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ABSTRACT

This Unified Sciences and Mathematics for Elementary Schools (USMES) unit challenges students to develop an outdoor area to help others appreciate nature. The challenge is general enough to apply to many problem-solving situations in mathematics, science, social science, and language arts at any elementary school level (grades 1-8). The Teacher Resource Book for the unit is divided into five sections. Section I describes the USMES approach to student-initiated investigations of real problems, including a discussion of the nature of USMES "challenges." Section II provides an overview of possible student activities with comments on prerequisite skills, instructional strategies, suggestions when using the unit with primary grades, a flow chart illustrating how investigations evolve from students' discussions of nature trails problems, and a hypothetical account of activities in a grade 5/6 combination. Section III provides documented events of actual class activities from grades 4, 4/5, and 7. Section IV includes lists of "How To" cards and background papers, bibliography of non-USMES materials, and a glossary. Section V consists of charts identifying skills, concepts, processes, and areas of study learned as students become involved with the activities. (JN)

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This book is a resource developed by the USMES Project; Earle L. Lomon, Project Director; Betty M. Beck, Associate Director for Development; Thomas L. Brown, Associate Director for Utilization Studies; Quinton E. Baker, Associate Director for Administration.

UNIFIED SCIENCES AND MATHEMATICS FOR ELEMENTARY SCHOOLS:
Mathematics and the Natural, Social, and Communications Sciences in Real Problem Solving.

Nature Trails

Second Edition

rabbit
we sawa rabbit running past but we lost sight of it when it ran in some tall grass.

rabbit,
Light Brown
with a white tail

Education Development Center, Inc.
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Trial Edition

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CHALLENGE: DEVELOP AN OUTDOOR AREA TO HELP OTHERS APPRECIATE NATURE.

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Preface

The USMES Project

Unified Sciences and Mathematics for Elementary Schools: Mathematics and the Natural, Social, and Communications Sciences in Real Problem Solving (USMES) was formed in response to the recommendations of the 1967 Cambridge Conference on the Correlation of Science and Mathematics in the Schools.* Since its inception in 1970, USMES has been funded by the National Science Foundation to develop and carry out field trials of interdisciplinary units centered on long-range investigations of real and practical problems (or "challenges") taken from the local school/community environment. School planners can use these units to design a flexible curriculum for grades kindergarten through eight in which real problem solving plays an important role.

Development and field trials were carried out by teachers and students in the classroom with the assistance of university specialists at workshops and at occasional other meetings. The work was coordinated by a staff at the Education Development Center in Newton, Massachusetts. In addition, the staff at EDC coordinated implementation programs involving schools, districts, and colleges that are carrying out local USMES implementation programs for teachers and schools in their area.

Trial editions of the following units are currently available:

Advertising	Nature Trails
Bicycle Transportation	Orientation
Classroom Design	Pedestrian Crossings
Classroom Management	Play Area Design and Use
Consumer Research	Protecting Property
Describing People	School Rules
Designing for Human Proportions	School Supplies
Design Lab Design	School Zoo
Eating in School	Soft Drink Design
Getting There	Traffic Flow
Growing Plants	Using Free Time
Manufacturing	Ways to Learn/Teach
Mass Communications	Weather Predictions

*See *Goals for the Correlation of Elementary Science and Mathematics*, Houghton Mifflin Co., Boston, 1969.

USMES Resources

In responding to a long-range challenge, the students and teachers often have need of a wide range of resources. In fact, all of the people and materials in the school and community are important resources for USMES activities. In addition USMES provides resources for both teachers and students. A complete set of all the written materials comprise the USMES library, which should be available in each school using USMES units. These materials include--

1. *The USMES Guide*: This book is a compilation of materials that may be used for long-range planning of a curriculum that incorporates the USMES program. It describes the USMES project, real problem solving, classroom strategies, the Design Lab, the units, and the support materials as well as ways that USMES helps students learn basic skills.

2. *Teacher Resource Books* (one for each challenge): Each of these guides to using USMES units describes a broad problem, explains how students might narrow that problem to fit their particular needs, recommends classroom strategies, presents edited logs from teachers whose classes have worked on the unit, and contains charts that indicate basic skills, processes, and areas of study that students may learn and utilize.

3. *Design Lab Manual*: This guide helps teachers and administrators set up, run, and use a Design Lab--a place with tools and materials in which the students can build things they need for their work on USMES. A Design Lab may be a corner of a classroom, a portable cart, or a separate room. Because many "hands-on" activities may take place in the classroom, every USMES teacher should have a Design Lab Manual.

4. *"How To" Series*: These student materials provide information to students about specific problems that may arise during USMES units. The regular *"How To" Series* covers problems in measuring, graphing, data handling, etc., and is available in two versions--a series of

cartoon-style booklets for primary grades and a series of magazine-style booklets with more reading matter for upper grades. The *Design Lab "How To" Series* is available in two illustrated card versions--one for primary grades and one for upper grades. A complete list of the *"How To" Series* can be found in the *USMES Guide*.

5. *Background Papers*: These papers, correlated with the *"How To" Series*, provide teachers with information and hints that do not appear in the student materials. A complete list can be found in the *USMES Guide*.

6. *Curriculum Correlation Guide*: By correlating the twenty-six USMES units with other curriculum materials, this book helps teachers to integrate USMES with other school activities and lessons.

The preceding materials are described in brief in the USMES brochure, which can be used by teachers and administrators to disseminate information about the program to the local community. A variety of other dissemination and implementation materials are also available for individuals and groups involved in local implementation programs. They include *Preparing People for USMES: An Implementation Resource Book*, the USMES slide/tape show, the Design Lab slide/tape show, the Design Lab brochure, videotapes of classroom activities, a general report on evaluation results, a map showing the locations of schools conducting local implementation of USMES, a list of experienced USMES teachers and university consultants, and newspaper and magazine articles.

* * * * *

Because Tri-Wall was the only readily available brand of three-layered cardboard at the time the project began, USMES has used it at workshops and in schools; consequently, references to Tri-Wall can be found throughout the Teacher Resource Books. The addresses of suppliers of three-layered cardboard can be found in the Design Lab Manual.

Introduction

Using the Teacher Resource Book

When teachers try a new curriculum for the first time, they need to understand the philosophy behind the curriculum. The USMES approach to student-initiated investigations of real problems is outlined in section A of this Teacher Resource Book.

Section B starts with a brief overview of possible student activities arising from the challenge; comments on prerequisite skills are included. Following that is a discussion of the classroom strategy for USMES real problem-solving activities, including introduction of the challenge, student activity, resources, and Design Lab use. Subsequent pages include a description of the use of the unit in primary grades, a flow chart and a composite log that indicate the range of possible student work, and a list of questions that the teacher may find useful for focusing the students' activities on the challenge.

Because students initiate all the activities in response to the challenge and because the work of one class may differ from that undertaken by other classes, teachers familiar with USMES need to read only sections A and B before introducing the challenge to students.

Section C of this book is the documentation section. These edited teachers' logs show the variety of ways in which students in different classes have worked at finding a solution to the challenge.

Section D contains a list of the titles of relevant sets of "How To" Cards and brief descriptions of the Background Papers pertaining to the unit. Also included in section D is a glossary of the terms used in the Teacher Resource Book and an annotated bibliography.

Section E contains charts that indicate the comparative strengths of the unit in terms of real problem solving, mathematics, science, social science, and language arts. It also contains a list of explicit examples of real problem solving and other subject area skills, processes, and areas of study learned and utilized in the unit. These charts and lists are based on documentation of activities that have taken place in USMES classes. Knowing ahead of time which basic skills and processes are likely to be utilized, teachers can postpone teaching that part of their regular program until later in the year. At that time students can study them in the usual way if they have not already learned them as part of their USMES activities.

A. Real Problem Solving and USMES

*If life were of such a constant nature that there were only a few chores to do and they were done over and over in exactly the same way, the case for knowing how to solve problems would not be so compelling. All one would have to do would be to learn how to do the few jobs at the outset. From then on he could rely on memory and habit. Fortunately--or unfortunately depending upon one's point of view--life is not simple and unchanging. Rather it is changing so rapidly that about all we can predict is that things will be different in the future. In such a world the ability to adjust and to solve one's problems is of paramount importance.**

Real Problem Solving

USMES is based on the beliefs that real problem solving is an important skill to be learned and that many math, science, social science, and language arts skills may be learned more quickly and easily within the context of student investigations of real problems. Real problem solving, as exemplified by USMES, implies a style of education which involves students in investigating and solving real problems. It provides the bridge between the abstractions of the school curriculum and the world of the student. Each USMES unit presents a problem in the form of a challenge that is interesting to children because it is both real and practical. The problem is real in several respects: (1) the problem applies to some aspect of student life in the school or community, (2) a solution is needed and not presently known, at least for the particular case in question, (3) the students must consider the entire situation with all the accompanying variables and complexities, and (4) the problem is such that the work done by the students can lead to some improvement in the situation. This expectation of useful accomplishment provides the motivation for children to carry out the comprehensive investigations needed to find some solution to the challenge.

The level at which the children approach the problems, the investigations that they carry out, and the solutions

*Kenneth B. Henderson and Robert E. Pingry, "Problem-Solving in Mathematics," in *The Learning of Mathematics: Its Theory and Practice*, Twenty-first Yearbook of the National Council of Teachers of Mathematics (Washington, D.C.: The Council, 1953), p. 233.

that they devise may vary according to the age and ability of the children. However, real problem solving involves them, at some level, in all aspects of the problem-solving process: definition of the problem; determination of the important factors in the problem; observation; measurement; collection of data; analysis of the data using graphs, charts, statistics, or whatever means the students can find; discussion; formulation and trial of suggested solutions; clarification of values; decision making; and communications of findings to others. In addition, students become more inquisitive, more cooperative in working with others, more critical in their thinking, more self-reliant, and more interested in helping to improve social conditions.

The USMES Approach

To learn the process of real problem solving, the students must encounter, formulate, and find some solution to complete and realistic problems. The students themselves, not the teacher, must analyze the problem, choose the variables that should be investigated, search out the facts, and judge the correctness of their hypotheses and conclusions. In real problem-solving activities, the teacher acts as a coordinator and collaborator, not an authoritative answer-giver.

The problem is first reworded by students in specific terms that apply to their school or community, and the various aspects of the problem are discussed by the class. The students then suggest approaches to the problem and set priorities for the investigations they plan to carry out. A typical USMES class consists of several groups working on different aspects of the problem. As the groups report periodically to the class on their progress, new directions are identified and new task forces are formed as needed. Thus, work on an USMES challenge provides students with a "discovery-learning" or "action-oriented" experience.

Real problem solving does not rely solely on the discovery-learning concept. In the real world people have access to certain facts and techniques when they recognize the need for them. The same should be true in the classroom. When the students find that certain facts and skills are necessary for continuing their investigation, they learn willingly and quickly in a more directed way to acquire these facts and skills. Consequently, the students should have available different resources that they may use as they recognize the need for them, but they should still be left with a wide scope to explore their own ideas and methods.

Certain information on specific skills is provided by the sets of USMES "How To" Cards. The students are referred only to the set for which they have clearly identified a need and only when they are unable to proceed on their own. Each "How To" Cards title clearly indicates the skill involved--"How to Use a Stopwatch," "How to Make a Bar Graph Picture of Your Data," etc. (A complete list of the "How To" Cards can be found in Chapter IX of the USMES Guide.)

Another resource provided by USMES is the Design Lab or its classroom equivalent. The Design Lab provides a central location for tools and materials where devices may be constructed and tested without appreciably disrupting other classroom activities. Ideally, it is a separate room with space for all necessary supplies and equipment and work space for the children. However, it may be as small as a corner of the classroom and may contain only a few tools and supplies. Since the benefits of real problem solving can be obtained by the students only if they have a means to follow up their ideas, the availability of a Design Lab can be a very important asset.

Optimally, the operation of the school's Design Lab should be such as to make it available to the students whenever they need it. It should be as free as possible from set scheduling or programming. The students use the Design Lab to try out their own ideas and/or to design, construct, test, and improve many devices initiated by their responses to the USMES challenges. While this optimum operation of the Design Lab may not always be possible due to various limitations, "hands-on" activities may take place in the classroom even though a Design Lab may not be available. (A detailed discussion of the Design Lab can be found in Chapter VI of the USMES Guide, while a complete list of "How To" Cards covering such Design Lab skills as sawing, gluing, nailing, soldering, is contained in Chapter IX.)

Work on all USMES challenges is not only sufficiently complex to require the collaboration of the whole class but also diverse enough to enable each student to contribute according to his/her interest and ability. However, it should be noted that if fewer than ten to twelve students from the class are carrying out the investigation of a unit challenge, the extent of their discovery and learning can be expected to be less than if more members of the class are involved. While it is possible for a class to work on two related units at the same time, in many classes the students progress better with just one.

The amount of time spent each week working on an USMES challenge is crucial to a successful resolution of the problem. Each challenge is designed so that the various investigations will take from thirty to forty-five hours, depending on the age of the children, before some solution to the problem is found and some action is taken on the results of the investigations. Unless sessions are held at least two or three times a week, it is difficult for the children to maintain their interest and momentum and to become involved intensively with the challenge. The length of each session depends upon the age level of the children and the nature of the challenge. For example, children in the primary grades may proceed better by working on the challenge more frequently for shorter periods of time, perhaps fifteen to twenty minutes, while older children may proceed better by working less frequently for much longer periods of time.

Student interest and the overall accomplishments of the class in finding and implementing solutions to the challenge indicate when the class's general participation in unit activities should end. (Premature discontinuance of work on a specific challenge is often due more to waning interest on the part of the teacher than to that of the students.) However, some students may continue work on a voluntary basis on one problem, while the others begin to identify possible approaches to another USMES challenge.

Importance of the Challenge

Although individual (or group) discovery and student initiation of investigations is the process in USMES units, this does not imply the constant encouragement of random activity. Random activity has an important place in children's learning, and opportunities for it should be made available at various times. During USMES activities, however, it is believed that children learn to solve real problems only when their efforts are focused on finding some solution to the real and practical problem presented in the USMES challenge. It has been found that students are motivated to overcome many difficulties and frustrations in their efforts to achieve the goal of effecting some change or at least of providing some useful information to others. Because the children's commitment to finding a solution to the challenge is one of the keys to successful USMES work, it is extremely important that the challenge be introduced so that it is accepted by the class as an important problem to which they are willing to devote a considerable amount of time.

The challenge not only motivates the children by stating the problem but also provides them with a criterion for judging their results. This criterion--if it works, it's right (or if it helps us find an answer to our problem, it's

Role of the Teacher

a good thing to do)--gives the children's ideas and results a meaning within the context of their goal. Many teachers have found this concept to be a valuable strategy that not only allows the teacher to respond positively to all of the children's ideas but also helps the children themselves to judge the value of their efforts.

With all of the above in mind, it can be said that the teacher's responsibility in the USMES strategy for open classroom activities is as follows:

1. Introduce the challenge in a meaningful way that not only allows the children to relate it to their particular situation but also opens up various avenues of approach.

2. Act as a coordinator and collaborator. Assist, not direct, individuals or groups of students as they investigate different aspects of the problem.

3. Hold USMES sessions at least two or three times a week so that the children have a chance to become involved in the challenge and carry out comprehensive investigations.

4. Provide the tools and supplies necessary for initial hands-on work in the classroom or make arrangements for the children to work in the Design Lab.

5. Be patient in letting the children make their own mistakes and find their own way. Offer assistance or point out sources of help for specific information (such as the "How To" Cards) only when the children become frustrated in their approach to the problem. Conduct skill sessions as necessary.

6. Provide frequent opportunities for group reports and student exchanges of ideas in class discussions. In most cases, students will, by their own critical examination of the procedures they have used, improve or set new directions in their investigations.

7. If necessary, ask appropriate questions to stimulate the students' thinking so that they will make more extensive and comprehensive investigations or analyses of their data.

8. Make sure that a sufficient number of students (usually ten to twelve) are working on the challenge so that activities do not become fragmented or stall.

Student success in USMES unit activities is indicated by the progress they make in finding some solution to the challenge, not by following a particular line of investigation nor by obtaining specified results. The teacher's role in the USMES strategy is to provide a classroom atmosphere in which all students can, in their own way, search out some solution to the challenge.

USMES in the Total School Program

Today many leading educators feel that real problem solving (under different names) is an important skill to be learned. In this mode of learning particular emphasis is placed on developing skills to deal with real problems rather than the skills needed to obtain "correct" answers to contrived problems. Because of this and because of the interdisciplinary nature of both the problems and the resultant investigations, USMES is ideal for use as an important part of the elementary school program. Much of the time normally spent in the class on the traditional approaches to math, science, social science, and language arts skills can be safely assigned to USMES activities. In fact, as much as one-fourth to one-third of the total school program might be allotted to work on USMES challenges. Teachers who have worked with USMES for several years have each succeeding year successfully assigned to USMES activities the learning of a greater number of traditional skills. In addition, reports have indicated that students retain for a long time the skills and concepts learned and practiced during USMES activities. Therefore, the time normally spent in reinforcing required skills can be greatly reduced if these skills are learned and practiced in the context of real problem solving.

Because real problem-solving activities cannot possibly cover all the skills and concepts in the major subject areas, other curricula as well as other learning modes (such as "lecture method," "individual study topics," or programmed instruction) need to be used in conjunction with USMES in an optimal education program. However, the other instruction will be enhanced by the skills, motivation, and understanding provided by real problem solving, and, in some cases, work on an USMES challenge provides the context within which the skills and concepts of the major subject areas find application.

In order for real problem solving taught by USMES to have an optimal value in the school program, class time should be apportioned with reason and forethought, and the sequence of challenges investigated by students during their years in elementary school should involve them in a variety of skills and processes. Because all activities are initiated by students in response to the challenge, it is impossible to state unequivocally which activities will take place. However, it is possible to use the documentation of activities that have taken place in USMES trial classes to schedule instruction on the specific skills and processes required by the school system. Teachers can postpone the traditional way of teaching the skills that might come up in work on an USMES challenge until later in the year. At that time students can learn the required skills in the usual way if they have not already learned them during their USMES activities.

These basic skills, processes, and areas of study are listed in charts and lists contained in each Teacher Resource Book. A teacher can use these charts to decide on an overall allocation of class time between USMES and traditional learning in the major subject disciplines. Examples of individual skills and processes are also given so that the teacher can see beforehand which skills a student may encounter during the course of his investigations. These charts and lists may be found in section E.

Ways In Which USMES Differs From Other Curricula

As the foregoing indicates, USMES differs significantly from other curricula. Real problem solving develops the problem-solving ability of students and does it in a way (learning-by-doing) that leads to a full understanding of the process. Because of the following differences, some teacher preparation is necessary. Some teachers may have been introduced by other projects to several of the following new developments in education, but few teachers have integrated all of them into the new style of teaching and learning that real problem solving involves.

1. New Area of Learning—Real problem solving is a new area of learning, not just a new approach or a new content within an already-defined subject area. Although many subject-matter curricula

include something called problem solving, much of this problem solving involves contrived problems or fragments of a whole situation and does not require the cognitive skills needed for the investigation of real and practical problems. Learning the cognitive strategy required for real problem solving is different from other kinds of learning.

3. Interdisciplinary Education--Real problem solving integrates the disciplines in a natural way; there is no need to impose a multi-disciplinary structure. Solving real and practical problems requires the application of skills, concepts, and processes from many disciplines. The number and range of disciplines are unrestricted and the importance of each is demonstrated in working toward the solution of practical problems.

3. Student Planning--To learn the process of problem solving, the students themselves, not the teacher, must analyze the problem, choose the variables that should be investigated, search out the facts, and judge the correctness of the hypotheses and conclusions. In real problem-solving activities the teacher acts as a coordinator and collaborator, not as an authoritative source of answers.

4. Learning-by-Doing--Learning-by-doing, or discovery learning as it is sometimes called, comes about naturally in real problem solving since the problems tackled by each class have unique aspects; for example, different lunchrooms or pedestrian crossings have different problems associated with them and, consequently, unique solutions. The challenge, as defined in each situation, provides the focus for the children's hands-on learning experiences, such as collecting real data; constructing measuring instruments, scale models, test equipment, etc.; trying their suggested improvements; and (in some units) preparing reports and presentations of their findings for the proper authorities.

5. Learning Skills and Concepts as Needed--Skills and concepts are learned in real problem solving

as the need for them arises in the context of the work being done, rather than having a situation imposed by the teacher or the text-book being used. Teachers may direct this learning when the need for it arises, or students may search out information themselves from resources provided.

6. Group Work--Progress toward a solution to a real problem usually requires the efforts of groups of students, not just individual students working alone. Although some work may be done individually, the total group effort provides good opportunities for division of labor and exchange of ideas among the groups and individuals. The grouping is flexible and changes in order to meet the needs of the different stages of investigation.

7. Student Choice--Real problem solving offers classes the opportunity to work on problems that are real to them, not just to the adults who prepare the curriculum. In addition, students may choose to investigate particular aspects of the problem according to their interest. The variety of activities ensuing from the challenge allows each student to make some contribution towards the solution of the problem according to his or her ability and to learn specific skills at a time when he or she is ready for that particular intellectual structure.

B. General Papers on Nature Trails

1. OVERVIEW OF ACTIVITIES

Challenge:

Develop an outdoor area to help others appreciate nature.

Possible Class Challenges:

How can we build a nature trail to teach other children in the school about nature?

How can we show others what we've learned about a nearby natural area without changing the place from the way we found it?

Find out more about the woods behind the school and teach others what you learn.

I see a tree with wholes in it

I saw a rabbit

I saw a medium sized Amardillo

Most students enjoy any opportunity to learn outdoors. Nature Trails gives a class a specific goal toward which children may direct their energy while investigating their surroundings: using an area on a piece of available land for teaching others about nature.

Work on the Nature Trails challenge may take place in any school where there is a natural area nearby, provided the children are able to obtain permission from the individuals or authorities responsible for the land. Activities need not be restricted to woodland areas; if a reasonable variety of plant and animal life can be found, classes may successfully make a nature trail in desert, savannah, meadow, or beach environments. The children need not actually clear a trail; they may take other people on guided tours of existing paths or open spaces, thus leaving the area the way they found it. (Making a temporary trail in this way also requires less time than clearing and maintaining a permanent trail.)

The challenge might be introduced after a class discussion about what the children observed during a field trip to a nearby park or natural area. A discussion of how the students could find out more about the living things in the area around the school may lead to work on the Nature Trails challenge. The challenge might also arise during work on another USMES unit; for example, children working on the Ways to Learn/Teach challenge might decide to construct an outdoor learning center as one way to learn or teach information on natural sciences.

As students become aware of the possibilities of studying nature outdoors near the school, they are usually eager to share their discoveries with others. They may decide to survey other classes in the school to find out who uses the natural area and for what purpose, whether or not people would use a nature trail if one were built, and what kinds of things other children would like to learn about the outdoors.

During class discussions the children might consider what to include on the nature trail. They might divide into groups to explore the area to find interesting things that might be shown to others, to identify plants and animals found in the woods, and to make lists of the kinds of life

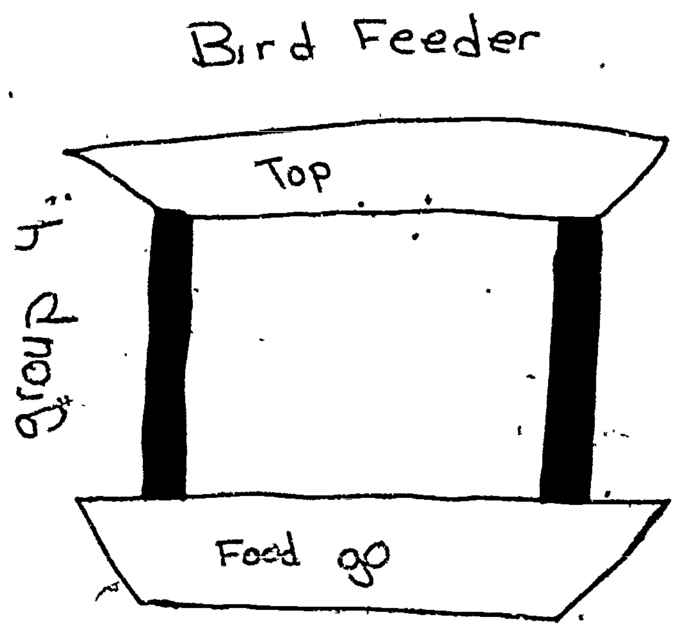
they have seen. Children might estimate total numbers of different types of animals or plants (e.g., squirrels, oak trees) by counting the number within a sample area and multiplying to find the number within the total area in which they are working. Some children might try making studies of micro-organisms by taking samples of soil and pond water (if there is a pond in the area) and examining them under the microscope.

Some children might conduct library research on the wildlife, ecology, geology, or history of the area or region within which they are working and compare their findings with those of children working in the field. While investigating the future trail area, children might keep logs of the things they have seen, noting such things as examples of animal cooperation (calls of birds or chipmunks which warn other animals of human presence), evidence of human settlement (campfires, stone walls, beer cans), or differences between types of trees on hills and in low spots. Children with cameras might take pictures of things they find or of the area in general as a way of keeping records.

Before actually making the trail, the class will have to obtain permission from authorities (school or park officials). When permission has been obtained to clear a trail, children will need to find the best route connecting the various points of interest they have chosen. Then they may start to clear a path by removing brush and rocks. If a path already exists in the area, the children might want to use it for the main trail and clear side trails to various points of interest. The children might make wooden signs to label points of interest or to indicate directions for the trail and pound them into the ground by the side of the path. Alternatively, they might hang signs made from the tops of large tin cans from low tree branches.

In some cases permission (to use the area) may be granted only if the class agrees not to clear trails or leave signs up over a long period of time. The children may then find interesting points along existing paths or in open spaces to show to other people. They may make signs that are easily removed or guide booklets listing interesting features.

The children might map the area using a spool of string for measuring and a compass to note general directional changes, drawing the rough outline to scale and marking the points of interest. The map could be useful for people following the trail. The children might also write pamphlets describing the various points of interest and other information they have found about the area in which the trail was built.



Martha Hellmuth, Grade 7
North Marion Middle School

The class may experience repeated vandalism or littering of the trail or natural area and might conduct advertising campaigns to promote their efforts and to show other children that their trail will be beneficial to the whole school. They might also give guided tours to other classes as a way of introducing the rest of the school to the trail.

A problem that may be encountered during work on Nature Trails is the "winter lag" in northern climates, where snow and cold weather may make working outdoors difficult for several months. Children might plan their activities so that they can work on sign construction or library research during this time. They might design and build a bird feeding station so that they can observe from indoors the kinds of winter birds that live in the area. The class might make occasional trips into the snow to observe animal tracks along their nature trail and to note seasonal changes in the area.

Work on Nature Trails may lead to extensive studies of ecology of the area. While making their trail, children might become interested in other USMES units such as School Zoo, Protecting Property (from vandalism), or Manufacturing.

Although many of these activities may require skills and concepts new to the children, there is no need for preliminary work on these skills and concepts because the children can learn them when the need arises. In fact, children learn more quickly and easily when they see a need to learn. Consider counting: whereas children usually count by rote, they can, through USMES, gain a better understanding of counting by learning or practicing it within real contexts. In working on Nature Trails, children also learn and practice graphing, measuring, working with decimals, and dividing. Although dividing seems necessary to compare fractions or ratios, primary children can make comparisons graphically or by subtracting medians (half-way values). Division may be introduced during calculation of percentages or averages.

2. CLASSROOM STRATEGY FOR NATURE TRAILS

The Nature Trails unit is centered on a challenge—a statement that says, "Solve this problem." Its success or failure in a classroom depends largely on (1) the relevance of the problem for the students and (2) the process by which they define and accept the challenge. If the children see the problem as a real one, they will be committed to finding a solution; they will have a focus and purpose for their activities. If the students do not think the problem affects them, their attempts at finding solutions will likely be disjointed and cursory.

The Nature Trails challenge--"Develop an outdoor area to help others appreciate nature"--is general enough to apply to many situations. Students in different classes define and reword the challenge to fit the particular problem of their school and thus arrive at a specific class challenge. "Find a way to make a nature trail for others to enjoy in the county woods near the school" might be the challenge for a class in a school that does not own any wooded property.

The Process of Introducing the Challenge

Given that a problem exists, how can a teacher, without being directive, help the students identify the challenge that they will work on as a group? There is no set method because of variations among teachers, classes, and schools and among the USMES units themselves. However, USMES teachers have found that certain general techniques in introducing the challenge are helpful.

One such technique is to turn a class discussion toward a Nature Trails challenge. For example, the teacher could simply ask the children what kinds of things they could learn outdoors and the children might list several observations they could make about natural history. The teacher then might ask how they could show the things they learned outside to other children.

A fifth-grade teacher introduced the Nature Trails challenge by asking her class what kinds of things people could observe outside. The children listed several things and which senses (sight, hearing, smell, etc.) people used to observe nature. After discussing other things about nature, the teacher asked the class if they could find a way to design and develop an area for studying nature. The children were enthusiastic about this idea and listed two nearby areas where they might develop a nature trail.

Frequently, a teacher will want to take children on a tour of a nearby nature area before introducing a Nature Trails challenge. In such cases a challenge might arise naturally during a class discussion in which the children list observations they have made on their walk.

A teacher and a science coordinator took a combined fourth- and fifth-grade class on a walk in a park near the school. They asked the children to make careful observations about things that they found in the park. After two class discussions about their findings, the children were asked how they could show the things they had found to other people. The children came up with several ideas, including giving tours of the areas to students. One child suggested that they make a nature trail similar to one that she had been on, and the class agreed enthusiastically.

A Nature Trails challenge may arise from the children's work on another USMES unit. For example, children collecting animals for the School Zoo unit in a natural area near the school might decide that they wanted to show other children the habitats of the animals. They might plan to give tours of the woods at the same time that they hold an open house to show their zoo.

When children working on another USMES challenge encounter a problem that leads to a Nature Trails challenge, one group of children may begin work on this second challenge while another group continues on the first. However, there should be at least ten or twelve students working on any one challenge; otherwise the children's work may be fragmented or superficial or may break down completely.

The Nature Trails challenge may also evolve during a discussion of a specific topic being studied by the class. A class studying natural history or ecology outdoors may become interested in showing plants they have identified or examples of natural cycles they have observed to other children.

Classroom experience has shown that children's progress on a Nature Trails challenge may be poor if the teacher and students do not reach a common understanding of what the challenge is before beginning work on it. Having no shared focus for their work, the children will lack the motivation inherent in working together to solve a real problem. As a result, they may quickly lose interest.

A similar situation occurs if the teacher, rather than ensuring that the children have agreed upon a challenge, merely assigns a series of activities. Although the teacher may see how these activities relate to an overall goal, the children may not.

