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ABSTRACT

A rationale for the teaching of reading in conjunction with the teaching of science is developed and illustrated. Specific activities at elementary, middle, and secondary school levels are discussed in terms of the reading skills involved and the science processes stressed. (AA)

A Reading Program For The 70s

Science

Division of Curriculum Development and Pupil Personnel Services
Office of Instructional Services
Georgia Department of Education
Atlanta, Georgia 30334
Jack P. Nix
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"I just love to read!"

This exclamation is probably the criterion reference for the behavioral objective that all children will be able to read current popular periodic literature. Of course there is no such behavioral objective stated for Georgia's Right-To-Read Program. But when teachers hear students make this remark, they often assume that reading education is complete, and they can turn their attention to those readers who still find the process of reading to be a less than desirable exercise.

Yet the statement, for all its finality to reading educators, is probably not complete. The student who enjoys reading should remark, "I just love to read what I want to read," for not all people who read extensively read the same collection of literature. In fact, people really read because they want information. Maybe the reading gives information about a fictional situation which excites the reader's imagination; maybe reading gives information about how to assemble a recipe, or wearing apparel, a building structure or stereo; maybe the information tells how to do something the reader wishes to accomplish or emulate in sports, games or physical prowess; or maybe the information the reader seeks relates to his environment or gives insight into the mysteries of his very presence. Even as you read this sentence, your reason is not for the exercise of reading, but because you think this total paper will give you a better insight into the commonalities of reading instruction and science instruction.

Reading is one of the tools which frees the curiosity of the learner to know whatever he wants, at least to the measure that others before him have recorded it. The education process then must provide a set of non-reading activities for young children to give them multi-sensory experiences which will fix in their awareness the potential for the full spectrum of intellectual endeavor. A very broad array of experiences provides the basis for a great variety of interest.

The Role of Science in the Curriculum

Science in contemporary curriculum should be taught in such manner as to stimulate the interest of students in the nature of things. Science as a human endeavor asks the same kinds of questions that children ask — Why? How? What? When? Where? The essential aspect of science education then is to understand that science is asking questions, but not necessarily giving answers to them.

Ideally, a science teaching exercise will first pose a question to be investigated by students and then provide an activity involving the physical senses of touch, taste or smell in addition to vision and hearing. These multiple inputs to the student's awareness are expected to establish a level of interest which will cause him to pursue vicariously the related learning experiences which may be constrained to the audiovisual senses through semantic symbolism of reading materials. Simply stated, the goal of every good science teaching exercise is to be sufficiently open-ended as to cause the student to want to know more than the exercise alone provides.

Therefore, when science teaching is properly done children will want to read. But most science teaching is not properly done. In fact, there is probably more science being taught contrary to the model given than in agreement with it.

Quality Science Teaching as an Incentive for Reading Readiness

Several studies, especially in the elementary grades, indicate that students in carefully planned and executed science programs surpass in reading skills development those students who participate in standard reading readiness programs.

Dr. Donald Kellog, in a dissertation study at the University of Oklahoma in 1971, compared the reading readiness of a group of students in first grade who used *Material Objects* from the Science Curriculum Study Program as a reading readiness program with that of another group who used the Harper and Row Reading Readiness Program. Reading readiness was measured in pre- and post-tests using the Metropolitan Reading Readiness Test. Both groups were chosen from first grade groups in Ada, Oklahoma.

The results of the testing showed that the science group had outgained the reading group in total reading readiness. The reading group gained 12.81 points per student, while the science group gained 16.53 points per student. The level of significance for this difference was between 0.10 and 0.20. In addition, the science group outgained the reading group in the sub-test areas of word meaning, listening, matching, alphabet and numbers while the reading group outgained the science group only in the area of copying.[1]

In a similar study with middle grade elementary children, W. J. Coffia sought to determine if there is any significant improvement in the achievement patterns of children who complete four years of an inquiry-oriented science curriculum. In this test the academic achievement of 46 fifth grade students who had experienced the Science Curriculum Improvement Study program (SCIS) since grade one was compared with 69 fifth grade pupils lacking this experience. Academic areas considered in the test included mathematics skills, concepts and applications; social studies skills and concepts; and reading paragraph and word meaning.

A review of the findings reveals significant differences between the two groups in mathematics application, social studies skills and reading paragraph meaning. This difference was in favor of the group who experienced the SCIS science curriculum. There was not a significant difference between the groups in mathematics skills and concepts, social studies content and reading word meaning. Coffia concluded that an inquiry-oriented curriculum does in fact have an impact on achievement in other academic areas, as children who have had an inquiry experience tend to utilize levels of thought that transcend mere recognition and recall. They appear more able to use the higher powers of thinking more effectively than those who have not had an inquiry experience.[2]

A study reported by J. B. Ayers and G. B. Mason shows that both traditional kindergarten instruction and instruction in Science: A Process Approach (SAPA) led to increased readiness for reading and school learning as measured by the Metropolitan Readiness Test. However, the nature of the gains differed. The experimental group made a significant gain in total test scores and in scores on listening, numbers and copying sub-tests. The implications, according to Ayers and Mason, are that the program can add to a reading readiness program for five-year-old children.[3]

Science Textbooks and Science Tradebooks

Elementary and secondary teachers often say, "I would like to use one of the newer science programs, but I feel I need a textbook," or "I feel that children need experiences in reading in all subjects." Although these statements are certainly correct, the textbook is not the only source of written science information. Illa Podendorf describes the use of trade books in the science classroom.

