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ABSTRACT

Finding ways to make bicycle riding a safe and convenient way to travel is the challenge of this Unified Sciences and Mathematics for Elementary Schools (USMES) unit. 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, flow charts illustrating how investigations evolve from students' discussions of bicycle transportation problems, and a hypothetical account of intermediate-level class activities. Section III provides documented events of actual class activities from grades 2/3 and 4/6. 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 bicycle transportation investigations. (JN)

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

Bicycle Transportation

Second Edition

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CHALLENGE: FIND WAYS TO MAKE BICYCLE RIDING A SAFE AND CONVENIENT WAY TO TRAVEL.

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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 one 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.

#Available fall 1976.

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. USMES provides resources in addition to these. One resource for students is the Design Lab or its classroom equivalent: using the tools and supplies available, children can follow through on their ideas by constructing measuring tools, testing apparatus, models, etc. Another resource for students is the *"How To" Cards*. Each set of cards gives information about a specific problem; the students use a set only when they want help on that particular problem.

Several types of resources are available for teachers: the *USMES Guide*, a *Teacher Resource Book* for each challenge, *Background Papers*, a *Design Lab Manual*, and a *Curriculum Correlation Guide*. A complete set of all these written materials comprise what is called the USMES library. This library, which should be available in each school using USMES units, contains the following:

1. *The USMES Guide*

   The USMES Guide is a compilation of materials that may be used for long-range planning of a curriculum that incorporates the USMES program. In addition to basic information about the project, the challenges, and related materials, it contains charts assessing the strengths of the various challenges in terms of their possible subject area content.

2. *Teacher Resource Books* (one for each challenge)

   Each book contains a description of the USMES approach to real problem-solving activities, general information about the particular unit, edited logs of class activities, other written materials relevant to the unit, and charts that indicate the basic skills, processes, and areas of study that may be learned and utilized as students become engaged in certain possible activities.

3. *Design Lab Manual*

   This contains sections on the style of Design Lab activities, safety considerations, and an inventory of tools and supplies. Because many "hands-on" activities may take place in the classroom, the Design Lab Manual should be made available to each USMES teacher.

4. *"How To" Cards*

   These short sets of cards provide information to students about specific problems that may arise during USMES units. Particular computation, graphing, and construction problems are discussed. A complete list of the "How To" Cards can be found in the USMES Guide.

5. *Background Papers*

   These papers are written to provide information for the teachers on technical problems that might arise as students carry on various investigations. A complete list of the Background Papers can be found in the USMES Guide.

6. *Curriculum Correlation Guide*

   This volume is intended to coordinate other curriculum materials with the Teacher Resource Books and to provide the teacher with the means to integrate USMES easily into 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, the USMES newsletter, 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.

Acknowledgments

Besides the contributors listed at the beginning of the book, we are deeply indebted to the many elementary school children whose investigations of the challenge form the basis for this book. Without their efforts this book would not have been possible. Many thanks to the Planning Committee for their years of service and advice. Many thanks also to other members of the USMES staff for their suggestions and advice and for their help in staffing and organizing the development workshops. Special thanks also go to Christopher Hale for his efforts as Project Manager during the development of this book.

* * *

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 companies that supply 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 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.

Role of the Teacher

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 textbook 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 Bicycle Transportation

1. OVERVIEW OF ACTIVITIES

Challenge:

Find ways to make bicycle riding a safe and convenient way to travel.

Possible Class Challenges:

How can we make bicycle riding a safe and convenient way to travel around our school area?

How can we make cyclists safer riders?

The subject of cycling will arise easily in the classroom since a bicycle is a major means of transportation for children. In some classes a recent bicycle mishap may lead to a discussion of safe cycling habits. Other classes may talk about the problems of getting to and from areas of interest in the school district safely and conveniently. From these discussions the challenge may readily evolve.

In discussing the unit challenge the class may generate a long list of concerns related to cycling that may later be shortened by the setting of priorities. Before such priorities are set, some classes may conduct an opinion survey among their schoolmates to confirm noted problems or to identify new ones. The class may then choose to work as a whole on one large problem or to divide into small groups to work on several major concerns. In some classes students may work on the problem of riding safely throughout the school district, some classes may work on the problem of safe cycling habits, and other classes may work on both problems simultaneously.

Students investigating ways to ride safely throughout the school district may observe or determine from an opinion survey the need for bicycle routes or paths. The data that they collect may show that present riding conditions are unsafe. Some students may enlarge to scale the school district area of the city map, indicate places of interest, and plan routes for bicycle paths that would be convenient and safe for most students in an area. In some classes the students may even measure the proposed routes and do a cost analysis of labor and materials if path construction is involved. Later, they may present their findings and recommendations to appropriate city planners.

Students working on the problem of safe cycling habits may plan a bicycle safety program incorporating a written test, a bicycle test course, and a bicycle inspection. To assist in designing a written test and a test course, the students may investigate the city laws on cycling. For the bicycle inspection the students may make a list of bicycle parts and accessories that should be in good order. They may also set up an area on the school playground with the necessary tools for bicycle repairs. After the riding tests and bicycle inspection the students may issue certificates congratulating those who passed every test. For those who

failed one test and/or the bike inspection, the students may develop a program to instruct these riders. Later the students may organize programs to promote bicycle safety, to protect bicycles while at school and to maintain safe bikes.

The students' work on the challenge may lead to an interest in other USMES challenges, such as Getting There, Traffic Flow, or Pedestrian Crossings (to study related traffic problems), Advertising or Mass Communications (to tell others about new routes or to remind students about bicycle safety), and Protecting Property (to secure the bikes).

Although many of the activities may require skills and concepts new to the students, there is no need for preliminary work on these skills and concepts because the students 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 learn to count by rote, they can, through USMES, gain a better understanding of counting by learning or practicing it within real contexts. In working on Bicycle Transportation 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; sets of data can also be compared graphically or by subtracting medians (half-way values). Furthermore, instead of using division to make scale drawings, younger children can convert their measurements to spaces on graph paper. Division may be introduced at the proper grade level during calculation of percentages and averages.

2. CLASSROOM STRATEGY FOR BICYCLE TRANSPORTATION

The Bicycle Transportation unit revolves around 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 Bicycle Transportation challenge--"Find ways to make bicycle riding a safe and convenient way to travel"--is general enough to apply to many situations. Students in different classes define and reword the challenge to fit their particular situation. For example, the Bicycle Transportation challenge has been restated by two classes in terms of finding safe and convenient bicycle routes in the school district. Another class worked on the problem of making the cyclist a knowledgeable and safe rider.

The Process of Introducing the Challenge

Given that a problem exists, how can a teacher, without being directive, help 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 spontaneous discussion of some recent event toward the challenge. For example, the teacher may focus a discussion of several recent bicycle accidents on the Bicycle Transportation challenge.

One fourth/fifth/sixth-grade teacher arrived on the first day of school wearing a brace to support her collarbone. She explained that her injury was due to a bicycle accident. After discussing the specifics of the accident she later focused the discussion on the Bicycle Transportation challenge.

Students in one fourth-grade class discussed the cycling situation in their area after one student complained about how the heavy traffic had ruined her family bicycle trip. The class agreed that cycling was popular and decided to tackle the Bicycle Transportation challenge.

Often work on one challenge leads to another. For example, a class may become interested in the Bicycle Transportation challenge after studying the traffic patterns around the school in response to the Traffic Flow challenge. Having identified congested streets, the students may wish to map out safe bicycle routes.

The Bicycle Transportation challenge evolved from the Pedestrian Crossings challenge in one intermediate class. While making observations at various pedestrian crossings, the students noted that their schoolmates were not riding their bicycles properly, such as not using hand signals and riding poorly equipped and maintained bikes. The class thought it would be good to organize a bicycle safety program and temporarily put aside the Pedestrian Crossings challenge.

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

An USMES challenge may also evolve from a discussion of a specific topic being studied by the class. For example, the class may be studying various modes of transportation and wish to investigate bicycle transportation because the bicycle is their main means of getting around the neighborhood. Another class studying about ways to conserve various forms of energy may wish to promote bicycle riding around the school district as a means to save fuel.

Sometimes the discussion of a broad problem may encompass the challenges of several related units. For example, a discussion of how to get to school may lead the students to the challenges for Bicycle Transportation, Pedestrian Crossings, Traffic Flow, or Getting There as the students identify specific problems.

An experienced USMES teacher is usually willing to have the children work on any one of the several challenges that may arise during the discussion of a broad problem. While this approach gives the students the opportunity to select the challenge they are most interested in investigating, it does place on the teacher the additional responsibility of being prepared to act as a resource person for whichever challenge is chosen.

Classroom experience has shown that children's progress on the Bicycle Transportation 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.

One fifth-grade class discussed the Bicycle Transportation challenge but did not agree upon a particular focus. Although small groups worked on bicycle safety, maintenance, and routes, several groups were fairly autonomous. Eventually student interest waned and by early spring only one small group continued to work on unit related activities.

A similar situation occurs if the teacher, rather than insuring 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.

The Bicycle Transportation challenge was not discussed in one third-grade class. The teacher initiated a discussion of bicycle safety by asking the class what the "dos" and "don'ts" of cycling were. After an exhaustive list was compiled, the teacher had the class draw a bicycle test course. Other class activities included discussing bicycle parts and their functions, labeling the parts of a bike, writing a newsletter on bikes, designing bicycle games, and putting on a play on bicycle safety. Several times during the course of some activities class interest waned and so a new activity was introduced by the teacher.

Initial Work on the Challenge

Once a class has decided to work on the Bicycle Transportation challenge, 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 exactly where they were in their investigations, and their momentum diminishes.

During the initial session, the children list problems they have cycling around the school district, and the list is usually long. By grouping together similar complaints and by choosing one or two major problems to work on first, the class can arrive at a manageable challenge. If the children try to tackle too many problems at once, their investigations will be superficial.

> *Students in one fourth/fifth/sixth-grade class listed on the board bicycling problems they had identified. The class then suggested possible solutions and noted the type of problems each solution would resolve. A vote was taken to determine which problems and solution the class wished to tackle first. The vote showed that almost everyone wished to work first on bicycle paths and bicycle riding permits.*

After identifying a workable challenge, the children usually list and categorize their suggested approaches, grouping similar ideas together. Priorities are set for the tasks the students consider necessary to help solve the problem. Most of these tasks are carried out by small groups of students. As various groups complete their work, their members join other groups or form new groups to work on additional tasks.

> *One second/third-grade class formed four small groups to carry out tasks related to their bicycle safety program. The groups were the Safety Test Group (to design the written and riding tests), the Poster Group (to advertise the bicycle tests), the School/City Bicycle Rules Group (to check the bicycle rules), and the Bicycle Survey Group (to survey the school to determine the kinds of bikes students owned). The groups worked simultaneously. When one group completed its tasks, its members joined another group or tackled other activities.*

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.

Refocusing on the Challenge

As the class works on the challenge, the children's attention should, from time to time, be refocused on it so that they do not lose sight of their overall goal. Refocusing is particularly important with younger children because they have a shorter attention span. Teachers find it helpful to hold periodic class discussions that include group reports. Such sessions help the students review what they have accomplished and what they still need to do in order to carry out their proposed changes. These discussions also provide an opportunity for students to participate both in evaluating their own work and in exchanging ideas with their classmates.

The second/third-grade class met periodically for class discussions. During these periods the students gave group reports and discussed problems they had encountered.

(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.)

Resources for Work on the Challenge

When children try to decide on solutions before collecting and analyzing enough data or encounter difficulties during their investigations, an USMES teacher helps out. 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, instead of telling the students ways to set up a bicycle safety program, the teacher might ask, "How can you test a rider's ability to ride his bicycle under different conditions? How can you test his knowledge of cycling rules? What should you do with faulty bikes?" Examples of other nondirective, thought-provoking questions may be found at the end of this section.

The teacher may also refer students to the "How To" Cards, which provide information about specific skills, such as drawing graphs or analyzing data. If many students, or even the entire class, need help in particular areas, such as using fractions, the teacher should conduct skill sessions as these needs arise. (Background Papers provide teachers with additional information on general topics applicable to most challenges, such as designing opinion surveys, and on specific problems associated with this challenge, such as designing a bicycle test course.)

USMES teachers can also assist students by making it possible for them to carry out tasks involving hands-on activities. If the children need to collect data outside of their classroom--at the police station, at a bicycle store--the teacher can help with scheduling and supervision.

One fourth-grade teacher assisted the class in making arrangements to visit a bicycle store and to attend an evening city meeting on bicycle path planning. On both occasions the teacher provided the necessary supervision.

If the children's tasks require them to design and construct items, 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) can be called a Design Lab.

Valuable as it is, a Design Lab is not necessary to begin work on the Bicycle Transportation challenge. The lab is used only when needed, and this need may not arise during early work on the challenge.

Before using the Design Lab to construct pylons and stop signs for their bicycle test course, second/third-graders in one class spent several weeks planning and making decisions. The students identified the riding skills they wished to test, designed a course, decided upon a scoring method and determined the types of materials necessary for the course. Before stop signs were made several children measured a real sign and scaled down the measurements.

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.

At times some classes may not need to use the Design Lab at all; the extent to which the Design Lab is used varies with different classes and different units because the children themselves determine the direction of the investigations and because construction activities are more likely to occur in some units than in others.

Culminating Activities

Student activities generally continue until the children have agreed upon and implemented some solution to their problem. They may write letters or make presentations before public officials, sharing their ideas for possible bicycle routes. Others administer their bicycle tests and bicycle inspections.

One second/third-grade class successfully administered their bicycle tests and inspection to forty-five students. In the spring the class organized a bicycle registration day that attracted over two hundred student cyclists. Because of the successful turnout, the city awarded the school with a bicycle rack.

One fourth-grade class presented their proposal for a bike path and bridge across a gully to a city meeting on bicycle path planning. The proposal was well received, and the class was asked to submit their plans to the city planning department.