A combined first- and second-grade class worked on several nature study activities outdoors. In the fall the children used different senses to observe nature in an area near the school. The teacher conducted skill sessions on set theory and graphing to help them interpret what they observed. Later in the year the children studied animal tracks in the snow and conducted habitat studies in various parts of their outdoor area. The teacher never issued a challenge, however, and without the motivation to develop a nature trail for other children to use, the children's activities were very fragmented.

Initial Work on the Challenge

:e a class has decided to work on a Nature Trails challeng, USMES sessions should be held several times a week, but they need not be rigidly scheduled. When sessions are held after long intervals, students often have difficulty remembering where they were in their investigations and their momentum diminishes.

When children begin work on their challenge, they list various tasks that need to be done before the trail can be made. This procedure is combined with or followed by observations of the natural area they have chosen and sometimes, by opinion surveys of children in the school to identify aspects of natural history that are interesting to others.

Next, the students usually categorize their suggested approaches, grouping similar ideas together. The children then set priorities for the tasks they consider necessary in order to make their trail and to show it to others. Most of these tasks are carried out by small groups of children.

A combined fourth- and fifth-grade class developed a challenge involving making other people aware of nature. They discussed several ways to interest people in nature, including giving tours of a school nature trail. The teacher asked how they could complete all of their planned activities, and the children decided to divide into groups so that their efforts would be organized. After examining their lists of things to be done, they broke into five groups to conduct library research, identify plants along the trail, find a location for the trail, organize the building of the trail, and document the class's efforts while making the trail.

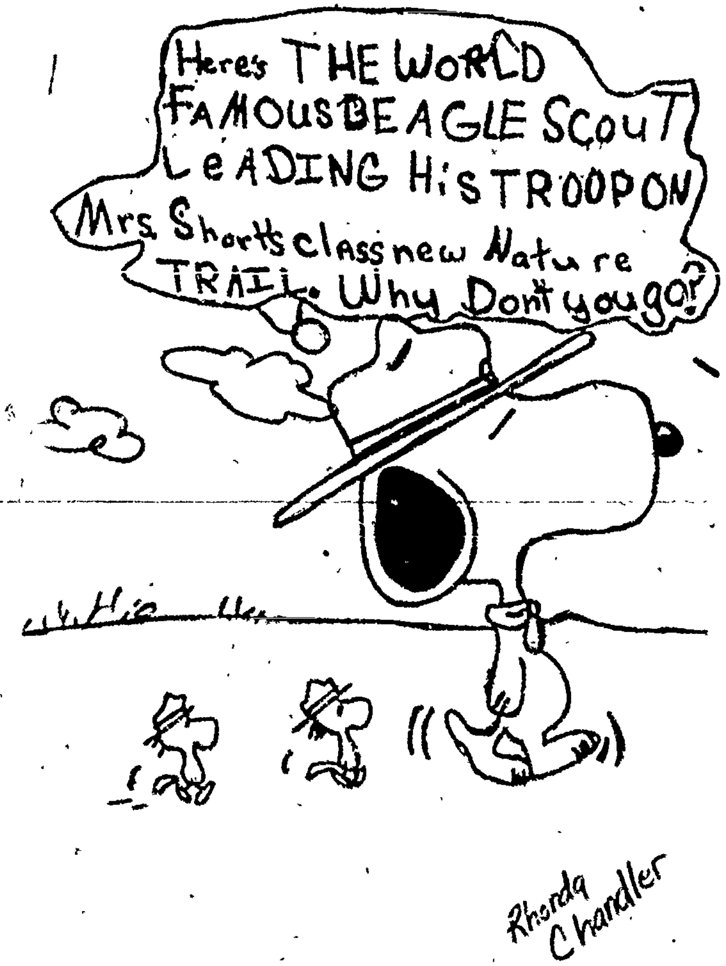
As various groups complete their work, their members join other groups or form new groups to work on additional tasks. However, if too many groups are formed, work on the challenge can become fragmented. The teacher finds it impossible to be aware of the progress and problems of each group; in addition, the small number of students in each group lessens the chance for varied input and interaction.

In one seventh-grade class working on Nature Trails, students worked as individuals or in pairs researching information on things they had observed outdoors. The teacher also asked each of them to select something outside to identify as an exercise in classification. The children's efforts were disorganized and fragmented because they could not remain attentive to their work. During a class discussion the children agreed to organize themselves in a better way and chose to divide into groups and to appoint a leader for each group. They chose six tasks that needed to be done. This time, one group was responsible for identifying features along the trail and another for finding information on them, and work proceeded more smoothly than before.

Refocusing on the Challenge

During work on Nature Trails, the children's attention should, from time to time, be refocused on the challenge so that they do not lose sight of their overall goal. If they are not reminded of time constraints, children may become involved in activities of lesser importance and forget to allow enough time to complete their trail before the school year has ended.

A fifth-grade class began work on Nature Trails in March. The students were concerned with the question of who would be interested in having a Nature Trail and what kinds of things people would like to learn. The whole class worked on designing a survey of the community near the school. The children mapped the blocks in the residential area, figured out a system for interviewing people, and spent several class sessions developing the wording of the questions for the survey. By the time they had tested the survey on another class, reworded some *questions, administered the survey, and tallied the results, the children had spent over a month on this activity and did not have enough time to work seriously on their trail before the school year had ended.*



Annette Short,[1] Grades 4-5
Whitehead Road School

To keep children's attention focused on the challenge, teachers find it helpful to hold periodic class discussions that include group reports on their various tasks. Such sessions help the students review what they still need to do in order to complete a trail and to show it to others. These discussions also provide an opportunity for students to evaluate their own work and exchange ideas with their classmates. (Another consequence of having too many groups is that not every group can be given enough time to report to the class, thereby increasing the possibility that the children's efforts will overlap unnecessarily.)

When children try to decide on solutions before collecting and analyzing enough data or encounter difficulties during their investigations, an USMES teacher helps out. However, instead of giving answers or suggesting specific procedures, the teacher asks open-ended questions that stimulate the students to think more comprehensively and creatively about their work. For example, to encourage the class to control vandalism and littering of the trail area, the teacher might ask children whether they can think of ways to involve other students in the trail so that they would respect their work and not try to destroy it. Examples of other nondirective, thought-provoking questions may be found at the end of section B.

The teacher may also refer students to the "How To" Cards that provide information about specific skills, such as choosing the right tool to measure distances or drawing bar graphs. If many students, or even the entire class, need help in particular areas, such as identifying trees from a key or using fractions in measurements, the teacher should conduct skill sessions as these needs arise. (Background Papers provide teachers with additional information on specific problems associated with the Nature Trails challenge and on general topics applicable to many challenges.)

USMES teachers can also assist students by making it possible for them to carry out tasks involving hands-on activities. If the children's tasks require them to design and construct items, such as wooden signs for the trail or bird feeders to hang outside the classroom window as a learning resource during winter months, the teacher should make sure that they have access to a Design Lab. Any collection of tools and materials kept in a central location (in part of the classroom on a portable cart, or in a separate room) may be called a Design Lab.

Valuable as it is, a Design Lab is not necessary to begin work on a Nature Trails challenge.

A seventh-grade class that was working on the Nature Trails challenge constructed signs for identifying trees and indicating directions along their nature trail without the help of a Design Lab. The children borrowed plywood and tools from the school shop room for making the signs.

1. keep on trail, stay on road
2. no touching trees, strings
3 no short cuts around trees
4 no littering
5. no talking
(no horse playing
7 keep up with your group
8. no more than ten to group
9 watch where going
10. no throwing things
11 no chewing gum

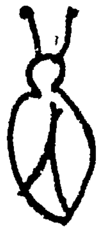
Martha Hellmuth, Grade 7
North Marion Middle School

To carry out construction activities in schools without Design Labs, students may scrounge or borrow tools and supplies from parents, local businesses, or other members of the community.

The extent to which any Design Lab is used varies with different classes because the children themselves determine the direction of their activities. In many classes working on Nature Trails, the major hands-on activities are conducted outdoors as children clear paths or erect signs along the trail. The teacher can help with scheduling and supervising when outdoor work is in process. Teachers of classes working on Nature Trails have found teacher's aides helpful for sharing supervision when a part or all of the class works outdoors.

In some ways, the natural area in which the children are working can be considered an outdoor Design Lab where rules concerning use of equipment similar to those applicable indoors are developed by the students. Outside, however, the children need to consider the delicate nature of the environment in which they are working. Teachers should ask children to suggest guidelines for working in the natural area so that trees and other plants are not disfigured or damaged and animal life is treated with respect. (In general, work on Nature Trails is likely to increase children's sensitivity towards the life they observe in their outdoor environment.)

Culminating Activities



I think it is a flea

Nature Trails activities generally continue until the children have completed their trail and shown it to other people. The children may also want to write pamphlets on natural history or make an indoor display explaining their outdoor investigations. The children may follow up their activities by asking children to evaluate their trail or by giving a survey to find out if awareness and interest in nature has increased in the school following exhibition of the trail.

Children in a combined fourth- and fifth-grade class made a temporary nature trail in a nearby park and gave tours to two other classes on the last day of school. Two children wrote an evaluation form for the other students and observed that most had enjoyed the trail and had learned something from their tour.

The class might also recommend to the principal or other authorities responsible for the land that the trail be continued or expanded in the future. The children might make preparations for continuing their own efforts the following year or find another class to take over care of the trail.

3. USE OF NATURE TRAILS IN THE PRIMARY GRADES

Young children have active imaginations that are easily stimulated by nature and the outdoors. Although their investigations during work on Nature Trails may lack the sophistication of those of older students, primary students may be even more fascinated by examining rocks, plants, insects, and other things found outdoors and showing them to other people.

Before a Nature Tr 'ls challenge is introduced, the teacher may want to conduct preliminary science activities such as directed walks, hunts, or other exercises to sharpen the children's perceptions of nature. One third-grade teacher took her class on several walks outside and asked the children to look for different things each time--objects beginning with different letters of the alphabet, changes in the area over a three-week period, etc. A first- and second-grade teacher asked her students to observe how often they used each of their five senses outdoors. Young children especially enjoy exercises involving touching and smelling (but not tasting!) leaves, bark, flowers, soil, and other natural things.

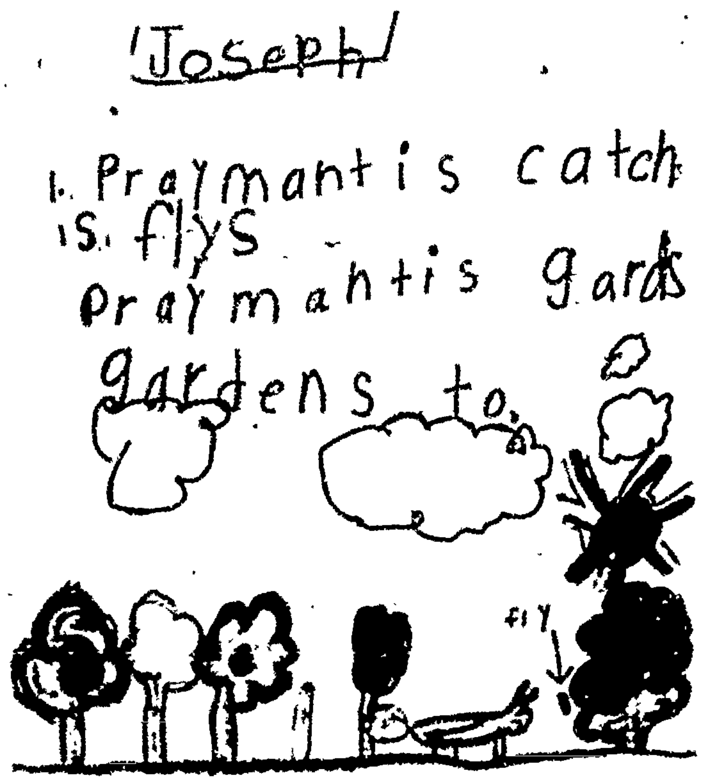
While the children are still excited about the things they have observed outdoors, the teacher may ask them how they can share the information they've learned with other students. The children may suggest several ways to do this, such as making displays, writing reports, talking to other classes, etc., but they will usually decide that giving tours outdoors or taking another class on a nature walk is the most interesting way to share their own enthusiasm about nature. Children in the third-grade class decided to teach first graders what they had learned by taking them around the woods near the school.

Once the children have decided on a Nature Trails challenge, they will want to consider what information to present to other people. During the course of their work many natural science topics will be explored. Children may learn (and teach) a great deal about natural history at an elementary level; they need not become bogged down with classification or complex ecological concepts.

Because primary children will not be able to read difficult reference books, they may rely on adult experts, such as a science curriculum specialist or a local naturalist, to help them interpret their outdoor discoveries. Children in the combined first- and second-grade class received help in identifying trees and understanding natural processes from the science specialist for the school system. Classification may also be carried out without even learning the names of the trees or other organisms involved. In the third-grade class children examined the bark of trees during the winter, comparing color, texture, and other properties and used these characteristics to decide which trees were similar. When the leaves came out in the spring the children compared leaf size, shape, texture, etc., to see whether the trees they had considered similar from bark studies also had similar leaves.

Young children will also enjoy watching the actions of small animals such as squirrels or birds at a winter feeder and will be able to draw conclusions about aggressive and cooperative behavior among animals from their observations. Work on Nature Trails will be most successful if children are guided by their own interests and observations rather than concepts or terminology from texts or field guides.

Although younger children will probably find it too difficult to actually clear a path for their nature trail, they may brush leaves and dead wood aside from existing



Judith White, Grades 1-2
Adams School

paths or interesting features that they plan to show to other students. They may also choose areas that are not wooded; the first- and second-grade class carried out interesting nature studies in a meadow, near a pond, and in the vicinity of an old stump. Signs for a nature trail may be constructed out of Tri-Wall and removed before periods of bad weather. Some children may also construct simple bird feeders to put outside during the winter months.

In addition to learning about natural history, ecology, animal behavior, and other sciences, primary children practice several math skills while working on a Nature Trails challenge. Counting is important for classifying plants or animals; during one walk, children in the third-grade class counted the number of lobes on various types of leaves and the number of pine needles in a cluster on different trees. Children also learn measuring skills when they measure Tri-Wall or wood for making signs or feeders.

Although graphing is not a necessary activity for most classes working on Nature Trails, young children may make bar graphs showing number of trees or animals of different types observed in their natural area. The first-grade class made bar graphs showing the number of times each of their five senses were used when taking a walk; the children discovered from their graphs that sight and touch were used more often than other senses outdoors.

Teaching others about nature provides many good opportunities for children to practice language arts. Children may research information on natural history and write simple pamphlets or give oral reports to people using their trail. A primary special education class working on Nature trails planned to write pamphlets so that other classes could use their trail; when they did not have time to complete the trail, they made a tape explaining their efforts to the next year's class.

Nature also excites artistic talent in young students; they may illustrate their pamphlets with interpretive drawings or make a display of pressed leaves and plaster casts of animal tracks found in mud or snow.

4. FLOW CHART

The following flow chart presents some of the student activities—discussions, observations, calculations, constructions—that may occur during work on the Nature Trails challenge. Because each class will choose its own approach to the challenge, the sequence of events given here represents only a few of the many possible variations. Furthermore, no one class is expected to undertake all the activities listed.

The flow chart is not a lesson plan and should not be used as one. Instead, it illustrates how comprehensive investigations evolve from the students' discussion of a Nature Trails problem.

Martha McIlvuth, Grade 7
North Marion Middle School

Challenge: Develop an outdoor area to help others appreciate nature.

Optional Preliminary Activities:

Directed walks in woods or fields.

Field trips to nature center or museum.

Other USMES Units:
- *School Zoo*
- *Growing Pla..ts*
- *Weather Predictions*

Possible Student Activities:

Children go for a walk in a nearby natural area; observe animals and plants; collect specimens to examine in the classroom.

Class Discussion: What do we enjoy most on walks? Why is it so much fun to learn outdoors? How could we make an area for learning outside? What kinds of things do people want to know about the outdoors? Who could use our outdoor area?

Children contact local or school authorities for permission (and help) in making trail.

Observation and collection of local plants and animals. Identification from books and field guides, logs of observations started, including date, place where plants and animals are found.

Points of interest along trail are determined.

Photos are taken of area and of plants.

Research of geology and ecology of area from books, government pamphlets, etc.

Data Collection: Children conduct surveys of other children or local people to find out who would use trail and what they would like to learn.

Data Representation: Analysis of surveys, calculation of per cents, bar graphs of answers to certain questions.

Class Discussion: Children discuss findings of various groups; decide on information to include in the trail, general layout of trail from the points of interest observed. What kinds and how many animals and plants are found in our area? How do they live together? How do people affect them?

Clearing of trail, laying out paths, marking them, etc.

Daily logs on observations continues; how weather and seasons affect living things in the area.

Identification of plants and animals continues. Soil samples and samples of pondwater examined for micro-organisms.

<u>Data Collection</u>: Numbers of certain plants or animals are counted in one or more sample areas.

<u>Data Representation</u>: Samples from different areas are compared. Total numbers of plants or animals are estimated from data in sample. Construction of bar-graphs, line charts.

<u>Class Discussion</u>: How can we present the information we've learned and things we've seen to other people?

Trail-building completed. Preparation of direction signs and signs to identify points of interest.

Preparation of pamphlet on the trail, including discussion of observations.

Trail is measured and scale map is prepared for people to use along trail.

Winter activities: Continuation of logs on observations. Preparation of indoor learning center on nature and bird-feeding stations.

Presentation of trail, nature study area, bird-feeding stations, etc., to school and public through guided tours.

<u>Class Discussion</u>: How can we learn from the work we've done? How can we improve the nature trail in the future?

Evaluation of tours. Preparing and administrating questionnaires or conducting interviews. Analysis of responses.

Removal of trail signs before summer vacation. Providing for trail maintenance and expansion the following year.

Optional Follow-Up Activities:

Field trips to other nature trails.

USMES Units:
- *School Zoo*
- *Advertising (against litter, pollution)*
- *Protecting Property (against vandalism)*

5. A COMPOSITE LOG*

This hypothetical account of a combined fifth- and sixth-grade class describes many of the activities and discussions mentioned in the flow chart. The composite log shows only one of the many progressions of events that might develop as a class investigates the Nature Trails challenge. Documented events from actual classes are italicized and set apart from the text.

Soon after the school year begins in the fall, one boy brings in an old wasp's nest which he has found. As the class discusses his discovery, one child asks where he found it, and the boy explains that he was walking in the wood behind the school when he spotted the nest in a tree. He climbed the tree, made sure the nest was empty, and took it down, he says.

When the teacher asks whether there are other interesting things to see in this wood, various children name things which they have seen or found while playing after school. The list includes birds' nests, squirrels, butterflies, wild flowers, mushrooms, a hole in the ground that "looks like a snake's home," an old shoe, animal bones, and "lots of trash." When the teacher asks whether the class would like to see this area, the children are unanimously in favor of taking a field trip to the wood.

The next day the entire class goes outside to investigate the area behind the school. At the teacher's suggestion, everyone brings his/her notebook to write down things they see or hear. The children agree that everyone should take notes and that no one should "run around" outside. Some of the children move from place to place, noting things they find as they go; others stay within small areas and describe everything they see around them. After a half-hour of observation, the class returns to the room to discuss what everyone has found.

A combined fourth- and fifth-grade class in Athens, Georgia, discussed learning in outdoor and indoor environments. The teacher suggested that they go outside, and the children began to observe things that they had never noticed before. They began naming things that they saw and collecting objects to bring back to the classroom. Once inside, the children listed the items they had collected and asked questions about animals and plants that lived outdoors. (From log by Annette Short.)

One child records on the board each item that is mentioned by the students. When their list is complete, the teacher asks whether they can think of ways to group the items they

*Edited by USMES staff

have observed. One student mentions that they can group them first as things to see--leaves, bugs, tin cans, etc., --and things to hear--bird calls, bees buzzing, etc.

"Is there any other way we can group them?" the teacher asks.

Another student replies, "By plant versus animal."

The class goes through the list and groups everything first into these two categories, until the children reach such items as rocks, old tires, and paper litter. They decide to make a third category for "rocks and dirt" and a fourth for "trash." A bird's nest someone has seen hanging in a tree provokes some discussion because the nest is made of plant matter but by a type of animal. The children finally decide that the fact that it is made by a bird is more important, and they put it in their "animal" category.

When all the items have been placed in one of their four categories, the teacher asks whether they can subdivide the list further. The children categorize animals by putting them in bird, mammal, or insect groups. One snake, which the children know is a reptile, has been spotted, but they are not sure whether the salamander that was seen is also a reptile. Someone finds a library book that says salamanders are amphibians, and the children put it in that category. They classify their plants as trees, flowers, ferns, mushrooms, and moss. This activity takes a long time and most of the children feel that they need to learn more about nature before they can figure out which categories to put some things in.

Children in a combined first- and second-grade class in Lexington, Massachusetts, began observing nature by listing the number of things they could see, hear, smell, or touch around them. They made lists of items they observed using each of their senses and graphed the results for each category. They determined from their bar graph that they used the senses of sight and touch most often outside. (From log by Judy White.)

Children in a fourth-grade class in Cotuit, Massachusetts, collected leaves and brought them back to the classroom to identify, first noting various characteristics. They grouped many of these characteristics by categories, such as number of lobes,

Nature Survey

Grade____Teacher____________________________

1. How often do you walk in the wood behind the school?

   a. Everyday____ b. Once a week____

   c. Once every few weeks____ d. Never____

2. Do you like to learn things about nature?

   Yes______________ No______________

3. If an area for learning about nature were set up in the wood behind our school, would you go there and use it?

   Yes______________ No______________

4. What kind of thing would you like most to learn about the area behind our school? (Mark only 1.)

   _____Information about animals
   _____Information about plants
   _____Information about geology and rocks
   _____History of people who lived there
   _____How people can learn to keep it nice

Figure B5-1

number of needles, leaf shape, opposite or alternative veins, and then used these groups to help identify the leaves. When they wanted to compare the sizes of leaves, they measured the perimeter of different leaves with pieces of string and graphed their measurements. (See log by Phyllis Viall Cooper, Fall 1974.)

The teacher asks whether they have learned a lot from their trip to the wood and whether they would like to try more outdoor learning activities. The children are very eager to do this. One child suggests that they might set up an area to study nature outside. The teacher asks whether they think other children in the school might also use such an area, and the children have mixed opinions about this. Some think that the whole school would be delighted and that it would be much better than learning biology from books; but another child counters, "Naw, older kids don't care about nature. All they do is mess up the woods with litter and shoot birds with BB guns." The teacher asks how they could find out if other children would like to study nature outside, and several children mention that they can take a survey of children around the school.

The children spend the next few class sessions designing a questionnaire and deciding whom to survey. They divide into groups to decide on wordings for the questions and come back together to vote on the choices they have worked out. The final design for their survey is shown in Figure B5-1.

When the children have chosen the final format, they discuss how they should administer the survey. One girl suggests that they stand outside the lunchroom and hand surveys to people who walk by. Other children object to this idea because they feel that it will be too hard to collect the finished surveys. Someone else suggests that they ask teachers if they can take a few minutes at the beginning of a class to administer surveys to students in the class. The children favor this approach and decide to give the survey to a sample of five children in every class in the school. Since most classes have about twenty-five students, the children estimate that their sample will represent about one-fifth of the school population.

When they have taken their survey, the children tabulate the results and discuss what they have found. Most of the children surveyed have responded that they walk in the wood at least once a week. The majority also have said that they liked learning things about nature and would use an area set up for studying nature.

The class ranks the responses to the question about what people would like most to learn about nature, and they find that "information about animals" has been checked most often. They discover that "information about plants," "information about geology and rocks," and the "history of the people who lived in the area," have also received large numbers of votes and that "how people can keep it nice" seems to be the least popular. Several children make a bar graph of the responses to show to others.

A fifth-grade class in Arlington, Massachusetts, began work on Nature Trails by designing a survey of people in the community. The students wanted to find out who would be interested in having a nature trail in the area and what kinds of things people would like to learn. The children compiled a survey of carefully worded questions and divided the interviewing among different children after making a large scale map of the neighborhood. Before going out, the children tested their questions on children from other classes. After interviewing people in the community, the children analyzed the results of their survey and found that most people in the community were interested in nature, knew a lot about it, and would like to observe it in a wooded area. (From log by Minnette Jeske.)

The children are excited about the results of the survey. They begin to talk about making an "outdoor learning center," and the teacher asks how they can do this. One boy responds that they can use the path that goes through the area to make a nature trail for the school. Other children suggest that they mark interesting things along the trail for other people to see.

When the teacher asks how they can use the results of the survey in making their nature trail, the children reply that they will find out as much information as possible about the animals in the area and can also research information on history, geology, and plant life in the area.

The teacher of the combined fourth- and fifth-grade Athens class asked the children if they thought others would be interested in learning the things that they found out about nature. The children were eager to share their enthusiasm for their outdoor discoveries and suggested making posters, holding discussions, putting up an exhibit, and conducting tours outside. One student suggested that they use the motorcycle paths behind the school for showing people about nature. Everyone thought this was a great idea, and the class began working on a school nature trail. (From log by Annette Short.)

When the teacher asked the children in her seventh-grade class in Athens, Georgia, whether they would like to work on the nature trail made by her class the previous year, the children were enthusiastic about the idea. They listed several ways the nature trail could be helpful to the school and the community. They felt that it would be especially useful to science classes studying animal communities and ecology because children could observe animal behavior and study food chains along the trail. (See log by Ida Campbell, 1974-1975.)

After a few more field trips to the wood behind the school, the children decide to break into groups to continue researching information about the area. One girl suggests that they ask the principal for permission to make a nature trail on the school property, and a group of children form to work with her on this task.

Another group of children decides to locate points of interest that should be included on the trail, such as different kinds of trees, small plants, old stumps, and other things which they find. A third group plans to make lists of all the kinds of animals and plants which they observe in the area and to look up information on them. Some of the children intend to see what they can find out about the geology and the human history of the region by researching information from books.

The first group obtains the principal's permission for building the trail. The principal tells them, however, that they should disturb the wood as little as possible; no trees are to be cut down to make the trail and no signs are to be nailed into trees. He also tells the children that they will need to call the town surveyor to determine the exact boundaries of the school property.

Children in a combined fourth- and fifth-grade class in Iowa City, Iowa, wanted to make a nature trail in a nearby park owned by the city. Two children got in touch with the park district and received permission to make a trail on the condition that nothing be destroyed and that everything be put back as it was found. Because of these restrictions and the short time period in which to complete their challenge, the class worked on making a temporary nature trail in the park. No weeds or saplings were pulled up or destroyed when the path was made and signs were removed immediately after the trail was shown to other classes. (See log by D. Ray Fredland and Lloyd Barrow.)

The children telephone the town surveyor's office and set up an appointment for meeting him and going over the school property lines in the northeast corner, where the natural area is located. The children feel that this is necessary because the wooded area extends into private property, and they want to make sure that their trail will be entirely on school grounds. When the town surveyor meets them, they walk around the property lines together. He shows them the small white markers, hidden by a thick overgrowth of weeds and vines, which mark boundaries between property. The children uncover many of these markers and make more of their own by piling up stones as they go along.

Meanwhile, the group working on locating the points of interest along the trail has found several interesting things. There are a couple of cleared areas in the wood, and in one of these is a huge old oak tree. One of the children finds out from his mother, who is a botanist, that the tree is known to be one of the oldest in the area; it is over 200 years old! The children also find a dead tree with several holes in it that one child says are holes made by woodpeckers. Another child becomes interested in a rotting log which is covered with moss and mushrooms. The group also finds the remnants of an old stone wall built long ago by a farmer.

The children decide to include all of these things on

the trail and also to mark several kinds of trees to be identified and included. They pick some of the most interestingly shaped trees at first, comparing leaf samples to be sure that the trees are different kinds. Some of the children in the group begin identifying these specific trees from field guides obtained from the school library. Others start making a rough map of the interesting points they have marked, sketching a trail that will connect the points using the existing path system.

The third group, which is the largest, is making a study of the natural history in the wooded area. Some of the children identify any plants, small animals, birds, and insects that they find in the area so that they can include a list of wildlife in the information they give other children about the trail.

The children in another fourth-grade class in Cotuit, Massachusetts, divided into groups to work on making a nature trail. One group of children chose different trees along the trail to mark as interesting points. Later, another group worked on identifying trees and small plants in the area using field guides. Since most of the trees were oaks, they counted number of "fingers" of oak leaves to distinguish between the different types. By the end of the school year the children had also identified ferns, lady slippers, Indian pipes, poison ivy, poison sumac, and reindeer lichen. (See log by Phyllis Viall Cooper, Spring 1975.)

Many children studying the natural history of the area are keeping daily logs of their observations in the wood: the sounds, sights, and smells of nature as autumn approaches. During one week in late September, they note a large influx of small birds in the wood. They read in bird books about the fall migration period when many different kinds of birds flock together on their way south. They also note when different kinds of trees change color and drop their leaves, what color the leaves are, and how weather and temperature seem to affect animal activity. (One girl observes that there are fewer birds singing on cold, cloudy days than on warm, sunny ones.)

Other children in this group ask the school librarian where they can find information on the geology and history

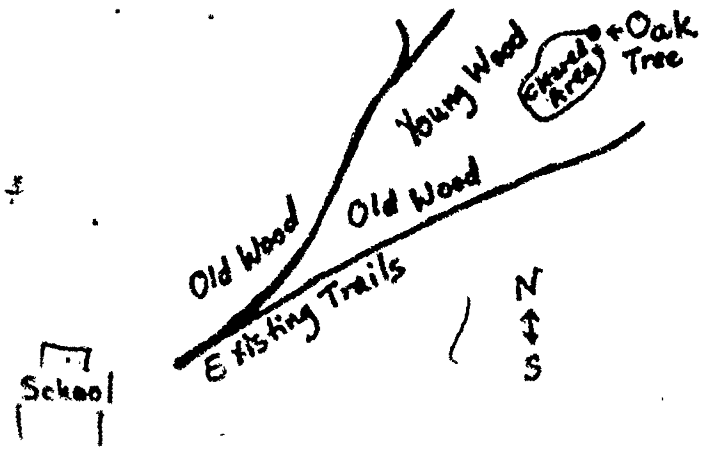


Figure B5-2

of the area. She refers them to the local library, which has pamphlets on the history of the town and county they live in and books on the geology of the region.

The children are fascinated by the information they find. They discover that the region (the Great Lakes area) was once covered with large ice sheets, called glaciers. These ice sheets left huge ridges of piled rock, dirt, and rubble—called moraines—when they receded. Some of the children read in pamphlets about their area that the long ridge which runs through the wooded section to the east of their school is a moraine made by a glacier. The pamphlets tell them that many of the kinds of rocks found in the nature trail area have been carried down from the north by the glacier.

Some children also find information on the human history of the area. When they read that Huron Indians once lived there, two of the children go out to look for arrowheads. The local librarian refers the students doing historical research to an old man, Mr. Phillips, whose family has lived in the area for over one hundred years. Several children go to his house to hear what he has to say.