> One alternative to the use of the textbook in elementary science is the trade book, whether fiction or non-fiction. Titles of trade books which supplement the content of the ongoing curriculum should be provided in the classroom and in the school library. The titles for use in the classroom should be changed or added to as the science curriculum progresses and selected according to the library and science standards. The reading levels should cover a wide range so all children will be able to find reading material which is suitable.
>
> Perhaps the most important consideration in the selection of books is the accuracy of the science content. If the processes of science are made evident in a trade book, they should be used with purpose. The degree of anthropomorphism or teleology which is conspicuous in a book is also an important consideration. Authors sometimes give their animals in the stories thoughtful, kindly

personalities and thus the book is anthropomorphic. A purpose is ascribed to an act of an animal – this is teleological. For example: The beaver slapped the water with its tail to warn . . . or . . . the little earthworm came to the top of the soil so it would not . . .

More and more trade books are coming on the market and it is less and less difficult to acquire a collection of tradebooks to accompany the science curriculum suitably. There are several good annotated buying guides which would be helpful in making selections. The American Association for the Advancement of Science has available annotated buying guides which would be helpful in addition to the buying guides which the librarians use. Most buying guides would not recommend a book that is not accurate scientifically, is not readable by students of the age level for whom it was intended or is either teleological or anthropomorphic.

How to use trade books in the classroom is a question to be considered. Every teacher will need to work out the use in her classroom according to her style of teaching. Mainly, books must be readily available. Children must be interested in the science activities and motivated to ask questions which can possibly be answered by referring to one of the trade books. They should also be encouraged to read for enrichment information about an idea or subject in which they have special interest. Students should learn to recognize the classroom library or the school library as one possible resource. There must be opportunities for children to share their newly acquired knowledge or information with their peers.

A teacher needs to set the model for students by raising questions and using the reading resources as but one way to acquire or check information. Students of all ages, and especially at the elementary levels, have a tendency to overgeneralize or to make their conclusions prematurely. The teacher may use the opportunity to set a model by questioning, reading and demonstrating the importance of reading to substantiate or not substantiate the data children have. This may lead to a repetition of the activity for further validation. It is common knowledge that interest is a powerful motivator and there is no determining how much reading a child will do on his own with sufficient motivation.[4]

Scientific Vocabulary and Science Education

One of the real problems of science instruction is that pseudo-explanations are often given for natural scientific phenomena. For example, the mysterious force or condition which differentiates living matter from nonliving matter has historically been known as "elan vital" – an imaginary material which, when pumped into ordinary substance, gave to that substance the quality of life. With the development of the microscope and the discovery of the cell as the common building block of all living things, "elan" was replaced by the term "protoplasm" to describe the substance within the walls of cells, for here must be the true elementary matter of life. Thus, for nearly a century students in beginning biology courses used an incorrect term to explain the secrets of life itself. Twentieth century refinements of microscopic techniques and the development of biochemistry as a branch of science helped scientists identify the protoplasm as a complex mixture of chemical compounds as ordinary as the materials outside the cell walls. The real mechanism of life, however, still eludes even the most sophisticated researchers. Victor Perks calls this kind of semantic, scientific cover-up a "tyranny of words."

•

Unfortunately, in teaching, words can bring about an unwanted outcome – to close the mind of the inquiring child unintentionally; to terminate the curious; to provide labels or sounds imposed on phenomena which are really pseudo-explanations– verbal nonsense poured on an excited, naive, boldly curious child. For example:

"Look at the red, red sky. Why is it red?"
"Because of what's in the air. Dust and moisture make the sky red."

"How come that tiny wire in the electric bulb glows?"
"Electrons are flowing through the wire, from the battery, and returning to it through the bulb. The electrons are squeezed and pushed through that smaller wire causing friction which makes the wire glow."

"Gosh, my plant is getting big! Where is it getting all the stuff to grow with?"
"The plant is photosynthesizing its food from carbon dioxide, water and sunlight."

What have the reply statements accomplished? A questioning child might be left with a set of new words, e.g., molecule, evaporate, electron flow, photosynthesis. But do these words make sense to the child in the context they were used? Are they unambiguous? Uncontradictory? Or have we not shoved nonsense at the children as if it were sense; as Holt states, ". . . cutting them off from their own common sense and the world of reality by requiring them to shove around words and symbols that have little or no meaning."[5] Do these pseudo-explanations have any function in a child's quest to understand his surroundings (as suggested in the comments above)? Or might they not bring the child to question his own adequacy to cope with that which he perceives as problematical or temptingly curious?

Instead of heaping verbal nonsense on a child's inquiry, we might ask him to look again at the problem he posed, cueing him to observe again; signaling him that it is certainly permissible and most desirable for him to speculate and to test his conjectures, to draw his own analogies, to structure his own explanatory models about phenomena—models which seem to make conceptual, logical or functional sense of the events he has observed.

Assume that a second-grade girl is rubbing the hair on her arm with a piece of vinyl. Holding the vinyl strip about one-half an inch above her arm, she moves it back and forth. The hairs on her arm bow and bend toward the plastic strip as it is moved across the arm. She asks the "why" question; i.e., "Why do the hairs stick up?" The latch to close this play would be to say, "Static electricity causes it" – and true, children often will accept this, much as they accept on faith the childhood myths of Santa Claus, the Easter Bunny and the Tooth Fairy.