3. USE OF BICYCLE TRANSPORTATION IN THE PRIMARY GRADES

Bicycle riders of any age are always concerned about not being seen by car drivers or having a bicycle part break down while they are riding. This concern increases considerably with young children as many are still unsure of their new bike riding skills. Because bicycle safety is a real problem, primary children are able to relate well to the Bicycle Transportation challenge of finding ways to make cycling a safe and convenient way to travel.

Since young children enjoy sharing their experiences with their classmates, a teacher may wait for a cycling incident to occur or for a related topic to arise from the children before introducing the problem of the challenge. A child may come to school one day with several bandages on his knee and arms. He may then reveal the details of his bicycle mishap. Another student may simply tell about a recent bicycle trip she and her family have taken. One second/third-grade teacher simply raised the subject of cycling and her class immediately began sharing their strange and scary bicycle experiences. Based on the children's bicycle experiences, the class will identify several major concerns.

From the many concerns identified, the class may agree on one that they wish to tackle first. Tasks are identified, and in classes where the children are familiar with small group work, groups are formed. With less experienced children the teacher may find it beneficial in the beginning for the whole class to work on one problem at a time. Gradually, as the children become more able to follow through on their proposed plans, the teacher may encourage the class to divide the various aspects of the problem among small groups. One second/third-grade class identified four tasks related to the bicycle safety program that they were interested in carrying out. The class divided into these four interest groups and convened periodically as a class to share group progress and problems.

In addition to being efficient, small group work provides for the opportunity to practice skills that are important in the socialization of young children. Through group work the children realize the necessity of cooperation and compromise. The smallness of a group may also encourage the quieter children to share their ideas and feelings which they may not otherwise do during a class discussion.

During class discussion times each group reports their findings to the class for discussion. This sharing experience not only provides for the opportunity to exchange ideas, but also allows for the practice of oral skills. Other language arts skills are learned and practiced as the children read about automobile and bicycle rules, write letters, scripts and newsletter articles on bicycling and design posters to advertise the bicycle safety program. One third-grade class wrote a newsletter on bicycling for other students in the school. Articles were written and critiqued by the class. The final copies were typed and laid out in a newspaper-type format with headlines and feature articles.

The need to collect information and opinions from other students in the school often arises during the course of the Bicycle Transportation challenge. The opinion survey is seen as an important vehicle for gathering the needed data. Young children may compile simple questions, decide upon a sample size and a way to choose the sample and organize an efficient way to administer the survey. Students in one second/third-grade class wanted to know the types of bicycles owned by students in the school. Their one survey question, "Do you have a one-, three-, five-, or ten-speed bicycle?" was written on poster boards and hung in the school halls. In order for bike owners to respond, a blank pad of paper and a shoe box with a slot in the top were attached to the poster. Several such posters were made.

Another important skill that is learned through the Bicycle Transportation unit is that of map reading when the class identifies safe and unsafe areas of the school district in which to ride their bikes. Map reading becomes more relevant to young children when they identify and mark on the map places that they are familiar with, such as their homes, homes of friends, the school, and parks. One second/third-grade class used a map of their school district on which to draw safe bike routes from their homes to school. The children also plotted safe bike routes from their homes to other places of interest such as friends' homes, the grocery store, and the stadium.

The Bicycle Transportation unit also provides opportunities for primary children to become involved with many math activities, such as counting, measuring, and graphing. Some of the simpler math activities, such as counting, tallying, and adding, frequently occur when the children count hands during a class vote, tally and add the total responses to opinion surveys, or count and add the total number of cars on a particular street. Graphing is easily introduced as the children see the need to organize and to make pictures of their information. Students in one second/third-grade class wished to tell the rest of the class the results of their survey on bicycle types owned by students in the school. The children wanted to make some sort of a chart but were unsure about how to lay it out. A skill session on bar graphs was then given by the teacher.

Another graph, the slope diagram, becomes particularly useful when young children need to compare ratios or fractions such as comparing the number of bike accidents to the total number of bike riders in different grades. Each ratio may be plotted on the graph form; a line from each plotted point to the origin is drawn. The ratio can then be compared visually by comparing the slopes of the different lines.

Measuring skills are used when the children lay out their bicycle test course. Measurement is also used in making stop signs, pylons, and other riding course materials. One group of second/third-graders used the measurements of a real stop sign outside of their school to determine the size of their bike course signs. If the class decides that riding time through the bike course is an important factor in judging riding ability, the children will learn and practice timing skills.

Primary children usually enjoy working in the Design Lab. Past experience has shown that young children are able to use power tools with adult supervision and are able to learn the proper ways to use hand tools and other materials. One second/third-grade class made signs and pylons for their bike course in the Design Lab. Primary students working on other USMES units have constructed Tri-Wall tables and bookshelves.

Most primary children will remain interested and spend great amounts of time completing investigations that they consider important and relevant for some sort of resolution to a real problem.

4. FLOW CHART

The following flow charts present some of the student activities--discussions, observations, calculations, constructions--that may occur during work on the Bicycle Transportation challenge. Because each class will choose its own approach to the challenge, the sequence of events given here represent only a few of the many possible variations. Furthermore, no one class is expected to undertake all the activities listed; a class usually works on just one of the aspects represented by the several charts.

These flow charts are not lesson plans and should not be used as such. Instead, they illustrate how comprehensive investigations evolve from the students' discussion of a Bicycle Transportation problem.

Challenge: Find ways to make bicycle riding a safe and convenient way to travel.

Optional Preliminary Activities:

USMES Units: •*Traffic Flow* •*Getting There* •*Pedestrian Crossings*

Social Studies Unit on Transportation

Social Studies Unit on Conservation of Energy

Possible Student Activities:

Class Discussion: How popular is bicycling among the students in the school? What are some of the problems you have cycling around the school district?

Data Collection: Investigation into the rules (city, school) for bicycling.

Data Collection: General observation of students riding bicycles in the school district.

Data Collection: Opinion survey to determine number of students who own bicycles, number who ride to school, and bicycling problems.

Data Representation: Compiling survey and observation data. Preparation of bar graphs, histograms, line charts.

Class Discussion: Reports from groups. Analysis and interpretation of observation data and graphs. Discussion of what changes are feasible. Assignment of priorities to different problems, e.g., safe bicycle routes and paths, bicycle safety program.

Investigation of bicycle routes and paths. (See Flow Chart A.)

Investigation of bicycle safety in terms of the rider and his bicycle. (See Flow Chart B.)

Class Discussion: Discussion of ways to evaluate changes made and effectiveness of ongoing bicycle programs.

Data Collection: Observation of students riding bicycles in school area: whether students use new routes, correct hand signals, etc.

Data Collection: School survey to determine opinions on changes and ongoing bicycle programs.

Data Representation: Compiling survey and observational data. Preparation of bar graphs, histograms, line charts, cumulative distribution graphs, slope diagrams.

Class Discussion: Discussion of ways to improve bicycle protection and maintenance programs, bicycle safety campaign and further ways to make the school district safe.

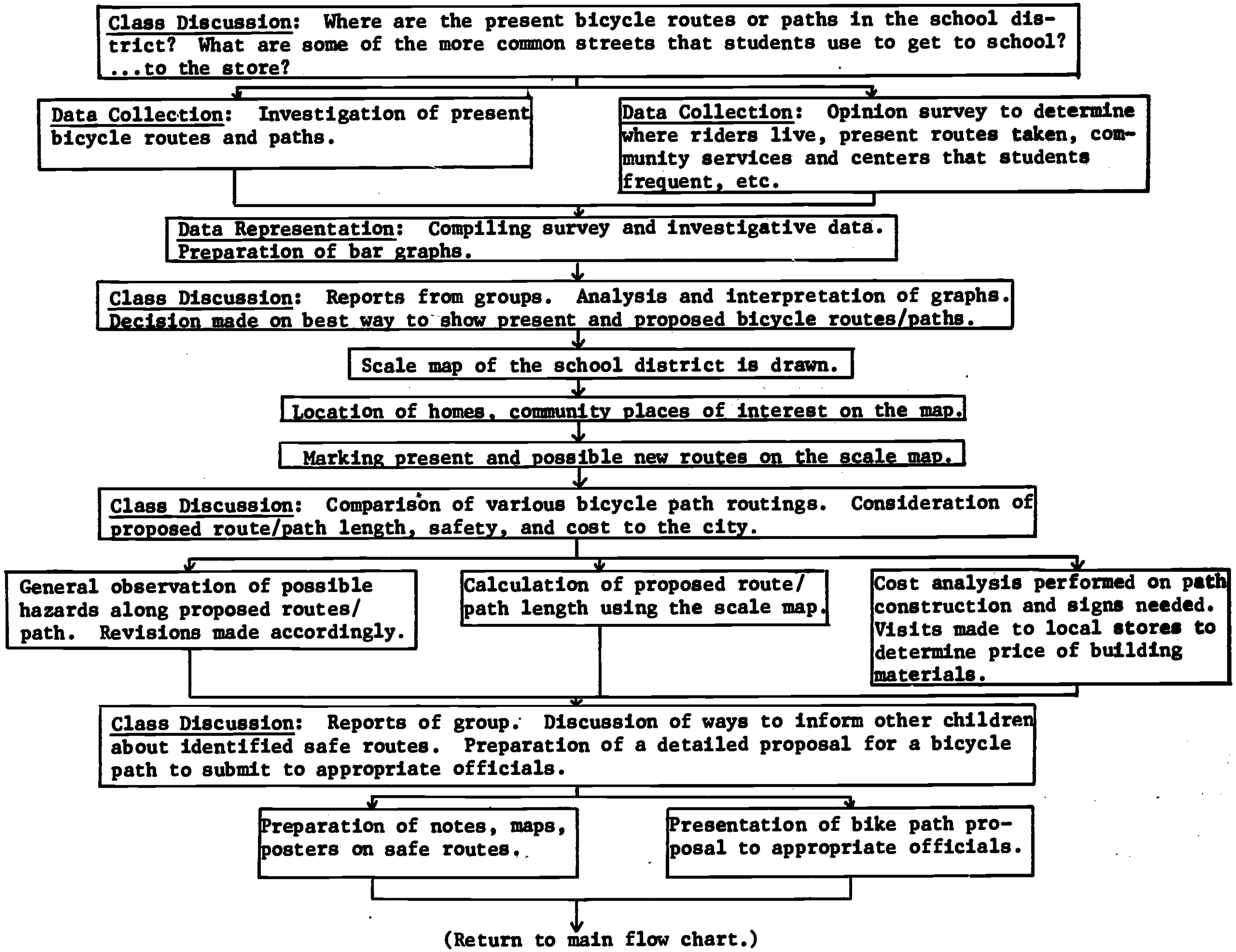
Optional Follow-Up Activities:

USMES Units: •*Advertising* •*Mass Communications* •*Traffic Flow* •*Pedestrian Crossings* •*Protecting Property*

Social Studies Unit on City Government

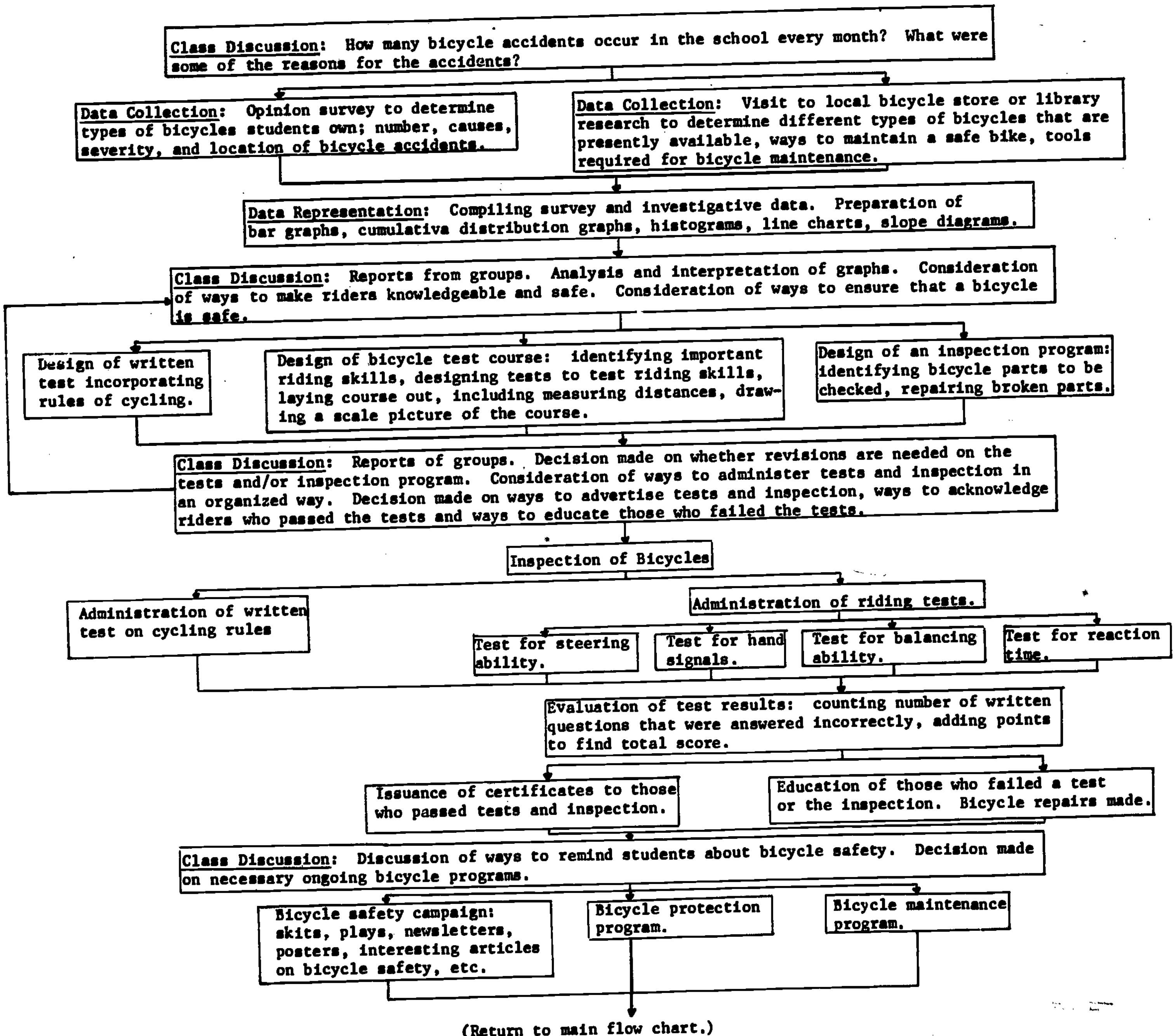
FLOW CHART A

Bicycle Paths or Routes



FLOW CHART B

Bicycle Safety Program



5. A COMPOSITE LOG*

This hypothetical account of an intermediate-level class describes many of the activities and discussions mentioned in the flow charts. The composite log shows only one of the many progressions of events that might develop as a class investigates the Bicycle Transportation challenge. Documented events from actual classes are italized and set apart from the text.

