primary school Mathematics and Science curriculum was based on an inquiry system of teaching and learning. This system would include emphasis on observing, measuring, recording, manipulating, devising, visualizing and predicting. These techniques are deemed to be vital in gaining an understanding of the processes of both Science and Mathematics and in the acquisition of fundamental knowledge inswparable from both disciplines.