Instead of giving the child a nonsense word, she should be asked to look again.

"In which direction do the hairs point?"
"Towards the plastic."

"Do all the hairs?"
"No, just those close to the plastic."

"What might be happening?"
"The hairs are being pulled."

"What would be pulling them?"
"Invisible hands."

Certainly an intriguing and vital analogy. The child's world of reality and her common sense appears to come to focus here. Implicitly, she has proposed the existence of a force which exists between hair and the vinyl strip – a force which can't be seen, but is evident by its effect. She draws from her own experience, e.g., hands pulling wagons, ropes, hair, etc.

The child's next quest can be aimed to find which other materials have "invisible hands" and which do not. She will display a spirit to gamble, to try, to experiment with the unknown—those qualities Holt believes education generally tends to destroy. This inquiry can be continued and expanded given form and shape by the child, and the support of materials and cues from the teacher.

Verbal purists argue that certain terms must be learned by scientists and a scientifically literate citizenry. This position is not questioned. Obviously, words are the common denominators of communication. The question teachers should ask is, "When should vocabulary be introduced?" The question can be answered only by an honest evaluation of the context in which the terminology will be introduced and what purpose it will serve. Does the word introduce a complex synonym for a term a child has found functional, e.g., viscosity vs. sluggish flow? Does the word appear to explain, but upon careful analysis from the child's embryonic conceptual framework, really serve as a senseless unassimilatable chunk? Does the term provide an apparent but unreal explanation, causing an end to an inquiry, producing a premature closure?

Children enter school curious, eager to devour life, to tackle the new. We must attempt to sustain their curiosity, avoiding the tyranny of words. By word and deed, we must convey the message that the unknown is a challenge, not to vanish with the utterance of a word.[6]

Podendorf supports Perk's position and offers teaching strategies to counter the condition. The following are her views of the children's use of scientific terminology.

It is not uncommon for children to quote a dictionary definition when they are asked the meaning of a word. There is nothing wrong with this. Quoting a definition does not necessarily mean that the student knows how to use the word in the right context. A definition that includes only what a child can observe, understand and describe and which has meaning for the child in the context of the current activity or experiment is more useful than a more generalized definition. The definitions by two different children may be written two different ways and still be equally correct. A dictionary definition of a leaf may be something like: *A leaf is a projected growth from a stem which functions in food manufacture by photosynthesis.* A child who has been working with leaves from deciduous trees may have no understanding of food manufacture or photosynthesis. He may be more satisfied with: *A leaf is the flat green part of some trees and plants that has a short part which holds it on the stem and it may be small like a cracker or big like an elephant's ear.* On another occasion the children who have been working with leaves in quite different activities or in a different context may define a leaf more like: *A leaf is a part of a plant that is seen above the ground, is usually attached by a stem-like portion, is flat or needle-like and many of them make a shade from sunlight.* Encouraging children to develop their own definitions, however unsophisticated, is more useful to the children and from one point of view is more precise. As children mature and have accumulated more experience with leaves, their descriptions or operational definitions will broaden and include more information. Eventually they will be able to understand the definitions which they find in an dictionary.

Children enter school curious, eager to tackle the new. We must attempt to sustain their curiosity, avoiding the tyranny of words. By word and deed, we must convey the message that the unknown is a challenge, not to vanish with the utterance of a word.[7]

Activities

Staff Development Model

Introduction

Reading skills and understandings are applicable to science activities in the same way that science processes are applicable to reading. According to Guilford in "Structure of the Intellect" there are four areas of content – symbolic, figural, semantic and behavioral. There is no hierarchy, as each area is equal in importance.

A common fault with contemporary reading programs is that they dwell in the semantic area almost exclusively after the child reaches a prescribed quantitative level of word recognition and usage. The intellectual demands of the child do not follow this pattern.

The child's environment obliges him to respond to constant stimuli. His level of response is proportional to his experience. If the child is required to always respond in a semantic way to stimuli, we seriously limit his ability to respond in a non-verbal way. Therefore, all of the educative process is involved in the expansion of awareness in all areas of the intellect.

We are doing a disservice to the learner when we neglect the enrichment of any one of the content areas. It is the educator's responsibility to enhance and increase the alternatives of responsiveness to external and internal stimuli. The content area teacher needs the expertise and insight of the reading teacher. The reading teacher also needs the expertise and insight of the content area teacher.

Science demands that students read in the figural, symbolic and behavioral content areas as well as the semantic. While the graphic arts may deal in the figural area and mathematics in the symbolic area, science is a common ground where all may be utilized and become mutually reinforcing.

Therefore, preparing teachers for reading in the content area of science should center around a new awareness of this condition. One approach to increasing awareness is to relate old situations to new strategies. The following exercise will help teachers relate reading skills and understandings to student activities presently in the science curriculum.

The three activities roughly correspond to the primary, middle and high school levels. Upon completion of the activities the booklet *Reading Skills and Understandings* will be used to relate particulars to the activities.

The identification and delineation of scientific processes involved in an exercise is the first task. Identifying and delineating the reading skills and understandings which are brought to bear in performing the exercises is the second task. Reconciling the two lists and relating them is the third task.