This "old timer" is both helpful and entertaining to the group. He tells them how the land that is presently the school grounds was settled by farmers in the early 19th century. A dairy farmer finally bought out all the small farmers around the turn of the century and then sold it off to small land holders many years later. One piece of land was bought by the town for their school, which was built about forty years ago.

Mr. Phillips also talks about the ecology of the forest owned by the school. The children discover that their woodland is called a "second growth" forest and that it is considered young, except for the old oak tree, which has been alive for two centuries. Mr. Phillips tells them to look carefully at their wood and to observe that some of the trees in an area near the old oak are smaller and of different kinds than in other parts. He explains that when the town had purchased the property for the school, the northern area had been a meadow. Trees had been allowed to grow there only during the last forty years. The southern part, near the road, had not been used for farmland for several years and was already wooded when purchased by the town. The town had cleared space for the school between the wood and the road. (See Figure B5-2.) Mr. Phillips explains that if the younger wood is allowed to grow up, many of the trees there now will die and be replaced by oaks, hickories, and other kinds of trees that grow well in dense woods.

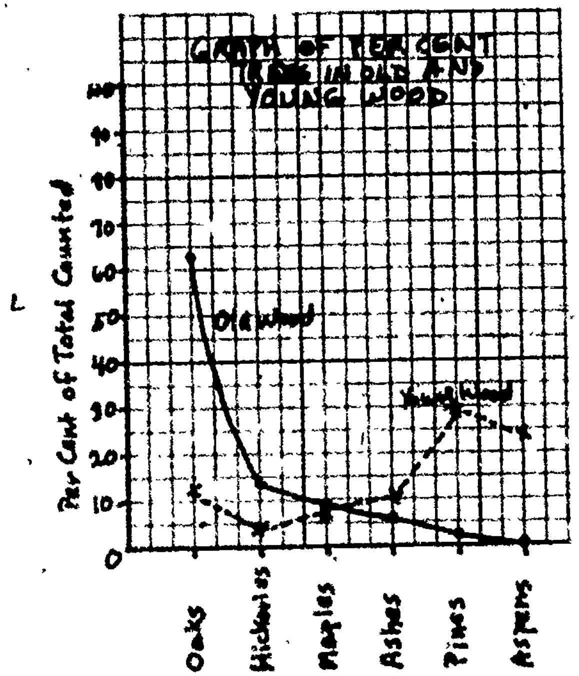
When the children report on their conversation with Mr. Phillips to the rest of the class, the other students remember noticing the younger wooded area that the old man has mentioned.

One boy in the group that is identifying trees to include as points of interest along the trail says that there are many pine and aspen there. The teacher asks if they have any idea whether most of the trees in the older wood are oak and whether the majority in the younger wood are pines. "Could one wood be called an oak wood and the other a pine wood?" she asks.

The children are not sure about this, and two girls from the Research Group volunteer to count trees to find out how many are oak, hickory, aspen, pine, etc. Because the girls need help identifying trees, two children from the Location Group who have learned to identify most of the trees in the area agree to help. Before they begin their work, the teacher suggests that they choose only a few of the most important kinds of trees to count so that they don't become bogged down in classification. After consulting with the rest of the children who have identified several trees in the wood, the group decides to count numbers of oak, maple, hickory, aspen, pine, and ash trees in a section within each of the two wooded areas.

The four children go out to the wood during the next USMES period. Two children work in the younger wood to the north while the other two children remain in the area closer to the school. Each pair of children starts counting trees along the existing trails. While one child marks a tree with a strip of rag to show it has been counted, the other child identifies the tree and makes a tally mark in the appropriate column on a chart. If the tree is not one of the six kinds that they are counting, it is marked on the chart as "other." Before removing the rag strips, the children recount the number of tagged trees to make sure the totals correspond with the charts. The two children in the younger wood have counted seventy-two trees, while the pair in the older wood have counted sixty-five.

Returning to the classroom, the children discuss their data with the rest of the class. They realize that in order to compare the areas, they need to figure the ratio of each of the six kinds of trees to the total number counted in each of the two areas. Other children suggest that percentages would be easier to use, however, and the four children enlist the help of the rest of the class in adding tally marks and calculating percentages of trees in the young wood



	OLD WOOD No. Trees	OLD WOOD Per Cent	YOUNG WOOD No. Trees	YOUNG WOOD Per Cent
Oaks	41	63%	9	12.5%
Hickories	9	14%	2	3%
Maples	6	9%	6	9%
Ashes	4	6%	8	11%
Pines	1	2%	21	29%
Aspens	0	0%	17	24%
(Other	4	6%	9	12.5%)

Figure B5-3

and in the old wood. They make a table of their information and a line chart comparing the two sets of ratios. (See Figure B5-3.)

When the group shows its results to the rest of the class, the children agree that the older wood can be called an oak wood because most of the trees are oak, although there are many other kinds of trees, too. The younger wood, however, has a greater variety of trees; there are more aspen and pine than any other types but there are also oaks, hickories, maples, ashes, and others. Someone reminds them that the old man predicted that other trees would "take over," and the children agree that this might be happening. They decide to include the line chart and a short explanation on the two types of wooded areas in the information they present to other classes when the trail is complete.

The children in another seventh-grade class in Athens, Georgia, made a nature trail in the thick pine wood near their school. They invited a forest ranger to help them with the trail, although most of the children preferred to learn how to identify the various plants they found without his assistance. The forest ranger brought an auger with him on one of his visits and showed the children how to take core samples of soil in the area. The children noticed that the soil changed drastically between the surface and 57" below. Above 57", the soil was deep red, dry, and coarse. The soil below 57" was fine, moist, gray-white clay. (See log by Ida Campbell, 1973-1974.)

The class holds periodic discussions to distribute information among groups. During one of these sessions, a group of students from another class in the school which has just started work on the USMES School Zoo unit comes in to ask information about the kinds of small animals that live behind the school. The children tell them about the salamanders, toads, snake, and turtle that they have found in the wood and answer their questions about where to find these animals and the kinds of homes that they might need.

When the other students leave, one of the children suggests that the class become a resource for other classes working on the School Zoo unit by writing information on the small animals in the area. A couple of children from the group researching natural history volunteer to work on this project. They write a report that includes paragraphs about the favorite foods and habitat of each of the types of amphibians and reptiles common to the area. They also include paragraphs on life cycles of insects such as caterpillars and grasshoppers that are commonly captured for the School Zoo unit. The children plan to mimeograph the report and make it available to any class using the school property for nature study.

When the groups have been working a few weeks on these activities the class meets to talk about building the trail and opening it to the public. The children who have been working on the area study want to continue their work and to include their information in a pamphlet for distributing to visitors when the trail opens. The other children are ready to discuss design of the trail. The group working on locating points of interest have found that the best design seems to be a loop with one or two short side trails for points not along the loop. After examining the rough map the children have made of the existing trails and the points to be included, the class decides to make the trail using part of the existing main trail and one of its branches. (See Figure B5-4.) In this way, only a small section, part of which includes a grassy area, will have to be cleared.

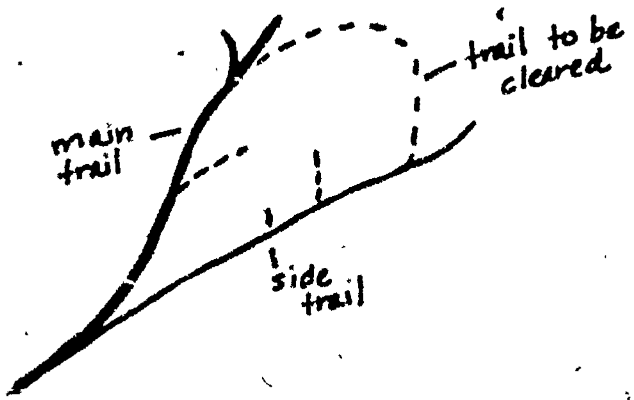


Figure B5-4

Children in one of the Cotuit classes decided to make a nature trail using an existing "T-shaped" path in their wooded area. The children cleared a few side trails that led from the path to interesting trees and other points. They made directional signs for the main trail and painted them one color for going out and another for coming back. (See log by Phyllis Viall Cooper, Spring 1975.)

After discussing several options, the class decides to put up a sign next to each point on the trail indicating the number of the point and to write information in the pamphlet about each item. The children also decide to include in the pamphlet a scale map of the area showing where each number is located.

The children break into three groups to clear the trail, to measure the area for making the map, and to construct the signs. Before working on these tasks, the whole class goes to the trail area to pick up litter and trash which they have found during their investigations.

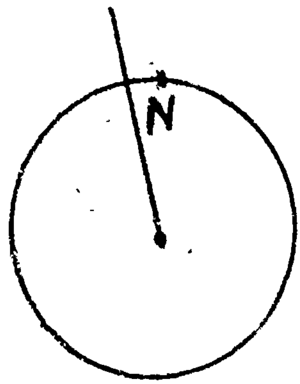
The children in the above-mention Cotuit class spent several days picking up trash in the nature trail area. They used plastic trash bags and gloves (for picking up glass) for collecting small pieces of trash such as cans, old socks, bottles, and paper litter. Large objects such as car fenders or sinks were brought to a trash collecting point for later removal to a dump. (See log by Phyllis Viall Cooper, Spring 1975.)

The group of children clearing the trail use rakes and shovels brought from home to level off the existing trail. When they begin working on clearing the new section, they borrow clippers for cutting grass and bushes and pile rocks to mark where the trail goes. They decide to ask the sign group to make signs with arrows that can be placed at strategic points to help people follow the trail.

Another group begins mapping the main trail by measuring the length of a string tied between the starting point and the first point of interest. They are immediately faced with the problem of how to measure directional change, as the trail veers slightly to the left before the first point. One child suggests that they use a magnetic compass so that they can tell when the trail changes direction, and he offers to bring one to class.

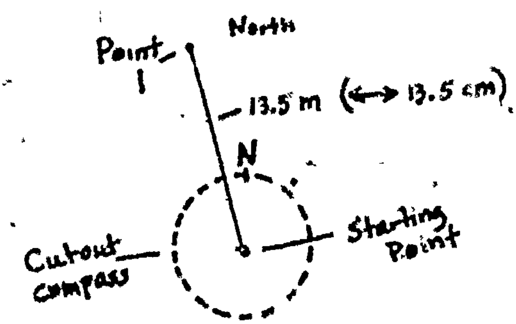
The following day, the group heads for the trail armed with a compass, a meter stick, and their spool of string. At the teacher's suggestion, the children measure and take directional readings of the first two segments of the trail and then plot these to scale on a sheet of paper before measuring the entire trail. They are confused by the system of finding direction by degrees on a compass and ask the teacher if there is an easier way to find directions and translate them onto paper.

With the teacher helping, the group practices a new way in the classroom. Two people hold the string, one at the starting point and another at the first point of interest. The children stretch the string as tightly as possible between them. Another child stands next to the taut string near the starting point, places a compass on a piece of paper, traces around it, and writes "N" where the needle points north. She then sights down the string without moving the paper and makes a mark in the direction that the string is stretched. She draws a line from the mark to the center of the circle to indicate the direction of the string in relation to north. The circle she draws for the first measurement looks like this:



When the direction has been recorded, the child at the far end of the string makes a mark on the string, and the children measure the length of the segment with the meter stick. After they have followed this procedure several times, the children are satisfied that they can use it to measure the whole area.

The teacher then shows them how to plot their measurements on paper. Arbitrarily picking a scale of one centimeter ↔ one meter, they mark "North" at the top of the paper and place a mark for the starting point near the bottom of the paper. They cut out the tracing of the compass and place it so that the center is over the starting point mark and N is at the top. Then they extend the line of the cutout on the paper. Their trial map for the first segment is done something like this:



Before going outdoors, the children cut out compass shapes to be used later for recording directions and making a map. They mark each cutout with the name of the trail segment. The children decide to call the measurements S-1, (S designating starting point), 1-2, 2-3, 3-4, etc., so as not to confuse them with the points of interest, which have been numbered 1 through 11. Later, when taking actual measurements, they find that the trail sometimes makes an obvious bend between points. In some cases the children take several directional readings, and in others they merely guess at the amount of curve. The children enjoy this activity immensely and take turns holding the string and making compass readings.

Children in one of the seventh-grade classes in Athens began measuring their trail for making a map. They invited one of the children's fathers who was experienced in forestry to help them take the measurements. He showed them how to set up markers at various points, how to measure between points with a special tape measure, and how to take compass readings at every point. The children did not complete their measurements in time to make a scale map of the area before the year ended. (See log by Ida Campbell, 1973-1974.)

The sign-making group finds some pine boards in the Design Lab and begins cutting out signs about eight inches long to identify the points of interest along the trail. They make signs for the eleven points of interest as well as one that says "Nature Trail--Start Here" for the beginning of the trail. This group also makes several directional arrows for the trail before going out with the trail-making group to determine the number of arrows needed. The children begin painting the signs, using red for the points of interest and green for the directional signs. When the initial painting is completed, the children paint white numbers and arrows on the signs. They nail some of the signs onto stakes to be driven into the ground next to the tree or other object to be identified. Others have holes drilled in them so that they can be attached to low branches of large trees with twine. The students decide not to put up the signs until the trail is completed because they are afraid that they will be removed or disfigured by other children.

The children in the first seventh-grade class in Athens to work on the nature trail identified trees to be included along the trail. A group of children painted large sheets of plywood and cut out signs for identifying trees and indicating the direction of the trail. The children were able to paint the names of trees on fourteen signs which were placed around the trail before the school year ended. (See log by Ida Campbell, 1973-1974.)

It is now November and winter is approaching. In a flurry of activity before the cold weather sets in, the children abandon all the things which can be done later indoors and help the trail-making group and the mapping group complete their tasks. By Thanksgiving, the trail has been completed, much to the children's delight (although there are groans when someone mentions the new layers of vegetation and human litter that can be expected on the trail come springtime).

During the winter, the children regroup to complete the signs, work on the map, and write descriptions for the pamphlet they plan to give out to other classes using the trail. When the weather is fair the children occasionally venture out onto the trail, keeping logs of their observations of the winter environment. The trees which they have identified by leaf shape in the fall are now bare (except for the pines), but they learn to identify a few of them by looking at the buds at the tips of the branches.

The children are fascinated by the variety of animal tracks they find in the wood following snowfalls, and they learn to identify rabbit, squirrel, and mouse tracks. One day the children spot a deer track and on another, a track which looks like that of a raccoon. These animals are added to a list of animals spotted in the wood. Using ideas from a bird checklist that a girl has brought from a nearby Aubudon Sanctuary, the children mark the raccoon and deer as occasional visitors; other animals, such as rabbits, are listed as residents.

The children in a special fourth/fifth/sixth-grade class working on Nature Trails, observed many signs of animal and plant life in their woods and a nearby park. They observed animal tracks, noted winter buds, and different kinds of birds. They frequently went out in the school *area with snowshoes to observe nature although they were disappointed by the lack of wildlife in these woods. (From log by Sandra Stevens.)*

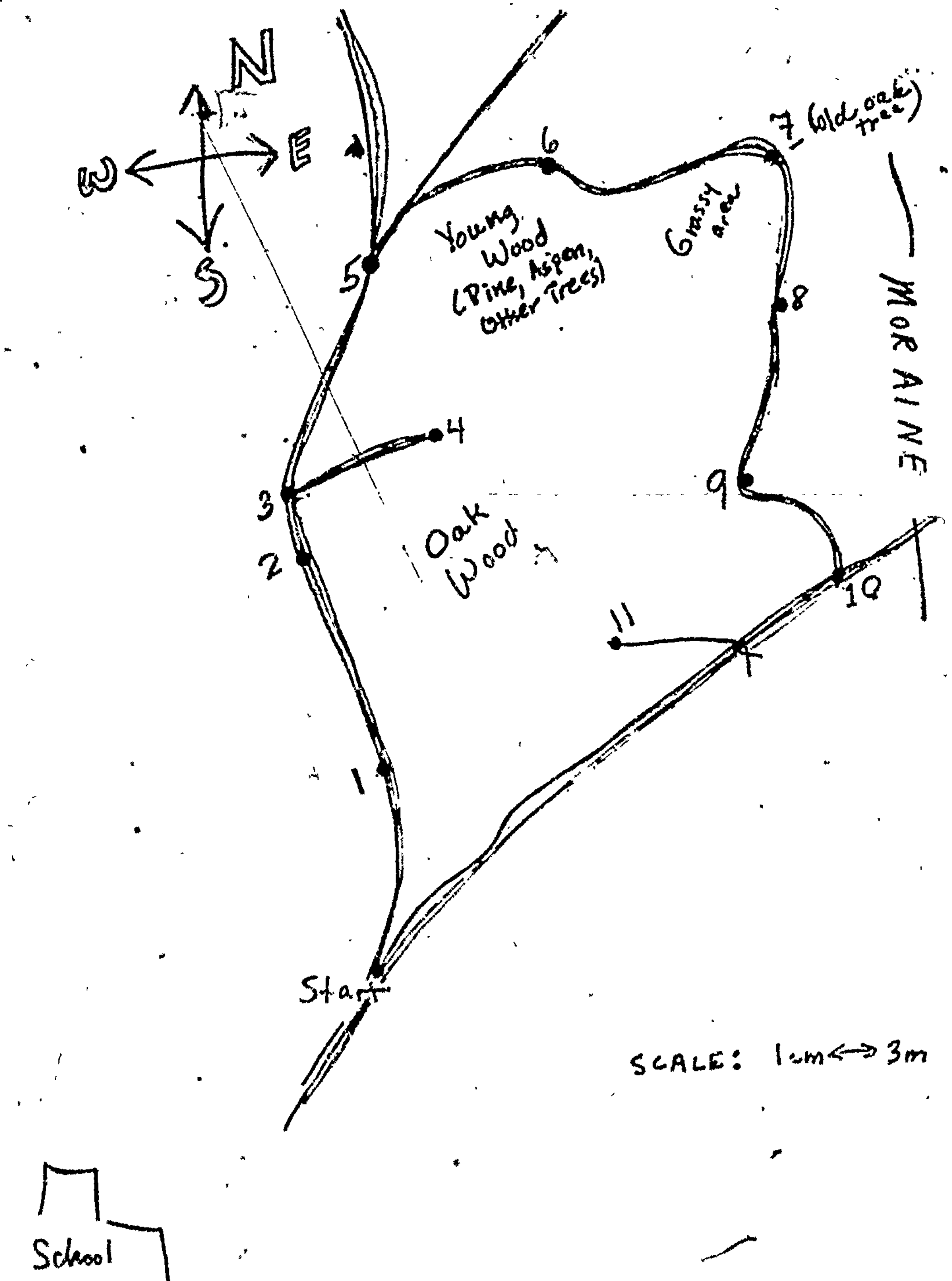
During their winter walks through the wood the children notice flocks of wild birds feeding on berries and wild seeds. One child suggests that they set up a feeding station outside the classroom window so that they could watch the birds more closely. "Besides," he adds, "we could help them find food."

A group of children forms to design and construct bird feeders from wood. They make one feeder to hang outside the window and one to attach to the window ledge (after obtaining permission from the principal). Each child in the class donates a quarter for bird seed, and someone brings in some suet which is put up for woodpeckers.

At first, the bird feeder is not very popular; the birds seem too timid to approach. The children entice them by scattering seeds on the ground in the direction of the wood. They also develop a system of watching the birds in secret by peeping out of partially closed venetian blinds in a darkened section of the room. The children's favorite visitors are the woodpeckers, which occasionally come to dine on the suet. The blue jays cause great indignation in the classroom by chasing all the other birds from the feeder. Some children call them "bullies" and try to shoo them away. The class invites other children to observe the feeding station frequently during the winter.

In a seventh-grade class in Citra, Florida, a group of children completed its tasks of marking points of interest along the nature trail and decided to make bird feeders to attract birds along the trail. The children designed their own feeders and wanted to start building them immediately, but the teacher's questions led them to realize that they needed to decide first on dimensions. When the children had chosen the form and dimensions of the feeders, they began sawing the parts out of pieces of wood and attaching them together. (From log by Martha Hellmuth.)

Meanwhile, the other groups continue to prepare information on the nature trail so that it can be opened to the



TRAIL	DISTANCES
S-1	13.5 meters
1-2	15.6 m
2-3	4.1 m
3-4	10.5 m
4-3	10.5 m
3-5	15.1 m
5-6	15.3 m
6-7	17.0 m
7-8	11.4 m
8-9	12.5 m
9-10	10.1 m
10-11	16.8 m
11-X	7.2 m
X-S	33.4 m
TOTAL TRAIL LENGTH	192 m

Figure B5-5

school in the spring. The map group first decides on the size of the map which will be included in the booklet to be distributed to other classes. They decide that the map will take up one page, and they choose a scale of 1 cm$\leftrightarrow$3 cm for drawing the trail. Then, using the cutout compass shapes with directions for the sections between points, they construct the trail on a sheet of paper. When the distances between points is very short, they cut the compass shapes to the size of a coin so that they will fit between the points.

Their first effort is unsuccessful because the trail ends a couple of inches away from the starting point. After much discussion the children decide to use pins with thread attached instead of pencil lines for the second trial; this way they are able to move the pins around until the first and last lines meet at the starting and ending point of the trail. The children number the points on their map and determine the total walking distance of the trail: 192 meters. The children's map is shown in Figure B5-5.

Children in one of the Cotuit classes measured their nature trail and made approximations of directional turns by drawing rough maps as they went. They then used these maps and their measurements to make a scale map of the trail. They chose a scale of 1/2"$\leftrightarrow$2' for their map, which they made on two pieces of paper each one yard square. The children planned to transfer this map onto plywood to place at the entrance of the nature trail. The map would identify the points of interest along the trail. However, the school year ended before the large map was completed. (See log by Phyllis Viall Cooper, Spring 1975.)

The pamphlet group works on the other sections of the pamphlet. A list is prepared of all the animal life seen along the trail so that other children will know what kinds of animals live there. Some children write information about the points of interest from class observations or reports from library books. Each point is identified and a short description written. One description is shown in Figure B5-6.

5. Sassafras: This tree has 3 kinds of leaves. One kind has two lobes, another kind has one lobe, and another kind has no lobes. It likes to grow near the edge of the woods. The Indians and Pioneers made tea from the bark. You can make root beer from the roots. The leaves smell spicy,

Figure B5-6

The Iowa City class chose nine points of interest to show to other children. The whole class visited these "stations" and decided on the best route that would connect them and make a nature trail. The children who had found these interesting things conducted library research on them and wrote notes to use for giving speeches to the other classes visiting the trail. Because the library did not have enough information, the children asked resource people, such as the school principal, for help with plant classification and natural history. The children who did not give speeches acted as guides during the tours. (See log by D. Kay Freeland and Lloyd Barrow.)

Other groups of children are writing information about the area around the trail. One group describes how the glaciers descended and retreated during the ice age and left the moraine that can be seen to the east of the trail. Another group writes a creative story to be included in the pamphlet about the human history of the area. The children tell the story from the point of view of the old oak tree that has lived in the area for 200 years. Many of the things Mr. Phillips told them about the people in the area are incorporated into the story. In the tale, the old oak tree starts out with a description of the young Indian boys who used to catch squirrels in its branches. Then the settlers came and cleared the area of trees, so that it stood alone in a cornfield. When the dairy farmer bought the land, cows grazed under its limbs and huddled there during storms. Once it was struck by lightning and a branch split off. When the land was bought by the town, young seedlings grew up under the old tree. The children end the story with a lament from the old tree about the teenagers who have parties and leave beer cans under its aging limbs.

When all sections of the pamphlet are complete, the children borrow a typewriter from the school office and take turns typing the text on mimeograph paper so that it will all fit onto a few pages. By the time the pamphlet is complete, spring has arrived, and the class sallies forth to work on clearing the trail and putting up the signs. After a few weeks of work, the trail is ready for the first visitors.

The children hold a class discussion to decide how to present the trail to the rest of the school. The children decide to give guided tours to one class at each grade level and to take turns explaining the points of interest and answering questions. They invite the principal to the first tour.

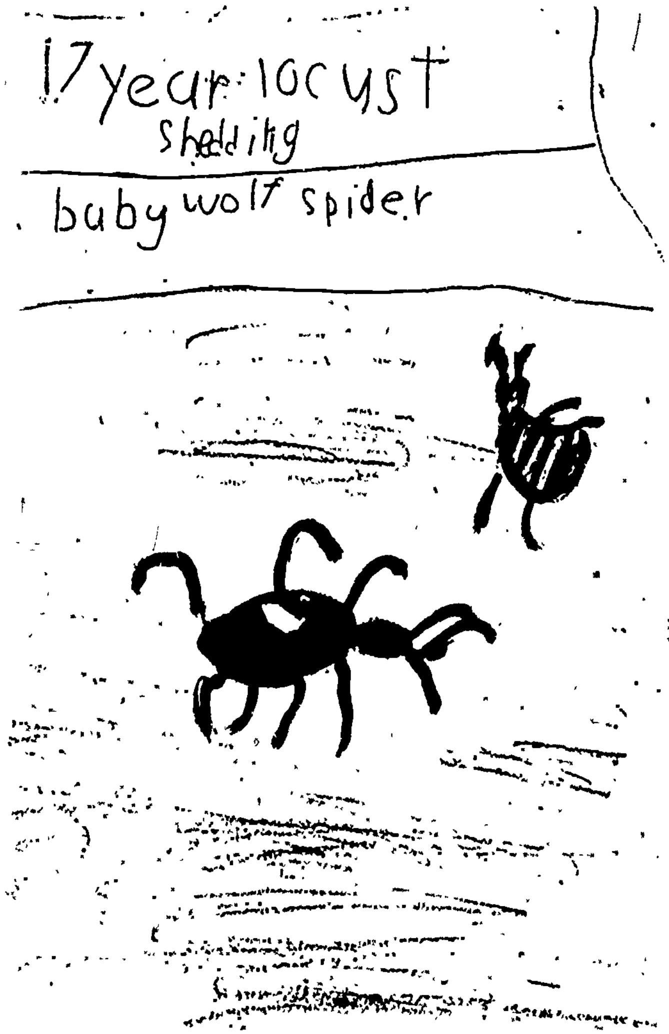
They mimeograph copies of their pamphlet to distribute to children in these classes. The guided tours are successful; certain children in particular enjoy leading them and are regarded as experts on wildlife in the area. One fifth-grade class which is given a tour of the nature trail seems especially interested in how the trail was made, and several of the children are given skill sessions in measuring and mapping by the tour guides.

The children in the first class in Athens to work on the nature trail hurried to complete the trail so that other people could use it before the school year ended. The class gave several adult visitors tours of the trail while they worked, and they staked their signs in the ground along the trail a few days before the school year ended. Some members of the class gave guided tours to other science classes. The children in the other classes enjoyed the trail and asked many questions. The only criticism the children received was that the trail needed more directional arrows. (See log by Ida Campbell, 1973-1974.)

During a later class discussion, the children decide to ask other children if they would like to take over trail maintenance the following year. Arrangements are made for the formation of a school "nature club" for all interested students to keep up the nature trail in the future. Several children come to the first meeting of this club, and the group makes plans for expanding the nature trail during the following year.

6. QUESTIONS TO STIMULATE FURTHER INVESTIGATION AND ANALYSIS

- How could we make an area on the school property to learn about nature?
- How could we show people the natural area near the school without clearing a path or changing it in any way?



Judith White, Grades 1-2
Adams School

- How could we find out who owns the area we plan to use? How could we obtain permission for using the area or making a trail?
- What kinds of things would our class and others like to learn about nature?
- What kinds of things might we find to include along the trail?
- What kinds of plant and animal life might we find in the area near the school? How can we find out their names?
- What do the animals and insects we find in our area eat? Are they food for some other kind of animal? If so, what kind?
- What kinds of things might we observe that show how plants and animals help each other?...how animals help other animals?
- How can we tell how many there are of different kinds of trees, flowers, insects, and animals in the area near the school?
- What kinds of interesting rocks might we find in the area? How can we find out more about the geology of the area?
- What kinds of things might we find in our natural area which show that people have been there?
- How can we find out about other people who lived in the area before it belonged to the school or park system?
- How do human beings affect the natural area now? What could people do to make this area a better place for the plants and animals that live there?
- How does our natural area change from day to day?...from season to season?
- How can we tell what kinds of little creatures live in the soil, pond, or stream near the trail if they are too small to see with our eyes?
- How can we keep records of the things we observe in the woods (desert, etc.)?

- How can we make a picture of our data?
- How can we design the trail to include as many interesting things as possible?
- How can we make a trail for others to enjoy without damaging trees or small plants?
- How can we map the trail so that other people can find their way around it?
- What kinds of things can we do in the winter when it is too cold or snowy to go outdoors? What kinds of nature can be observed through the classroom window? How can we teach others about it?
- How can we tell other people about the things we have learned in our natural area?
- How can we influence other children to respect nature and the area we have explored?
- How can we provide for the trail to be cared for next year?

The Florida Pine Snake is sometimes called the Bull Snake because of the loud blowing noise he makes by blowing air out of his nose when disturbed.

C. Documentation

1. LOG ON NATURE TRAILS

by D. Kay Freeland and
Lloyd Barrow*
Ernest Horn School, Grades 4/5
Iowa City, Iowa
(May 1976)

ABSTRACT

The teacher of this fourth- and fifth-grade class and the science coordinator of the school system worked together on Nature Trails with the children in the class. After a trip to a nearby park, the children were asked how they would show the park to other people, and they came up with the idea of giving tours to the other fourth- and fifth-grade classes. As they had only about three weeks to prepare a nature trail before the end of school, they worked in groups to develop the trail, conducting research on various points of interest and making signs to put up along the trail. They received permission from the park district before starting their work on the trail. Shortly before school ended the children gave tours to groups of children in the two classes. Students at each of the nine points of interest gave speeches using information they had researched; other students guided the groups along the trail. The class itself evaluated its efforts and two students made up evaluation forms which they gave to the other classes. Almost everyone was pleased that the class had successfully developed and exhibited a nature trail in so short a time.

Before introducing a Nature Trails challenge, Lloyd Barrow (Science Coordinator) and I took my class on a field trip to Willowcreek Park, an area containing both playground equipment and a woods that is only a fifteen-minute walk from the school. During the session before our trip to the park, we discussed what the children felt to be reasonable rules for the trip, such as staying in line, following my instructions, etc.

On the following Monday we walked to the park. When we reached our destination, Lloyd asked the children to find something interesting to show to other people. They could draw a picture of it, describe it, or, if it were not living (for example, a rock), they could bring it back with them to

*Edited by USMES staff

Doug Van Dyke

Dandelions There were millions of dandelions down at the creek. If you split a dandelion you will find gooey milk like stuff. This will stick to your finger. If it dries it will wash off. Another fact of this flower is in its life span it will be closed (Thread). It will bloom yellow and then have white seeds that will blow away and make others. These plants are also hard to get out of yards because of there long roots.