One day one girl arrives at class a little out of breath and late. She explains that because there was so much traffic on Oak Street today she was unable to ride and had to walk her bike the rest of the way to school. Four other students confirm that this situation occurs frequently. Another boy also comments that the traffic on Sidney Street was also heavy today. Many students then wonder why cyclists cannot have rights too.

> *The topic of cycling arose quite naturally at the beginning of school in one fourth-grade class in Monterey, California. One girl, who was new to the area, reported that her family had had a very nerve-racking bicycle trip through a nearby area. They had ridden on the road and discovered that the traffic was extremely heavy. The other students quickly identified other congested areas. One student even noted that some areas were so congested on holidays and weekends that the city closed these roads to cyclists. (From log by Norma Lazzarini.)*

The student's complaints and comments raise the issue of whether they think they can do anything about the problem. The teacher challenges them to find ways to make cycling a safe and a convenient way to travel around the school district.

The class responds to the challenge with different ideas. One student suggests that the class should figure out several possible bike routes in the school area that would be safe, tell others about them, and perhaps even get the town to allocate money for path construction. Someone else suggests that the class should inspect everyone's bike. One boy adds that a rider's ability should also be tested. Two girls wonder if the class should also investigate the laws governing bicycle riding. This suggestion prompts several others to scoff at the idea of any rules even in existence. One boy claims that even if there are rules in existence, they don't seem to matter because no one enforces them.

> *In one second/third-grade class in Iowa City, Iowa, student suggestions for making bicycling safer ranged*

*Written by USMES staff

from wearing football gear to administering a riding test. After discussion, the class decided to design and administer a bicycle test. They felt that such a test would be particularly useful for younger children. (See log by Dorothy Wilkening.)

One fourth/fifth/sixth-grade class in Lansing, Michigan, saw bicycle routes as a means of making cycling safer in the school district. Later, they also organized a bike rodeo to test cyclists' ability to ride. A written test was also a part of the bike rodeo. (See log by Kathryn McNenly.)

The class summarizes the above discussion by identifying and recording on the board key issues that concern them. Their list appears as follows:

1. good routes for cycling around the school district
2. town/school rules on bicycling
3. bicycle safety, the rider and the bike itself
4. school/town support of any proposed bicycle program

In examining the list the class decides that their concerns center around two main activities, a safe and convenient way to ride around in the school district (good routes on streets or bicycle paths) and a means to ensure that the rider is competent and his bicycle is safe. Since the students are divided in interest, they decide to break into two large groups, one group to work on the bicycle routes (Bicycle Routes Group) and the second group to work on bicycle safety (Bicycle Safety Group).

The Iowa class divided into four interest groups. The groups included the Safety Test Group (to design the written and riding tests), the Poster Group (to advertise the bicycle tests), the School/City Bicycle Rules Group (to check the bicycle rules), and the Bicycle Survey Group (to survey the school to determine the kinds of bicycles students owned). The groups worked simultaneously. When a group completed *its tasks, the students assisted other groups. Periodic class discussions were held to share reports and problems. (See log by Dorothy Wilkening.)*

Bicycle Routes Group

This group first talks about ways to identify safe bicycle routes in the school district. One student suggests walking through the entire district, but most members veto this idea because it would take too long to cover the whole school district, and it would be a hassle to make the necessary arrangements to leave school. The group then agrees to obtain a map of the city, to enlarge the school district area of the map to scale, and to record possible bike routes on the map. Later, the proposed bike routes would be checked for any unforeseen hazards.

During the above conversation someone raises the question of the number of bicycle riders who would use the routes. The group realizes that they need to conduct an opinion survey to determine the number of students in the school who presently ride their bicycles. They decide to start work on the map before handling the survey.

While three group members go to the school office to get the map, the others look through the "How To" Cards to see whether there are any that would help them enlarge the map to scale. Using the "How To" Cards, the group then enlarges the school district part of the map. They decide that ten centimeters on their map can represent one centimeter on the town map.

The Michigan students decided to draw a map of their school district so that they could record their proposed bicycle routes. At first they drew the map relying on their memories. They refreshed their memories by walking around sections of the district. The resulting map, however, contained several gaps. When a city map finally arrived at the school, the students agreed that this should be used. Because the school district section was so small in relation to the total city map, the class agreed that this section needed to be enlarged to scale. The students spent several weeks trying to pick an appropriate scale for enlarging the district section of the map, but failed. The enlargement was finally done with the use of an opaque projector. (See log by Kathryn McNenly.)

The fourth-graders in California enlarged their school district section of the city map using grids. One grid was drawn on the city map. A larger grid was drawn on the desired size of Tri-Wall. The sudents then transferred, block by block, the district portion of the map. (From log by Norma Lazzarini.)

While several group members enlarge the map to scale, the rest of the Bicycle Routes Group plans the opinion survey. Considerable time is spent deciding which and how many students to poll. It is agreed that kindergartners through second graders do not need to be polled because they are too young to ride their bicycles in the streets and to school. One girl questions whether the group can poll the remaining twelve classes that represent the third through sixth graders. One boy does a quick calculation and estimates that this population would involve about 300 students. The students readily admit that this number is too many.

A debate evolves over a fair way to pick a sample. The suggestion of polling students in every other horizontal row in each class is voted down because (1) there may be a reason why some students are in the front or back row and (2) not all classes are arranged in rows. Other possible ways to choose a sample include polling one class per grade level (putting all the fourth grade teachers' names in a hat and pulling one name) or using the alphabetical class list in every class (poll every fourth or third student on the class list). When no one can think of further methods, the suggested methods are listed on the board and a hand vote is taken. The vote is in favor of polling one class per grade level. Two students volunteer to prepare for the name drawing.

The group next writes the survey questions. After much sorting and rewording of various questions, the group agrees on the following survey:

Bicycle Survey

Name:
Address:
Grade:
Age:

	Circle your answer	
1. Do you own a bike?	yes	no
2. Do you ride your bike to school?	yes	no
3. If you don't ride your bike to school, why?	________________	
4. Do you ride your bike after school?	yes	no

Convenient times when the group can administer the survey are then arranged with those teachers whose names were drawn for the sample.

When the survey has been administered, the results are tallied and appear as follows:

1. Do you own a bike?	yes = 89	no = 23
2. Do you ride your bike to school?	yes = 51	no = 35

3. If you don't ride your bike to school, why?

   a. too dangerous = 5
   b. afraid of vandalism = 19
   c. parents won't allow = 4
   d. don't feel like riding to school = 7

4. Do you ride your bike after school hours?	yes = 75	no = 11

At the next class meeting the Bicycle Routes Group reports the status of their activities. While the survey results are being reported, the group finds that they must repeat several times the totals to some of the questions. Finally one group member proceeds to record the survey

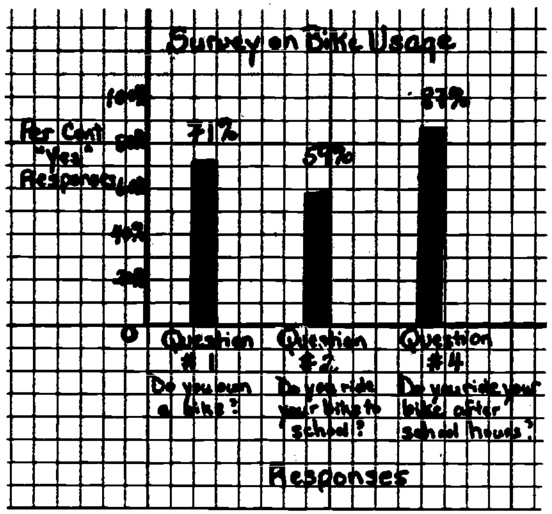


Figure B5-1

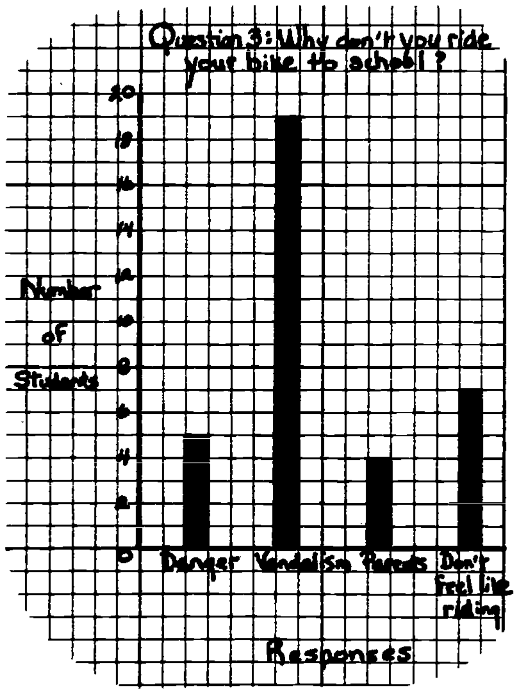


Figure B5-2

totals on the board. Several classmates comment that the group really should have prepared a graph. One girl adds that a graph will have to be made anyway because the class will need it as proof that bicyling is popular. The Bicycle Routes Group agrees that a graph should have been made and promises to have one ready in time for the next class discussion period.

During the week the Bicycle Routes Group graphs the survey results. The first graph constructed by the students shows the number of "Yes" and "No" answers to each question. The group agrees that it is hard to get information from the graph. They also see that the total number of answers is different for each question. After discussing the problem with the teacher, they decide to calculate the percentage of "Yes" answers and make another graph showing those numbers. Figures B5-1 and B5-2 show their final graphs.

When the map of the school district has been fully enlarged to scale, the group plans the next steps. They decide to indicate on the map--

1. the busy streets by putting slash lines on these streets,
2. major areas of interest, such as stores and the school,
3. homes of those students who ride their bicycles to school by drawing circles around the homes,
4. homes of those students who ride their bicycles only after school hours by drawing squares around the homes.

To draw the circles or squares around students' houses, the group uses the addresses on the surveys. Figure B5-3 shows their map with the markings.

The group shows the class the map with the markings. The class notes that the students who ride their bikes to school generally live the farthest distance from the school; those who live closer tend to use their bikes after school hours. Since the homes are distributed fairly evenly around the school, the class identifies safe main routes for each area of the district. For example, those students who live in the Berkshire Street area can ride their bikes through Bucks Path and then along Oak Street. The class gives the Bicycle Routes Group the responsibility of checking each proposed

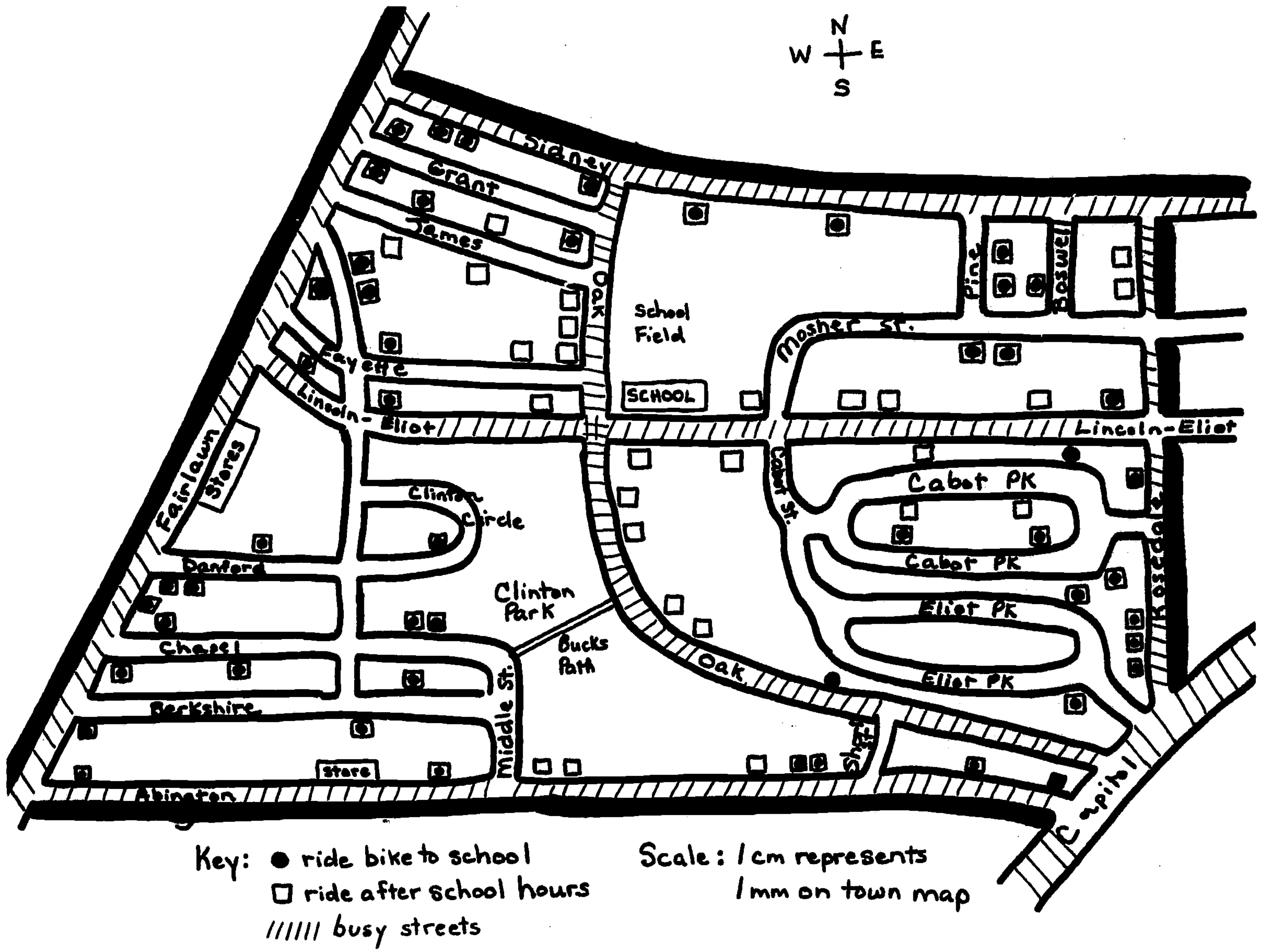

N
W
E
S
Sidney
Grant
James
Oak
School Field
SCHOOL
Mosher St.
Pine
Boswell
Fayette
Lincoln-Eliot
Lincoln-Eliot
Fairlawn
Stores
Clinton Circle
Danford
Clinton Park
Bucks Path
Chapel
Berkshire
Middle St.
Store
Abington
Cabot St.
Cabot PK
Cabot PK
Eliot PK
Eliot PK
Rosedale
Oak
Capitol
Key: ● ride bike to school
□ ride after school hours
////// busy streets
Scale: 1 cm represents
1 mm on town map