It should be remembered that skills and understandings from several levels may be included in one exercise, just as several processes may be involved. Readiness skills such as rhythmic response and manipulation and recognition of multi-dimensional forms are usually included in numerous activities at varying learner levels.

The establishment of pattern recognition is not limited to literary forms. This is common to scientific experimentation and the building of logical conceptual schemes in all disciplines. Processes such as observation, making predictions and dealing with space and time relationships also cross learner levels with facility.

A new awareness of the relationship between science and reading as a part of the discipline will enable the teacher to see the applications to his teaching.

The Model

I. Activities

A. Symbols, figures and words — putting it all together

B. Reading isn't all science

C. Reading isn't all words

II. Identification of scientific processes involved

III. Identification of reading skills and understandings involved

IV. Synthesis of processes, skills and understandings — a new awareness

Symbols, Figures and Words — Putting It All Together

Grade Level: Primary

Objectives:

1. To recognize and identify two and three dimensional shapes.
2. To understand that three dimensional shapes project two dimensional images on a two dimensional screen.

Materials:

1. Solid geometric forms such as cones, cylinders, square and rectangular blocks, spheres
2. an overhead projector
3. two pieces of 24" x 30" cardboard taped together to make shield for the projector

Strategy:

1. Have the students identify as many of the shapes as they can by showing each of them to the class. Identify and list each name on the chalkboard.
2. Using the shield to block the students' view of the projector stage, place each form on the stage and have the students predict the three dimensional shape of the two-dimensional image which is projected on the screen.
3. Remove the screen so that the students will see how well they predicted.

Reading skills and understandings	Scientific processes
Observing	Observing
Recognizing shapes	Recognizing shapes
Predicting	Predicting
Understanding two and three dimensional images — words as symbols	Using space relationships
	Classifying

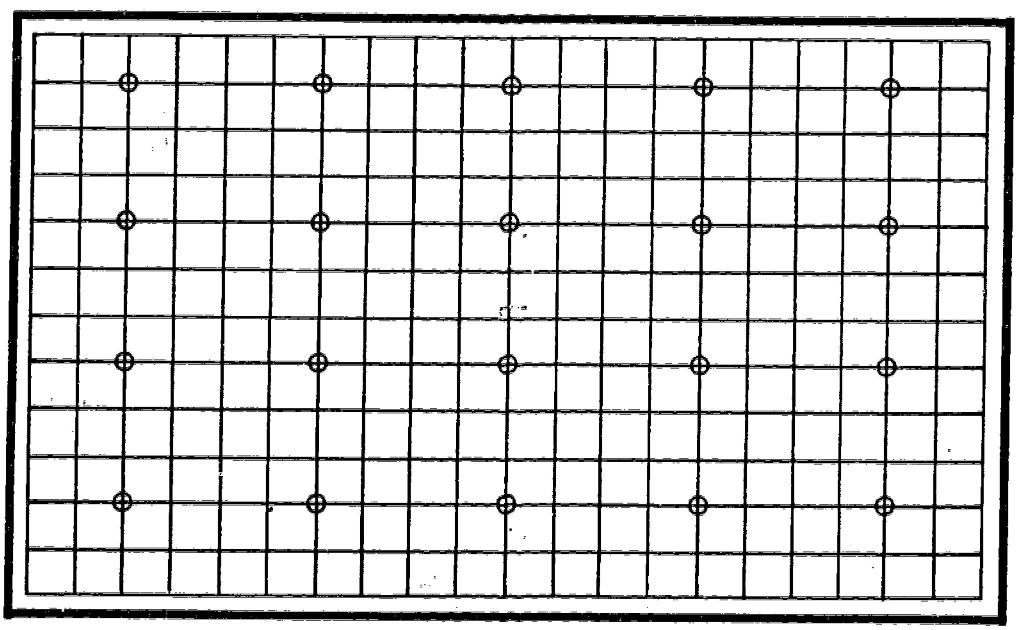
Grade Level: Middle

Objective: To understand how to determine the shape of something unseen.

Materials: (for each team)
1. one box with a removable top (shoe box)
2. enough graph paper to cover the box
3. ruler
4. tape
5. long thin rods (knitting needles)

Strategy:
1. Tape graph paper to top of box.
2. Put an object in each box.
3. Give one box to each team.
4. Have team members puncture the box top at various points and mark the needle at the level of the box top. When they draw the needle out have them measure the depth. Also, have them note the location where each depth measurement was taken.
5. Take measurements at widely separated locations, such as the open circles shown in Figure 1. Ask the students if this is enough information about the shape of the object to figure out what the object is?
6. Make many more measurements. (for example, at every intersection of lines on the graph paper shown in Figure 1). Remind the students to record their data in an orderly manner.
7. Use the data collected to figure out the shape of the

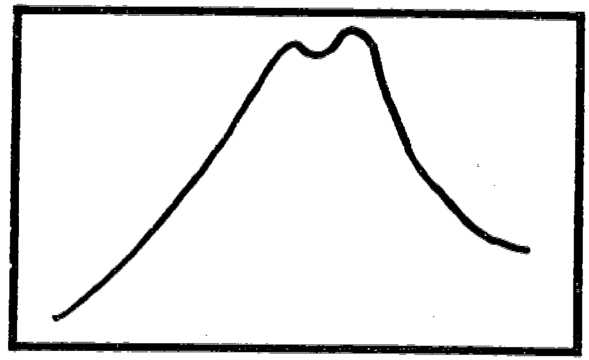
Figure 1



object hidden in the box. A good way to do this is to make many "profiles" of the object. For example, suppose the object in the box is a model of a volcano. The profile made along the plane that cuts the volcano in half would look something like Figure 2.