Dam, This is just one of the 7 dams of the creek. This pacific dam is nature made. It backs up the pollution.

Figure B5-1

our meeting place--a picnic table. They could work in pairs, but they were to stay on one side of the creek and not to go into the water.

For the next fifteen minutes, the children spread out over the area and wrote notes or drew pictures of the objects they found. Lloyd and I walked from group to group. At the end of the fifteen minutes I called everyone together to discuss our findings. Because our time was limited, we started our return trip.

Back in the classroom, Lloyd led a discussion about what each child or group had found to share with the rest of the class. Because the area was wooded and had underbrush and wild animals, they saw many interesting things, such as mushrooms, "beaver dam," and poison ivy. One child's description of two things he observed is shown in Figure C1-1. Several of the students who were already familiar with the park said that they had found things they had never noticed before. The children seemed generally enthusiastic about their trip.

During our next session, we planned to continue sharing the rest of our findings, and so we gave the children the choice of holding class in the school or at the park. Needless to say, they chose the park. For safety, we developed some new rules for the walk to the park: (1) stay in pairs, (2) stay between Lloyd and me, (3) and keep your hands to yourself.

Before we had gone very far, the childrens' high spirits got the better of me, and I told the children that they could either discuss our findings on the school grounds or back in the classroom--the park was out for this session. They chose to discuss the trip to the park on the school grounds, but everyone's attention span was still very short and we didn't have a very successful discussion.

Lloyd asked them questions about things they'd seen in the park. For example, was the twin tree two trees of the same type or of different types? These questions helped them to realize that they needed to be more observant outside.

During the next USMES session Lloyd led a brainstorming session on how the class could develop the park into a nature trail. He first asked the children if they felt that other people would be interested in the things they had found in the park. This led to a discussion of ways in which the park could be shown to people. A few children came up with the idea of leading people to various points of interest within the park. One girl mentioned that they could make a nature trail like one she had been on previously. When she described the trail she had visited, the children agreed that it sounded interesting and that maybe we could do similar things.

During the last part of the session we brainstormed ideas for tasks that needed to be done and questions that needed to be decided when we made our trail. One student wrote these on the board. Here is their list:

1. What to show
2. Who to take
3. When to take them
4. How to show
5. Permission
6. Pick what to see
7. Time to walk there and back
8. Map

At our next meeting we talked about how these various things could be done. Here is a summary of our discussion on each point.

1. What to show

The children felt that they wanted to show the things we had found on our trip.

2. Who to take

This question caused considerable conflict because some students wanted to take the entire school, others wanted to take the sixth-grade, while others preferred either the fourth or fifth grades. We decided that taking the entire school would not be feasible, and the children eliminated the sixth-grade. They decided to ask me to talk to the two other fourth- and fifth-grade teachers to find out whether they wanted to take their class on a nature walk.

3. When to take them

There was no question about this, as May 21--the last day of USMES time--was our last opportunity.

4. How to show

After much discussion the children decided to split the classes into small groups with one person from our class to act as leader for each group. The groups would go from station to station on the trail.

5. Permission

A group needed to be formed to obtain permission from the park district. By popular vote, one girl and one boy were chosen for this task.

6. Pick what to see

The children felt this was the same as #1--what to show.

7. Time to walk there and back

The children, from experience, knew they could tell other classes that the trip was fifteen minutes each way.

8. Map

One boy, with class support, decided to call the park district to see whether they had a map of the area.

During the next session, one of the children in the permission group reported that the park district had approved a nature trail as long as no living things were destroyed and the area was left the way we had found it.

The children decided that we needed to visit the park again to explore the things we planned to include in the trail. Off we went to the park, and the children divided into groups (mostly pairs) to develop the areas of interest to be used as stations for the trail. Each group spent about fifteen minutes clearing the area around its station of dead brush and litter so that it would stand out more clearly. At the end of this time we all met and began going around to the various stations to plot our trail.

Two girls had found the den of some animal and a rotten log that had fallen across the creek. These two items made up the first station on our trail. A couple of boys showed us the second station--some toadstools and moss that they had found around the bottoms of trees. We had time to visit only these first two stations, but we planned to continue this tour at our next outdoor session.

We stayed inside during the next session, dividing into groups to work on various tasks. One group of six children

May 14, 1976

Dear Parents,

We are planning to take your child to Willow Creek Park on Friday, May 21 in the afternoon. Mrs. Freeland and Mr. Barrow will be coming with us. May we have your permission to take your child?

Child's name ____________

Parent's signature ____________

Thank you,
Mrs Freeland's
USMES class

P.S. If it rains it will be scheduled for Monday, May 24. Please return this note by May 19.

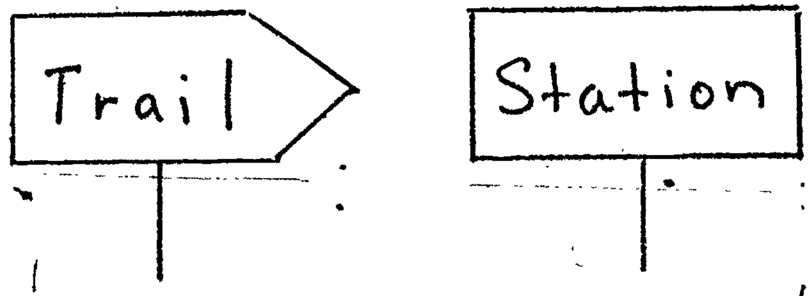
Figure B5-2

worked with the principal to develop a permission slip so that the other students could go on the walk. They wrote the slip on a ditto master and ran off fifty copies. (One copy is shown in Figure C1-2.)

Another group called the park district to find out if they had a map of Willowcreek Park and were disappointed to find out that they did not.

Another group worked on researching information about various stations along the trail. They were frustrated by a lack of reference material in the school library. Most of the information found on natural history came from encyclopedias; there were few field guides or other descriptive books available. Two girls who had found an animal track in the mud near the creek managed to identify it as a raccoon footprint from the pamphlet, *Animal Tracks of Iowa*, printed by the state conservation department. The group also enlisted the help of the principal, who was an expert on mushrooms, in identifying fungi they had seen in the park. The children were fascinated that an unattractive species they called "yuk" was actually edible.

I worked in the Design Lab with a group making signs to identify stations and to mark the trail. They decided on the shapes and sizes they wanted and set to work drawing them on Tri-Wall and cutting them out. By the end of the period they had finished five station signs and seven trail signs. (Designs for the two types of signs are shown below.)



We spent the next session in the park. Before leaving, the students listed what they still had to accomplish:

1. plan a trail
2. clear a trail
3. pass out permission slips
4. see the rest of the stations
5. figure out how many more trail and station signs will be needed

[illegible]

This is a racoon track. It was a very, very large racoon to make a track this deep. We know this is a racoon track because we looked in a book.

This is a plaster cast of the track. We came to Yellow Creek with a can, a container, plaster of paris, tape and oaktag. One of the pails was full of water. We poured the water into a container. Then with the tape we made a collar with oaktag. We mixed the plaster with the water. We found a stick to stir it with. We placed the collar around the track and poured the plaster onto it. We let it dry and peeled off the collar. The first time it didn't work so we did it again.

Figure B5-3

When we reached the park we met briefly and then each group went to its station to clear the area and examine it for the last time before the tour. After fifteen minutes we came together again to go over the seven stations on the trail that we had not visited on the previous trip. We were delighted to find that the stations the children had chosen all conveniently fell into a nice pattern for a trail.

The third station along the nature trail was the raccoon footprint found near the creek. While the class watched, the girls made a plaster cast of the track so that it could be preserved for the other students to examine. They left the cast overnight and returned the next morning to peel off the hardened plaster. The girls wrote a description of the track and the process of making the plaster cast, as shown in Figure C1-3. (The children used this description while explaining the station to the other classes.)

Station #4 was a dam that had been made long ago by beavers. The children were impressed that the dam collected "pollution"--metal cans, paper, and other human debris--and kept it from going downstream.

The remaining stations along the trail were as follows:

Station #5	two very large trees that had grown together
Station #6	a mushroom growing on a rotting stump
Station #7	another dam (this one probably man-made)
Station #8	hanging grape vines
Station #9	poison ivy

When we had visited all the stations, we spent the rest of our time clearing a "trail" between stations by removing dead wood and litter. Then we returned to the school.

The six students who had prepared permission slips went to the two other fourth- and fifth-grade rooms to explain them and hand them out.

As our next session was the last one before we were to give our tours, we met as a class to plan our strategy. Because we were taking a total of fifty students, the class felt that we should have seven guides and one or more people to explain each of the nine stations. We decided that part of the class would go with Lloyd at 1:00 P.M. to set up the trail signs and station signs. The rest of the children would come with me at 1:20 P.M. and report to their stations. Then at 1:30 P.M. Mrs. Duncan's class would start for the park with Jim as their guide, and at 1:45 P.M. Mr. Trunnell's class would start with Anne as their guide.

One student came up with the idea that the girls at the

This mushrom gets its food from wood, and this mushrom is edible.
The safest mushrooms to eat come out of a box from the grocery. When it is scrachd whith the point of a pencil or knife, it will turn dark brown. You can do a skech on shelf fugi.
When you look at the underside of a shelf fungus you will notice that it consists of thousands of little holes. Each hole is a tube. The spores develop inside these tubes, dropping out through the holes when they are ripe. The holes are known as pores which explains polypore, a Greek word meaning many pores.
Bugs get into the holes and Block the tubes to make it dry and then it's unedible

Figure B5-4

liked - Because I had fun walking the trail with the different groups. I liked setting up the trail. I liked planning the trail and making the signs. The trail was nicely made.

Change - I think some groups didn't get enough information to attract the people and there were two groups doing the same thing.

Figure B5-5

first station could signal the next group to start by blowing a whistle after each group had left their station.

During the remainder of the session, the children who were going to give explanations at the nine stations continued researching information. They wrote notes for themselves on notecards so that they could remember the information. The boys at Station #6 (mushroom on a stump) wrote the notes appearing in Figure C1-4.

Because the class had decided that we needed eighteen trail signs and nine stations signs, I took the rest of the children to the Design Lab to finish making them.

On the last day of our USMES unit (only a few days before school ended), the weather looked threatening but we decided to go ahead with the tours. (We were glad that we did!). Thirteen students went with Lloyd at 1:00 P.M. to set up the signs along the trail. The children had trouble pounding the signs into the ground. Unfortunately, the pieces of scrap wood that the children had used for stakes did not easily penetrate the ground. Lloyd felt that wooden dowels might have worked better as stakes. Also, the children had run out of glue for attaching the Tri-Wall signs to the stakes. They had been forced to use nails for some signs, and these didn't hold together very well when the signs were pounded into the ground.

One group of students put up the station signs at the various points of interest. Then the rest of the children placed the directional arrows between these stations. When all the signs had been put up (we hoped they would hold for the afternoon) the guides walked the trail for the last time to make sure they wouldn't get lost.

I followed at 1:20 P.M. with the rest of the students. The children reached their stations just in time, as Mrs. Duncan's class arrived right behind us. We divided her class into groups of four; each group was guided by someone from my class. The guides were *not* supposed to show the way, but only to redirect the groups if they lost the trail.

The program worked like clockwork. By the time Mr. Trunnell's class arrived, the first group of four students was just finishing their tour so that the guide was available for another tour.

Besides the students and the two teachers, five parents and the principal came on our tours. The children at the stations did an excellent job with their speeches, and there were many positive comments about the tours from both adults and students.

After all the groups had gone through the trail, the students picked up the signs. Before we walked back, we had a

Nature Trails

I thought it was neat, because we got a chance to be outside and have fun. Not fun like fooling around, but just getting to have a chance to make signs do research and learn alot of fun things. I thought that it was really neat! I like the idea of getting to show people what we found out

Figure B5-6

Dear 4th and 5th graders,

① Did you enjoy the USMES nature trail?

Yes ✓ No ___

② Would you please write a few sentences or why (or why you didn't enjoy the USMES nature trail? I enjoyed walking around because it felt like I was in a forest. The [illegible] ly told me things I didn't know.

The thing I didn't like was that there were [illegible] were good thorns. It scratched me.

I liked it very much and would like to thank all of you for your work and time put into it

Figure B5-7

short discussion about the day. The children at the stations had given their speeches a total of twelve times; they felt that this was too much, but they were proud of their efforts. They also felt the guides had been helpful because they had kept the groups moving.

Back in the classroom, the children in our class wrote evaluations of the unit. (Two students' evaluations are shown in Figures C1-5 and C1-6.) The evaluations and students comments appeared to support our own feelings about Nature Trails. The short time span of the unit with an expected completion date seemed to be an asset. Many children were surprised that the time had gone so fast. Several students indicated that they wanted to expand the trail the following year.* They felt that Willow Creek Park had become an area of "theirs" that they were proud of and wanted to show to family and friends.

Two girls came up with the idea of writing an evaluation form for the students in the other two classes. They received support from the rest of the class. The girls wrote the form on their own and ran it off on the ditto machine. During the week following our tours, they took the copies to Mrs. Duncan's class and Mr. Trunnell's class where they explained and distributed them. One evaluation form with a student's remark is shown in Figure C1-7.

The girls returned with the forms and read them over before giving them to Lloyd and me. (Unfortunately, there was not enough time before the school year ended to show the evaluations to the rest of the class.) The other students' comments were generally favorable and we were pleased with their responses to the nature tours.

*At that time they might make a map of the trail so that others could find the points of interest without being guided.—ED.

2. LOG ON NATURE TRAILS

by Phyllis Viall Cooper*
Cotuit Elementary School, Grade 4
Cotuit, Massachusetts
(September-October 1974,
May-June 1975)

ABSTRACT

This teacher introduced the Nature Trails challenge to two of her fourth-grade science classes during the 1974-1975 school year. The first class discussed in the fall the science topics that interested them. Since many of the topics involved nature study, they explored the second-growth oak and pine woods surrounding the school. They discovered a network of existing trails and began clearing the area of large amounts of litter and trash that had been dumped there. The children collected leaves which they brought back to the classroom to identify, first noting various characteristics. They grouped many of these characteristics by categories, such as number of lobes, number of needles, leaf shape, opposite or alternative veins, etc., and then used these groups to help identify the leaves. When they wanted to compare the size of leaves, they measured the perimeter of the leaves and graphed the measurements. This class stopped work on Nature Trails in the fall and decided not to resume in the spring because they were involved in other science activities.

The teacher introduced the Nature Trails challenge to another science class in the spring. This class had been envious of the other class's work during the fall. The children worked on their trail in groups every day during their forty-five minute science period. They picked up trash around the area, identified interesting points to include on the trail, and began mapping various side trails. One group worked on measuring the main trail between points of interest and another added the measurements to find a total length for the trail. A group of children used the measurements to make a rough scale map of the trail which they planned to transfer to a piece of plywood and place at the beginning of the trail. Another group of children worked on identifying trees and smaller plants along the trails. The school year ended before the children could finish their work, but they planned to work on the trail during the summer and to present it to other classes the following year.

*Edited by USMES staff

Part I
(September-October 1974)

In the fall of 1974 I introduced the Nature Trails challenge to one of my three fourth-grade science classes. We began work on the unit by discussing what kinds of scientific activities the children had done the previous year. It turned out that the children had generally learned science from a textbook by reading and performing the experiments listed at the end of the chapter. They had not been exposed to real problems while learning about nature. We talked about some of the things that the children wanted to learn about this year, and their list included "animals," "trees," "nature," and "insects."

Since this was my first year at the Cotuit Elementary School, I told the children that I was curious about the wooded area which surrounded the school. The children proceeded to tell me that there were woods, overgrown trails, a frog pond, and a meadow. Most of the children had also come from another school and were not familiar with the area. One boy who was familiar with the trails suggested we go out to explore the area. The class was excited by this idea, and we spent the last twenty minutes walking the trails and listening for sounds.

The following day the class went out to explore the opposite end of the school grounds. We decided to take paper and pencils to write observations in our "science logs." At my suggestion each person sat in one spot and recorded everything he/she could see, hear, or touch around them. Some of the children returned to the classroom at the end of this session with specimens of mosses and leaves they had found.

The following day we went out once more and discussed everything we had observed in the woods. We made lists of the things that children had jotted down. Several children were disturbed by the amount of litter we had found, and one group asked if we could clean up the following day. Several children offered to bring trash bags. One girl also volunteered to bring a couple of rakes for clearing the paths.

Since the children were talking about "trails" and "paths," I said that it sounded as if they wanted to make this area into a trail. Everyone said "yes," and one girl pointed out that when they were finished with the trail, other children might use it. Someone else suggested getting wood to make signs for the trail.

A few days later I asked the class why it would be a good idea to make a nature trail. Responses included the following:

(1) We could learn stuff by doing it.
(2) We could show it to other classes and then they could learn something.
(3) We could make it a nicer place to walk so people could use it again.

We then listed ideas for developing the nature trail:*

(1) Name the trees.
(2) Put names of plants and trees on boards and nail them to the trees.
(3) Plant new plants in certain areas.
(4) Make log steps on a hill.
(5) Name the paths; make signs.
(6) Make arrows for direction on the trails so people won't get lost.
(7) Make a color code for the path, i.e., main path--one color on trees, other paths--another color.
(8) Use stakes with ribbons for marking the paths.
(9) Place bird feeders along the path.
(10) There is one cleared area which could be made into a picnic area or a place for holding classes outdoors.

During the next few days the children worked in groups clearing the trail and looking for interesting points to include along the trail. I asked the children how they were going to decide which kinds of trees to include. They replied that they would pick only living trees and would try to choose trees of different types and trees that were interesting to touch.

After about ten minutes on the trail the children made the following observations:

(1) There are a lot of dead trees.
(2) Most of the trees are some kind of oak or some kind of pine.
(3) There are more different kinds of small trees/plants than larger trees.
(4) A lot of the places we cleared are littered again.

*After the list is complete, the children might group their ideas into major categories and then decide which tasks needed to be done first.--ED.

Leaf shape is round
Leaf margin is flat
Number of primary veins 3
Secondary veins are alternet
Length of leaf 6½ inches
Width of leaf 4 inches
Number of points (if any) 3
Additional observation

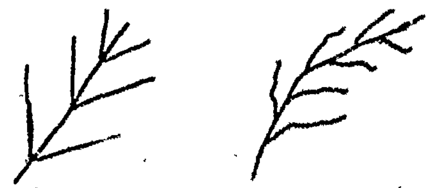
Figure C2-1

The children noticed differences in the shapes of trees which could help in identifying them. They collected several kinds of leaves, and I showed them how to press them between pages of a book to keep them flat. We had a class session on categorizing the leaves by examining their characteristics. The children wrote down various characteristics which I asked them to identify for each type of leaf (see Figure C2-1). I asked the children to list the different ways they could group their leaves. They thought of the following ways:

--Size of leaves
--Length of leaves
--Color of leaves
--Pointed vs. smooth
--Shiny vs. dull
--Shape of leaves
--Width of leaves (fat-skinny)
--Broad leaf vs. needle.

After we had discussed these characteristics, I asked the children to take one of their groups of leaves and subdivide it into smaller groupings. One girl discovered that some of her pointed leaves had seven points while others had five. Another boy found that some of his needle clusters were in threes while others were in fives.

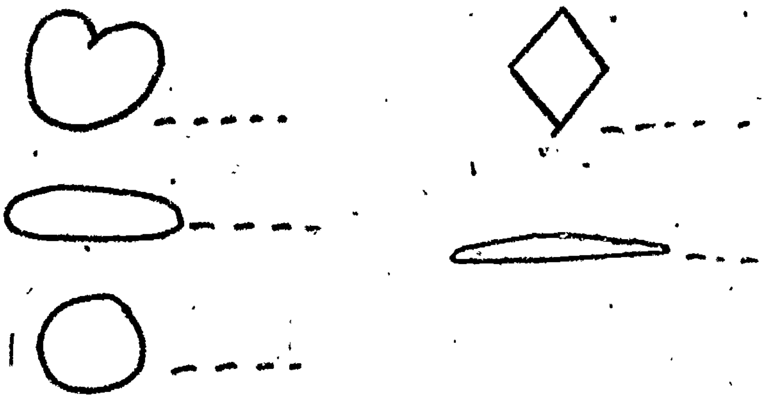
We then began looking at the vein structure of the leaves and discussed the purposes of veins/for transporting fluids in our bodies as well as in trees. One boy noticed that all the leaves had big veins in the center and other veins branching off which were too hard to count. I asked if there were any differences in the way the veins were placed, and one girl drew two vein structures on the board. Her drawing looked something like this:



I told them this was an important characteristic in identifying leaves. We gave the different placement of the veins the terms opposite and alternate.

The children also traced each leaf and examined the outlines of the various shapes. We gave our own names to the shapes: heart-shaped, oval, round, diamond, feather-shaped. When I asked them which shape seemed to be most common, one girl suggested that we line up all the leaves according to shape and find out.

We cleared an area of the floor, drew our shape symbols with chalk, and tried to categorize the leaves we had collected accordingly.



There was much disagreement over the placement of various leaves. Since some children were more interested than others in working on this project, I suggested that a group of interested children continue to categorize the leaves and present their findings to the class.

While we were examining our leaves, two boys began arguing over who had the biggest leaf. I asked them how we could determine which was the largest. Some children replied: "Measure them." We discussed how this could be done. Various children suggested measuring how long or how wide the leaves were. One boy said that we could measure around the leaves, but another countered that a ruler could not go around a leaf. I posed the question to the whole class: How could we measure around a leaf? One of the girls said that we could outline the leaf with a piece of string and then measure the length of the string.

The children thought this was a good idea and we teamed up to work on measuring the perimeter of the leaves. I suggested that each group make a "string graph" of their measurements by cutting and pasting the lengths of string on a piece of construction paper after they had been measured. I felt that this would be a good way for children to be able to "eyeball" differences in perimeter of the leaves.

During the last few days of good fall weather the class worked outside trying to clear the area around the trails. They collected huge amounts of trash from the area, and one group tried to keep an area clear for making an "outdoor classroom." They made a sign requesting people not to dump things in the outdoor classroom and attached it to a wooden stick which was driven into the ground. Other children brought various small plants back to the classroom to identify. I suggested that we plant terrariums to keep these specimens alive. The children were excited by this idea and began bringing in jars for growing the plants they had collected.

Cold weather brought our Nature Trails activities to a halt at this point, and we planned to resume in the spring. However, this class began a study of marine biology in the winter which absorbed their efforts. Since we had many opportunities to go out on the beach and examine marine life, they preferred to continue working on this during the spring rather than resuming Nature Trails activities.

Part II
(May-June 1975)

Children in one of my other fourth-grade science classes had been asking me for some time if they could work on the nature trail in the wooded area around the school "like the other class did" at the beginning of the year. In mid-May I asked the class if everyone were interested in going out on the nature trail to explore the area and to see what they thought of it. Everyone said, "Yes," vehemently. I told them that we would spend this morning's science period exploring the trail and that they could take their science logs to record observations and feelings if they wished.

The general feeling when the class came back from investigating the trail was that it needed a great deal of work and that it had become a "dump." I asked the children if they would be interested in fixing it up. Everyone said, "Yes."

I requested suggestions about how the trail might be used if we improved it, and the children replied that our own class and other classes could go out on it and that other children would enjoy using it. One boy suggested that we make trails with signs to follow. Another thought that we could make signs telling what kinds of trees there were. Someone else wanted to clean up two areas he had seen that would be good for picnic areas. Before beginning any of these activities, we decided to spend more time on the trails familiarizing ourselves with the area.

We returned the following day to explore the trails and the woods. I suggested more strongly that the children record ideas for making a nature trail as they went. Everyone decided to take his/her science logbook, and we spent twenty to thirty minutes outside.

When we returned to the classroom, I asked the children what they had seen. One group of boys said that they had found several good trails that were overgrown and needed to be cut back. Another group felt strongly that we needed to keep the area clean. I asked them for suggestions about how we might do this, and they replied that there should be signs stating that the area was a nature trail for walking and requesting people to please not litter or dump things on it. Another group felt that we should make a large map at the entrance showing people the various trails they might take. I asked the class what order all these things should have--should some things be done before others? All agreed that clean-up must be done before anything else. We agreed to spend the remainder of the week exploring and to begin cleaning up the trail the following week.

The following day we held a scavenger hunt and, working in pairs, collected samples of things found in the woods. If the children did not want to pick the item, they showed it to me and then marked it down. We spent the last few minutes of the science period indoors examining our findings and trying various ways of categorizing them: green things, long things, round things, things with points, things that grow close to the ground vs. things that grow in high places, things that could be found in winter vs. things which were new in the spring.

During the next class session we made plans for beginning our Nature Trail activities. The children listed the important things that needed to be done:

1. Clean up the trail
2. Make a map of the trail
3. Identify various things to be included along the trail
4. Develop a system of marking the trail.

The last item on this list generated some discussion as we talked about whether we should have the same trail for coming and going or two trails, one for entering the woods and one for leaving. One boy suggested we use red marks to indicate the trail entering and green marks to indicate the trail, leaving the woods.

Most of the children seemed to want to use wooden signs rather than metal markers. One boy asked if he could bring in a hatchet to help make new trails. After some discussion we decided to choose the existing trails we planned to include in the trail before deciding whether it would be necessary to make new trails.

We spent the last few minutes of our science period that day finding spots which needed to be cleared of litter. Some of the children took "before" pictures of these areas to document what they looked like prior to clean-up.

On Monday of the following week the children arrived armed with plastic trash bags, burlap sacks, and paper bags. Since only one child had brought gloves, he was chosen to be the "glass picker-upper" for the morning. We discussed what was trash and what was not and what should be done with it. Dead branches and sticks were to be left in the woods. Large objects such as car fenders were to be carted to the "main dump area," an area we agreed must remain, at least temporarily, as a trash collecting point since a large dump truck was necessary for removing all of the trash left there.

During their trash collecting activities the children found everything from old socks, kitchen mixing bowls, fenders, car batteries, and many bottles and jars to a large sink. After about twenty-five minutes of cleaning we had five full trash bags and several partially-filled bags of trash. We decided that we still had a long way to go and planned to continue cleaning up the next day.

After clean-up the next day we returned to the class to discuss what to do next. About one-third of the children decided to continue cleaning up the area. Another third planned to explore new trails, making a rough map as they went. The remaining third wanted to begin marking trees on the main trail, which is T-shaped. I asked this group how they planned to determine which trees to mark. One boy suggested that we mark trees at intervals of a certain number of feet along the trail. Another boy countered that trees might not be found at those specific points, and a girl suggested that they just choose appropriate trees. The group decided that we could measure between the points chosen and use the measurements for making a scale map of the trail.

During the next few days the three groups worked hard on their various activities. The clean-up group continued to remove litter and, after making a final sweep of the area, agreed that all the trash that could be removed had been picked up. No new litter appeared during their clean-up activities. The children in the trail-finding group were excited by some of the new trails they had discovered and had begun making rough maps of them. The trail-marking group had trouble deciding how to divide their labor, but they finally agreed to have one person measure the distance between points with a carpenter's ruler, another person add up the measurements, another mark down the total numbers, and a fourth make a small mark on the tree with spray paint to show that it was a point on the trail.

When these tasks were more or less completed, the children decided to regroup to work on new projects. The groups they chose were—

1. sign-making group
2. group for choosing trees for signs and measuring distance between markings in preparation for making a scaled map (continuation of former group)
3. group for using calculator to find total distance of major "T" trail (would work with Group 2)
4. map-drawing group
5. identification group (for classifying trees and plants).

When one boy said that he felt we should find out the names of some of the trees so that other people could learn them, I asked how we could pass on this information to other people. The children had two important suggestions:

1. Attach the names on the trees along with signs marking the trail.
2. Make a pamphlet with a map and identification key with a number corresponding to the one on the tree. ("Then the kids could just look it up in the pamphlet.")

This second idea seemed to be the most popular.

The children decided that the directional signs they planned to make should designate the number of a particular trail. Trail #1 would be the major trail while Trails #2, 3, 4, etc. would lead off of Trail #1. The mini-map they

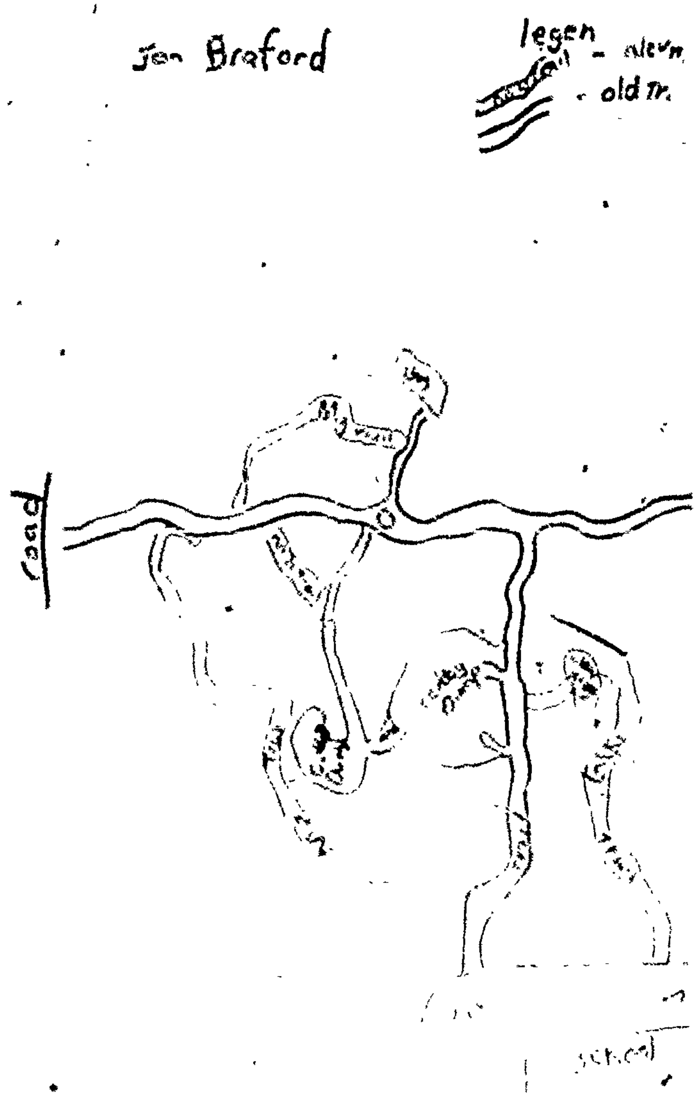


Figure C2-2

intended to draw would show the various options. I asked the children if they planned to make a large map of the trail as they had previously indicated, and they decided that it would be good to have a large one either in the school or at the beginning of the trail.

For the next few weeks the children worked diligently in their separate groups to complete work on the trail. The sign group brought in several pieces of wood approximately eight feet long. They decided that signs should be six inches long and began marking off the boards, finding that each board could make sixteen 6" x 3" x 1/2" signs. When they had finished measuring, they sawed the wood and began sanding the signs.