Figure B5-3

route for potential hazards after school. If the proposed route has no serious hazards, then the route can be drawn on the map with ink.

After several days the Bicycle Routes Group shares their recommendations with the class (see Figure B5-3).

1. Berkshire Street area - ride through Bucks Path, then along the park side of Oak Street.

2. Grant Street area - ride down individual street to Oak Street. Cross Oak Street. Ride along the school field side of Oak Street.

3. Mosher Street area - ride along Mosher Street. Along Lincoln-Eliot Street walk bicycle.

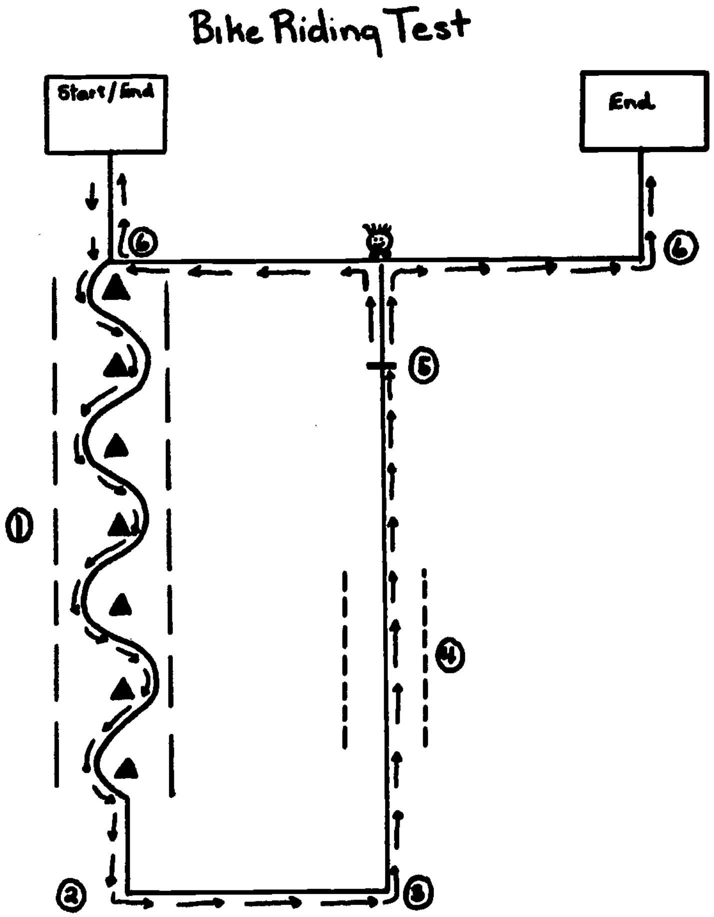
4. Cabot and Eliot Parks - ride in the parks down Cabot Street. Walk bicycle along Lincoln-Eliot Street.

In the Lansing, Michigan, class each student first mapped out the route that he thought was the shortest and safest from his home to school. The class then formed small groups to map out a short but safe main artery that accommodated the majority of the students in that part of the school district. Later the whole class picked the best main artery for each part of the school district. (See log by Kathryn McNenly.)

Bicycle Safety Group

In the meantime the students in this group have agreed that an organized bicycle safety program needs to be set up for the school. A written test to test a rider's knowledge of cycling rules and an obstacle course are seen as good ways to determine safe and unsafe bicycle riders. The group agrees to split into two smaller groups to work on the two tasks. One group, the Obstacle Course Group, is to design and lay out an obstacle course. The second group, the Written Test Group, is to look into the town and school rules regarding cycling and choose several important rules to be included in the written test.

The students designing the bicycle obstacle course make a list of riding skills they feel are necessary for safe riding. The list is then pared down to four main riding skills: balancing ability, steering ability, proper use of hand signals, and reaction time. To test these skills the group devises a course with the following check points:



Check Points

1. Steer through the pylons, staying within the margin.
2. Hand signal for stop and left turn.
3. Hand signal for left turn.
4. Steer through narrow "bridge" (two lines). Rider must not touch or go over either line.
5. Test for reaction time: at top of "T" rider approaches person who holds up a sign indicating a direction to turn or to stop.
6. Hand signal for right or left turn.

On a nice day the group goes outside to check the available space and the feasibility of the course. They choose a large asphalt area near the faculty parking lot for the course. While several students get their bikes, others begin to sketch out the course with chalk. Each skill station is tried by the cyclists and the spacing adjusted accordingly. After many trials, suitable spacings are determined. These spacings are then measured and recorded. Figure B5-4 shows the course measurements.

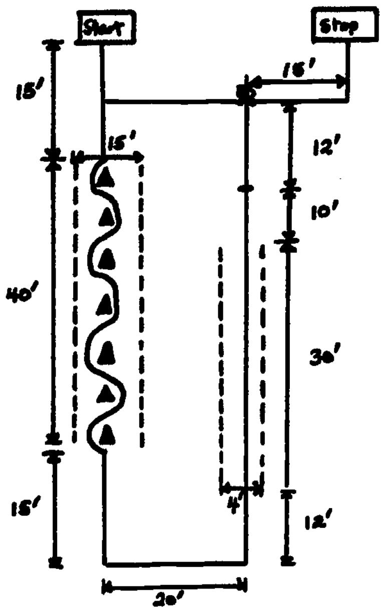


Figure B5-4

A list of materials needed for the course is made: seven pylons and two stop signs. Various group members volunteer to make these things in the Design Lab.

The Iowa City, Iowa, class designed a riding course that tested a rider's balance, knowledge of hand signals, and steering ability. Materials for the course, such as stop signs and pylons, were made in the Design Lab. After the course was set up, the students practiced administering the test using the students who had brought their bikes to school that day. (See log by Dorothy Wilkening.)

For greater safety, the group decides that a bicycle must be checked before the rider takes the riding test. If something is found wrong, it will be corrected. A checklist of bicycle parts is made and includes the following parts:

1. tires--adequate amount of air
2. brakes
3. handlebars--secure
4. seat--secure
5. chain--adequate tension
6. chain guard--secure
7. wheel axle--secure
8. horn/bell and light

Because the group is unsure of the type of tools they will need, they decide to bring this subject up at the next class meeting.

In the Monterey, California, class, one group of students set up an obstacle course that included sharp turns, a roadway incline, a sandy area (already on the playground), and a fast stop.

Four students who had ridden their bicycles to school that day attempted the course. Because the bicycles were not checked for safety before the test, one boy fell on the sharp turn. The accident was caused by loose handlebars. (From log by Norma Lazzarini.)

The Obstacle Course Group shows and explains the course to the rest of the class. Comments from the class are favorable. Because the group forgot to devise a scoring system, the class as a whole does this. Skills that are seen as being fairly difficult are given more points than those skills that are seen as easy. The number of points for the various skills is shown below.

<u>Points for Riding Test</u>

2 points for steering easily through pylons

4 points for correct hand signals (1 point for each hand signal in the course)

2 points for steering easily through narrow bridge

<u>2</u> points for quick reaction time

10 points total for course

Since the course is so short and every skill important, the class agrees that a rider must obtain a perfect score of ten points to pass. It is agreed that those who pass will receive certificates. Those who fail will be educated, allowed to practice, and then allowed to retake the test.

Of the forty-five students who took both the riding and the written tests administered by the Iowa City, Iowa, class, twenty-eight passed. The seventeen students who failed both tests were all kindergarteners who were not familiar with hand signals. Later, a small group was formed to teach the kindergarteners the proper hand signals. (See log by Dorothy Wilkening.)

Bicycle Test

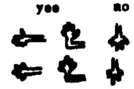
	Circle Correct Answer	
1. Should a cyclist use hand signals?	yes	no
2. What is the hand signal for left turn?		
3. What is the hand signal for right turn?		
4. What side of the road should you ride on?	right	left
5. Should you obey traffic lights?	yes	no
6. Do you need a license to ride to school?	yes	no
7. Should you walk your bike across a street?	yes	no
8. Do pedestrians have the right of way?	yes	no
9. Should two people ride on a bike made for one?	yes	no
10. Should you have a light on your bike?	yes	no
11. Do you have to go one way on a one-way street?	yes	no
12. Can you ride on the sidewalk?	yes	no

Figure B5-5

The Obstacle Course Group then explains their plans of checking bicycles before the test is taken, and their lack of knowledge of what tools are needed to repair bicycles. Several guesses are made of kinds of tools that may be useful; no one is sure of what specific tool would fix a particular bicycle part. At this point three boys volunteer to make a trip to the local bike shop to find out this information. When the tools are known, the class agrees that they can then check with the Design Lab manager and perhaps scrounge some of the more common tools from home.

The Written Test Group calls the police department to find out what the town's rules are for cyclists. The officer they speak to mentions several major laws and agrees to mail the class a complete list of all the laws. The group also inquires about the school's rules and learns that there are only a few.

A fourth/fifth/sixth-grade class in Burnsville, Minnesota, put their ideas on bicycle safety and maintenance into practice. Wishing to find out the cycling rules for the city, the class organized a bike trip to the police station. Lists of safety rules as well as bicycle parts to check were compiled. When the class returned the students modified some of their safety rules. (See log by Marcia Schroder Mertens.)

In comparing automobile and bicycle laws, the group learns that the laws for both are quite similar. Using the information from the police department and tips from a bicycle safety book, the students design the written test. Several drafts are necessary before a final one is decided upon. Each draft is critiqued by the rest of the class for clarity and relevance. The final test appears in Figure B5-5.

Fifth-graders from Lexington, Massachusetts, designed a written test that served to inform and to test one's knowledge of bicycle rules. Study manuals were prepared and distributed before the test was administered. When any third through sixth grader felt he knew the rules, he signed up to take the test during a lunch period. (From log by Sandra Szerenyi.)

With the completion of the map, the riding course layout and the written test, the class refocuses on the challenge and makes further plans. The class feels strongly that the Bicycle Routes Group should tell other students in the school about the bicycle routes the group has identified as being safe and convenient. The class agrees that the map showing their proposed routes and the survey showing bicycling popularity in the school district should be part of the presentation. Various members of the Bicycle Routes Group then volunteer to prepare an explanation of their project and to make a presentation before other classes.

The Monterey, California, class substantiated their argument for a bicycle path and bridge through a gully in the school district by measuring the distance to school with and without the use of the path and gully. The class determined that their proposed path was not only much shorter than the other way (36½ yards vs. 745 yards) but also much safer. (From log by Norma Lazzarini.)

The class next deals with their bicycle safety program. They identify the date on which to hold the tests and decide to post sign-up sheets and posters to advertise the tests around the school hallways. One small group of students volunteers to make the posters. The students who made the pylons and the stop signs for the course say they are almost finished and remind the class that certificates still need to be designed and made. Several students volunteer to do this task. The three boys who checked about the bicycle repair tools report that the list was submitted to the Design Lab manager who is purchasing the tools. A small group is selected to practice checking bicycle parts once the tools arrive.

A long discussion evolves when someone asks who will administer the tests. The Bicycle Routes Group members express a strong desire to participate. It is decided then that everyone should help. Tasks are identified for both the riding and written test administrations. For example, the riding test requires observers at each check point. To record the rider's score for each skill, his score sheet will be relayed from point to point by runners.

In order that everyone have an opportunity to administer both the written and riding tests, the Iowa City class divided into two parts. Each half alternated between the written and the riding tests every half hour. Some of the tasks the students performed for the riding test were checking in and explaining the test to the rider, relaying the score sheet between check points, observing along the test routes, and checking bicycle parts. (See log by Dorothy Wilkening.)

On the day of the bicycle tests, 163 students show up with their bicycles. Of the 163 students, only 18 fail to pass one of these tests. These students are educated on proper bicycle riding and given a second chance to take the test that they had failed the first time. Certificates are then given to all those who passed the tests.

In the Iowa City class, two types of certificates were given upon completion of the riding and written tests. One type of certificate congratulated the rider for passing the two tests. The other type thanked the rider for participating in the tests. (See log by Dorothy Wilkening.)