8. Make many profiles and cut them out on cardboard. Copy Figure 1 on a piece of graph paper. Glue the bottom edges of the profiles on the graph paper along the lines corresponding to the profiles. (The profiles should stand up vertically from the paper). Glue down several profiles to get a good idea of the shape of the hidden object.

Figure 2
A profile of a volcano might look something like this.



Reading skills and understanding	**Science processes**
Predicting	Predicting
Infering	Infering
Words as symbols	Using numbers
Classifying	Measuring
Organizing information	Classifying
Observing	Interpreting data
Interpreting	Hypothesizing

Activity reprinted from
Challenges to Science: Earth Science
by R. Heller, J. Byrne, D. Darby, W. Dexter, B. Hawkes, K. Kaufmanis and R. Ojakanges

Reading Isn't All Words

Grade Level: Secondary

Objective: To understand the figural and symbolic relationship of graphs and numbers to actual occurences.

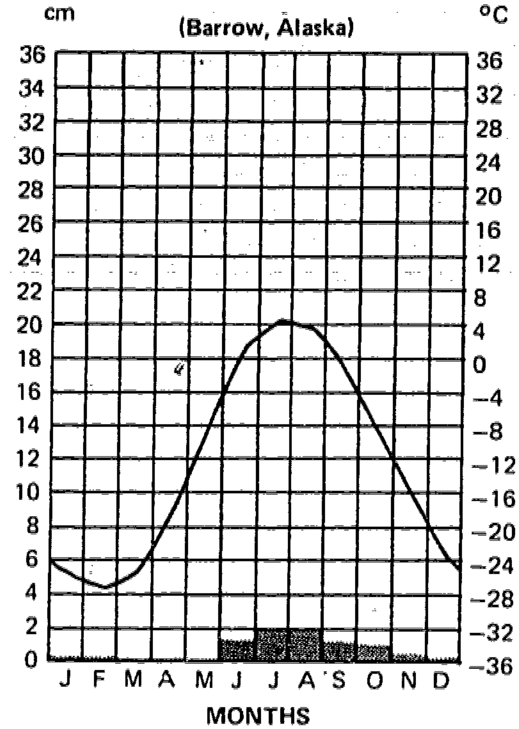
Materials:
1. 10 climatograms representing 10 major world biomes
2. Data collected on temperature and precipitation from widely diverse places in the world

Strategy:
1. Explain how a climatogram works – two vertical axes, right and left and two sets of data on each graph.
2. Hand out data sheets and have students predict which biome is represented by each set of data (Table 1, a-i).
3. Compare student responses with answers in Table 2.

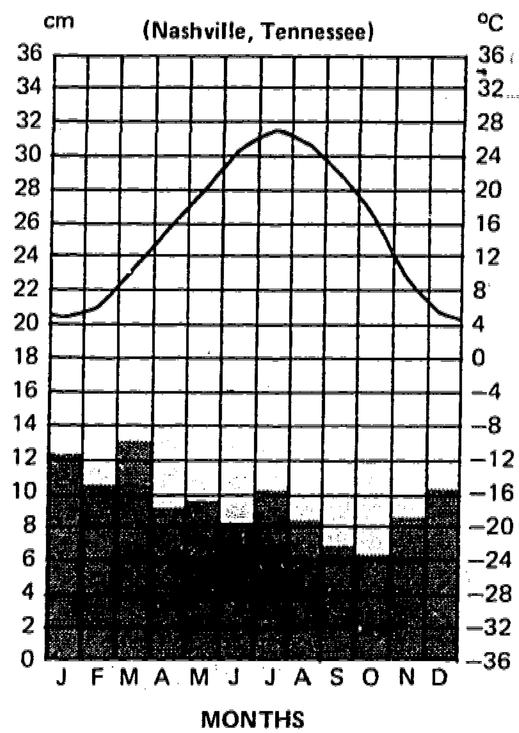
Reading skills and understanding	Science processes
Using figural and symbolic means to communicate	Observing
Time and space relationships	Predicting
Main idea and supporting detail observation	Infering
Classifying	Using numbers
Organizing information	Measuring
Observing	Classifying
Interpreting	Interpretive data
	Using time – space relationships
	Hypothesizing

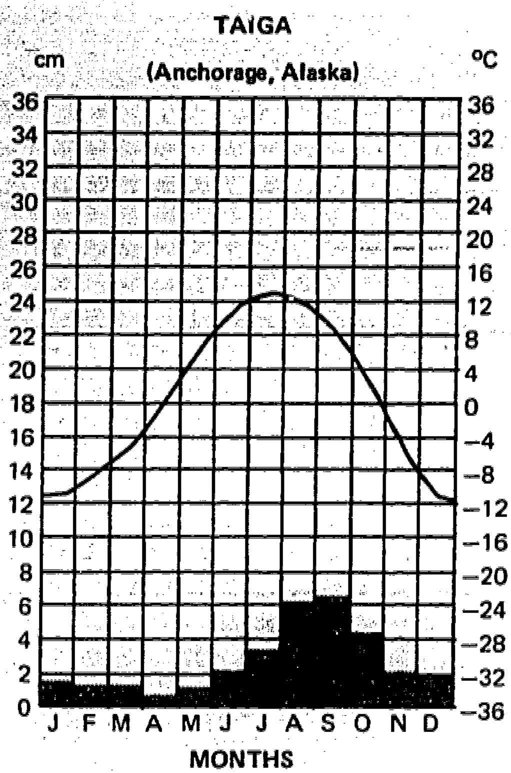
Graphs and data from
High School Biology, BSCS Green Version, 1968
Rand McNally and Company
By permission of the Biological Sciences Curriculum Study