When they had made the signs, they held a discussion to determine what to put on them. They decided to wait until the trails to be used had been determined. They then made letters on the signs for five of the trails, writing T1, T2, etc., and leaving space for names of trees if these were desired. They brought in green and yellow yacht paint and began painting the letters on the signs that had been completed, using green for trails going <u>in</u> and yellow for trails going <u>out</u>. I found an aide to work indoors with this group while I went out with the other children.

The group measuring the main trail continued to determine distances between trees which they marked along the trail. When they had completed the measurements, two children worked with a calculator attempting to compute the total length of the main "T" trail. Their first efforts were not successful. They had tried to convert measurements in inches to feet and had ended up with nearly the same number of feet as they had inches! During the following session I worked with them, and we uncovered one of their problems—they seemed not to be using decimal points in figuring calculations. Our results were much more reasonable the second time.

The group mapping the trail worked in subgroups making rough maps of the various side trails. They made these maps by walking the trails, measuring distances, and noting general directional changes by moving their lines to the right or left on their paper. One of these rough maps of part of the nature trail is shown in Figure C2-2.

The children discussed which trails to include on the main map, deciding first to work together to see if they could combine their different maps into one. They found several discrepancies in the various maps the children had made, and they walked these trail segments as a group to iron out their differences before making a combined map. Part of the group also began to examine sequences of trails and to determine

how they could be numbered. These children also began planning the best appearance for the final map--how it should be labeled and whether it should have a legend.

The map group decided at first to work in various subgroups on drawing their rough maps to scale. Two boys read the USMES "How To" Cards on scaling and then began working on scaling the maps they had made. Another group of girls read the "How To" Cards and decided to work on the exercise given in the cards--scaling down a playground of 100 ft. by 50 ft.--before working on their maps. Working as a whole group, the children chose a scale of 1/2 in.↔2 ft. They put together two large pieces of plain paper, each 1 yd. by 1 yd., and drew the map to scale using all the measurements of trails that had previously been calculated. They made marks on the paper at half-inch intervals to figure out the length of the trails on the map.*

The children completed this map and tried it out on several children not involved in making it to find out if it could be clearly understood. The children planned to transfer it to a piece of plywood sealed with contact paper or lacquer to resist poor weather. They decided to place the map at the beginning of the trail so that it would be helpful to everyone walking the trail.

Two children broke off from the mapping group and began lining the trail with dead logs and branches.

The identification group was slow in getting started. During the first few class sessions after the groups were formed, the children in this group explored new areas of the woods, searching for other trails. Then they worked on tying back tree branches that were across the major trails. Finally, they began collecting leaves to decide what types of things they could try to identify. They looked at some books that I had brought and began determining what kinds of trees grew along the trails. They stuck pressed leaves to pieces of paper and wrote the names of the plants underneath, as shown in Figure C2-3. When they had identified all of their samples, I asked them which things were most important to look for in figuring out what kinds of trees the leaves came from. They mentioned shape, number of points, and types of edges. We discussed several shapes they had found: round, oval, and diamond. These had been determined by drawing outlines of the leaves and categorizing the rough shapes. We counted the "fingers" of the different oaks to see what the differences were between types.

*The children might also make their maps on large sheets of manila graph paper with half-inch square grids.--ED.

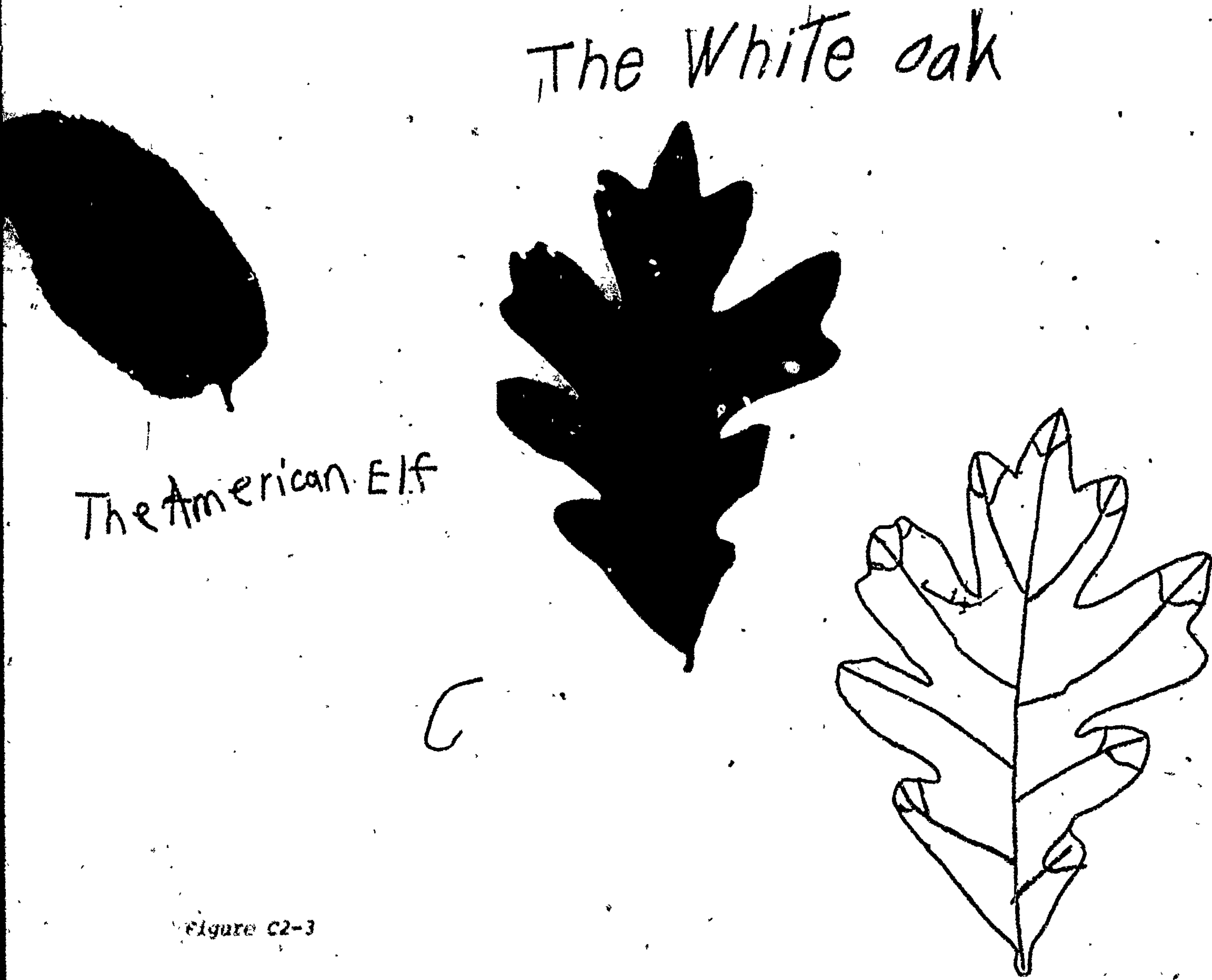


Figure C2-3

I showed them the alternate and opposite types of vein patterns on different leaves. The group also worked on identifying other kinds of plants. By the end of the school year they had identified several different oaks, two evergreens, ferns, lady slippers, Indian pipes, poison ivy, poison sumac, and reindeer lichen.

In the midst of this group activity I held a class discussion to help refocus on the problem of creating a trail for other people. I asked the class if they had thought about how we might introduce the trail to other children. They had several suggestions:

1. We could give them written directions and a map and see if others could follow the directions.
2. We could teach some how to use a compass and give them compass directions to a particular place or to a prize.
3. We could make up a scavenger hunt for them to use.
4. We could ask them to find, e.g., two different kinds of oak or direct them to an area, e.g., one square foot, which they would examine to see how many different kinds of things they could find.
5. We could make up activities like "Find the tree with the biggest trunk on Trail #1."

The school year ended before we had a chance to finish the trail or to take other classes on tours around the area. We hoped that we would be able to meet during the summer to finish the nature trail, but my schedule was too full to include this activity. Our hope is that the work we began has been useful to other classes observing nature in our woodlands.

3. LOG ON NATURE TRAILS

by Ida Campbell*
Hilsman Middle School, Grade 7
Athens, Georgia
(March-May 1974,
October-November 1974)

ABSTRACT

Two seventh-grade classes worked successively on designing and building a nature trail for their school during the 1973-1974 and the 1974-1975 school years. Both classes spent nearly every science period on Nature Trails activities during the months involved. The first class planned and cleared the trail. With some help from a forester, the children identified trees along the trail and constructed signs to label them. These signs and some directional arrows were put up shortly before the school year ended. The children also took soil samples in their area and compared the texture, color, and moisture content of soil at different depths and in different places along a slope. With some help from another expert, the children began mapping their trail by measuring distances between markers set up along the trail and also taking compass readings at these points. They wrote their measurements down but did not have time to make a scale map before the school year ended. During the last few days of school, several children gave tours of the completed trail to other classes. The children were pleased with their results and proud of the compliments they received on their work.

The following year, the same teacher introduced the Nature Trails challenge to another seventh-grade class. These children had many ideas about what could be done to fix up the trail, but they had time only for clearing the path and lining it with fallen tree trunks. The children employed various physics principles, such as leverage, in figuring out how to break up logs to line the path. Some children also disposed of trash found along the trail. One day during this outdoor activity a boy found a rattlesnake, which provoked much anxiety and discussion. The class also identified trees along the trail so that they could put up the signs made by the previous class. During the year the signs were torn down, and the children could not figure out a way to involve other students to avoid these acts of vandalism. However, the class still found the trail useful for studying fungi, moss, lichen, and insect life later in the year.

*Edited by USMES staff

Part I
(March-May 1974)

When I introduced the Nature Trails challenge to my seventh-grade class in the spring, the children were excited by the idea of working outside. They immediately wanted to explore the surrounding wooded area. Before we ventured outside, however, we discussed conduct for working outside and made the following rules:

1. Stay within sight of the teacher.
2. A whistle will be blown to get attention--you must gather around the teacher or aide who blew the whistle.
3. Do not pick anything unless asked to do so.

Our principal went with us on our first exploration of the woods. He showed us the property lines and discussed how far the trail could go on property not owned by the school. Some of the children went with him through the thickest vegetation in the wooded area while the rest of us circled around to see where the paths went.

One group found the skeleton of a dog which still had patches of hair stuck on the bones. The children felt that someone had hanged the dog because there was an electrical cord tied around its bones. The children were very upset by this, but they decided that it might make a good point on the nature trail.

I had asked the children to note whether all the pine trees looked the same, and, during our class discussion the following day, the children agreed that there were distinct differences. One girl had collected some pine needle clusters from different trees, and she noticed that some trees had needles in clusters of twos and others in clusters of threes.

Before we started working on the nature trail, I posed the following questions for the children to answer:

Questions:

1. What is a nature trail?
2. What things would you expect to see on a nature trail?
3. Have you seen any interesting things outside that we should include in our nature trail?
4. What should be our next step in making our trail?
5. What things do we want to learn from our nature trail?
   About:
   (1) Animals (2) Plants (3) Other

Group
Patricio Ruben
Carl Sneats
Homer Jordan
Dale Patrick
Tony Dorsey

Problem: How can we make an outdoor area to learn about nature ?

Questions:
1. What is a nature trail ?
A. A place were there are plants are animals.
B. Learn about nature and life.
2. What things would you expect to see on a nature trail ?
A. plants and animals
B. bones of animals
C. trees and insects
3. Have you seen any intersting things outside that we should include on our nature trail ?
A. the bones together
B. And put up signs
C. put out flowers
D. put some chairs out
4. What should be out next step in making our natuse trail ?
A clean the trail out
B. put signs on the tree to tell you were you going
BACK→

5. What things do we want to learn from our natuwa trail ?
About: 1. Animals
2. Plants
3. Others

Animals: what kind of animal are out there. How they live how they communicate How they build there homes
Plants: How they grow what kind of color they are.

Figure C3-1

The children recorded their suggestions in groups of three to four. One group's suggestions are shown in Figure C3-1.

When the children discussed their suggestions the following day, they noticed that different people expected different things of a nature trail. The class decided that the best idea for the next step was to find interesting things and to make signs.

We took a trip outside to look for interesting things to identify along a small portion of the trail through the forest. The children looked for other kinds of trees besides the pines, which predominated, and one girl noticed a "dog tree" (dogwood). The children decided that there was enough variety among the trees to produce an interesting trail.

I called the Forest Service for information on identifying trees, and a forest ranger agreed to work with the class and give some informal lectures. The ranger they sent began by discussing the difference between evergreen and deciduous trees. He said that it would be hard to find differences between trees which had dropped their leaves during the winter, but he gave us some clues to watch for, such as bark, berries, and buds.

The children wanted to make a pond in the woods as an extra attraction along the trail. One boy suggested that we put rocks or plastic in the bottom to keep the water from seeping out. I reminded them that we should keep the trail as natural-looking as possible—perhaps we could dig a hole and allow it to fill up with rainwater.

The children were concerned that the water would drain out and that we wouldn't have enough rain to fill it. Our aide explained that her husband had made a pond which had stayed filled with water, and we discussed how soil could reach a saturation point, preventing the loss of water seepage.

One boy suggested that we dig a hole at the bottom of a slope so that we could catch as much runoff as possible. The class thought that this was a good idea and decided to pursue it, but several children were still concerned that we would not have enough water to fill a pond. We decided that, in science, we couldn't always know how an experiment would turn out, but we could make a hypothesis and hope for the best!*

*The children might discuss whether the experiment could be carried out on a small scale and the results subsequently discussed.—ED.

When the class went out to select a spot for making the pond, the principal came with us to make sure we stayed on school property. With his guidance, the children selected a shady place lower than the surrounding land. We decided to build a dam to hold back the water in the depression, and some of the children set to work on building up the dam and packing the dirt firm. Other children began clearing pine needles and leaves from the floor of the pond.

During the next few sessions, one group of children began digging the pond. Another group took the initiative of raking away pine needles to make a path from the dirt road to the pond. They discussed the best place for their path first and decided that it should branch off with one fork leading to the edge of the pond and the other going around the side to the back of the dam. This path would lead back to the dirt road. The children beat down briars and pulled up vines to make the path. Three boys lined the path with rocks and bricks to make it easier to see.

We held a class discussion to determine the next activities to do for the trail. The children wanted to make signs for the trail, but realized that this could not be done until we knew what types of trees grew in the area. While some of the children continued working on the pond, the rest of the class read library books to find information on twig and leaf characteristics and names of trees. The children decided that they preferred to work on identifying trees themselves at first rather than asking the Forest Ranger to help them.

We had a series of rainy days during which it was too wet to work outside. The class went on a field trip to the University of Georgia to observe their nature trail. The guide was very informative and the children listened attentively to him. On the way back the guide asked the children to pick up some trash from an overflowing can and emphasized the need to place trash cans along a trail and to post signs asking people not to pick plants.

When the ground was drier, the children returned to the woods to make their pond. Some of the children made drainage ditches to channel water into the pond. They packed down the dirt on the dam wall after it seemed to be built high enough.

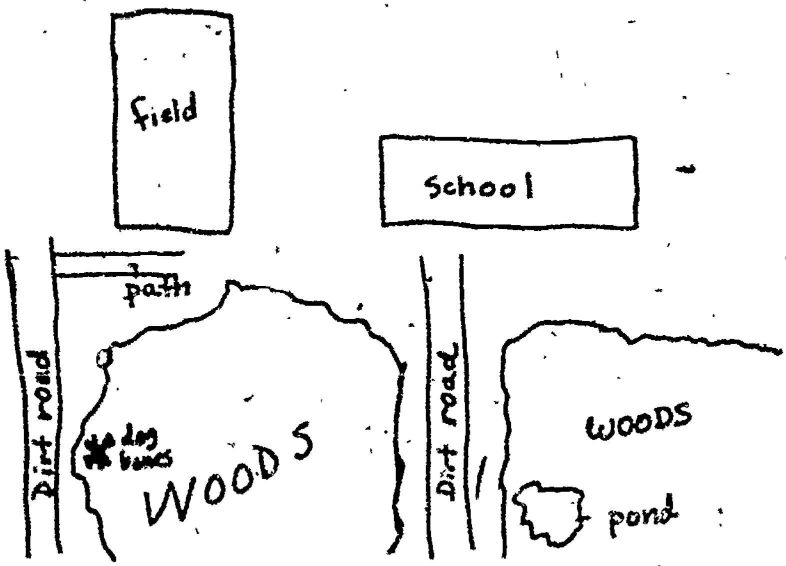
When we had progressed far enough on the pond, the class agreed that our most pressing need was to decide where the rest of the trail should go and to make the path. The children decided to make a trail connecting the pond with the dog bones which we had found on our first visit to the woods. This proved to be difficult, as the woods were very dense, and we had trouble finding our way from one point to another. Finally, five boys found a way to get from the pond to the dog bones, and we decided to use their route since no one could think of a better way. This way took us through a burned area which we decided was probably caused by an accidental forest fire.

The class watched a film, "How Nature Protects Animals," which stimulated a discussion about the kinds of animals we might find along our nature trail. The children listed the birds they had seen as sparrows, blue jays, cardinals, crows, and robins. We talked about how noise might scare birds away and how planting seeds and putting up bird feeders might attract them. After reading more about birds and their habits from a pamphlet, "Let's S.E.E.," a publication of the Georgia Conservancy, Inc., the children decided to walk quietly along the trail, to avoid wearing bright colors, and to be more observant about bird life in the woods.

On our way to the pond the next day we spotted a bird's nest. In the pamphlet on birds we had read that adult birds would not go near a nest which had been disturbed, and one girl reminded us that we should leave it alone. The children were generally more observant of wildlife in the woods after our indoor reading and film-watching session.

To make our path between the pond and the dog bones, we tied the end of a huge spool of string to a tree near the pond and followed the five boys on their trail to the bones. One boy sang a song about "dragging your feet," so we did this to help start a pathway through the deep pine straw. As we made our way back, I had misgivings because our proposed path went through dense woods and required almost crawling under tree branches at times. The naturalist at the Botanical Gardens had told us that a trail should be easy to follow. I decided to ask the children for suggestions about how we could improve our pathway.

We discussed the best way to begin clearing the new path. One girl suggested that we leave the string up so that we could follow it to our destination. A boy suggested that people line up along the route and each clear a section. Another boy insisted that we should only clear a little at a time to be sure we were going the right way.



When we went outside to our woods, I reminded the children of what the naturalist at the Botanical Gardens had said—that our trail should take the easiest route. We then chose a short distance from the dirt road and cleared a path along this segment.* This method seemed to work well, and we continued planning the trail as we went along.

In spite of our efforts to choose the easiest route, we could not avoid cutting down seedlings and tree branches which grew in the way with a saw borrowed from the shop room. At one point, the children who were laying out the path laid the string too close to some houses, and the class had them move the string to another section. The children used rakes, hoes, and clippers to clear the trail and cut away vegetation which grew in the way.

The class decided that other groups should be formed to work on marking trees along the trail, identifying them, and making signs for them. I asked the children how we could identify trees outside, and one girl suggested that we take our "tree books" with us to find out what kind of

*The children might explore different ways to get through the woods, making notes about problems encountered and interesting things to see on the different routes. The distance of the most interesting routes might be measured later and the trade-offs among distance, difficulty in making the trail, and interesting points discussed.—ED.

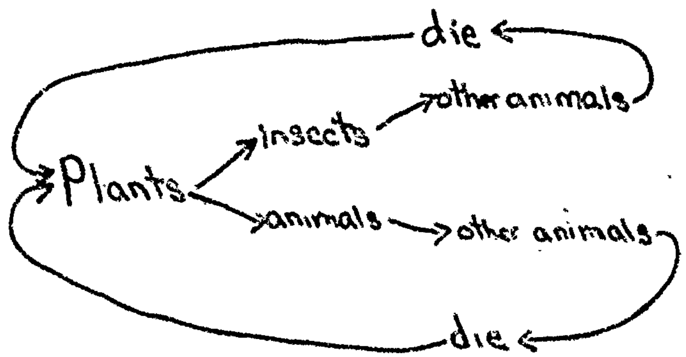


Figure C3-2

trees grew in the area. One boy said that the trees we decided to include along the trail should be growing next to the trail, and that they should be different kinds of trees. The children formed a committee to pick the trees for identification and to tie strings around their suggested specimens. The class would make the final decision on which trees should be included.

Three girls who showed no interest in working outside with the rest of the class on the trail made a bulletin board display of leaves we had collected and began designing signs for identifying trees along the trail. The shop teacher gave us wood, nails, and paint for the signs, and the girls drew outlines for the signs on plywood. The only guidance I gave them was to tell them to be sure to place the paper patterns side by side so that there would be no wastage of wood.

The entire class stayed inside one day to watch a movie entitled "The Temperate Deciduous Forest." This film showed the interrelationship between organisms living in the forest and how animals eat other animals as part of the natural food chain. I asked them to think back to the beginning of the movie and to tell me where the food chain begins. The children remembered that plants are the basis of life. I drew a food chain on the board which the children dictated. One child's copy of our food chain is shown in Figure C3-2.*

Later in the week I noticed that two boys were acting bored with the trail because there were not enough tools for everyone to work on it at once. I asked them if there were anything they could do to make the trail more interesting, and the boys suggested planting flowers. I reminded them that we should keep the trail as natural-looking as possible, and they decided that they would dig up wild flowers from a field to plant along the trail. When the boys brought up their idea in class, one boy warned them to be sure to dig very deep so that the root system would not be destroyed.

Another teacher in the school brought in six clumps of wood violets for them to plant. The group of three boys took a wheelbarrow, two watering cans, and three shovels that I had located out on the trail. They surveyed the woods for the best location for the violets and chose two sites which had partial sunlight.

*The children might discuss how this knowledge might be passed on to those who would use the trail.--ED.

By-Shaila Hunter
Vanessa Cox
Patricia R.

Sign design

We are working on Signs. Frist we got some wood and, then we measure off blocks on the wood with paper. After we finsh doing that we decide to cut the blocks and arrow out. But we thought that If we Paint the hole thing frist

Figure C3-3

One of the boys directed the other two boys to chop up the clods of dirt. He told them that they should put pine straw around the violets so that the dirt would not dry out and the violets would not be choked by grass weeds. When they had planted the violets and spread pine straw around, the two boys thoroughly wet the surrounding area with water from their can. They repeated this procedure for the next site.

The forester came again to our class to help us with identifying trees. He brought with him several "Native Trees of Georgia" booklets and asked the children to identify a pine tree which he had picked out. One child looked at a picture in the book and guessed that it was a slash pine. Another child reminded us that we should check needle length, and we measured the needles and found that they were six inches long. We found that the bark and needles fit the description of a loblolly pine.

The forester helped us tell the difference between a simple and compound leaf on a tree. The children quickly learned to tell the two types apart. By the end of the day the children had identified black cherry, persimmon, cedar, sweetgum, and dogwood trees.

The girls in the sign group stayed inside and painted half of the plywood red and the other half yellow. They intended to make the directional signs yellow and the identification signs red with black labelling to be sure they were obvious to people using the trail. A report of this group is shown in Figure C3-3.

One girl found a snake skin and another uncovered another pile of bones on one of our trips to the woods. We stopped our work that day and talked about the animals that lived in the woods and the food chain that existed there. The children found this discussion very absorbing and requested that we have talks about our environment more often.

The forester visited our school again to show one of the boys how to take soil samples with a soil auger. This boy led us outside to the top of a hill and took a sample 42 inches deep with the auger. The children noticed that the soil was much wetter and a little lighter in color at lower depths. We took another sample in the middle of the hill, and the children noticed that here the sample went from a deep red at the top to a bright yellow at a depth of 37 inches. Quite a bit of mica was evident and the soil became soft at lower depths. A chart showing the children's soil data is shown below.

Site I						
Sample No	1	2	3	4	5	6
Color	red	red	red	red	dark red and a little sandy	dark red and a little sandy
Feel (wet or dry)	a little damp	same	slightly damper	damper	damper and rockier	damper
Depth	6½"	12"	17"	22"	26"	32"

Site II								
Sample No	1	2	3	4	5	6	7	8
Color	red orange	same	lighter	lighter	orange	lighter	tan or yellow	lighter
Feel	← Same as Site I →							
Depth	5"	10"	15"	19"	2½"	24"	33"	37"

The next day the boy who had become our soil expert showed us the hole that the forester had made at the bottom of the hill while taking a soil sample. This hole was very deep, and we could hear water sloshing around when we put the auger down it. This intrigued some children in the class. Another boy took charge of taking samples at different depths and putting them in a coffee jar with disks in between to separate the levels. We felt the samples from different depths and checked their color and wetness. The soil changed drastically in texture, moisture, and color as we went from the surface to 57 inches below the surface. The top soil was deep red, dry, and coarse; the soil at 57 inch depth was very moist, gray-white clay. The children enjoyed this activity immensely, and all were involved in passing samples around in jars.*

The forester came again to work with children interested in identifying trees. The forester picked some of the more difficult trees in the woods to key this time. He would not tell the children the name but only nodded when they found the right answer. This activity became a guessing game, and the children in the trail-clearing group became interested and joined in. The children identified a sassafras tree and a southern red oak.

*The children might discuss how this information might be passed on to the children using the trail.--ED.

We had a series of "treasure hunts" to help the children identify trees. They were given a list of trees to find, and they went outside to look for the trees and to bring leaves as proof. Many children who had not previously been involved in identifying trees became interested in this activity.

The children felt that they were ready to identify the trees to include along the nature trail. A group of children went out to mark trees as points on the trail; some children on the sign committee went with them to see how many signs to make. The children marked fifteen trees, but some members of the class wanted to include more along the trail.

Since the children in the sign group were having trouble cutting plywood with a handsaw, the shop teacher gave the group several strips of wood to use for tree identification signs. The children in the group decided that we would have enough wood if we cut each strip in half. One of the girls in the group began measuring the wood (using centimeters) and dividing the length by two to make each sign. Several boys joined this group to help cut signs. One boy thought of a good method of sanding the edges of the signs; he took a piece of sandpaper, wrapped it around a small piece of wood, and tacked it in place to make a good sanding block.

A boy who stayed indoors during one class session made a remarkably accurate map of the nature trail from memory. His drawing is shown in Figure C3-4.

Several children found wild flowers growing in fields across the street, dug them up, and carted them to the trail in a wheelbarrow. They planted these flowers along the trail near the violets. Since they had been taken from a sunny field, the children planted them in a sunny place in our woods.* Some of the flowers died because the children did not dig up enough dirt with the roots.

The pond which we had made at the beginning of work on the challenge did not fill up with water except immediately following a heavy rain. The soil in that area was too sandy, and water quickly seeped through it. Toward the end of the school year we removed the plastic from a former greenhouse, intending to use it for the floor of the pond to prevent continued seepage. Because of the limited time

*The children could also take soil samples in the field and the new location to see if the soil was similar and would provide similar growth conditions.--ED.

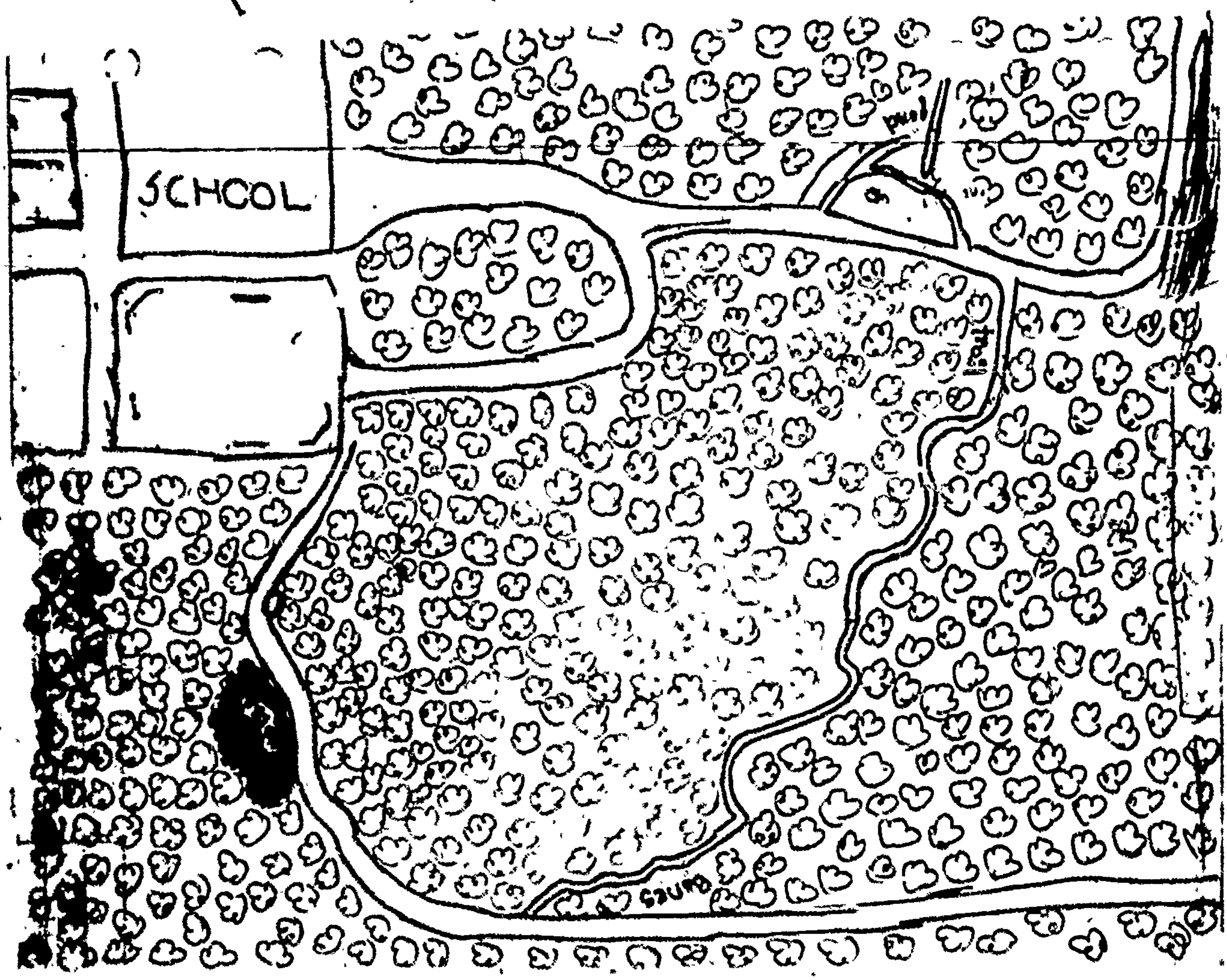


Figure C3-4

NATURE TRAIL
PATTI HILSMAN MIDDLE SCHOOL

STARTING POINT	BEARING (DIRECTION)	DISTANCE	POINT	NOTES
A	S-60W	100ft 10in	B	
B	S60W	111 ft 2in	C	
C	S-60W	224ft 5in	D	
D	S-50-W	78 ft 11in	E	
E	S-30W	60 ft 5in	F	
F	S-45-E	42 ft 10in	~~H~~	
	S-20W	59 ft 9 in		
H	N-85W	14 ft 2 in	I	
I	S-35W	34 ft 11 in	J	
		33 ft 7½ in	K	
J	N-40W	30 ft 9½ in	L	
L	N-84W	31 ft 8 in	M	
M	S-70W			
N	S-30-E	41 ft	N	
	N-40W	26 ft 3 in	O	
Q	N-43-W	34 ft 10 in	P	
P	N-5-W	31 ft ½ in	R	
P	N-30-W	34 ft 1"		
R	S-10-W	39 ft	S	
S			T	
	50-N-W	27 ft 11"	U	
T	S-N-E	48 ft 6"	V	
U				
V	10-5-E	36 ft 5"	W	

Figure C3-5

remaining in the school year, we decided not to put it up until next year. If the plastic were left out over the summer, it would certainly be stolen or vandalized.