Several days after the bicycle tests, the five students who made presentations before the other classes report that all classes were very receptive to their bicycle routes. In fact, each class wanted a copy of the map to post in their room. The class suggests that the map be redrawn on a ditto master and duplicated for the other classes. Three students volunteer to do this.

The class then evaluates whether they have adequately resolved their challenge of making cycling safe and convenient around the school district. The general consensus is that they have. To further expand safety in the school district, the class chooses to work next on the Pedestrian Crossings challenge.

6. QUESTIONS TO STIMULATE FURTHER INVESTIGATION AND ANALYSIS

- How popular is bicycling among the students in the school?
- Where can you ride your bicycle safely in the area?
- What are some of the problems that you encounter while riding in the area? How can these problems or hazards be alleviated? How can you find out if other students think these are problems too? What can you do to prove to others that a problem(s) exists?
- How can we find out how many bike accidents occur every month among students in the school? What were some of the reasons for the accidents? What kind of information do we need to convince the proper authorities that cycling to school can be safe?
- What are the state/city/school rules on cycling? How can we find out what these rules are? How do these rules differ from those that cars must obey? How can we find out if bike riders in the school know the cycling rules?
- How can we make sure bikes are safe to ride? What can be done with faulty bikes?
- What are the bike skills needed for safe riding? How can we check a rider's skills? What should be done if a rider's skills are found to be inadequate?
- How can we educate the rest of the school on bike safety?
- How can we enforce bike safety rules? What should be done with offenders?
- What do we need to know to plan bike routes for all the cyclists in our school? How can we find out this information?
- What is a safe and convenient route to school from your house? What are some of the more common streets that students use to get to school?...to the store? How can we find out? How do these routes compare with the way you walk?
- How can we identify main routes for children in various sections of the district? How shall we designate our proposed bike routes? How long are our proposed routes?

How can we tell others in the school about our proposed bike routes?

- If a bike path should be constructed, how much will it cost for materials and labor? What are the best materials to use to build the paths? From whom must we seek authorization of our bike path plans? What do we need for our presentation?

- Where would be the best place to park bikes here at school?

- How can we prevent bike vandalism?

C. Documentation

1. LOG ON BICYCLE TRANSPORTATION

by Dorothy Wilkening*
Ernest Horn School, Grades 2-3
Iowa City, Iowa
(August 1974-December 1974)

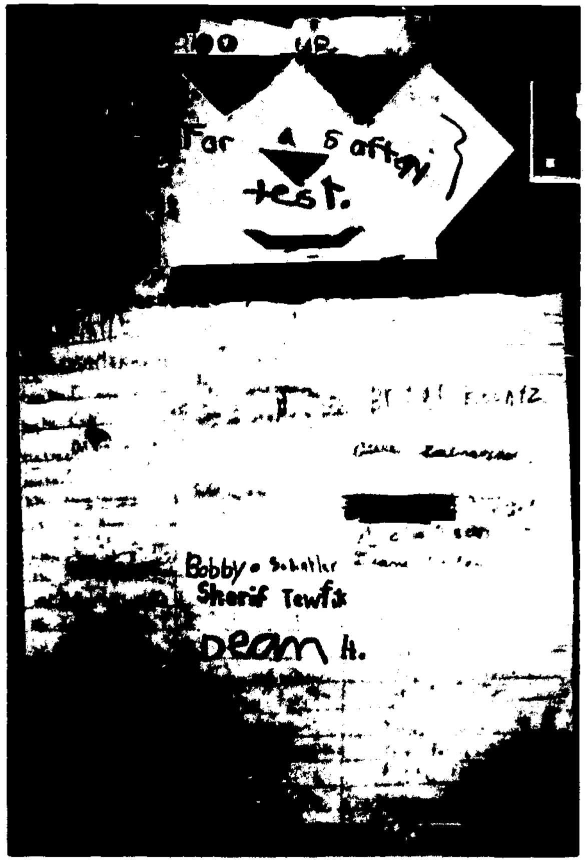
ABSTRACT

This second/third-grade class worked regularly four hours a week on their challenge of making bicycling safer for students in the school. The children designed written and riding tests to assess the cyclists' ability to ride safely. They also investigated cycling rules in the city and at school, and educated their schoolmates about safe bicycling habits. To prepare for the riding test the children constructed in the Design Lab materials for the test course, such as pylons and stop signs. Posters were made to advertise the tests. A survey was conducted among the various grades to determine the kind of bicycles the children owned, such as one-, three-, five-, or ten-speed bicycles. The children discussed bicycle security and investigated the possibility of holding a bicycle registration session at school. The bicycling tests were administered before inclement weather arrived. In the spring the class was successful in organizing a bike registration day. The registration was a huge success, and the class won a bike rack for the school for having the largest turnout of cyclists.

When I introduced the topic of bicycles, the children immediately began relating strange and scary experiences they had had on their bicycles. Just the preceeding day one girl was thrown over the handlebars of her bike. Her fall resulted in a cut requiring fourteen stitches. Other bike accidents mentioned included falling off bikes due to faulty brakes or other defective parts. These accidents resulted in skinned knees and chipped teeth. It was clear to everyone that riding one's bicycle involved a certain amount of risk.

We discussed why cycling was so popular despite all the risks and how it could be made safer. The children expressed three reasons for bike riding: fun, transportation, and exercise. Suggestions for making cycling safer ranged from

*Edited by USMES Staff



wearing a football uniform to administering a riding test to all the children in the school. After much discussion, the class decided to design and administer a bike test to assess a rider's skills. The class felt that such a test would be particularly useful for younger children.

The children had many ideas for assessing a rider's skills. One idea was to divide the test into two parts, a written exam to test the cyclist's knowledge of safety rules and a riding test to assess the cyclist's ability to ride his bike. The children identified skills they felt were important and should be included in the riding test. These skills included the following:

1. Can the rider balance on his bike?
2. Steering ability.
3. Using the right and left hand signal.
4. Does the rider start and stop correctly?

In order to test the above skills, the children agreed they needed the following:

1. a student with a bicycle
2. a place to ride
3. obstacles, such as cones or pylons

An advertising campaign, in the form of posters, was seen as an effective way to announce their tests.

The children were very anxious to begin work, so we decided to divide into interest groups to do some preliminary planning. Four groups were formed:

1. The Safety Test Group--this group would design the written and riding tests, construct the necessary materials and set up the riding course.

2. The Poster Group--this group would be responsible for advertising the bike tests.

3. School/City Regulations Survey Group--these children would investigate what the city and school regulations are for cycling.

4. Bicycle Survey Group--this group would survey the school to find out the kinds of bikes owned by the children.

Written test for Bike Safety Test.
(First Copy)

name ____________________

1. Go over jumps no yes
2. Ride in the middle of the street
3. yes no
4. Use hand signals no yes
5. Stunts no yes
6. Obey traffic signs no yes
7. Keep to right no yes
8. Rides across busy intersections no yes
9. Ride double no yes
10. Hitch Rides no yes
11. Ride single file no yes

Signals

12. Left turn
13. Right turn
14. Stop or slow

15. which side of the street do you ride on? ____

Figure C1-1

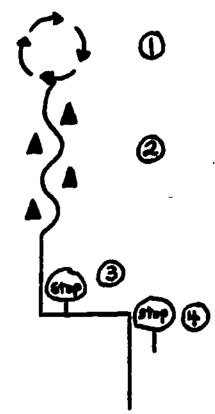
The groups worked regularly and simultaneously. Children moved to new groups when they had completed work in their old group. Periodically, we had class sessions during which each group reported its progress and discussed the problems that it had encountered. In order to provide continuity this log documents the activities of each group one at a time.

Safety Test Group

The Safety Test Group further discussed how they could make everyone in the school a safer bike rider. After much debate the children decided that teachers should also be asked to take the bike test. They also agreed that it would be safer if everyone rode his or her own bike. For those who failed a test, the group decided that these people should be required to attend sessions on bike safety which would be conducted by the group.

Several weeks were spent in preparing for the written and riding tests. The children divided the many tasks among the members of the group. One pair of children drew a bicycle showing unsafe features. Another pair of children prepared a sign-up sheet announcing the riding test and the time. Interested children were to sign either for the 1:00 p.m. time or the 2:00 p.m. time. A simple score sheet for the riding test was also made by two other children. Several children wrote questions for the written test. Figure C1-1 shows the test. The final copy was typed by the children onto a ditto and copies made. The group decided that only two errors on the written test would be permissible to pass.

The group designed a seven-part riding test shown below.



1. The rider rides around a premarked circle (to test steering and balancing ability).

2. The rider steers through four pylons.

3. The rider makes the hand signal to stop, then a left hand signal and turns left.

4. The rider shows the signal for a right hand turn and turns right

Dear Parents,

We are doing a Science projeet and we need wood for stop Signs for a safty test Please tell yourchild to bring the wood careful to school.

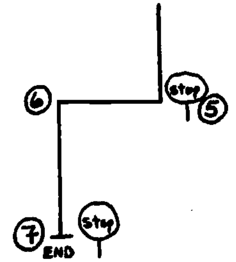
Your friends
from the
Horn school
Wilkening Sciene group
one. Tom Healy Renee Fiscella
John Nesbitt Debbie Jacobsen.

Figure C1-2

5. Another stop sign, then the correct signal for a right turn.

6. Another left hand signal.

7. The rider shows the signal for "stop"; the test terminates here.



In studying their course the children agreed that each part was very important. They therefore decided that a rider had to pass every part in order to pass this test.

The group next designed and constructed materials for the bike course in the Design Lab. They received assistance from several poster committee members who had completed their posters. The cones were made from oaktag and several trials were necessary to get a steady, standing cone. For the stop signs, the children decided to use wood. After it became clear that it would be too time-consuming to try to raise money to buy the necessary wood, the group wrote letters to parents requesting that wood scraps be sent to the class. One letter is shown in Figure C1-2. To determine the size of the sign a small group of children measured a real stop sign outside the school. Figure C1-3 shows their resulting measurements. The children agreed that such a large sign was not necessary for their course and decided to make signs half this size. The children tried to determine the new sign dimensions by dividing the large sign measurements by two. However because none had used division before, their efforts proved to be very frustrating. Finally one child put up stick markers for each inch of the measurements of the large sign. The group counted one marker for their sign and one marker for the other half they would not use. By this process they were able to divide the large measurements in half--fractions of inches were rounded to whole inches (see Figure C1-4). The signs were then cut and painted according to plan.

By mid-October we began thinking about setting a definite date for the safety tests after we realized that bad weather would soon be upon us. We reviewed what needed to be done and set the date for October 30, 1974.

During the next few weeks the children worked hard finishing their projects. When the cones and stop signs were

Ground - 8"
Pole Tall = 6' 5"
Sign tall 2' 6"
across 30', & 2'6"
stripe 1"
letters tall 10"
across 6"

Letters to Stripe - 9½" to bottom
2" to side

Figure C1-3

Sign = 1 ft 3" Across + down
Post = 3 ft 2½"
Stripe = ½ in
Stripe to letters on side 1"
" " " on bottom 4¾"

letters tall = 5"
letters across = 3"

Figure C1-4

completed, the course was laid out according to plan. The children went outside to look for a suitable area on the hardtop to use for the course. Several children immediately suggested using one of the painted circles on the asphalt for the first test. Everyone agreed that this was a good idea. Several children who had brought their bicycles began trying the various circles for feasibility. One circle with a line about five inches wide was finally selected because the children agreed that the circle was big enough (in diameter) to comfortably ride around and still remain on the wide line. The children then decided where to place the cones and the stop signs. The process was trial and error with the cyclists riding through each set up. When the final course arrangement was decided, the children used chalk to mark out the course path and placed an "x" where the stop signs and cones should be placed.

After the course was set up, the children practiced administering the riding test, using the children who had brought their bicycles to school. They determined where the critical points were along the course and assigned people to watch at these places. For example, observers made sure that the rider's bike wheel did not go off the painted line on the first test. Observers also made sure that a rider's right or left turn was a sharp turn. The children agreed that as a rider rode through the course, his score sheet would follow him from step to step. Seven children were assigned to relay the score sheet from step to step.

A last-minute publicity campaign was put together by one group of children. Notes were written and distributed to all the classes reminding the children of the date. During a general meeting of the entire school, the children again reminded the school about the tests. No one could have possibly forgotten October 30!

The day of the test arrived and so did the rain. We had to postpone the tests for one week. The test day was beautiful, cold but sunny. Forty-five children took both the written and riding tests. After taking the riding test, the contestant went inside to take the written test. In order that everyone have an opportunity to administer both the written and the riding tests, the class divided into two parts and each half alternated between inside and outside every half hour.

The testing lasted from 1:00 p.m. to 3:00 p.m. Before a rider took the riding test, he or she checked in with the checker. The checker recorded the rider's name on the score

Figure C1-5

sheet, and afterwards, carefully explained the various skills that were being assessed in the riding test. The children were critical of the first few riders since they were older children, but became less strict when the kindergartners rode through. Except for not having enough pencils at each post to check off each passing rider, the children were quite efficient and everything went smoothly.

The following day we discussed how the tests had gone and the test results. Of the forty-five children who took the tests, twenty-eight children passed both. No adults had participated. The seventeen children who failed both the written and riding tests were all kindergartners who were not familiar with hand signals. Four children immediately volunteered to teach the small children hand signals. Other children wondered what we should do about all the children who had passed the tests. Many suggestions were made and finally the class agreed that two kinds of certificates should be made. One type of certificate would congratulate the rider for passing the test. The other kind would be for the kindergartners thanking them for participating in the tests. A group of children volunteered to design and make these certificates.

The four children who had volunteered to teach the kindergartners hand signals soon discovered that they had to first teach the children the concepts of left and right. The four children divided the class into four groups, each child teaching a group the signals and directions. When the children returned to our room they were quite satisfied with their accomplishment.