TUNDRA



MIDDLE-LATITUDE DECIDUOUS FOREST




TAIGA
(Anchorage, Alaska)
cm
°C
36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2 0
36 32 28 24 20 16 12 8 4 0 −4 −8 −12 −16 −20 −24 −28 −32 −36
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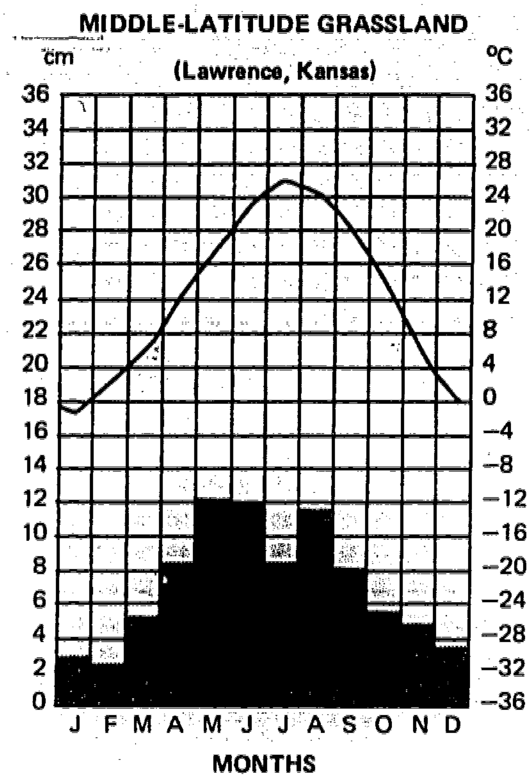
MONTHS


MIDDLE-LATITUDE GRASSLAND
(Lawrence, Kansas)
cm
°C
36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2 0
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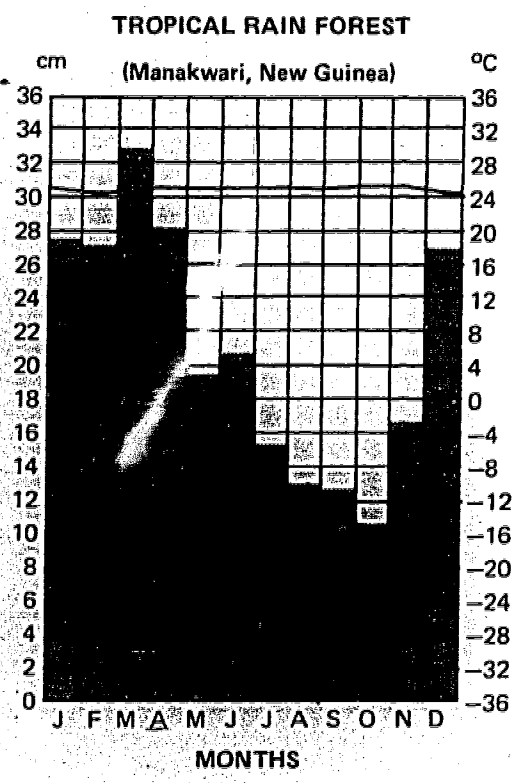
MONTHS