One child's father, an entomologist with a forestry degree, came to help the children map the nature trail now that we had completed most of the trail-clearing.* Before going out on the trail, Dr. Yeats explained the mapping procedure. Markers would be placed at various points along the trail, a special tape measure would be stretched between points, and the distance would be recorded. Compass readings were to be taken at every point.

We realized when we went out that we had never chosen a starting point for the trail. The children decided to begin at the dirt road so that the sign we planned to make for the entrance could be seen from the school.

Dr. Yeats showed the children working with him how to mark two points with a stick or rock and to stretch the tape between them. The children recorded the measurement on a chart as the distance between A and B. The compass group was shown how to take compass readings that were recorded with the measurements. The children's first page of measurements for the trail is shown in Figure C3-5.

In the classroom, Dr. Yeats briefly explained how to draw a scale map of the trail using the compass readings and the distances we had measured. After class, he showed me how to plot points on the large sheets of graph paper he had brought.

The following day, the children continued to take measurements. The children worked very effectively with the tape measure and the compass. Since our points were farther apart than the length of the tape measure, the children had to take more than one measurement for each segment and add up the distances. A typical calculation looked like this:

50' 5" 50' 5" 7' 4" 107'14"	12" in a foot, so total = 108' 2"

The measuring activities proved to be very useful experiences for the children working on them. The boy taking the compass readings also improved in skill. He remembered to give north and south readings first, then the degrees, then east or west directions, e.g., North 38° West.

*The children might discuss how they would use the maps and decide how accurate the maps needed to be for that purpose. --ED.

Since the end of the year was rapidly approaching, we worked hard trying to complete our signs for the nature trail. The sign group painted the strips of wood that had been cut out for identifying trees. Then two other children joined the group to help paint the tree names on the signs. The children formed a very efficient assembly line for completing this task. The names were printed on the signs with Magic Marker, and the signs were passed to other children who painted over the letters with black paint. We had a hard time deciding whether names of trees should be capitalized or not; after asking several teachers, we finally decided to capitalize them. The children completed fourteen identification signs during this operation.

A few red directional signs had been cut out of the plywood and were ready to be put up. Several children came from working outside to saw and sand more directional signs. The following day, the children came by during their spare time to make additional signs to put up in the afternoon.

As this was one of the last days before school ended, all the children worked with either the sign group or the measuring group to complete the trail. The measuring group completed taking measurements of the trail the following day, but we had no time to make a scale map of the trail before the year ended. However, the total measurement for the trail showed that it was nearly a mile long!

The sign group worked on identifying the trees that we had marked with our completed signs. The group ran into difficulty when they discovered that the nails were not long enough to penetrate tree bark.* Since they were aluminum, they also bent very easily. The following day, the shop teacher graciously gave us some nails that were long enough to go into the trees.

Most of the class went out to help put up the signs, and we finished quickly. Some signs were nailed into trees while others were nailed to stakes and driven into the ground. We ran out of red arrows for indicating direction, but there were no more cut out. Some of the children said that they would like to come back after school let out to "do this thing right."

Meanwhile, other children remained in the classroom to work on a large red sign for the beginning of the trail. Some children traced the letters onto the sign during math class, and four children painted the sign while the rest of us went out to put up the rest of the signs.

*The children might discuss whether nailing signs to trees would be harmful to the trees.—ED.

When the lettering was completed, the children took the board to the shop teacher and asked him to cut it out with an electric saw. Two children came by the following morning to put the sign up at the beginning of the trail. The sign, which could easily be seen from the school, read:

Nature Trail
Follow the
red arrows

I put an announcement in the teachers' bulletin inviting other classes to use our completed trail.

A photographer from our local paper took a picture of our class in front of the nature trail sign. The children were quite happy because a previous photograph appearing in the paper had shown only a few of the children working on the trail.

Another science teacher in the school asked to have children in our class give guided tours of the trail to two of his classes. One boy and one girl in the class were excused from classes to give these tours. When they reported to our class, they both said that Mr. A's classes had asked many questions and seemed to enjoy the trail a lot. The only criticism they received was that the trail needed more directional arrows.

Mr. A was so impressed with these tours that he asked for more students to give tours to his four classes the following morning. Two of my students volunteered for each class period. Everyone who wanted to give a tour had a chance to do so. I received good reports from the teacher, who said that the children were very informative and seemed well-acquainted with the points of interest along the trail. The children who gave the tours were very proud of their accomplishment and felt that, for the first time, they had contributed something to make the school a better place.

Since this was the last day of school, we collected all of the signs from the trail. As we returned, another class was approaching the trail. Their teacher was very disappointed that they would not be able to use the trail, but one of my students volunteered to give them a tour. All morning, classes had been on the trail. The students felt that it was well worth the work to have the signs up for only a few days.

We then had a party to celebrate the end of the school year and the completion of the nature trail.

Part II
(October-November 1974)

During the following fall I began a discussion about "re-opening" the nature trail made by my class the previous year by asking the children in my seventh-grade class if they had heard of the trail. Most of the children knew about the trail, and some had gone on it last spring. I told them that there had been no maintenance of the trail over the summer: what would it be like now? The general feeling was that it must be all grown over. Perhaps the path was gone completely.

I admitted that I had not gone on the trail since the previous year and could not be sure of its condition. I asked what they thought could be done for the trail if someone wanted to reopen it.

"Stomp the bushes," one girl replied.

"We could bring stuff to help clear it up," someone added.

When I asked whether they would like to clear the trail and use it this year, there was a resounding, "Yeah!"

I asked them how the trail would be used. The students replied:

"We could use it to study nature."
"Others could use it."
"We could give guided tours."

I reminded them that we had been studying ecology and communities and asked how we could have used the trail for this study. The children replied that we could have collected "rolly pollies" (sowbugs) for our experiments or studied food chains and animal life along the trail.

We started to discuss how we could clear the trail, but the children wanted to see the trail first. The paths turned out to be in pretty good shape and the children were encouraged by their condition.

The following day, we began discussing how we could fix up the trail. The children had some very elaborate suggestions. One girl suggested that we take the metal trash scattered along the trail and weld it together to make sculpture. Another suggested that we make wooden cutouts of the animals that lived in the woods with wood-burning sets and hide them in the brush for people to find.

There was a discussion of whether or not we should leave the trail "natural," but the children decided that we would have to clear the trail so that people knew where it went. We decided to form committees that would be responsible for clearing different sections of the trail.

The agriculture teacher sent rakes, hoes, and shovels to our room, and these were distributed to the children.

We went first to the area where last year's class had attempted to make a "pond." The children began to rake and hoe the underbrush on the floor of the pond with vigor. Other children quickly cleared the pathway to the pond.

One group of girls wanted to line the pathway with rocks to make it look attractive; they quickly discovered, however, that there were few large rocks in the area. One child suggested that they use fallen branches. The girls decided that fallen tree trunks were even better. They had fun running through the woods to find decaying trees and bringing them back to line the path. All of the children who did not have a hoe or a rake joined in and quite a bit of the path was lined before the day was over.

At the beginning of the next class, one boy suggested that we find a way to control the weeds on the trail to keep it from getting overgrown during the year. Someone else told us about a big pile of sawdust no one wanted which could be spread along the trail to keep the weeds down. I asked the class to decide on a way to get the sawdust to school so we could spread it on the path.

The children formed into five committees which they called the rakers, the hoers, the shovellers, the trash picker-uppers, and the collectors of (dead) trees. However, we had a tool shortage when the agriculture teacher reclaimed his hoes and rakes for working on the garden. The children suggested that we bring our own tools from home and that we mark them with "tape that won't come off" to keep track of who owned them. I asked for volunteers to bring tools from home so that we would have enough.

One boy broke a hoe while trying to drag a fallen tree along the trail. We discussed the correct use of the tools and mentioned some safety rules to follow along the trail. The children suggested that no one should wear sandals when people were hoeing along the trail and that tools should be carried with the prongs facing downwards. No one was allowed to run with the tools.

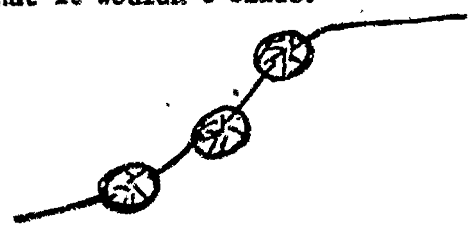
Some boys in our class wanted to get rid of a pile of trash that had been dumped in the trail area. They decided to use an upright, broken cement drainage pipe as a "trash can" for the trail. Some of the trash was to be buried in a hole in the ground.

When the boys began digging their hole, they uncovered some bones about four inches below the surface. The bones appeared to have belonged to a cow or some other large animal. The children were intrigued by this discovery. It stimulated their interest in finding out who used to live on the property a long time ago. "Maybe a mean farmer shot his poor mule," one child suggested. However, they later abandoned the search for bones because they seemed to be scattered all over.

The trash group dug a hole about 4'x4'x3' and gathered trash to be buried. Everyone pitched in and helped put the trash into the hole. The junk included rusted metal buckets, a lawn mower, an ironing board, cans, sheets of metal, and shoes. As the large pieces were thrown into the hole, one boy crushed them with a heavy metal pipe. When everything was in the hole, the children shovelled dirt over it and packed it down by dancing on the top.*

The children were concerned with putting up the signs which the last year's class had made. They decided that the directional arrows should go up before the signs identifying various trees, but most children felt that clearing the trail was the most important thing. We continued clearing away weeds on the trail and lining the paths with fallen trees.

One section of the path was very rough, and the shovel committee decided it needed to be evened up. They chopped away at the slope for awhile until someone suggested that they form steps. The children packed down the soil to make steps and collected stout branches which were placed into the soil so that it wouldn't slide.



One day I told the children that rain was expected and asked what we should do to prepare for it. The children decided that we should get as much done as possible on the trail because work would be difficult when the ground was wet. They also wanted to put the plastic on the floor of the pond in hopes of collecting rainwater. Five of us worked to lay out the plastic. We used rocks to anchor it

*The children should check state and local laws concerning trash. Many areas have laws preventing disposal anywhere except in designated landfill areas. The children might also consider ways to recycle or reuse trash collected along the nature trail.--ED.

down, and we spread pine needles over it to make it more natural.

As we worked on these various activities a boy came up to me and casually mentioned that Charles had seen a rattlesnake. Charles was last noticed running down the trail trying to find me. Gathering all my composure, I instructed the children to gather their equipment and come with me to find Charles. Others working on the trail joined us as we went along. There were many vows not to come here again if snakes were around.

We finally found Charles at the school. He had circled the trail twice to find me. He told me he had bent over to pick up a snake when he had noticed the rattle. The snake was about two feet long and was crawling across the path when he saw it. He told us that he had passed it again on his second time around the trail but was going too fast to notice much more about its appearance.

I began the next class by discussing the snake. I asked why the snake had not struck Charles when he got so close to it. The children replied that the cold weather had slowed the snake down. I then inquired why the snake would be slowed down in cold weather. The children said that its body temperature had been lowered because snakes are cold-blooded and their body temperature is the same as their surroundings.

Since our weather had suddenly turned warmer, I asked how this would affect our work on the trail. One child said that we could expect to see more snakes, but the children seemed calm and wanted to continue their work.

On our next trip to the nature trail, the children stomped their feet as we approached to "scare away the snakes." We continued to work on lining the trail with broken dead trees.

In this process the children employed more physics principles than I could ever teach them. When no saw was available, they used leverage to break up tree trunks. The log to be broken was wedged between two strong trees. The children pulled to exert pressure on one end of the log until it broke in half. An alternative method was to lay the log across two elevated areas and jump on the middle. This was dismissed as dangerous because they sometimes missed the log.

Since I am in a team-teaching situation I had to begin another unit the following week. The children had been aware of this time constraint and were ready to finish up their work.

The trash group began burying a second pile of trash they had collected. Some children wanted to put up the tree identification signs that last year's class had made. I asked them how they would know which signs went on which trees. Since we had not had time to work on identification, I felt we could do this in the spring. But one girl insisted that they could do it if I gave them some books.

When I asked the class who would like to identify trees and put the signs up, all the children raised their hands! I brought out the "Native Trees of Georgia" booklets from last year and briefly explained how to use them. We went out on the trail to see if we could identify any of the trees.

The first tree we came to the children recognized as a pine, but they could not agree on which kind. I reminded them about the "Key Characteristics" in their booklets. They read this section and decided that the tree was a loblolly pine because the needles were 6-9 inches long and were in clusters of three to a sheath. There was some argument over who would hammer the nail into the sign. After some confusion and several bent nails they decided that one boy was clearly the best with a hammer.

As we went along, two sweetgums, a black cherry, and some honeysuckle were identified and signs were placed on them.

During our trips to the trail we sometimes passed other classes on the trail. The class was really pleased to see other people using the trail and especially proud when they received compliments on their good work. The children wanted to work on the trail again in the spring when we could also give guided tours. Some children suggested making a pamphlet to go with the trail.

The day we started our new unit (which was on pollution and could be tied in well with the trail), I thought it worth our while to have a short evaluation of our work from the children. I asked the children the following questions:

1. Tell what you liked about making the trail.
2. Tell what you didn't like about it.
3. What should we have done differently?
4. What should we do next in developing the trail?
5. Let your imagination go and tell me what you would like the trail to be like when school is out for the year. What do you want to be included on the trail?

I read over the papers and was pleased with the responses. One child's evaluation is shown in Figure C3-6.

Colettie
Nov. 2, 1974
1st Period
Polaros

Science — Mrs. Campbell

1. What I liked about the Nature Trail
I liked to Rake
I liked following the trail.

2. What I did not like about it
I did not like picking up trash.
I did not like stomping my feet.

3. We could of done something different like:
We could of made posies Every time we move from a place to let you know we were near.

4. What we could of done: On the Natural Trail
We could of cut down some trees that was in our way.

5. If we could do the best trail we could make what would it be like?
It would be really beautiful the flowers, would boom. the trees would be so pretty green grass. Birds singing. Squarrels running from tree to tree. Maybe Rabbits hopping, playing The sun shinning. A little wind blowing.

Figure C3-6

During the following spring, my class cleared the new growth from the path so that people could use the trail again. The other seventh-grade science class helped them in order to get the work done more quickly. The trail was ready after one day!

When my class had cleared the trail the previous fall, they had put up ten tree identification signs, red arrow signs to mark the way, and the large sign indicating the beginning of the trail. All but one of the signs were torn down and taken within two weeks. The children had not made these signs, but they had taken great pride in putting them up in the fall. There was no mention of replacing them.

When we discussed this vandalism problem, the children decided that the only solution would be to get the whole school involved in a way to stimulate pride in the trail. The children did not know how to go about accomplishing this, and we did not discuss it again.*

We were still able to use the nature trail for studying molds, fungi, moss, and lichens. All of these plants grew abundantly on the logs we had used to line the paths. We also found several insects along the trail which the children tried to identify from a key.

*The children might be asked to think of ways to inform others about the trail and the vandalism, and they might then begin work on the Advertising or Mass Communications unit.--ED.

D. References

1. LIST OF "HOW TO" CARDS

Below are listed the current "How To" Card titles that students working on the Nature Trails challenge may find useful. A complete listing of both the "How To" Cards and the Design Lab "How To" Cards is contained in the USMES Guide. In addition, the Design Lab Manual contains the list of Design Lab "How To" Cards.

GRAPHING

GR 1 How to Make a Bar Graph Picture of Your Data
GR 7 How to Show Several Sets of Data on One Graph

MEASUREMENT

M 2 How to Measure Distances
M 9 How to Make a Conversion Graph to Use in Changing Measurements from One Unit to Another Unit
M 10 How to Use a Conversion Graph to Change Any Measurement in One Unit to Another Unit

PROBABILITY AND STATISTICS

PS 2 How to Record Data by Tallying
PS 3 How to Describe Your Set of Data by Finding the Average
PS 4 How to Describe Your Set of Data by Using the Middle Piece (The Median)

RATIOS, PROPORTIONS, AND SCALING

R 1 How to Compare Fractions or Ratios by Making a Triangle Diagram*
R 2 How to Make a Drawing to Scale
R 3 How to Make Scale Drawings Bigger or Smaller

New titles to be added:

How to Round Off Data
How to Record Your Data
How to Design and Analyze a Survey
How to Choose a Sample

A cartoon-style set of "How To" Cards for primary grades is being developed from the present complete set. In most cases titles are different and contents have been rearranged among the various titles. It is planned that this additional set will be available early in 1977.

*Presently called Slope Diagram.

2. LIST OF BACKGROUND PAPERS

As students work on USMES challenges, teachers may need background information that is not readily accessible elsewhere. The Background Papers fulfill this need and often include descriptions of activities and investigations that students might carry out.

Below are listed titles of current Background Papers that teachers may find pertinent to Nature Trails. The papers are grouped in the categories shown, but in some cases the categories overlap. For example, some papers about graphing also deal with probability and statistics.

The Background Papers are being revised, reorganized, and rewritten. As a result, many of the titles will change.

BIOLOGY

B 3 *Identifying Organisms* by Abraham Flexer

GRAPHING

GR 3 *Using Graphs to Understand Data* by Earle Lomon
GR 4 *Representing Several Sets of Data on One Graph* by Betty Beck
GR 7 *Data Gathering and Generating Graphs at the Same Time (or Stack 'Em and Graph 'Em at One Fell Swoop!)* by Edward Liddle

GROUP DYNAMICS

GD 2 *A Voting Procedure Comparison That May Arise in USMES Activities* by Earle Lomon

MEASUREMENT

M 3 *Determining the Best Instrument to Use for a Certain Measurement* by USMES Staff

PROBABILITY AND STATISTICS

PS 4 *Design of Surveys and Samples* by Susan J. Devlin and Anne E. Freeny
PS 5 *Examining One and Two Sets of Data Part I: A General Strategy and One-Sample Methods* by Lorraine Denby and James Landwehr

RATIOS, PROPORTIONS, AND SCALING

R 1 *Graphic Comparison of Fractions* by Merrill Goldberg
R 2 *Geometric Comparison of Ratios* by Earle Lomon
R 3 *Making and Using a Scale Drawing* by Earle Lomon

3. BIBLIOGRAPHY OF NON-USMES MATERIALS

The following are references that may be of use in teaching Nature Trails. A list of references on general mathematics and science topics can be found in the USMES Guide. (Publisher's prices, where listed, may have changed.)

Reference Books for Teachers

Biological Sciences Curriculum Study. *Investigating Your Environment* (Teacher Guide and Student Handbook). Addison-Wesley Publishing Company, Menlo Park, California (1975).
This program, designed for high school students, explains techniques for making investigations of such environmental factors as air and water quality, and use, human population density, and noise. Techniques for taking opinion surveys or conducting interviews will be most useful to teachers of Nature Trails.

Elementary Science Study (ESS). McGraw-Hill Book Co., Webster Division, Princeton Road, Hightstown, N.J.

_____. *Butterflies*. Teacher's Guide ($3.48).
This book is mainly about captured butterflies, but it also describes the life cycle and feeding habits of butterflies.

_____. *How a Moth Escapes from Its Cocoon*. ($1.50)
Describes the life cycle of a moth and in particular, how a caterpillar becomes a moth.

_____. *Mapping*. Teacher's Guide ($5.22).
A very useful book which describes everything about mapping from finding your way with compasses to making things to scale to mapping outdoor areas. Useful for teachers of classes making maps or models of their nature trail.

_____. *Pond Water*. Teacher's Guide ($2.82).
Useful for classes working in a natural area with a stream. It explains how to collect water samples and examine them under a microscope for small organisms. Also describes how to tell if a pond is seriously polluted.

____. *Rocks and Charts.* Teacher's Guide ($2.46).
Describes charting and classification activities connected with rocks, including how to test for hardness, streak, and alkalinity. Useful for classes which become interested in geology of their natural area.

____. *Tracks.* Teacher's Guide ($3.60).
Explains how to tell things about animals and their habits by observing tracks made in mud or snow. Also describes how to keep records of animal tracks by making plaster casts of them.

Environmental Science Center, 5400 Glenwood Ave., Minneapolis, Minn. 55422. Teacher resource materials.

____. *Contour Mapping.* ($1.00)
Describes a simple method to make a contour map of a slope. Useful if children wish to compare vegetation on flat land to vegetation on a slope. Grades 4-9.

____. *Microclimates.* ($.30)
Shows how to compare temperature, soil, moisture, etc., in different places within a natural area. Grades 3-9.

____. *Population Sampling.* ($.30)
If children want to estimate the number of insects, flowers, shrubs, etc., in an outdoor area, they may sample a smaller area and multiply by the total area. This booklet describes how this is done. Grades 3-8.

ESSENCE (Environmental Studies Project). Addison-Wesley Publishing Co., Menlo Park, California.
This series of cards and teacher guide comprise a non-directed curriculum project aimed at teaching children concepts about environment and change through a series of mini-challenges such as, "Go outside and prove that some living thing in your environment changes." If teachers find that some of these exercises increase the children's ability to observe and to think creatively about their environment, they might be incorporated into work on the Nature Trails challenge.

Foundati. al Approaches in Science Teaching (FAST). Write to University Laboratory School, University of Hawai', Honolulu, for information on materials on making a map of a natural area or taking a sample of organisms living in an area.

Griffin, Donald R. *Bird Migration*. Science Study Series. Garden City, N.Y.: Doubleday & Company, Inc. (1964). During fall and spring children in certain areas will notice a large influx of birds into their natural area while the birds are traveling south or north. This book provides useful information on migration, including theories on how birds navigate.

MINNEMAST Series. Minnesota Mathematics and Science Teaching Project, University of Minneapolis, 720 Washington Ave., S.E., Minneapolis, Minn. 55455.

_____. *Conditions Affecting Life*. Describes how children may observe seasonal changes in areas, including conditions of moisture and light.

_____. *Natural Systems*. Describes how plants grow, how animals get around, and how erosion affects natural systems.

National Wildlife Federation (NWF). Environmental Investigations (Teacher Guides). Written by Minnesota Environmental Sciences Foundation, Inc. Available from NWF, 1412 Sixteenth St., N.W., Washington, D.C. Several of these teacher guides could be helpful during work on Nature Trails because they describe investigations students can make outdoors or indoors working with natural objects. They discuss observations that can be made about seasonal change, topography, natural cycles, and identification or classification of organisms. They also include simple graphing activities.

Change in a Small Ecosystem - Natural Succession. Grades 5-9. ($1.50)
Color and Change - Magic Colors in Nature. Grade K-2. ($1.00)
Contour Mapping - The Ups and Downs of Land. Grades 4-9. ($1.50)
Differences in Living Things. Grades 4-8 ($1.00)
Nature Hunt - Similarities and Differences in the Natural World. Spec. Ed, K-1. ($1.00)

Nature's Part in Art - Creating with Natural Objects. Grades 3-6. ($1.50)

Oaks, Acorns, Climate, and Squirrels - Elements of a Natural Cycle. Grades 1-6. ($1.50)

Outdoor Fun for Students - Natural Resources for Learning. Grades 1-12. ($1.50)

Sampling Button Populations - Statistics in the Classrooms. Grades 3-9. ($1.00)

Soil - Acidity, Moisture, Minerals, and Organisms. Grades 2-9. ($1.50)

Stream Profiles - Activities with Flowing Water. Grades 4-9. ($1.00)

Transect Studies - Different Life Forms Along a Line. Grades 3-9. ($1.50)

Vacant Lot Studies. Grades 5-9. ($1.50)

National Education Association (NEA). *Man and His Environment.* 1201 Sixteenth St., N.W., Washington, D.C. 20036 (1970).
This booklet describes how a class can use an area for studying the environment in a multi-disciplinary fashion. Gives an idea of some of the concepts which could possibly arise during work on Nature Trails.

Outdoor Biology Instructional Strategies (OBIS). Available from OBIS, Lawrence Hall of Science, University of California, Berkeley, California 94720.

_____. *Trial Edition Set I* ($8.50) and *Set II* ($9.50).
Both sets include 24 activities and introductory folios. Topics include adaptation, food chains, natural cycles, etc.

_____. *Lawn Guide* and *Pond Guide* ($.60 each).
Useful for children identifying many of the common animals and plants found in each environment.

_____. *Trail Module* ($2.00).
Consists of four activities dealing with the impact of trails on people and the environment. Also contains information on trail construction.

Science Curriculum Improvement Study (SCIS). Available from Rand McNally & Company, Chicago.
These are teacher guides useful for classes working in an outdoor environment. They describe many ecological

principles, including interaction of different organisms with their environment.

Organisms	*Environments*
Life Cycles	*Communities*
Populations	*Ecosystems*

Snedigar, Robert. *Our Small Native Animals: Their Habits and Care.* Dover Publications, Inc., 180 Varick Street, New York, N.Y. 10014. ($2.50)
An inexpensive paperback which describes habits of many of the common mammals, reptiles, and amphibians that children might find outdoors.

Vancouver Environmental Education Project (VEEP). Write to Lesson Aids Service, British Columbia Teacher's Federation, 105-2235 Burrard Street, Vancouver 9, B.C., Canada. The Bush Studies Series of this project contains exercises that may help children to answer questions about vegetation, water sources, soil, and the cycle of growth and decay in their natural area.

Reference Books for Children

Booth, Thurman W., Jr., and Pfitzer, Donald W. *Attracting and Feeding Birds* (Conservation Bulletin No. 1, Fish and Wildlife Service, U.S. Dept. of Interior). Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. ($.25)
Some classes may set up a winter feeding station as a winter activity during work on Nature Trails. This booklet describes how to set up feeding stations and also lists shrubs and plants which attract different kinds of birds during other seasons.

Carthy, John. *Animal Camouflage.* New York: McGraw-Hill Book Co. (1974).
Describes basics of animal camouflage in simple terms and could be useful for helping young children find some insects and small animals while investigating a natural area.

Chinery, Michael. *Animal Communities.* London: Franklin Watts, Inc. (1974).
This illustrated book describes the principal of community in animal populations, including the purpose of communities and how various communities function. Useful if older children observe wild animals or insects in their native habitat.

Davis, Bette J. *Winter Buds*. New York: Lothrop, Lee, & Shepard Co. (1973). ($4.25)
In simple terms, this book describes how shape and arrangement of winter buds can help in identifying trees.

DeWaard, E. John. *What Insect Is That?* Xerox Corporation (1965). Available from Xerox Education Center, Columbus, Ohio 43216. (Free)
This booklet has a simple key for children classifying common insects found in the field.

Elementary Science Study (ESS). Available from McGraw-Hill Book Co., Webster Division, Princeton Road, Hightstown, N.J.

_____. *Making Maps*. Student booklet. ($1.95)
Explains the process and principles of making maps of in' .r and outdoor areas. Students will find the illustrations helpful.

_____. *Pond-Water Cards*. ($4.98)
These illustrate how to collect pond water and various animals which can be observed. Useful for children working in a natural area with a water source.

_____. *Track Pictures Book*. ($3.15)
Contains illustrations of tracks made by various animals, including human beings.

Man: A Course of Study (MACOS). Available from Curriculum Development Associates, Inc., 1211 Connecticut Ave, N.W., Suite 414, Washington, D.C. 20036
Six of the thirty-one student booklets are useful to children investigating animal behavior in their environment. Humorous illustrations and simple vocabulary are suitable for fourth- to fifth-grade children.

Animal Adaptation
Information and Behavior
Innate and Learned Behavior
Life Cycle
Natural Selection
Structure and Function

Russell, Solveig Paulsen. *Like and Unlike-A First Look at Classification*. New York: Henry Z. Walck, Inc. (1973). Basics of scientific method of classification (family, order, species, etc.). Useful for young children learning to identify animals and plants observed outdoors.

Simon, Seymour. *A Tree on Your Street*. New York: Holiday House (1973). ($3.95)
Book for young children about trees and the creatures which live in them.

Ward's Natural Science Establishment. *How to Make a Plant Collection*. Wards, P.O. Box 1712, Rochester, N.Y. 14603. (Free)
This pamphlet describes how to preserve plants collected in the field so that they can be used as study specimens. Useful if children want to collect specimens for exhibiting.

Guides for Field Identification of Plants and Animals

Brockman, C. Frank. *Trees of North America*. New York, Golden Press (1968). (Paperback)
Excellent book for teachers and children identifying trees in their natural area. Complete with illustrations and maps to show ranges of tree species.

Golden Guides, Golden Press, New York. Very inexpensive paperbacks available at most book stores. They have many illustrations, and children can use them to identify their animals by looking at the pictures. Titles include—

Birds	*Mammals*
Butterflies and Moths	*Non-Flowering Plants*
Ecology	*Pond Life*
Fishes	*Reptiles and Amphibians*
Flowers	*Spiders*
Fossils	*Trees*
Insects	

Knobel, Edward. *Identify Trees and Shrubs by Their Leaves--A Guide to Trees and Shrubs Native to the Northeast*. New York: Dover Publications, Inc. (1972).
Provides a key to common trees. Useful for teachers and older children.

The Peterson Field Guide Series, Published by Houghton-Mifflin Company.
Available at most book stores. These guides are more detailed than the Golden Guides, and the text may be too difficult for students. However, teachers will find them helpful for identification, and students may find the excellent pictures useful. The series includes field guides on Birds, Butterflies, Mammals, Insects, Rocks and Minerals, Animal Tracks, Reptiles and Amphibians, Eastern Wild Flowers, Ferns, and Trees and Shrubs.

Robbins, C., et al. *Birds of North America: A Guide to Field Identification*. New York, Golden Press, (Paperback)
Excellent guide for teachers and children identifying bird species along the trail or at winter feeders. Contains illustrations, maps of ranges, and short descriptions.

Places to obtain more information about nature

State conservation agents and state Audubon Societies will provide your class with free or inexpensive materials on plants and animals found in your particular area. Children may also get in touch with local nature centers or universities for help with identification or ecological concepts. These sources may be even more valuable than the books listed above because they can provide information specific to your local environment.