Poster Group

Before making posters to publicize safe bicycling habits, the Poster Group discussed what made a poster attractive. The children agreed that lots of color and an interesting design were effective attention-getters. Individual designs were first drawn, critiqued by the group, and then made into a final poster. The group spent several weeks making posters. Figure C1-5 shows one child's poster design. As members finished, they joined other groups or began other projects.

Upon completion of their posters, two girls became interested in educating and informing the kindergartners about bicycle safety. For their presentation they made transparencies depicting various bicycle parts and investigated films on bicycle safety. In making the final arrangements with the kindergarten teacher, the girls informed the teacher that their presentation would take exactly nineteen minutes: eleven minutes for the film and eight minutes for both of them to speak. The presentation was given to both the morning and the afternoon classes. After the film was shown, the girls talked about the importance of bike safety and explained what the third-grade class was doing about it in school. Their presentation was well received.

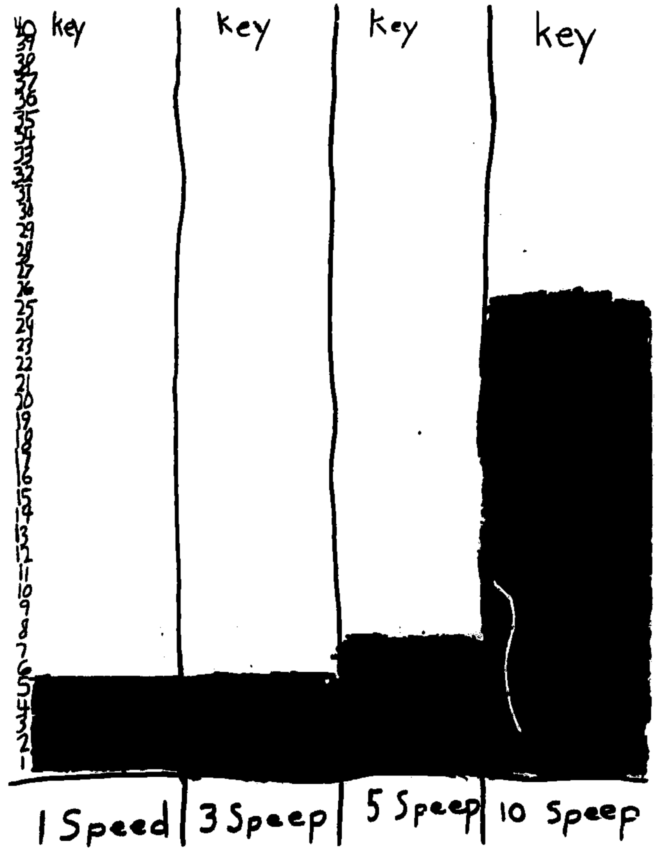


Figure C1-6

Bicycle Survey Group

The Bicycle Survey Group agreed on a simple one-question survey, which they decided to put on illustrated posters to hang in the school hallways. Their question was, "Do you have a one-, three-, five-, or ten-speed bicycle?" In order for children to respond to the question, the group attached to each poster a blank pad of paper and a shoe box with a slot in the top. The group decided on the number of posters that were needed and divided the work up accordingly.

A few days later the children compared their questionnaire posters and discovered that some children had phrased the original question, "Do you have a one-, three-, five-, or ten-speed bicycle?" as "Do you like a one-, three-, five-, or ten-speed bicycle?" Rather than eliminating these posters, the group decided that it would be equally interesting to find out what children's preferences were.

The posters were hung around the school, and after one week the children noted that some of the boxes were stuffed. They decided to begin counting the votes but to leave the posters up for another week. By the end of two weeks, the children had tallied a total of forty-two responses. The distribution of bicycle ownership was that twenty-five children owned ten-speed bicycles, seven owned a five-speed, five owned a three-speed and five owned a one-speed bicycle. I asked the group what they wanted to do with this information. Several children expressed an interest in telling the rest of the class. The children suggested making some sort of chart. Since they were not sure how to chart their information a skill session was given on making bar graphs. The children were quite intrigued with the process of making the bar graphs.* One child's graph is shown in Figure C1-6.

*The children might tally the results according to grade level and put several sets of data on one graph by using lines. This would show whether older children had more of a certain type of bicycle than younger children did.--ED.

Bicycle Rules and Regulations Group

The fourth group, which was investigating cycling rules and regulations in Iowa City and around the school, divided into two groups. Four children chose to inquire about city rules and decided the police department would be the place to go. One boy chose to inquire about the school policy on cycling. Both groups carefully discussed how they would explain the class project to the police and the principal. Questions were written and dates set for the interviews.

The trip to the police department was very successful. After introductions and an explanation of the bicycle project, each child asked the officer a question. The children's questions were as follows:

1. Which side of the street should one ride one's bicycle?
2. What are the rules for riding in Iowa City?
3. Where are there bicycle lanes in the city?
4. Where do you find out the locations of existing paths, and what streets could possibly have a bicycle path?

The children were surprised to learn that the city rule for cycling was to ride with the traffic while the state rule for cycling was to ride against the traffic. The officer gave each child a copy of the Iowa City rules on cycling and referred the last two questions to the city engineering department. Before the children left, the officer went over the procedures for handling cycling violations for young children.

Upon their return, the group briefed the rest of the class on their trip. Because the list of cycling rules for the city was long, they had it copied onto a ditto and copies were made for everyone in the class.

Bicycle Registration Group

When a few children had completed their work for their groups, I assembled them, and we began discussing ways that they could protect their bikes. The children suggested locks and bike registration. We talked about the possibility of having a fireman come to the school to register bikes.

Bike Safety Speech

1. Say (ABC Order) our names and what we study
4. Pass out papers
2. Talk about upper unit accidents (two)
3. Causes of bike accidents
4. Talk about bike safety test

Causes of Bike Accidents

1. Rider makes improper turn
2. Rider doesn't signal correctly
3. Bike doesnt have proper controls (poor brakes, no headlamps, no rear reflectors, or rider doesn't use them.
4. Carrying an extra rider
5. Rider rides into open auto doors.
6. Riding too fast
7. Cutting in between cars
8. Hitching a ride.
9. Riding against traffic
10. Not coming to full stop when riding down driveway to street
11. Riding when rider doesn't feel well or tired
12. Carrying a person on the handle bars
13. Fixing your bike on the road
14. Not riding on correct side of road
15. Riding in busy sections

Figure C1-7

The children decided to go to the fire department to inquire about this.

The following day twelve children and I went to the fire department. The children asked the fire chief many questions and finally asked about registering bikes at school. The chief apologized that he could not accommodate them due to the fact that the department could not afford to release a fireman for one day. However, he suggested that we contact Patrolman S. at the police station since he had registered bikes at schools before. Since Patrolman S. was not in, the children left their names and school number for him to return their call.

In April the class learned that Patrolman S. was finally available to register bicycles at the school. The date was quickly set for April 26, 1975, from 9:00 a.m. to 12:00 p.m. The first 100 bike owners would get their bicycles registered free. The class was extremely excited and spent the next three days making posters and announcements to advertise the registration.

The bike registration was a huge success with more than 200 children attending. A few days after the registration the class learned that they had won a bike rack for the school for having the most children register their bikes. The children were naturally very pleased.

As the various groups worked, the class as a whole also worked on other aspects of bicycle safety. At the end of September two older children were involved in serious bicycle accidents. The class felt that they should inform the older children about the safety rules in Iowa City and about what their class was doing to insure safe riding habits. The children decided to take several of their safety posters and copies of the city bike rules to each of the four intermediate grades and give a talk on safety. They would also put in a plug for their bike safety test. We decided that two children per class would be sufficient.

It was interesting for me to note that until this point the children were very hesitant to go to the upper grades. Now they were all eager to go to instruct the "bigger" children on bike safety!

After a fairly disorganized presentation in one of the upper grades, the class discussed what the other three groups could possibly do to avoid the same mistakes. After much discussion the children agreed that an outline of the presentation would be helpful. The remaining three groups made their outlines. One group's outline is shown in Figure C1-7.

The class also discussed a newspaper article that I had brought to school on the Federal Highway Commission's plans to allocate $676,000 for hiking and bike trails throughout the country. I told the children that the local government in Iowa City could request some of this money and asked if they could think of a way they could initiate some action towards such a request. After much discussion the children decided to contact the chairman of the Iowa City Bikeways Committee. They felt that the chairman would know to whom one should write in the Federal Highway Commission.

Upon the advice of the committee chairman, the class wrote letters to the Iowa State Highway Commission requesting that part of the $676,000 be provided for Iowa City. A reply was received several weeks later stating that the children should contact their local city officials regarding this matter. The children decided to write letters asking the city officials to request part of the federal funds.

Finally, the class spent several days investigating safe ways to bicycle to school from home. A map of the school district was obtained from the school office and put on a ditto so that each child could plot the safest and fastest route from his home to school. The children also plotted how to get from their homes to other places in the district, such as friends' homes, the grocery store, and the stadium. As they worked on their maps, we talked about where traffic signals, stop signs, and safety patrols were located. Also noted were busy streets and streets with and without sidewalks. When the maps were completed, the children shared them with the class, giving reasons for the chosen routes; each child then took his/her map home for future reference.

By December the weather had become impossible for us to think about cycling. We agreed that we had resolved our original challenge of making bicycling safer, therefore we decided to move on to another USMES challenge.

2. LOG ON BICYCLE TRANSPORTATION

by Kathryn McNenly*
Allen Street School, Grades 4-6
Lansing, Michigan
(September 1973-June 1974)

ABSTRACT

The teacher of this intermediate-level class arrived on the first day of school wearing a neck brace. The class soon learned that their teacher had been involved in a bicycle accident which had resulted in a broken collarbone and other injuries. Her incident brought up the whole issue of bicycle safety as the school's rationale for the "No bicycling to school" rule. The children felt that cycling could be made safe and decided to prove this to school officials. Working on their challenge approximately two and one-half hours per week, the class first listed safety problems. One of the problems identified was the need for safe bicycle paths around the school district. The children spent several weeks mapping out possible bicycle routes in the school district. Each child drew on a map the best bicycle route from his house to school. Based on the distribution of the children's homes, main bicycle arteries were identified. The children soon saw a need for an enlarged map to combine all their information on paths. After several unsuccessful attempts of enlarging a city map to scale, the children resorted to using an overhead projector. Later, the map was made three-dimensional by the addition of models of houses, trees and signs. A city patrolman was invited to speak on city regulations and to learn about the children's progress with the bicycle challenge. Based on his suggestion, the children surveyed the school to determine interest in cycling to school, bicycle safety measures, and where students would park their bicycle once they reached school. Armed with their map of proposed bicycle paths, graphs of survey results and diagrams of proposed bicycle parking lots, the class presented their argument for cycling to school to the school staff. Finally, the class organized a bicycle rodeo (safety program) to further support their argument that cycling could be made safe. The rodeo which was held on a Saturday, included a test of the rider's ability to ride, a written test on cycling rules and a maintenance check of the bicycle itself.

*Edited by USMES staff

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A discussion of bicycles occurred on the first day of school when I appeared in class wearing a brace to support my collarbone. Immediately, the class wanted to know what had happened, and I revealed my unfortunate mishap. I had been training for a long distance bicycle trip, and on one of the training days a dog had run out in front of me, causing me to accidently bump the dog. I was thrown from my bicycle, breaking my collarbone and incurring several lacerations. We talked briefly about my accident, and then the subject was temporarily dropped.

Two weeks later we again talked about cycling. I polled the class to find out what the bicycle riding situation was in the school area. My poll revealed that twenty-seven out of the thirty-one children in the classroom owned bicycles. Of the twenty-seven bicycle owners, twenty rode them almost everyday, but no one had ever ridden his bicycle to school.

I asked the class why no one rode his or her bicycle to school. The children's responses revolved around three main reasons:

1. The bikes may be vandalized (parts ripped off, etc.).
2. Riding was dangerous due to traffic, dogs, older kids pestering you, hitchhikers.
3. It's against the school regulations.

After the third reason was mentioned, I sent one child down to the office to call the Lansing School Board to inquire about the validity of this statement. The child returned and reported that the policy on bicycle riding had recently been made the responsibility of the school principal. After this report the class became excited about the possibility of getting the whole school on wheels.

One girl reminded the class of the problem they might have in obtaining permission from their principal. Most, if not all, of the safety problems just mentioned would have to be solved. A big debate followed these remarks about whether the principal would indeed allow bicycling to school.

STUDENT: She (principal) isn't gonna let us, anyway.

STUDENT: Oh yeah, she usually says yes if we can prove it.

STUDENT: She's going to want it safe.

STUDENT: There'll be more kids killed with bikes than feet.

TEACHER: Can you solve some of those safety problems so we can get permission?

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TEACHER: Can you solve some of those safety problems so we can get permission?

Most of the children felt the problems could be solved. After the session, the class talked about the bicycle paths which permeate the Michigan State University campus.

The following week I presented the unit challenge: How could they organize themselves to make bicycling a safe and convenient way to travel to school? We decided that the first thing we needed to do was to identify and suggest solutions to safety problems. On the board I recorded the following problems that the students identified as needing solutions:

1. Car accidents involving cyclists
2. Some cyclists don't watch where they're going
3. Increased accidents
4. Bicycles tipping over, causing injuries
5. Speeding nuts
6. Double riding

During the discussion it became evident that the children were not really sure which rules of the road pertained to cyclists. Almost none of them watched traffic signs. One girl remarked, "If I had to follow all of those signs, it wouldn't be fun to ride anymore." Despite this inattentiveness to signs, they were quite concerned with bicycle safety. This concern was substantiated by a paper slipped into my mailbox from the principal which presented bicycle accident statistics in the city over a two-year period. According to these statistics, bicycle accidents, which involved primarily men, were on the increase.* Also, many near-accidents were reported by motorists because bicycle riders had violated one or more rules of the road. Here, again, several children questioned which traffic rules pertained to cyclists. We decided to list on the board those items which needed further investigation. Included on this list were the following:

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*In discussing these bicycle accident statistics the students might see that the important point is whether the proportion of bicycle riders having accidents is increasing. Because the number of cyclists has increased, one would expect the *total* number of accidents to increase. If adequate statistics are available, students could draw slope diagrams to compare ratios of *number of accidents* according to grade level.--ED.