TROPICAL RAIN FOREST
(Manakwari, New Guinea)
cm
°C
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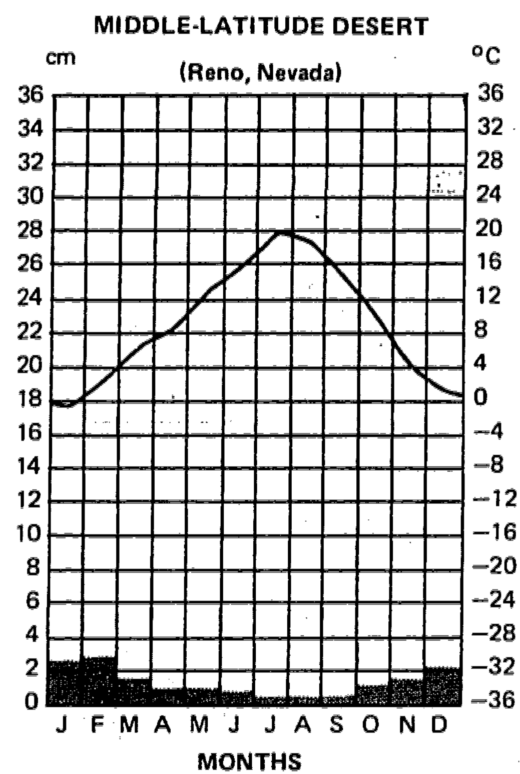
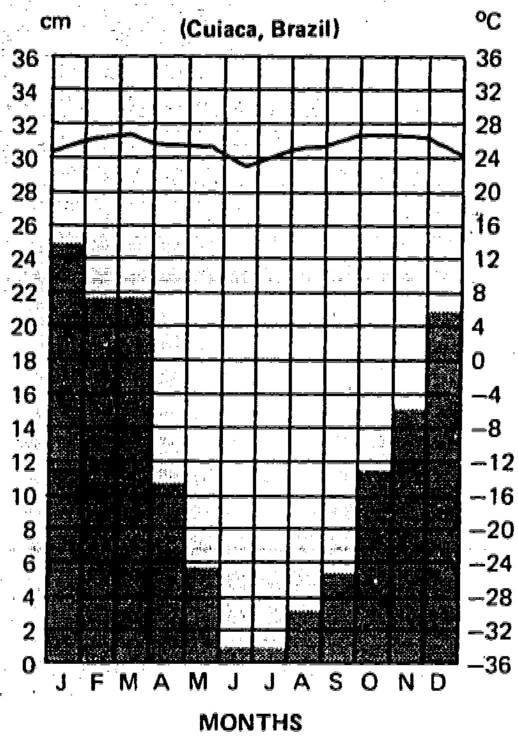
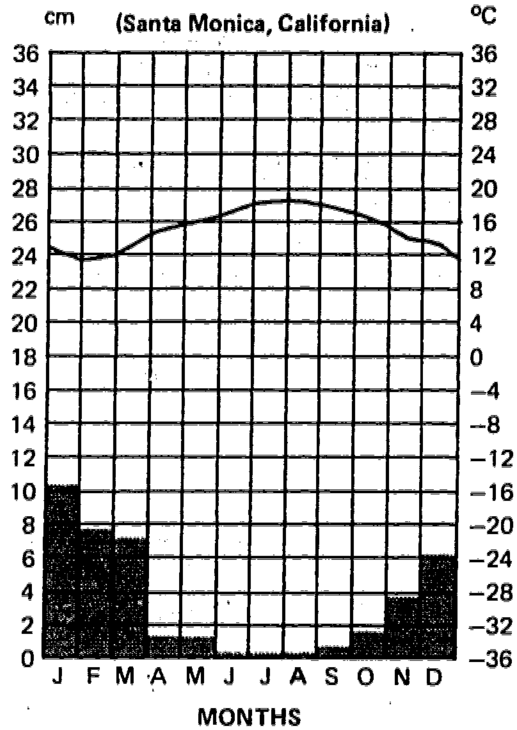
MONTHS


MIDDLE-LATITUDE DESERT
(Reno, Nevada)
cm
°C
36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2 0
36 32 28 24 20 16 12 8 4 0 −4 −8 −12 −16 −20 −24 −28 −32 −36
J F M A M J J A S O N D
MONTHS