4. GLOSSARY

The following definitions may be helpful to a teacher whose class is investigating a Nature Trails challenge. Some of the words are included to give the teacher an understanding of technical terms; others are included because they are commonly used throughout the resource book.

These terms may be used when they are appropriate for the children's work. For example, a teacher may tell the children that when they conduct surveys, they are collecting *data*. It is not necessary for the teacher or students to learn the definitions nor to use all of the terms while working on their challenge. Rather, the children will begin to use the words and understand the meanings as they become involved in their investigations.

Algae — Small, single-celled plants, usually aquatic, that contain chlorophyll and are often found in colonies (e.g., seaweed, pond scum).

Amphibian — A cold-blooded vertebrate with non-scaly skin whose young are usually aquatic. Examples: frogs, toads, newts, salamanders.

Average — The numerical value obtained by dividing the sum of the elements of a set of data by the number of elements in that set. Also called the mean.

Bias — A deviation in the expected values of a set of data, often occurring when some factor produces one outcome more frequently than others.

Bird — A feathered, warm-blooded vertebrate that has wings (or rudiments of wings) and reproduces by laying eggs.

Calibration — Setting and marking an instrument to correspond to standard measurements.

Carnivore — An animal that feeds on other animals. Examples: spiders, owls. (Also, an insect-eating plant.)

Chlorophyll — A green substance in some kinds of plants that helps them synthesize food.

Climate	Average weather conditions of an area.
Cold-blooded Animals	Animals having a body temperature not internally regulated but approximating that of their environment. Examples: invertebrates, fish, reptiles, amphibians.
Colony	A group of animals or plants of the same kind (e.g., ants, termites, bees) that live and often work together.
Community	An interacting population of various kinds of plants and animals living in the same area.
Complement of a Set	See *Set*.
Conifer	One of a group of mostly evergreen trees and shrubs having needle-like leaves and usually producing seeds in cones. Examples: pine, spruce, fir.
Conversion	A change from one form to another. Generally associated in mathematics and science with the change from one unit of measure to another or the change from one form of energy to another.
Correlation	A relationship between two sets of data.
Cotyledon	The first leaf or one of the first set of leaves developed by the embryo of a seed plant; often called "seed leaves."
Crustacean	A cold-blooded water animal with a hard outside covering. Examples: shrimp, crayfish, lobster.
Data	Any facts, quantitative information, or statistics.
Deciduous Trees	Trees that shed leaves or other parts seasonally or at certain stages in their life cycles.
Degree	A unit of measurement of temperature or angle.
Dicot (Dicotyledon)	One of a large group of flowering plants that put out two cotyledons, or seed leaves, when they first sprout. Examples: maple tree, aster.
Distribution	The spread of data over the range of possible results.
Ecology	A study of the interrelationships of plants and animals and their environments.

Ecosystem — The interactions among plants and animals and their environment in a certain locality.

Edit — To collect and arrange materials into a finished publication or program.

Environment — The conditions in which an organism lives, including temperature, light, water, and other organisms.

Erosion — The process by which rock or soil is worn away by the action of water, wind, temperature change; ice, or glacial movement.

Event — A happening; an occurrence; something that takes place. Example: the sighting of an animal in the woods.

Fern — One of a group of plants that have stems, roots, and leaves and that reproduce by spores.

Fish — A cold-blooded vertebrate that lives in the water and breathes by using gills.

Force — A push or a pull.

Frequency — The number of times a certain event occurs in a given unit of time or in a given total number of events.

Frost — Ice crystals that are deposited from the air on surfaces that cool by radiating their heat.

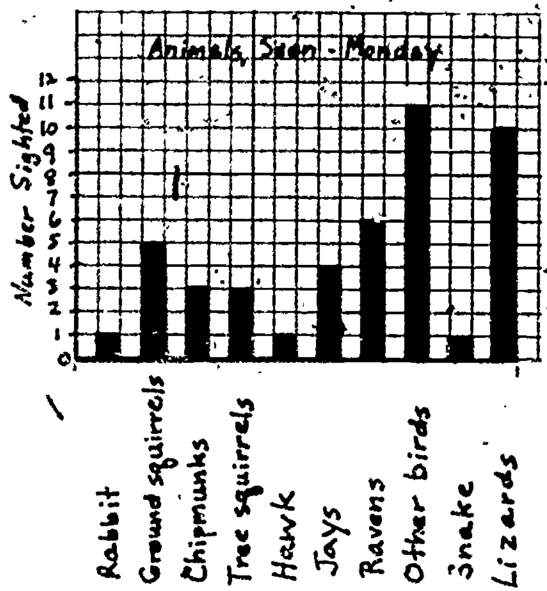
Fungus — One of a group of plants lacking chlorophyll and obtaining nutrients from living or dead organic matter. Examples: mushrooms, molds.

Graph — A drawing or a picture of one or several sets of data.

Bar Graph — A graph of ~~a set of~~ measures or counts whose sizes are represented by the vertical (or horizontal) lengths of bars of equal widths or lines. Example: numbers of different animals sighted in the woods near the school in one day's observation.

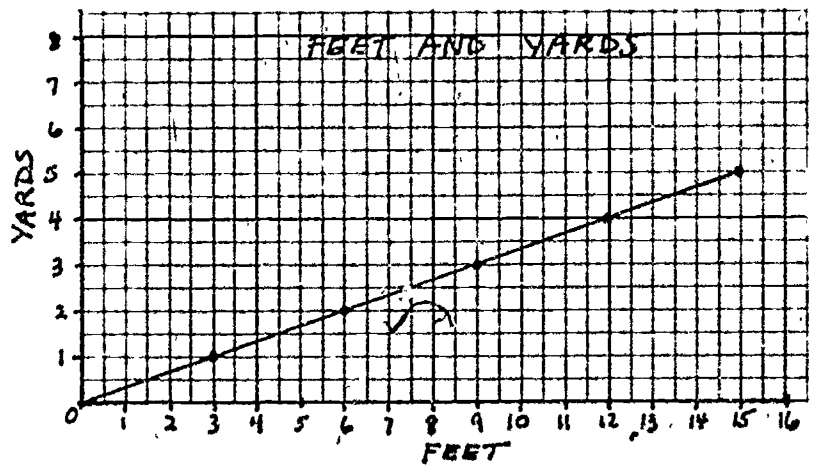
Bar Graph (cont.)

Animal	Number Sighted
Rabbit	1
Ground squirrels	5
Chipmunks	3
Tree squirrels	3
Hawk	1
Jays	4
Ravens	6
Other birds	11
Snake	1
Lizards	10



Conversion Graph

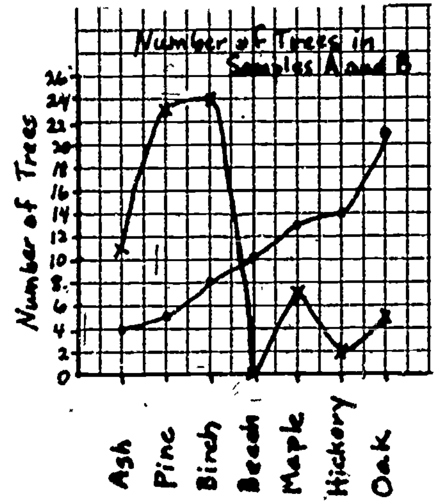
A line graph that is used to change one unit of measurement to another. For example, changing feet to yards or vice versa.



Line Chart

A bar graph that is represented by circles, triangles, or crosses with lines connecting them so that it has the appearance of a line graph. (See *Line* Graph.) This is a useful representation when two or more sets of data are shown on the same graph. Example: the number of trees of different kinds counted in two different sample areas.

Trees	Number in Sample A	Sample B
Ash	4	11
Pine	5	23
Birch	8	24
Beech	10	0
Maple	13	7
Hickory	14	2
Oak	21	5



Line Graph

A graph in which a smooth line or line segments pass through or near points representing members of a set of data. Since the line represents an infinity of points, the variable on the horizontal axis must be continuous. If the spaces between the markings on the horizontal axis have no meaning, then the graph is not a line graph, but a line chart (see *Line Chart*).

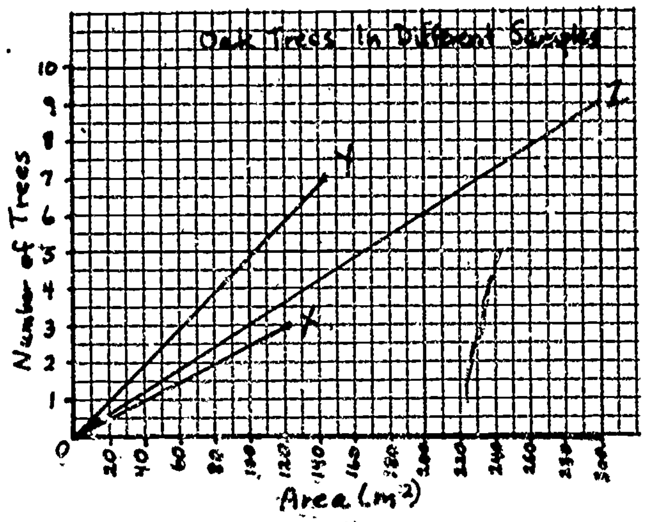
*Slope Diagram**

A graphical means of comparing fractions or ratios. To represent the ratio a/b, plot the point (b,a) and draw a line from (b,a) to the origin, (0,0). The slope of this line represents the ratio a/b. By comparing slopes of different lines, different ratios can be compared; the steeper the line the larger the ratio. For example, in the diagram below showing the ratio of oak trees counted in areas of different sizes, the ratio of oak trees to the area in Sample Y is the highest. Therefore, the Sample Y area seems to be better suited for growing oaks than the other sample locations.

*Formerly called Triangle Diagram.

Slope Diagram (cont.)

	Number of Oak Trees	Area (m^2)
Sample X	3	121
Sample Y	7	144
Sample Z	9	298



Habitat — The place or type of environment in which an organism lives.

Herbivore — A plant-eating animal. Examples: squirrels, rabbits.

Hibernation — The state of inactivity in which many animals pass the winter.

Hypothesis — A tentative conclusion made in order to test its implications or consequences.

Igneous Rock — A type of rock formed by the cooling and solidification of molten rock (magna). Examples: granite, basalt.

Inference — An assumption derived from facts or information considered to be valid and accurate.

Insect — An animal with three pairs of legs and three distinct parts of the body: head, thorax, abd[illegible]n.

Intersection of Sets — See *Set*.

Invertebrate — An animal without a backbone. Examples: worms, snails, insects, spiders, crayfish.

Key — An arrangement of the important physical characteristics of animals or plants designed to facilitate the identification of an unknown type.

Lichen	A type of small plant made up of a fungus and an alga growing in close association; the fungus provides the structure for the plant and the alga provides the chlorophyll.
Life Cycle	The series of stages through which an organism passes during its life.
Mammal	Any warm-blooded animal that has hair and suckles its young.
Mapping	Assigning each element in one set of data to a corresponding element in another set.
Matrix	A chart of data arranged in rows and columns.
Mean	See *Average*.
Median	The middle value of a set of data in which the elements have been ordered from smallest to largest. The median value has as many elements above it as below it.
Metamorphic Rock	A type of rock formed when extreme pressure or heat compacts the crystal structure, e.g., marble is formed from limestone.
Microorganism	An organism that is too small to be seen with the naked eye but can be seen through a microscope. Examples: amoebae, bacteria, some types of algae.
Migration	The process of passing from one geographical area to another—for seasonal breeding or feeding.
Monocot (Monocotyledon)	One of a large group of flowering plants that put out one cotyledon, or seed leaf, when they first sprout. Examples: lily, grass.
Moraine	An accumulation of earth and stones carried and deposited by a glacier.
Nutrient	Any chemical substance (found in food or soil) necessary for an organism's life and growth.
Omnivore	An animal that feeds on both plants and animals. Examples: raccoons, humans.
Ordered Set	A set of data arranged from smallest to largest.

Organic	A term used to describe something that is or was part of a living plant or animal. Examples of organic matter: humus, rotting log.
Organism	A living entity. Example: any plant or animal.
Parasite	An organism that depends on a living organism of another species for food or support without giving anything beneficial in return. Example: mosquito, some kinds of fungi.
Per Cent	Literally per hundred. A ratio in which the denominator is always 100, e.g., 72 percent = 72/100 = 0.72 = 72% , where the symbol % represents 1/100.
Percentage	A part of a whole expressed in hundredths.
Photosynthesis	The process by which green plants use light energy to make food from water and carbon dioxide.
Pollination	The process by which pollen is transferred from male to female flower parts to form seeds necessary for reproduction.
Population	Any group of objects (e.g., people, animals, items) or events from which samples are taken for statistical measurement.
Precipitation	Rain, snow, hail, sleet, or freezing rain. Produced when water vapor in the air form droplets or crystals heavy enough to fall earthward.
Predator	An animal that lives by killing and eating other animals.
Probability	The likelihood or chance (expressed numerically) of one event occurring out of several possible events.
Propagation	Reproduction of an organism by one of many ways, e.g., through stem or leaf cuttings from a larger plant or through germination of a seed.
Proportion	A statement of equality of two ratios, i.e., the first term divided by the second term equals the third term divided by the fourth term, e.g., 5/10 = 1/2. Also a synonym for ratio: when two quantities are in direct proportion, their ratios are the same.
Range	A region throughout which a type of organism or ecosystem naturally occurs.

Rank — To order the members of a set according to some criterion, such as size or importance. Example: to put pieces of data from smallest to largest.

Ratio — The quotient of two denominate numbers or values indicating the relationship in quantity, size, or amount between two different things. For example, the ratio of the number of squirrels counted to the area of land occupied by the squirrels might be 3 squirrels/400 square meters or 3 squirrels: 400 square meters.

Reptile — Any cold-blooded, air-breathing vertebrate with scaly skin. Examples: snake, turtle, lizard.

Rodent — A small, gnawing mammal with large front teeth that grow continuously. Examples: rat, mouse, chipmunk, squirrel, woodchuck.

Sample — A representative fraction of a population studied to gain information about the whole population.

Sample Size — The number of elements in a sample.

Scale — A direct proportion between two sets of dimensions (as between the dimensions in a drawing of a lab and the actual lab).

Scale Map — A map whose dimensions are in direct proportion to the dimensions of the area represented.

Scavenger — An animal that lives by eating dead organisms and refuse. Examples: vulture, crow, maggot (fly larva).

Sedimentary Rock — A type of rock formed of particles deposited by water. Examples: limestone, sandstone, shale.

Seed — A product of pollination of some types of plants. The seed contains the embryo of a new plant.

Set — A collection of characteristics, organisms, or objects. Each thing in a set is called a member or an element.

Set Theory — The branch of mathematics that deals with the nature and relations of sets.

Complement of a Set — The set of all elements in the universal set but not in the given set. For example, if the universal set is the set of all trees in the woods, then the set of oaks is the complement of the set of maples.

Intersection of Sets — The set of elements common to two or more sets. For example, if set A is all warm-blooded animals and set B is all egg-laying animals, the intersection of set A and set B is the set of all birds.

Universal Set — A set that contains all elements relevant to a particular problem.

Venn Diagram — A drawing d to illustrate the relationship between sets.

Slope Diagram — See *Graph*

Species — A categor of scientific classification referring to a group of organi s that look alike and can interbreed.

Spore — A tiny pro uct of some types of plants. A spore can produce another pla t either directly or after combining with another spore.

Statistics — The science of drawing conclusions or making predictions using a collection of quantitative data.

Tally — A visible record used to keep a count of some set of data, especially a recor of the number of times one or more events occur. Example: n ber of animals sighted in the school woods each day.

Temperature — A measure of hotness or coldness. Technically, an indication of the average kinetic energy of molecules. Temperature is commonly measured in degrees Fahrenheit or degrees centigrade (Celsius).

Thermometer, Centigrade, (or Celsius) — A thermometer on which the interval between the normal freezing and boiling points of water is divided into 100 parts or degrees, ranging from $0^{\circ}C$ to $100^{\circ}C$.

Thermometer, Fahrenheit — A thermometer on which the interval between the normal freezing and boiling points of water is divided into 180 parts or degrees, ranging from $32^{\circ}F$ to $212^{\circ}F$.

Topography	The practice of graphic representation in detail, usually on maps, of natural and man-made features of a place or region in order to show their relative positions or elevations.
Vascular Plant	Any highly developed plant having channels for transporting fluids throughout its system. Examples: fern, pine tree, grass.
Vertebrate	Any animal with a backbone. Examples: fish, amphibian, reptile, bird, mammal.
Warm-blooded Animals	Animals having a relatively high and constant body temperature that is relatively independent of the surrounding temperature. Examples: birds, mammals.
Weather	Condition of the atmosphere in terms of heat, pressure, wind, and moisture.
Work	Work is done when a force is exerted through a distance. Work is the product of the force exerted and the distance moved.

E. Skills, Processes, and Areas of Study Utilized in Nature Trails

The unique aspect of USMES is the degree to which it provides experience in the process of solving real problems. Many would agree that this aspect of learning is so important as to deserve a regular place in the school program even if it means decreasing to some extent the time spent in other important areas. Fortunately, real problem solving is also an effective way of learning many of the skills, processes, and concepts in a wide range of school subjects.

On the following pages are five charts and an extensive, illustrative list of skills, processes, and areas of study that are utilized in USMES. The charts rate Nature Trails according to its potential for learning in various categories of each of five subject areas--real problem solving, mathematics, science, social science, and language arts. The rating system is based on the amount that each skill, process, or area of study within the subject areas is used--extensive (1), moderate (2), some (3), little or no use (-). (The USMES Guide contains a chart that rates all USMES units in a similar way.)

The chart for real problem solving presents the many aspects of the problem-solving process that students generally use while working on an USMES challenge. A number of the steps in the process are used many times and in different orders, and many of the steps can be performed concurrently by separate groups of students. Each aspect listed in the chart applies not only to the major problem stated in the unit challenge but also to many of the tasks each small group undertakes while working on a solution to the major problem. Consequently, USMES students gain extensive experience with the problem-solving process.

The charts for mathematics, science, social science, and language arts identify the specific skills, processes, and areas of study that may be learned by students as they respond to a Nature Trails challenge and become involved with certain activities. Because the students initiate the activities, it is impossible to state unequivocally which activities will take place. It is possible, however, to document activities that have taken place in USMES classes and identify those skills and processes that have been used by the students.

Knowing in advance which skills and processes are likely to be utilized in Nature Trails and knowing the extent that they will be used, teachers can postpone the teaching of those skills in the traditional manner until later in the year. If the students have not learned them during their USMES activities by that time, they can study them in the usual way. Further, the charts enable a teacher to integrate USMES more readily with other areas of classroom work. For example, teachers may teach fractions during math period when fractions are also being learned and utilized in the students' USMES activities. Teachers who have used USMES for several successive years have found that students are more motivated to learn basic skills when they have determined a need for them in their USMES activities. During an USMES session the teacher may allow the students to learn the skills entirely on their own or from other students, or the teacher may conduct a skill session as the need for a particular skill arises.

Because different USMES units have differing emphases on the various aspects of problem solving and varying amounts of possible work in the various subject areas, teachers each year might select several possible challenges, based on their students' previous work in USMES, for their class to consider. This choice should provide students with as extensive a range of problems and as wide a variety of skills, processes, and areas of study as possible during their years in school. The charts and lists on the following pages can also help teachers with this type of planning.

Some USMES teachers have used a chart similar to the one given here for real problem solving as a record-keeping tool, noting each child's exposure to the various aspects of the process. Such a chart might be kept current by succeeding teachers and passed on as part of a student's permanent record. Each year some attempt could be made to vary a student's learning not only by introducing different types of challenges but also by altering the specific activities in which each student takes part. For example, children who have done mostly construction work in one unit may be encouraged to take part in the data collection and data analysis in their next unit.

Following the rating charts are the lists of explicit examples of real problem solving and other subject area skills, processes, and areas of study learned and utilized in Nature Trails. Like the charts, these lists are based on documentation of activities that have taken place in USMES classes. The greater detail of the lists allows teachers to see exactly how the various basic skills, processes, and areas of study listed in the charts may arise in Nature Trails.

The number of examples in the real problem solving list have been limited because the list itself would be unreasonably long if all the examples were listed for some of the categories. It should also be noted that the example(s) in the first category--*Identifying and Defining Problems*--have been limited to the major problem that is the focus of the unit. During the course of their work, the students will encounter and solve many other, secondary problems, such as the problem of how to display their data or how to draw a scale layout.

Breaking down an interdisciplinary curriculum like USMES into its various subject area components is a difficult and highly inexact procedure. Within USMES the various subject areas overlap significantly, and any subdivision must be to some extent arbitrary. For example, where does measuring as a mathematical skill end and measurement as science and social science process begin? How does one distinguish between the processes of real problem solving, of science, and of social science? Even within one subject area, the problem still remains--what is the difference between graphing as a skill and graphing as an area of study? This problem has been partially solved by judicious choice of examples and extensive cross-referencing.

Because of this overlap of subject areas, there are clearly other outlines that are equally valid. The scheme presented here was developed with much care and thought by members of the USMES staff with help from others knowledgeable in the fields of mathematics, science, social science, and language arts. It represents one method of examining comprehensively the scope of USMES and in no way denies the existence of other methods.

REAL PROBLEM SOLVING	Overall Rating
Identifying and defining problem.	1
Deciding on information and investigations needed.	1
Determining what needs to be done first, setting priorities.	1
Deciding on best ways to obtain information needed.	1
Working cooperatively in groups on tasks.	1
Making decisions as needed.	1
Utilizing and appreciating basic skills and processes.	1
Carrying out data collection procedures—observing, surveying, researching, measuring, classifying, experimenting, constructing.	1
Asking questions, inferring.	1
Distinguishing fact from opinion, relevant from irrelevant data, reliable from unreliable sources.	1

REAL PROBLEM SOLVING	Overall Rating
Evaluating procedures used for data collection and analysis. Detecting flaws in process or errors in data.	1
Organizing and processing data or information.	1
Analyzing and interpreting data or information.	1
Predicting, formulating hypotheses, suggesting possible solutions based on data collected.	1
Evaluating proposed solutions in terms of practicality, social values, efficacy, aesthetic values.	1
Trying out various solutions and evaluating the results, testing hypotheses.	1
Communicating and displaying data or information.	1
Working to implement solution(s) chosen by the class.	1
Making generalizations that might hold true under similar circumstances; applying problem-solving process to other real problems.	1

KEY: 1 = extensive use, 2 = moderate use, 3 = some use, - = little or no use.

MATHEMATICS	Overall Rating
Basic Skills	
Classifying/Categorizing	1
Counting	1
Computation Using Operations	
Addition/Subtraction	1
Multiplication/Division	1
Fractions/Ratios/Percentages	2
Business and Consumer Mathematics/ Money and Finance	-
Measuring	1
Comparing	1
Estimating/Approximating/Rounding Off	1
Organizing Data	1
Statistical Analysis	3
Opinion Surveys/Sampling Techniques	3
Graphing	-
Spatial Visualization/Geometry	1
Areas of Study	
Numeration Systems	2
Number Systems and Properties	2
Denominate Numbers/Dimensions	1
Scaling	2
Symmetry/Similarity/Congruence	2
Accuracy/Measurement Error/ Estimation/Approximation	1
Statistics/Random Processes/Probability	3
Graphing/Functions	-
Fraction/Ratio	2
Maximum and Minimum Values	-
Equivalence/Inequality/Equations	2
Money/Finance	-
Set Theory	1

SCIENCE	Overall Rating
Processes	
Observing/Describing	1
Classifying	1
Identifying Variables	3
Defining Variables Operationally	3
Manipulating, Controlling Variables/ Experimenting	3
Designing and Constructing Measuring Devices and Equipment	2
Inferring/Predicting/Formulating, Testing Hypotheses/Modeling	1
Measuring/Collecting, Recording Data	1
Organizing, Processing Data	1
Analyzing, Interpreting Data	1
Communicating, Displaying Data	1
Generalizing/Applying Process to New Problems	1
Areas of Study	
Measurement	2
Motion	-
Force	3
Mechanical Work and Energy	-
Solids, Liquids, and Gases	3
Electricity	-
Heat	3
Light	3
Sound	3
Animal and Plant Classification	1
Ecology/Environment	1
Nutrition/Growth	1
Genetics/Heredity/Propagation	2
Animal and Plant Behavior	1
Anatomy/Physiology	3

KEY: 1 = extensive use, 2 = moderate use, 3 = some use, - = little or no use

SOCIAL SCIENCE	Overall Rating
Process	
Observing/Describing/Classifying	2
Identifying Problems, Variables	1
Manipulating, Controlling Variables/ Experimenting	3
Inferring/Predicting/Formulating, Testing Hypotheses	3
Collecting, Recording Data/Measuring	3
Organizing, Processing Data	3
Analyzing, Interpreting Data	3
Communicating, Displaying Data	3
Generalizing/Applying Process to Daily Life	3
Attitudes/Values	
Accepting responsibility for actions and results	1
Developing interest and involvement in human affairs	1
Recognizing the importance of individual and group contributions to society	1
Developing inquisitiveness, self-reliance, and initiative	1
Recognizing the values of cooperation, group work, and division of labor	1
Understanding modes of inquiry used in the sciences, appreciating their power and precision	1
Respecting the views, thoughts, and feelings of others	1
Being open to new ideas and information	1
Learning the importance and influence of values in decision making	1
Areas of Study	
Anthropology	-
Economics	3
Geography/Physical Environment	2
Political Science/Government Systems	2
Recent Local History	1
Social Psychology/Individual and Group Behavior	3
Sociology/Social Systems	3

LANGUAGE ARTS	Overall Rating
Basic Skills	
Reading	
Literal Comprehension: Decoding Words Sentences, Paragraphs	1
Critical Reading: Comprehending Meanings, Interpretation	1
Oral Language	
Speaking	1
Listening	1
Memorizing	-
Written Language	
Spelling	2
Grammar: Punctuation, Syntax, Usage	2
Composition	2
Study Skills	
Outlining/Organizing	2
Using References and Resources	1
Attitudes/Values	
Appreciating the value of expressing ideas through speaking and writing	1
Appreciating the value of written resources	1
Developing an interest in reading and writing	1
Making judgments concerning what is read	1
Appreciating the value of different forms of writing, different forms of communication	1

KEY: 1 = extensive use, 2 = moderate use, 3 = some use, - = little or no use

REAL PROBLEM SOLVING IN NATURE TRAILS

Identifying and Defining Problems	• Students decide that their school needs an area for observing and learning about nature.
Deciding on Information and Investigations Needed	• After a discussion students decide they need to observe a natural area near the school and to collect data on natural history, etc. • After a discussion students decide to make a nature trail. • After analyzing data, students decide that more data comparing different environments at different times of year is needed. • Students decide that they need to research more information on plants and animals by reading library books.
Determining What Needs to Be Done First, Setting Priorities	• Students decide to observe wooded area first before making a nature trail. • Children decide to research information on plants and animals before writing about them.
Deciding on Best Ways to Obtain Information Needed	Students decide that only four children, observing in different sections of the natural area, will count birds and animals to avoid overlap. • Students decide to conduct opinion surveys to find out attitudes towards nature or preferences for type of nature trail. • Students decide to make a scale map of the trail for showing other classes where to go. • Children decide to research information on animals and plants found near the trail by reading library books.
Working Cooperatively in Groups on Tasks	• Students form groups to collect data in the natural area, to decide what points of interest to include along the trail, ~~and~~ to conduct library research on plants, animals, geology, etc.
Making Decisions as Needed	• Students decide to work in groups so that more can be accomplished. • Students decide to count numbers of only five types of trees when comparing two sample areas.

Making Decisions as Needed (cont.)	• Students decide to use existing paths for a trail rather than clearing new ones. • Children decide that making a pamphlet will be the best way to explain the observations they have made outdoors.
Utilizing and Appreciating Basic Skills and Processes	• Students measure distances and directions along the nature trail for making a scale map. • Students divide to obtain measurements for a scale map. • Students identify plants and animals along the nature trail. • Students conduct surveys to find out other children's attitudes towards nature. • Students write pamphlets and give tours of the trail to other classes. • See also MATHEMATICS, SCIENCE, SOCIAL SCIENCE, and LANGUAGE ARTS lists.
Carrying Out Data Collection Procedures--Opinion Surveying, Researching, Measuring, Classifying, Experimenting, Constructing	• Students conduct opinion surveys to find out other's preferences for information to include along a trail. • Students look up information on natural history, ecology, geology, etc., in books. • Students classify plants and animals found along the trail. • Students measure temperature at areas along the trail. • Students construct signs to be placed at points of interest along the trail. • See also MATHEMATICS list: *Classifying/Categorizing; Measuring.* • See also SCIENCE list: *Observing/Describing; Classifying; Manipulating, Controlling Variables/Experimenting; Designing and Constructing Measuring Devices and Equipment; Measuring/Collecting, Recording Data.* • See also SOCIAL SCIENCE list: *Observing/Describing; Classifying; Manipulating, Controlling Variables/Experimenting; Collecting, Recording Data/Measuring.*
Asking Questions, Inferring	• Children ask whether other students feel that a nature trail would be useful and infer from data collected that it would. • Students ask whether there are different birds in their woods in the summer and in the winter. They infer from observations that there are. • Students ask whether numbers of different kinds of trees vary from one area of their wood to another. They infer from the results of counting trees in samples that they do.

Asking Questions, Inferring (cont.)	• See also SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses/Modeling.* • See also SOCIAL SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses.*
Distinguishing Fact from Opinion, Relevant from Irrelevant Data, Reliable from Unreliable Sources	• Students recognize that many superstitions about animals (e.g., toad giving warts) are not borne out by factual observation. • Students recognize that experts in natural history are good sources of information on plants and animals.
Evaluating Procedures Used for Data Collection and Analysis, Detecting Flaws in Process or Errors in Data	• Students discuss manner in which samples were taken when counting trees, insects, squirrels, etc. • Children decide that their opinion survey needs improvement and discuss changes they need to make in it. • Students decide that stretching a string between points along the trail and then measuring is a faster way to determine distance along the nature trail than using a tape measure along the ground. • See also MATHEMATICS list: *Estimating/Approximating/Rounding Off.*
Organizing and Processing Data	• Students record animal sightings on a chart. • Students order number of trees of different kinds in one of the sample areas before making a line chart. • See also MATHEMATICS list: *Organizing Data.* • See also SCIENCE and SOCIAL SCIENCE lists: *Organizing, Processing Data.*
Analyzing and Interpreting Data	• Students find the median number of animals counted over several days for each type. • Students find that 65% of the students surveyed say they would use a nature trail if one were developed. • See also MATHEMATICS list: *Comparing; Statistical Analysis; Opinion Surveys/Sampling Techniques/Graphing.* • See also SCIENCE and SOCIAL SCIENCE lists: *Analyzing, Interpreting Data.*
Predicting, Formulating Hypotheses, Suggesting Possible Solutions Based on Data Collected	• Students hypothesize that the results of their opinion survey reflect the opinions of all students. • After the first five tours, students predict that it will

Predicting, Formulating Hypotheses, Suggesting Possible Solutions Based on Data Collected (cont.)

take student guides approximately 45 minutes to take each class on the nature trail.