1. Traffic laws--which pertain to cars? To cyclists?
2. Are bicycle licenses required?
3. Has the number of bike accidents really increased? Or are there just more cyclists?

We talked about possible solutions to the safety problems. It was generally agreed that there were certain rules of the road that did pertain to cyclists, so it was suggested that tickets could be given to violators. Two other suggestions included:

1. Make bicycle paths
2. Have safety patrols assist cyclists and pedestrians cross the street

The children felt that bicycle routes were needed for the school district so that anyone could get safely around the area. Other children felt that there should be bike qualification tests to see who was able to ride and who was not. Someone suggested issuing bicycle permits. The permit would show that the cyclist had demonstrated he could ride safely. Other thoughts on the issuing of permits were as follows:

1. No one can ride if he or she is under nine years old.
2. A permit should cost money.
3. The person who issues the permit should retain a copy for the records.
4. A policeman should help us establish good bicycle habits.
5. There should be written and riding tests, just as there are for car permits.

We took a vote to find out which areas really interested the children. The vote revealed that the whole class wished to work on bicycle paths, as well as bicycle permits. Only two people wished to present the project to the school staff.

We began working on bicycle paths a few days later. The children decided that the first logical step would be to map out safe bike routes in the school district. Then they could find out whether the city would be willing to mark the routes with paint. I gave the children large sheets of paper and told them to draw what they thought was the safest route from their house to school. On their maps they were to include all streets along the way, as well as to indicate where traffic lights, stop signs, and safety patrol posts were.

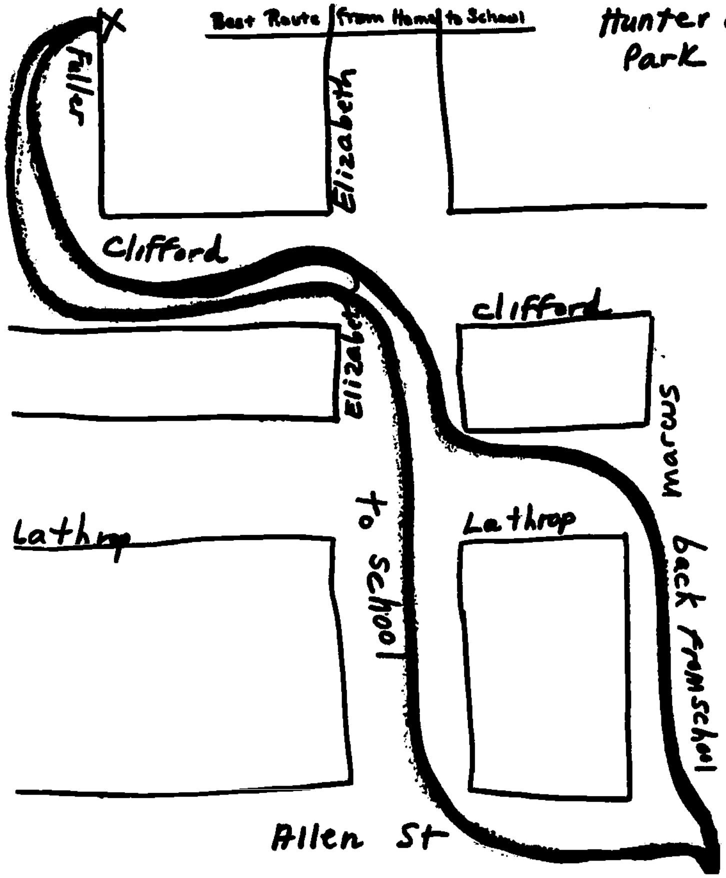


Figure C2-1

Before they began mapping, they made the following conclusions:

1. Kalamazoo Street is the quickest, but most dangerous way to school because of fast and heavy traffic.
2. Safety patrols could help with bike traffic in the streets.
3. Side streets would be safer than main streets.
4. Sometimes you might have to use the sidewalks.

The children began in earnest, but had a great deal of trouble remembering street names and determining directions. Crayon was used to indicate the bike route. Figure C2-1 shows one child's map. After a while, many children became so confused that they destroyed their maps and joined another child or group that was well under way with the project.

The children were quite surprised to find that although they had lived in the neighborhood all of their lives, they really did not know anything about how the streets were laid out. As groups felt they had finished, their maps were compared. Several children questioned the placement of various streets on different maps. At that time, there was no area map handy to settle disputes. Therefore, the class decided that one large map should be compiled on the board. We went through the district relying on people in the room who were most familiar with the streets to give some sort of order to the board map. When the streets were laid out in a somewhat orderly fashion, each child put an "X" where his house was.

The following week, after all of the maps were finished, we went over them in class and commented on the reasonableness of the bike routes as well as the quality of the map. Many children came to the conclusion that the safest route was much longer than the shortest route. Errors in mapmaking included forgotten streets, streets in the wrong order, and no clear indication of the location of traffic signs and lights.

The class was generally dissatisfied with their homemade maps and felt that much of their confusion was generated because each group's map was different. They wanted uniformity in all the maps and asked me to get one from the office. I told them that the office had no maps of the district. One student said, "Then we'll have to make our own." The class agreed to this idea.

We talked about the best way to begin our map. The class decided that the best way to get an accurate picture of the area was to walk around the whole school district. Later they would survey the entire area for potential traffic hazards.

The next day was a half day due to conference planning, so I assigned the class to do the following on their time off:

1. Travel on your bike the shortest and safest way from your house to school.
2. Draw a map of the way you went.
3. Count the number of cars you see, as well as other cyclists.
4. Time yourself.
5. Check for people violating safety rules.

A few days later we discussed the above assignment. Ten children had completed compiling their data. Most of the ten children made the run around noontime. Except for one girl, riding the bicycle reduced the amount of time it took to get to school. In all cases, traffic was reported as being very light. The children concluded that the light traffic was because school was not in session. We talked about when traffic would be heavy, and two times were noted:

1. When the Oldsmobile factory shift changed
2. On Friday evenings

During the bike run several children discovered faulty bicycle parts. One boy's bike handles fell off, thus preventing him from even doing the test run. These students brought in their bikes one day and worked in the Design Lab making whatever repairs they could. One girl brought in patches and a bike tire to repair, but both were stolen when she was out on safety patrol duty. This brought up the problem of theft, but the class decided to postpone investigating a possible solution for a while.

Another problem arose when the children worked in the Design Lab: there were no proper tools for bicycle repairs available. It was difficult to find substitutes but this problem did not dampen the children's enthusiasm.

During the month of November the class worked on accurately mapping the school district. On one cold windy day the class set out on foot to walk the southwest part of the school district. Upon returning, the students discovered that most of them had recorded very inaccurate information and had just messed about, tormenting dogs, neighbors and each other. After discussing an irate phone call to the office about their behavior, they proceeded to do some serious mapping, relying mostly upon their memories rather than referring to their walk. Again, there was a lot of confusion as to directions and street locations, but many did finish mapping the area. They then determined one bicycle route for all students in the southwest area of the school district. Many children were very impressed that they had produced a fairly accurate picture of the area.

The following week, a small group accompanied the teacher aide to map out the northwest part of the school district. This time a car was used since many children complained that the previous walk had been too long. They covered the area twice in order to double check their observations and then added the information to the already finished southwest sector.

The following day we discussed how we could finish mapping out the rest of the school district. Because of the gas shortage and the hassle of obtaining permission slips, use of the car had to be discontinued. After a long debate, the class decided that pairs of students could work in their spare time filling in the unfinished portion of the map. Each pair would be responsible for main streets, intersecting streets, and marking traffic lights, stop signs, and other road signs in the section they chose to work on.

Since the mapping began, the students have become more observant and aware of how each city sector fits into the whole city plan. Three children even discovered a street near their homes that they never knew about.

During the last week of November we reviewed and evaluated the work completed to date. This review was essential since camp time was coming up very shortly, and they needed to drop unit activities in order to make plans for camp. The children reviewed and outlined four major steps in their bicycle path plan:

1. Mapping the area (present activity)
2. Making a large map with the bicycle paths designated on it
3. Using the large map to make a model of the area
4. Making a presentation to the school staff using the model

During the month of December the class was busy with camp plans.

In January, the children returned to unit activities. I asked the class where we had stopped in November, and to my surprise, eight students quickly listed all accomplished and proposed activities. The class quickly reviewed the problems they had making their maps. While they had been away at camp, a map of the school district had finally arrived so we decided to explore this official map together. Enough copies were dittoed so that each child could determine the most efficient and safest route from his home to the school yard. The class figured out the proper directions and recorded this on their maps. Much of the time thereafter was spent finding individual homes and the homes of friends. Only seven children could not find anything on their maps.

Bicycle routes were not drawn until the following day. When the routings were completed, each child showed his map on the overhead projector and gave the rationale for his route.

Based on all the individual bike routes, the class came up with three recommendations for determining a main artery bike route:

1. The route should be easily accessible from most side streets in the district.
2. No riding on Kalamazoo Street, except on the sidewalk, in order to get to the corner where the crossing guard was located.
3. No riding on Michigan Avenue. (Figure C2-2 shows a map of the school district.)

The class then broke into groups, and each group plotted a possible main artery bike path. This task took considerable time because there were many clashing personalities in the same groups.

We discussed the proposed main arteries a few days later. Each group put their map on the overhead projector and carefully explained the strategy of their bicycle system. Some of the groups also gave alternative plans for several streets. The class made many comments and in many cases gave some good suggestions. However, the groups were very defensive over their plans, and at one point during a presentation I barely averted a fight. The class decided that Groups One and Two had the best plans for possible main arteries. Figures C2-3 and C2-4 show the maps of the two groups.

The following day the school held its annual safety assembly with several officers from the Lansing Police Department participating. After the program, one officer returned with our class to observe the work done so far on the bicycle paths. Various students explained the class project and