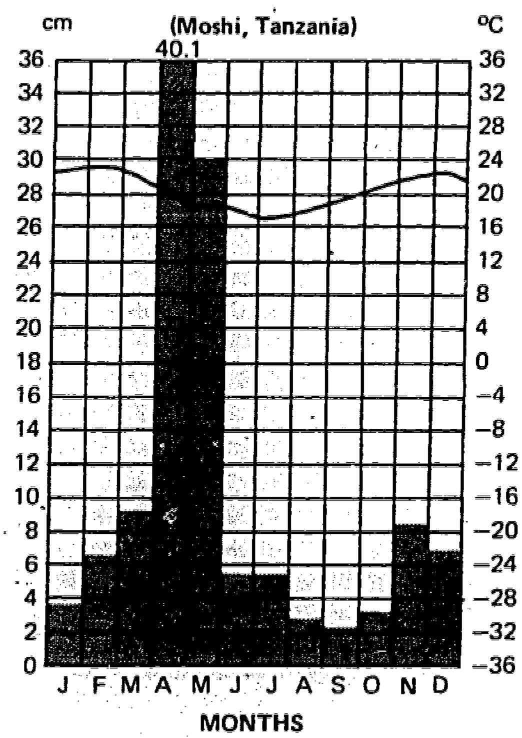
TROPICAL DECIDUOUS FOREST



CHAPPARAL



SAVANNA



TROPICAL DESERT

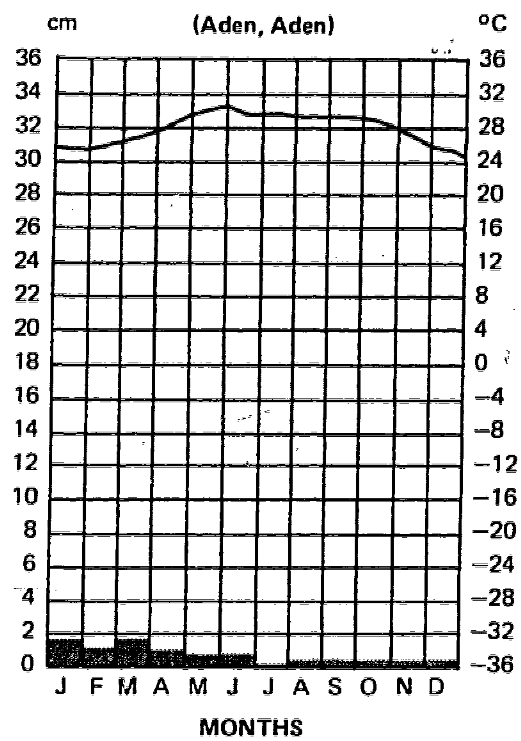


Table 1
Temperature and Precipitation by Month

		J	F	M	A	M	J	J	A	S	O	N	D
a.	T	1.1	1.7	6.1	12.2	17.8	22.2	25.0	23.3	20.0	13.9	7.8	2.2
	P	8.1	7.6	8.9	8.4	9.2	9.9	11.2	10.2	7.9	7.9	6.4	7.9
b.	T	10.6	11.1	12.2	14.4	15.6	19.4	21.1	21.7	20.0	16.7	13.9	11.1
	P	9.1	8.9	8.6	6.6	5.1	2.0	0.5	0.5	3.6	8.4	10.9	10.4
c.	T	25.6	25.6	24.4	25.0	24.4	23.3	23.3	24.4	24.4	25.0	25.6	25.6
	P	25.8	24.9	31.0	16.5	25.4	18.8	16.8	11.7	22.1	18.3	21.3	29.2
d.	T	12.8	15.0	18.3	21.1	25.0	29.4	32.8	32.2	28.9	22.2	16.1	13.3
	P	1.0	1.3	1.0	0.3	0.0	0.0	0.3	1.3	0.5	0.5	0.8	1.0
e.	T	−3.9	−2.2	1.7	8.9	15.0	20.0	22.8	21.7	16.7	11.1	5.0	−0.6
	P	2.3	1.8	2.8	2.8	3.2	5.8	5.3	3.0	3.6	2.8	4.1	3.3
f.	T	19.4	18.9	18.3	16.1	15.0	13.3	12.8	13.3	14.4	15.0	16.7	17.8
	P	0.0	0.0	1.5	0.5	8.9	14.7	12.2	8.1	2.0	1.0	0.3	0.8
g.	T	−22.2	−22.8	−21.1	−14.4	−3.9	1.7	5.0	5.0	1.1	−3.9	−10.0	−17.2
	P	1.0	1.3	1.8	1.5	1.5	1.3	2.3	2.8	2.8	2.8	2.8	1.3
h.	T	11.7	12.8	17.2	20.6	23.9	27.2	28.3	28.3	26.1	21.1	16.1	12.2
	P	3.6	4.1	4.6	6.9	8.1	6.9	6.4	6.6	8.9	5.1	5.6	4.6
i.	T	23.3	22.2	19.4	15.6	11.7	8.3	8.3	9.4	12.2	15.1	18.9	21.7
	P	5.1	5.6	6.6	5.6	2.8	0.9	2.5	4.1	5.8	5.8	5.1	5.3
j.	T	17.2	18.9	21.1	22.8	23.3	22.2	21.1	21.1	20.6	19.4	18.9	17.2
	P	0.3	0.5	1.5	3.6	8.6	9.2	9.4	11.4	10.9	5.3	0.8	0.3
k.	T	−20.0	−18.9	−12.2	−2.2	5.6	12.2	16.1	15.0	10.6	3.9	−5.6	−15.0
	P	3.3	2.3	2.8	2.5	4.6	5.6	6.1	8.4	7.4	4.6	2.8	2.8
l.	T	−0.6	2.2	5.0	10.0	13.3	18.3	23.3	22.2	16.1	10.6	4.4	0.0
	P	1.5	1.3	1.3	1.0	1.5	0.8	0.3	0.5	0.8	1.0	0.8	1.5

Table 2
Answers

- **a.** Washington, D.C. (mid-latitude deciduous forest)
- **b.** Lisbon, Portugal (chaparral)
- **c.** Iquitos, Peru (tropical rain forest)
- **d.** Yuma, Arizona (mid-latitude desert)
- **e.** Odessa, U.S.S.R. (mid-latitude grassland)
- **f.** Valparaiso, Chili (chaparral)
- **g.** Upernavik, Greenland (tundra)
- **h.** San Antonio, Texas (mid-latitude grassland)
- **i.** Bahia Blanca, Argentina (mid-latitude grassland)
- **j.** Oaxaca, Mexico (tropical deciduous forest)
- **k.** Moose Factory, Ontario, Canada (taiga)
- **l.** Fallon, Nevada (mid-latitude desert)

Footnotes

[1]D. H. Kellog, "An Investigation of the Effects of the Science Curriculum Improvement Study's First Year Unit, *Material Objects*, on Gains in Reading Readiness" (unpublished Ph.D. dissertation, University of Oklahoma, 1971).

[2]W. J. Coffia, "The Effects of an Inquiry Oriented Curriculum in Science on a Child's Achievement in Selected Academic Areas" (unpublished Ph.D. dissertation, University of Oklahoma, 1971).

[3]J. B. Ayers and G. B. Macon, "Differential Effects of Science: A Process Approach Upon Change in Metropolitan Readiness Test Scores Among Kindergarten Children" (unpublished and undated paper, Xerox Corporation).

[4]Illa Podendorf, "Alternatives in Reading," *Science and Children,* April, 1973, p. 15.

[5]John Holt, *How Children Fail* (New York: Dell Publishing Company, 1964), quoted by Victor Perks, "The Tyranny of Words—Nonsense, Pseudo-explanations and the Stifling of Curiosity," *Science and Children,* September, 1971, p. 18.

[6]Victor A. Perks, "The Tyranny of Words—Nonsense, Pseudo-explanations and the Stifling of Curiosity," *Science and Children*, September, 1971, p. 18.

[7]Podendorf, "Alternatives in Reading," p. 16.

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