- After investigating, students predict that they will see more animals on sunny days than on cloudy or rainy days.
- See also SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses/Modeling.*
- See also SOCIAL SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses.*

Evaluating Proposed Solutions in Terms of Practicality, Social Values, Efficacy, Aesthetic Values

- Students designing a nature trail consider cost, land use, estimated number of users, and appreciation of nature.
- Students consider whether or not nailing identification signs to trees is harmful to the trees.

Trying Out Various Solutions and Evaluating the Results, Testing Hypotheses

- Students walk around the natural area and experiment with different ways to connect interesting features they would like to show on the trail.
- Students try different ways of showing the nature trail to volunteers from other classes and decide which way is the best.
- See also SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses/Modeling.*
- See also SOCIAL SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses.*

Communicating and Displaying Data or Information

- Students make a bar graph showing median numbers of animals of different kinds counted in the area near the trail.
- Students draw a scale map of the trail.
- Students make pamphlets explaining information along the trail.
- See also MATHEMATICS list: *Graphing, Scaling.*
- See also SCIENCE and SOCIAL SCIENCE lists: *Communicating, Displaying Data.*
- See also LANGUAGE ARTS list.

Working to Implement Solution(s) Chosen by the Class

- Students present the trail to other classes through guided tours and/or explanatory pamphlets.
- Students present their trail to school or park authorities and propose that it be continued with student input.

Making Generalizations That Might Hold True Under Similar Circumstances; Applying Problem-Solving Process to Other Real Problems

- Students working on Nature Trails apply skills they have acquired to School Zoo.
- Students who have given a survey about the nature trail may give surveys to find out information on other problems.
- See also SCIENCE list: *Generalizing/Applying Process to New Problems.*
- See also SOCIAL SCIENCE list: *Generalizing/Applying Process to Daily Life.*

Basic Skills

Classifying/Categorizing

- Categorizing characteristics or properties of animals, plants, habitats, rocks.
- Categorizing characteristics of animals or plants in more than one way, e.g., warm-blooded/cold-blooded, herbivorous/carnivorous (animals).
- Using the concepts and language of sets (subsets, unions, intersections, set notation) for discussing animal and plant classification.
- See also SCIENCE list: *Classifying*.
- See also SOCIAL SCIENCE list: *Observing/Describing/Classifying*.

Counting

- Counting votes on decisions made about trail.
- Counting survey data, questionnaire data on whether people would use a nature trail and what they would like to learn.
- Counting number of meters, number of trees, number of animals sighted while collecting data.
- Counting to read scales on instruments, such as meter stick, thermometer, magnetic compass, etc.
- Counting by sets to find scale for graph axes.

Computation Using Operations: Addition/Subtraction

- Adding one-, two-, or three-digit whole numbers to find total tally or total measurement, such as total number of oak trees in the area around the nature trail or total length of trail.
- Subtracting to find differences between predicted and actual measurements, such as number of birds sighted.
- Subtracting one-, two-, or three-digit whole numbers to find ranges for graph axes or for measurement data or to compare sets of data.

Computation Using Operations: Multiplication/Division

- Multiplying whole numbers to find total tally of animals sighted, total measurement of trail length.
- Multiplying or dividing to find scale for graph axes.
- Multiplying or dividing to convert from meters to centimeters (yards to feet) or vice versa.

Computation Using Operations: Multiplication/Division (cont.)	• Using multiplication or division to increase or decrease measurements for scale maps of the trail. • Dividing to calculate average number of animals sighted, average number of trees counted in different areas, etc. • Dividing to calculate ratios of number of animals to area of land, percentages of different trees out of total counted.
Computation Using Operations: Fractions/Ratios/Percentage	• Using decimals to perform calculations, such as totaling trail length in meters and fractions of meters. • Using mixed numbers to perform calculations, such as totaling the length of the trail in feet and fractions of feet. • Changing fractions to higher or lower terms (equivalent fractions) to perform operations such as addition of measurements. • Using fractions or decimals in measurement, graphing, graphic comparisons, scale drawings or models. • Using decimal fractions to convert from centimeters to meters. • Using ratios to increase or decrease measurements for scale maps. • Using slope diagrams to compare ratios of number of animals or plants of one type per unit area along the trail if the areas investigated are of different sizes. • Calculating actual measurements from scale maps using ratio of scale map. • Calculating percentage of students that gave a particular response on a survey question, percentage of oak trees compared to total number of trees in an area.
Computation Using Operations: Business and Consumer Mathematics/ Money and Finance	• Investigating costs of materials or equipment for nature trail vs. use of materials or equipment and budget restrictions. • Adding, subtracting, multiplying, and dividing to perform cost analysis for building a trail, for constructing and stocking bird feeders.
Measuring	• Converting from inches to feet, centimeters to meters, and vice versa. • Using arbitrary units (e.g., paces) to measure length of trail. • Using different standard units of measure to measure temperature of the air.

Measuring (cont.)

- Using different measuring tools to measure distances along the trail.
- Reading measuring devices accurately when measuring temperature, distance, direction (on a compass).
- See also SCIENCE list: *Measuring/Collecting, Recording Data.*
- See also SOCIAL SCIENCE list: *Collecting, Recording Data/Measuring.*

Comparing

- Using the concept of "greater than" and "less than" in making comparisons of numbers of oak, pine, maple, or aspen trees.
- Comparing measurements obtained by using a meter stick and a tape measure.
- Comparing qualitative information, such as information on habits of birds, gathered from various sources, such as through library research and from observations outside.
- Comparing qualitative information on habitats of different trees or animals gathered from library research with quantitative data gathered from taking a sample.
- Comparing estimated and actual results of measurements or counts.
- Making graphic comparisons of ratios when comparing data collected from samples of different sizes.
- See also SCIENCE and SOCIAL SCIENCE lists: *Analyzing, Interpreting Data.*

Estimating/Approximating/Rounding Off

- Estimating error in qualitative judgments when collecting survey data.
- Estimating number of animals or plants in the total area from the results of a sample.
- Estimating the number of people who will use a nature trail if one were developed.
- Estimating trail distances and direction when making a map of the area.
- Determining when a measurement is likely to be accurate enough for a scale map.
- Rounding off measurements when measuring direction, distance, or temperature.
- Rounding off data after measuring trail length.

Organizing Data	• Tallying on bar graphs. • Organizing numbers on a graph axis. • Ordering the steps in a process. • Ordering sample or survey results. • Ordering meters, degrees (angle) on a magnetic compass, or degrees (temperature) on a thermometer. • See also SCIENCE and SOCIAL SCIENCE lists: *Organizing, Processing Data.*
Statistical Analysis	• Finding the median in an ordered set of data, such as median number of squirrels counted in woods over several days. • Taking repeated measurements of t: il length and using the median measurement. • Determining the range of data on air temperature or number of plants or animals. • See also SCIENCE and SOCIAL SCIENCE lists: *Analyzing, Interpreting Data.*
Opinion Surveys/Sampling Techniques	• Conducting opinion surveys to find out how people use the natural area, what information about nature people want to learn; defining data collection methods, makeup and size of sample. • Devising methods of obtaining quantitative information on subjective opinions about nature and the area near the school. • Evaluating survey methodology, data obtained, size and type of samples. • Taking a sample of animals or plants found in natural area; determining size and type of sample. • Assessing predictability of numbers and types of animals or plants found in larger sample area based on results from smaller sample area. • See also SCIENCE and SOCIAL SCIENCE lists: *Analyzing, Interpreting Data.*
Graphing	• Using alternative methods of displaying data on animal or plant counts. • Making a graph form--dividing axes into parts, deciding on an appropriate scale. • Representing data on graphs: • Bar graph--plotting numbers of animals of different kinds.

Graphing (cont.)	• Conversion graph--plotting feet vs. yards. • Line chart--number of animals of different kinds counted in different areas. • Slope diagram--number of trees of different kinds counted in sample areas of different sizes. • See also SCIENCE and SOCIAL SCIENCE lists: *Communicating, Displaying Data*.
Spatial Visualization/Geometry	• Drawing a map of the natural area and trails. • Constructing and using geometric figures, for example, circles in making compass directions on map of a trail. • Using geometric figures to understand and utilize relationships, such as shapes of various leaves, leaf perimeter, area, etc. • Using standard mensurational formulas, e.g., Area = Length x Width. • Measuring and constructing signs, maps, using measuring devices, magnetic compasses. • Using spatial arrangements of points on maps to convey information.

Areas of Study

Numeration Systems	• Using metric system (decimal) in measuring distances. • Using fractions in measuring feet. • Using decimal system in calculating costs of materials such as Tri-Wall, lumber, and paint.
Number Systems and Properties	• See *Computation Using Operations*.
Denominate Numbers/Dimensions.	• See *Measuring*.
Scaling	• Deriving information from scale maps of the natural area. • Finding an appropriate scale (proportion) for the scale map. • Using a scale to draw and make representations on a scale map of the trail. • Making a scale map of the trail.
Symmetry/Similarity/Congruence	• See *Spatial Visualization/Geometry*.

Accuracy/Measurement Error/ Estimation/Approximation	• See *Measuring* and *Estimating/Approximating/Rounding Off*.
Statistics/Random Processes/ Probability	• See *Statistical Analysis*.
Graphing/Functions	• See *Graphing*.
Fraction/Ratios	• See *Computation Using Operations: Fractions/Ratios/ Percentages*.
Equivalence/Inequality/Equations	• See *Comparing* and *Computation Using Operations*.
Money/Finance	• See *Computation Using Operations: Business and Consumer Mathematics/Money and Finance*
Set Theory	• See *Classifying/Categorizing*.

ACTIVITIES IN NATURE TRAILS UTILIZING SCIENCE

Process	
Observing/Describing	• Observing and describing various things about nature and the outdoor environment, e.g., animal behavior, interactions among plants and animals, physical characteristics. • Describing various ways in which nature can be shown to other students. • Describing trail and its points of interest to others. • See also SOCIAL SCIENCE list: *Observing/Describing/Classifying*.
Classifying	• Classifying animals, plants, rocks, soil, or environments according to physical characteristics. • Categorizing types of information, as geology, natural history, ecology, etc., that can be presented to other students. • Categorizing methods of presenting information to others. • See also MATHEMATICS list: *Classifying/Categorizing*. • See also SOCIAL SCIENCE list: *Observing/Describing/Classifying*.
Identifying Variables	• Identifying numbers of different animals or plants, size of area, temperature, etc., as things to measure in order to learn about a natural area. • Identifying weather, temperature, time of day, time of year, etc., as factors that affect a natural area and what one sees there. • Identifying factors which distinguish plants from animals, conifers from deciduous trees, pines from spruces, etc. • Identifying time to go through a nature trail as a variable to measure when setting up a trail. • See also SOCIAL SCIENCE list: *Identifying Problems, Variables*.
Defining Variables Operationally	• Defining outdoor temperature as the temperature measured by a thermometer in degrees Celsius (or Fahrenheit) at a given point near the trail. • Defining sample size as 100 trees or as trees within a 400 sq. in. area.

Defining Variables Operationally (cont.)	• Defining length and width of sample area as that measured in meters by a tape measure. • Defining insect as an animal with six legs and a hard outer covering. • Defining time to go through nature trail as the time, measured by a stopwatch, that a student takes to go from start to finish stopping at each point of interest.
Manipulating, Controlling Variables/Experimenting	• Designing a nature trail that includes some of the area's most interesting features. • Measuring number of plants or animals within a sample area. • Measuring amount of time it takes to go through the nature trail. • See also SOCIAL SCIENCE list: *Manipulating, Controlling Variables/Experimenting.*
Designing and Constructing Measuring Devices and Equipment	• Constructing devices to use with a compass for measuring direction of the trail. • Designing and constructing signs or bird feeders for the trail.
Inferring/Predicting/Formulating, Testing Hypotheses/Modeling	• Inferring from observations or data from samples that certain animals prefer certain environments over others. • Inferring from observations that weather affects animal activity. • Using observations to predict animal activity on sunny, rainy, snowy, or windy days. • Predicting how a cleared area will change if allowed to grow up based on observation of surrounding environment. • Hypothesizing that measurements of the nature trail will be accurate enough for a scale map. • See also SOCIAL SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses.*
Measuring/Collecting, Recording Data	• Collecting data on natural history by daily observations. • Counting the number of squirrels, toads, insects, oak trees, etc., within a sample area. • Measuring distances along the trail in order to make a scale map of the area. • Measuring time it takes to go through the nature trail. • Researching information on animals, plants, ecology, history of a natural area.

Measuring/Collecting, Recording Data (cont.)	• Measuring to construct signs or bird feeders for the nature trail. • See also MATHEMATICS list: *Measuring*. • See also SOCIAL SCIENCE list: *Organizing, Processing Data*.
Organizing, Processing Data	• Ordering number of animals or trees from smallest to largest. • Organizing researched data on animals and plants in the area. • Tabulating measurements of the trail before making a scale map. • See also MATHEMATICS list: *Measuring*. • See also SOCIAL SCIENCE list: *Organizing, Processing Data*.
Analyzing, Interpreting Data	• Calculating either the average or the median time it takes to go through the trail. • Calculating total length of the trail. • Spotting trends in animal activity according to time of day, temperature, or season. • Determining from samples that woods with tall trees and heavy shade contain more oaks and maples than wooded areas with shorter trees and more light. • Interpreting graphs. • See also MATHEMATICS list: *Comparing; Statistical Analysis; Opinion Surveys/Sampling Techniques; Graphing*. • See also SOCIAL SCIENCE list: *Analyzing, Interpreting Data*.
Communicating, Displaying Data	• Showing data on various types of graphs. • Showing design of the trail and placement of points of interest on a map of the trail. • Showing information about nature in displays for people using the nature trail. • Communicating facts about nature to people using the trail by means of pamphlets or guided tours. • See also MATHEMATICS list: *Graphing*. • See also SOCIAL SCIENCE list: *Communicating, Displaying Data*. • See also LANGUAGE ARTS list.

Generalizing/Applying Process to New Problems	• Using knowledge acquired about plants or animals to work on Growing Plants or School Zoo. • See also SOCIAL SCIENCE list: *Generalizing/Applying Process to Daily Life.*
Areas of Study	
Measurement	• Using trundle wheel, tape measures, or string to measure distances along the nature trail. • Using a magnetic compass to determine direction along the trail. • Measuring time it takes to go through the trail. • See also MATHEMATICS list: *Measuring.*
Force	• Observing that force must be used to drive signs into the ground next to the trail. • Noting that sticks, boards, or hoes may be used as levers to multiply force when prying rocks from the nature trail.
Friction	• Observing that as a piece of wood is sanded it becomes smoother and offers less resistance to the motion of the sandpaper. • Observing that a blade becomes warmer when a piece of wood is sawed vigorously because doing work against the force of friction generates heat.
Weight	• Noting the significance of gravity in pulling objects such as falling leaves towards the earth. • Observing that birds and insects such as butterflies overcome force of gravity through the use of their wings.
Mechanical Work and Energy	• Observing that using rakes, hoes, hand saws, or hammers requires energy. • Observing that electrical energy is transformed into mechanical energy when power tools are used. • See also *Force.*

Solids, Liquids, and Gases

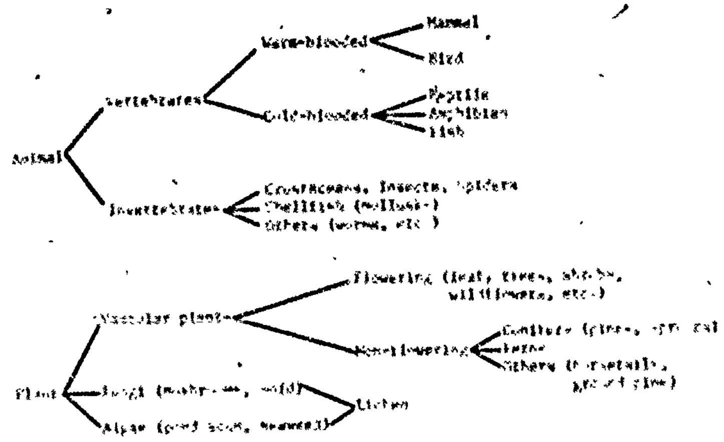
States of Matter	• Observing that water in ponds or streams freezes into ice in the winter and melts again in the spring. • Observing that precipitation comes in solid and liquid forms. • Observing that water vapor in the air condenses on the grass to form dew or frost.
Properties of Matter	• Observing when testing rocks for hardness that different forms of matter have different physical properties. • Observing when testing rocks for limestone with hydrochloric acid that different forms of matter have different chemical properties. • Noting that paints for trail signs have different colors and different weathering abilities. • Observing that glues, lumber, paints, soil, meadows, pine woods, flowers, etc., all have particular odors. • Observing that a compass needle points towards magnetic north; the earth is a huge magnet which attracts other magnets such as the compass needle. • Noting that certain metallic objects attract the needle of the magnetic compass while others do not.
Heat/Temperature	• Observing and measuring changes in temperature in the area around the trail by using a homemade or commercial thermometer. • Noting that wooded areas are often cooler than surrounding environments because the shade prevents the sun's rays from warming the ground and the air under the trees.
Light	• Observing that autumn leaves, flowers, butterflies, birds, etc., come in different colors, caused by the reflection of light of a given color and the absorption of light of other colors by the pigment in the plant or animal. • Observing that certain birds exhibit irridescence as light is reflected from their feathers at different angles. • Observing that bees and hummingbirds are attracted to brightly colored flowers. • Observing that some types of plants require more light than others to grow.

Sound

- Observing that sounds made by birds, insects, and other animals differ in pitch, tone, loudness, and quality.
- Observing that sound becomes less intense as it moves away from its source.

Animal and Plant Classification

- Observing that the animals and plants they find have different physical characteristics which distinguish them from other types of plants and animals. A scientific system of classification has been devised for all living things based on physical differences and similarities.



Ecology/Environment

- Observing that animals in the area near the trail use plants and other animals for food and shelter.
- Noting that different kinds of trees and plants grow in different places according to their needs for moisture, light, and space.
- Noting that living things grow in soil made up of dead plant and animal matter.
- Observing interesting rocks or rock formations in an area and noting soil changes from one spot to another.
- Noting that the nature trail area may have fewer animals, birds, wild flowers, etc., than larger government-owned parks that are farther from human settlements.

Nutrition/Growth

- Observing animals, plants, and insects feeding in their natural environment.

Nutrition/Growth (cont.)	• Observing that some animals eat plants, (e.g., inchworms), some eat animals (e.g., spiders), and some eat both (such as chickadees feeding on suet and seeds at bird feeders). • Noting that rotting logs provide nutrients and a surface area for fungi to grow. • Noting that green plants, unlike fungi, cannot grow *inside* a hollow log because the chlorophyll in their leaves requires light to make food. • Observing that buds form on trees in the fall and break open in the spring to make new growth.
Genetics/Heredity/Propagation	• Observing that plants found in the natural area have different means (e.g., runners and various types of seeds) to reproduce themselves. • Observing that young squirrels, rabbits, birds, etc., closely resemble their parents.
Animal and Plant Behavior	• Observing that animals move around and respond to different stimuli in their natural environment. • Noticing that blue jays may act aggressively by chasing other species away from the bird feeder or cooperatively by warning other animals that people are approaching.
Anatomy/Physiology	• Observing differences in plants or animals based on internal and external structure.

ACTIVITIES IN NATURE TRAILS UTILIZING SOCIAL SCIENCE

Process	
Observing/Describing/Classifying	• Observing and describing effects of learning outdoors on students. • Observing that most people enjoy being outside and are interested in nature. • Categorizing types of information that can be presented to other students. • Classifying people who will use the trail--students, teachers, visitors, parents, etc. • Distinguishing sets and subsets of quantitative survey data on what kinds of information other children would like to learn about nature. • See also MATHEMATICS list: *Classifying, Categorizing.* • See also SCIENCE list: *Observing/Describing; Classifying.*
Identifying Problems, Variables	• Identifying different attitudes students have toward nature. • Identifying types of nature trails, displays, tours, etc., as variables that could be changed to increase interest and appreciation of nature. • Identifying causes of vandalism, litter, pollution, etc., of the natural area. • Identifying variables that affect the results of an opinion survey, such as age, grade level, habits of people, backgrounds of people. • See also SCIENCE list: *Identifying Variables.*
Manipulating, Controlling Variables/ Experimenting	• Conducting attitude surveys before and after a nature trail is developed to see whether other students' attitudes towards nature change. • Designing and conducting opinion surveys to determine what types of information to present on the trail. • See also SCIENCE list: *Manipulating, Controlling Variables/Experimenting.*
Inferring/Predicting/Formulating, Testing Hypotheses	• Inferring from results of opinion surveys that particular information about nature is most interesting to other students.

Inferring/Predicting/Formulating, Testing Hypotheses (cont.)	• Hypothesizing that the results from a sample of students reflect the opinions of all the students. • Predicting the number of students who will use a nature trail from results of a survey. • Hypothesizing that if older students were involved in making a school nature trail, there would be less vandalism of trail signs. • See also SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses.*
Collecting, Recording Data/ Measuring	• Using voting procedure to determine preferences for setting up a trail. • Administering an opinion survey about information to present on the trail; administering an attitude survey on nature and the outdoors. • Recording number of students who use the trail. • See also MATHEMATICS list: *Counting; Measuring.* • See also SCIENCE list: *Measuring/Collecting, Recording Data.*
Organizing, Processing Data	• Tallying questionnaire data on attitudes towards nature or opinions about the trail. • Tallying votes when making decisions about the nature trail. • Tallying number of students who use the trail. • See also MATHEMATICS list: *Organizing Data.* • See also SCIENCE list: *Organizing, Processing Data.*
Analyzing, Interpreting Data	• Interpreting results, ~~including~~ graphs, of opinion surveys on information desired and ~~or~~ attitude surveys on nature; comparing data from different groups. • Comparing qualitative information gathered from interviews with biology experts, naturalists, or park officials. • Evaluating survey methodology, size and makeup of sample. • See also MATHEMATICS list: *Comparing; Statistical Analysis; Opinion Surveys/Sampling Techniques; Graphing.* • See also SCIENCE list: *Analyzing, Interpreting Data.*
Communicating, Displaying Data	• Making and displaying map of trail. • Representing survey data, such as attitudes about nature or opinions about type of nature trail, on graphs or charts.

Communicating, Displaying Data (cont.)	• See also MATHEMATICS list: *Graphing*. • See also SCIENCE list: *Communicating, Displaying Data*. • See also LANGUAGE ARTS list.
Generalizing/Applying Process to Daily Life	• Using knowledge acquired from taking opinion surveys to help solve other problems where attitudes are important. • Using knowledge acquired from teaching students about nature for teaching people other types of things. • Using knowledge acquired about nature to improve personal behavior and behavior of other people towards animals, plants, and natural environments. • Using knowledge acquired from observing natural systems for understanding human social systems; comparing similarities and differences between the two. • See also SCIENCE list: *Generalizing/Applying Process to New Problems*.

Attitudes/Values

Accepting Responsibility for Actions and Results	• Making sure that various tasks (e.g., identifying trees, putting up signs, mapping the trail) are done. • Scheduling meetings with nature experts or park officials. • Scheduling hours and personnel for guided tours of the nature trail. • Being responsible for actions while out of the classroom.
Developing Interest and Involvement in Human Affairs	• Designing a nature trail for others to use. • Attempting to stop vandalism by involving other students or publicizing the benefits of a nature trail.
Recognizing the Importance of Individual and Group Contributions to Society	• Recognizing that the nature trail will benefit not only themselves but the whole school. • Assessing the effects of group action on the school or local park system.
Developing Inquisitiveness, Self-Reliance, and Initiative	• Conducting small and large group sessions with help from the teacher. • Finding solutions to problems encountered in addition to the main problem of the challenge.

Developing Inquisitiveness, Self-Reliance, and Initiative (cont.)	• Using the telephone to find information or to get in touch with officials or experts. • Choosing and developing the best way of presenting a nature trail to other people.
Recognizing the Values of Cooperation, Group Work, and Division of Labor	• Finding that work on a nature trail progresses more rapidly and smoothly when done in groups. • Eliminating needless overlap in work. • Finding that work is fun when people cooperate.
Understanding Modes of Inquiry Used in the Sciences; Appreciating Their Power and Precision	• Using scientific modes of inquiry to investigate the natural environment and solve problems when building a trail. • Using data, graphs, maps, and written materials to explain the natural area to other people. • See also MATHEMATICS and SCIENCE lists.
Respecting the Views, Thoughts, and Feelings of Others	• Considering all suggestions and assessing their merits. • Considering the opinions of others when developing a nature trail. • Recognizing and respecting differences in values according to age, experience, occupation, income, interests, culture, race, religion, ethnic background. • Respecting the thoughts, interests, and feelings of members of the opposite sex when working in groups.
Being Open to New Ideas and Information	• Considering alternative ways of doing various tasks. • Conducting library research on natural history, ecology, geology, etc. • Asking other people for opinions, ideas, and information.
Learning the Importance and Influence of Values in Decision-Making	• Recognizing that preferences for types of nature trail reflect the values of each individual.

Areas of Study

Anthropology	• Observing and describing preferences for natural environments (e.g., deserts, mountains, deciduous woods) related to cultural and geographic background.

Economics	• Gaining experience in comparative shopping for materials for building the trail, making signs, bird feeders, etc.
Geography/Physical Environment,	• Investigating differences in natural areas due to differences in geography of regions. • Comparing topography of the trail area to the geography of the region. • Making and using a map of the nature trail. • Recording topographical information of the trail area on a map of the trail.
Political Science/Government Systems	• Investigating systems of administration and control of land; deciphering role of governing body over the land. • Investigating regulations and policies affecting land used for a nature trail. • Working with school or government authorities to develop a nature trail. • Determining needs for rules and regulations when working outside on the trail and when others use the trail.
Recent Local History	• Investigating previous attempts to establish a nature trail. • Investigating history of the area to be used for a nature trail to discover records of human settlement, legends, etc.
Social Psychology/Individual and Group Behavior	• Recognizing and using different ways of approaching different groups, such as students and administrators. • Recognizing need for leadership within small and large groups; recognizing differing capacities of individuals for various roles within groups. • Analyzing the effects of a small group making decisions for a larger group.
Sociology/Social Systems	• Considering the integral, related nature of the school community and its physical surroundings as a factor in the problem of making a nature trail. • Devising a system of working cooperatively in small and large groups. • Investigating problems and making changes that affect not only themselves, but society (other students in the school, parents, etc.).

Sociology/Social Systems (cont.)

- Working within established social systems to promote development of a nature trail.
- Experiencing and understanding differences in social systems in different social groups (children, adults, women, men, homemakers).
- Recognizing that there are many different social groups and that one person belongs to more than one social group.

ACTIVITIES IN NATURE TRAILS UTILIZING LANGUAGE ARTS

Basic Skills	
Reading: Literal Comprehension—Decoding Words, Sentences, and Paragraphs	• Decoding words, sentences, and paragraphs while reading books on natural history, ecology, geology; while reading field guides; while reading city park regulations or restrictions.
Reading: Critical Reading--Comprehending Meanings, Interpretation	• Obtaining factual information about animals, plants, rocks, park restrictions, etc. • Understanding what is read about animals, plants, rocks, park restrictions, etc. • Interpreting what is read, such as biology and ecology concepts, rules and restrictions, etc.
Oral Language: Speaking	• Offering ideas, suggestions, and criticisms during discussions in small group work and during class discussions on the trail and points of interest. • Reporting to class about data collecting, mapping activities, sign construction, etc. • Responding to criticisms of activities. • Preparing, practicing, and giving effective oral presentation to classes or other people using the trail. • Using the telephone properly and effectively to obtain information or to invite a resource person to speak to the class. • Conducting opinion surveys about possible improvements to the nature trail. • Using rules of grammar in speaking.
Oral Language: Listening	• Conducting interviews of classmates. • Follow spoken directions. • Listening to group reports.
Oral Language: Memorizing	• Memorizing portions of oral presentations to be given during tours of the nature trail.
Oral Language: Spelling	• Using correct spelling in writing.

Written Language: Grammar	• Using rules of grammar in writing.
Written Language: Composition	• Writing to communicate effectively: • preparing written reports and pamphlets using notes, data, charts, graphs, maps, etc., explaining the area around the nature trail. • writing posters advertising the trail, requesting students not to litter, etc. • writing opinion surveys for other children; devising questions to elicit desired information; judging whether a question is relevant and whether its meaning is clear. • preparing write-ups of rules to follow while using the nature trail.
Study Skills: Outlining/Organizing	• Taking notes when consulting authorities or books about natural history, plant and animal classification, geology, ecology, local history, etc. • Developing opinion surveys; ordering questions around central themes, such as preferences for type of nature trail or attitudes towards nature. • Planning presentations, data collection schemes, etc. • Organizing ideas, facts, data for inclusion in pamphlets about the nature trail.
Study Skills: Use of References and Resources	• Using the library to research information on plants, animals, rocks, ecology, etc. • Using dictionary and encyclopedia to locate information. • Inviting a naturalist, park official, topographer, or other expert to speak to the class and answer questions. • Using indexes and tables of contents of books to locate desired information • Using "How To" Cards for information on making a survey, using tools, etc.

Attitudes/Values

Appreciating the Value of Expressing Ideas Through Speaking and Writing	• Finding that classmates and teacher may approve of an idea if it is presented clearly. • Finding that other students may appreciate the nature trail if it is explained clearly and with enthusiasm.

Appreciating the Value of Expressing Ideas Through Speaking and Writing (cont.)

- Finding that school or park officials may approve of a nature trail if presented with a good proposal.

Appreciating the Value of Written Resources

- Finding that certain desired information can be found in books on nature, e.g., identification of trees, birds, insects, etc.

Developing an Interest in Reading and Writing

- Willingly looking up information on plants, animals, geology, local history, etc.
- Looking up further or more detailed information.
- Showing desire to work on drafting pamphlets.

Making Judgments Concerning What is Read

- Deciding whether what is read is applicable to the particular natural area.
- Deciding how reliable the information obtained from reading is.
- Deciding whether the written material is appropriate, whether it says what it is supposed to say, whether it may need improvement.

Appreciating the Value of Different Forms of Writing, Different Forms of Communication

- Finding that how information can be best conveyed is determined in part by the audience to whom it is directed.
- Finding that certain data or information can be best conveyed by writing it down, making maps, drawing graphs or charts, etc.
- Finding that information on points of interest can be most easily shared by speaking.
- Finding that certain data or information should be written down so that it can be referred to at a later time.
- Finding that spoken instructions are sometimes better than written instructions, and vice versa.