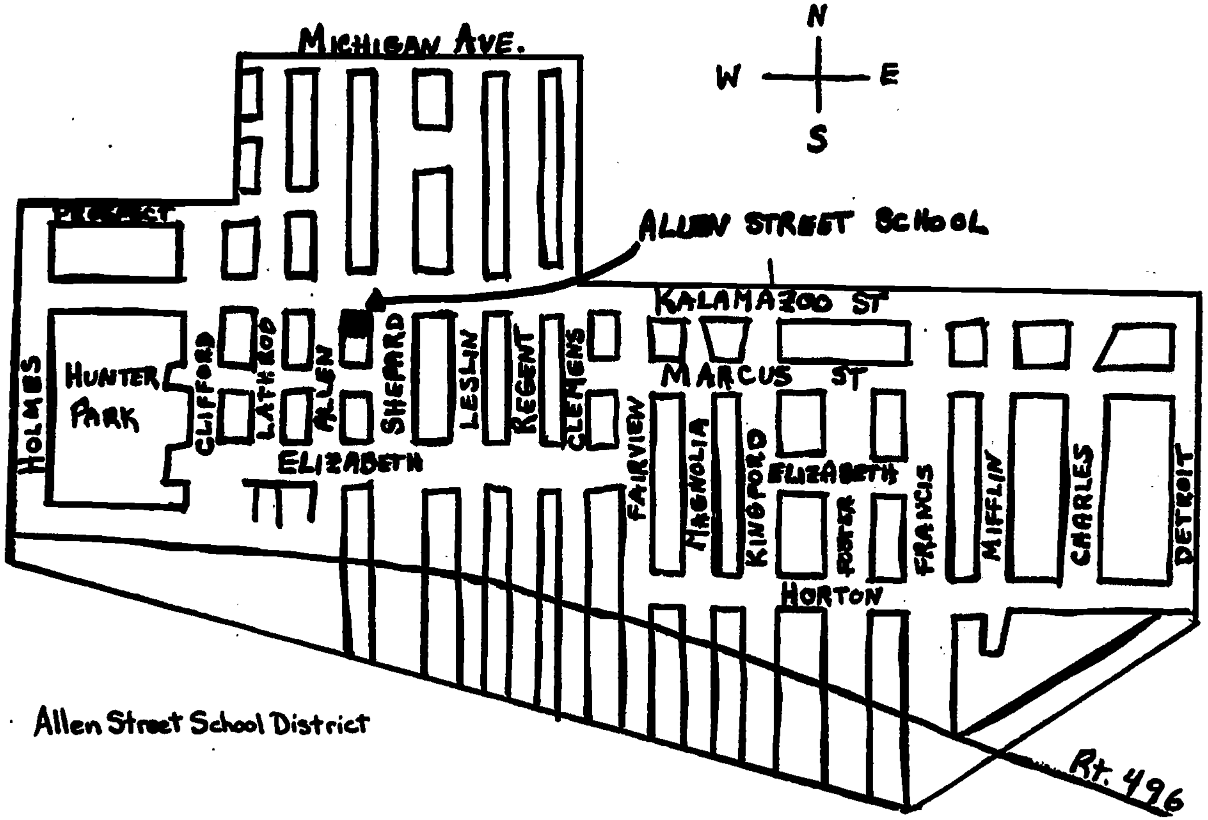


Figure C2-2

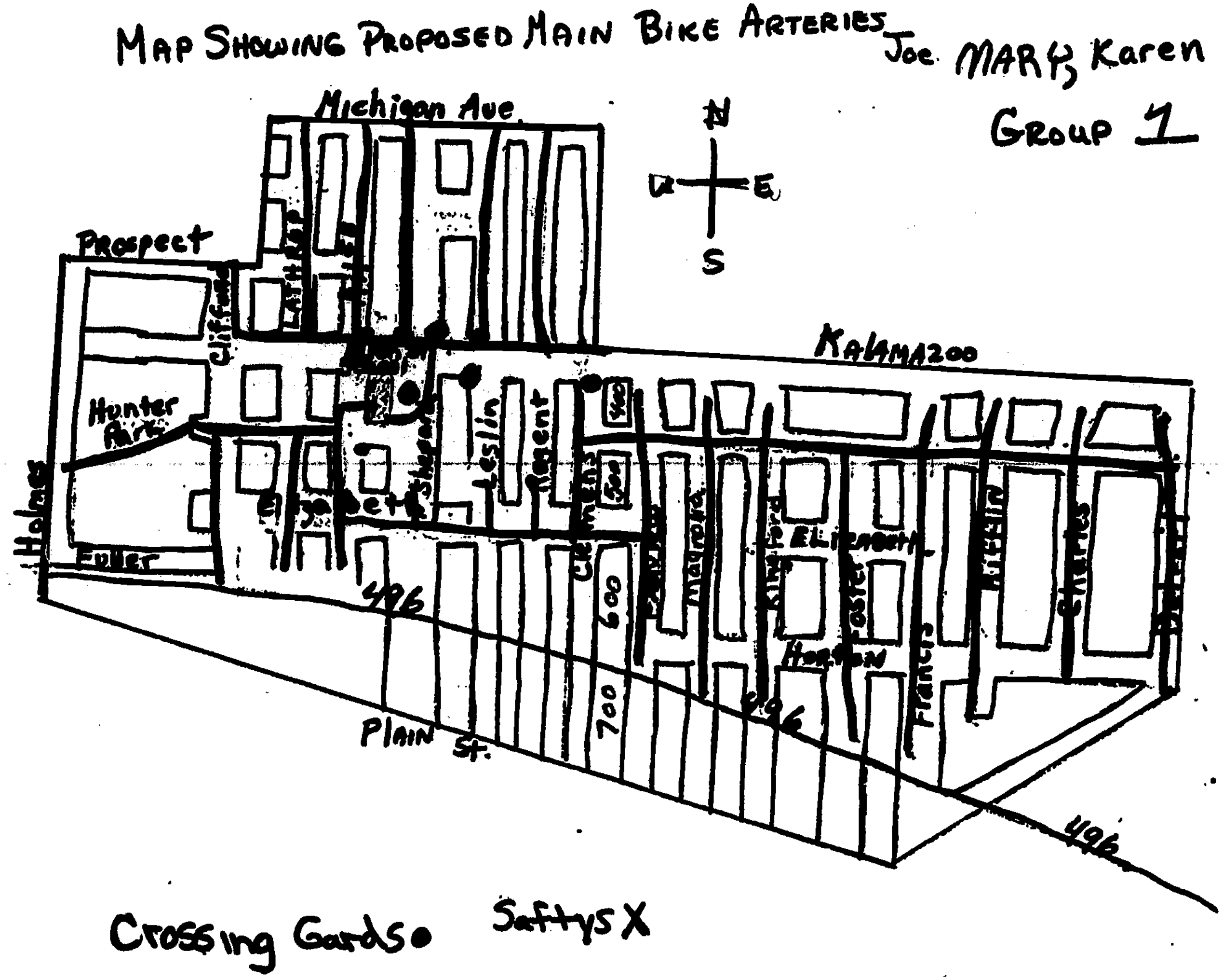
Allen Street School District

their future plans. The officer played the role of the devil's advocate and asked them the type of questions they had brought up earlier in the year:

1. How will you provide security for bikes at school?
2. How will you handle unsafe bikes?
3. Will you have a program to inspect bikes?
4. What about a bike rodeo or testing ground?

The officer was then shown the proposed bike path. He was favorably impressed with their work and their explanations of why they had picked those particular streets. The class asked him if the Clemens Street policeman would cross cyclists at Kalamazoo Street. He said he would check into it.

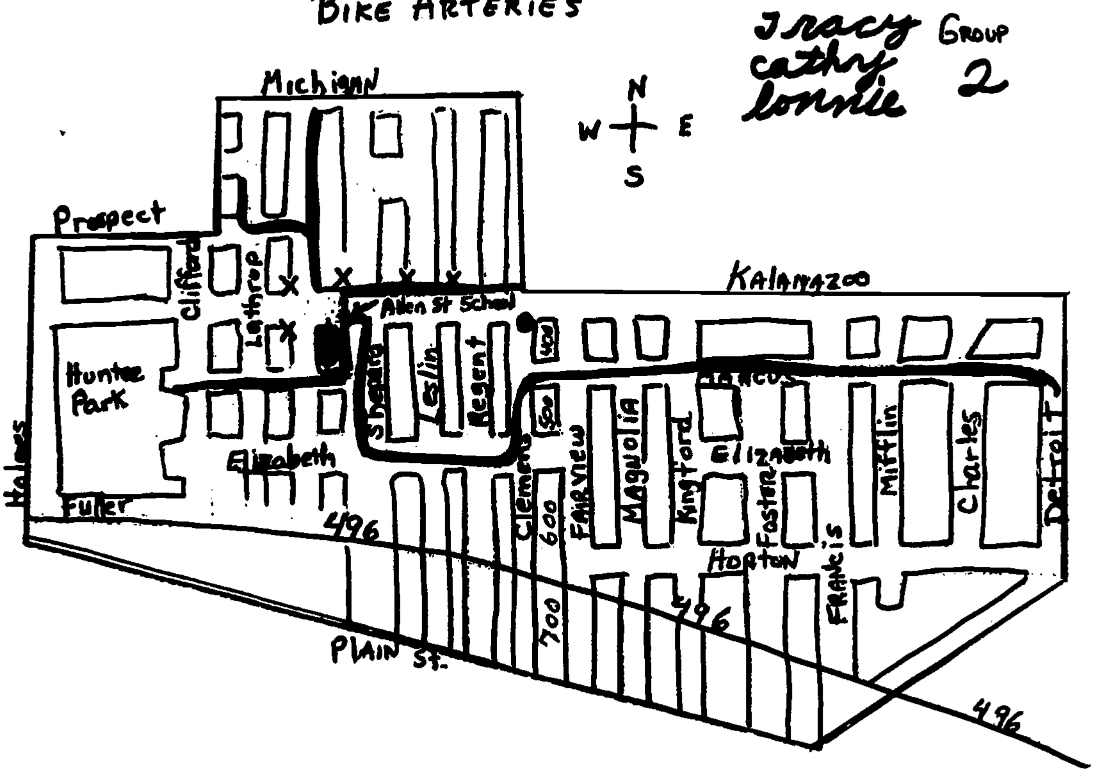
Officer Bannon mentioned that he would like to help them with some of the trickier things, such as traffic patterns, city permission, etc. He inquired whether they had checked with the city about permission to paint a line on the streets.



The dark lines indicate
Group one's main arteries.

Figure C2-3

MAP SHOWING PROPOSED MAIN BIKE ARTERIES



Crossing Gards o   Saftys X

The dark lines indicate Group two's main arteries.

Figure C2-4

He estimated the paths to be approximately six miles in length and suggested they find a method to economize on the number of paths they would need. Perhaps a survey could be done to discover which streets, if any, could be excluded.* Before he left, he mentioned that it was illegal for children under ten years old to ride in the streets.

After Officer Bannon left the room he chatted out in the hall with me for a few minutes. He again mentioned how impressed he was with the quality of the children's work. He told me that he would have done the routing precisely the same way the students had done it but would not have used all the cross streets. Finally, he informed me that, "just between us," his office would never sanction bike riding to school, and if I called the Board of Education, I would discover it was forbidden. I told him that this had already been checked and informed him of the current policy. He left rather surprised.

The following week, the class began the project of enlarging the small map of the school district to fit on a large sheet of Tri-Wall.** This was a mind-boggling project and took a considerable amount of time. The Tri-Wall was found to be 183 cm. by 122 cm. The map's measurements were 22 cm. by 11 cm. Since the bell rang at that point, I asked them to figure out at home how many times they would have to enlarge the map in order for it to fit on the Tri-Wall.

The following session I recorded on the board some of their answers to the number of times the map should be enlarged to fit on the piece of Tri-Wall:

*The children might estimate the distance students would have to travel to get to several possible main bike arteries which were only two or three miles in length. They could then pick the route that provided the least road distance per length of bike path.--ED.

**Because Tri-Wall was the most 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. There are several other brands of three-layered cardboard available and the addresses of the companies that supply three-layered cardboard can be found in the Design Lab Manual.--ED.

1. 1 mile
2. 96 times
3. 32 times
4. 22,326 times
5. 8.3 times

We discussed the probabilities of each answer being correct. One student felt one mile was a reasonable amount, while everyone else felt ninety-six times was a reasonable enlargement amount. With the figure settled they wanted to begin work immediately. I asked them if they wanted to first practice on a sheet of paper before they started marking up the Tri-Wall. They agreed and began with the measurement of a street length of 1/2 cm. After they multiplied 1/2 cm. by ninety-six they began to realize that by using ninety-six, the map would be far too big to fit on the Tri-Wall.

Someone suggested that perhaps they should concentrate on enlarging the sheet of paper the map was on rather than just the map. This would be easier and the map would not get distorted. Someone else thought it would be easier to figure out the number of sheets of paper that would fit on the Tri-Wall. This was done and thirty-two sheets were found to fit. They multiplied again and found that each street would be 16 cm. long, way too long to fit on the Tri-Wall. At this point, they began guessing at random, and I decided to have them stew a while on the problem and turned to another subject.*

One girl wondered if we were going to allow everyone in the school to ride their bikes to school. There was much heavy debate on this point. One boy reminded the class about the ten-year-old minimum age requirement which Officer Bannon had mentioned. The class decided to accept this fact only tentatively since they had not verified it yet. Meanwhile, they voted that grades kindergarten through two would definitely not be allowed to ride, whereas third graders might be able to, depending upon what they found out about the law.

The following week the class decided to divide in half in order to complete the two major tasks facing them: the map and the survey. Before splitting up however, the whole class worked on finding a suitable ratio to use to enlarge the map. They determined the ratio of a sheet of ditto paper to a

*The students might look at the "How To" Cards for ideas. The set, "How to Make Scale Drawings Bigger or Smaller" is applicable to this problem.--ED.

sheet of Tri-Wall. Using skills learned in previous math sessions, several students quickly came up with the ratio of eight to one. Since it seemed close enough to be successful, the mapping committee went off to enlarge the map. They decided to tackle the job by first multiplying each east and west measurement of blocks and streets by eight.*

The children interested in conducting the survey agreed that the survey's purpose was to determine the number of children in the school who were interested in riding their bikes to school and if they could eliminate any areas in the district, thereby shortening the total length of the proposed bike paths. The group agreed that grades three through six should take the survey. Ideas that they considered might be helpful to include in their survey were recorded:

1. Name and age.
2. Address.
3. Do you have a bike?
4. If not, do you plan to get one before June?
5. Do you have a bicycle license?
6. Is your bike safe?
7. Would you like to be able to ride it to school?
8. Could you get your parent's permission to ride to school?
9. Bicycle check list.
10. How would you lock your bike up?
11. Where would you park your bike?

Other ideas which were suggested but thought not to be relevant included such questions as:

1. How old is your bike?
2. How many wheels does it have?
3. What color is it?
4. Do you ride in the street? .

The group felt this last question was irrevelant because they knew most children rode in the streets already.

Several children questioned whether bicycle licenses were required. I read them the city regulations which stated that they were necessary in order to ride in the city. One stu-

*The children might decide to draw squares on the ditto paper and then make squares on the Tri-Wall that were eight times bigger.--ED.

Bicycle Survey

Name ________________ Age ________

Address ________________________

1. Do you have a bicycle? ☐ yes ☐ no
2. Is your bike safe? ☐ yes ☐ no ☐ maybe
3. Do you have a license? ☐ yes ☐ no
4. Would you like to ride your bike to school? ☐ yes ☐ no ☐ maybe
5. Would your parents let you? ☐ yes ☐ no ☐ maybe
6. How would you lock it up? Check one
   - ☐ chain
   - ☐ wire
   - ☐ rope
   - ☐ lock
7. Would you park it in the bike parking lot? ☐ yes ☐ no ☐ maybe

Figure C2-5

dent wanted to know if a policeman could register bicycles and collect the money if our class sponsored a bicycle rodeo. I told him to keep that good idea in mind until we got to the project later.

A few days later the group wrote the survey. They took the original eleven suggestions and made them into questions. Many children were reluctant to part with any of the sample survey questions, but the group finally voted on what to keep and what to eliminate. They decided to use the bike check list for registering cyclists. Figure C2-5 shows the group's final survey form.

Next, we reviewed the traffic violations pertaining to bicycles. The children laughed because they knew that no one bothered to enforce these laws in the city.*

The following week the survey was put on a ditto and run off. In order to judge how the questionnaire might work, the survey was passed out to each child, and together we went over the questions. Several children wondered if it was necessary for non-bike owners to complete the questionnaire. Others raised the point that these children might get a bike in the future, and then the information would be needed. It was finally decided to encourage everyone to answer the questions in case they got bikes.

Most of the survey questions caused very little discussion. However, the last two questions, "Where would you park it?" and "How would you lock it?" aroused some debate. A few students felt that some children might not understand parts of the questions, e.g., what a combination lock is or where the bicycle parking lot is. The class decided that whoever was administering the survey would have to explain some of the questions so that the results would be more valid. It was also brought up that, in some cases, the surveyor would have to read and explain every question to those children who could not read well.

We talked about variables (after first discussing what the word meant) which would affect the survey. They mentioned two variables:

1. The number of students who might be ill the day the survey was administered
2. Situations might change by the time they put their plan into action

*The student might discuss whether stricter enforcement of these laws might make bicycling safer.--ED.

The class decided to administer the survey in groups of two. Each team was responsible for setting up an appointment with a class and administering the survey. The students spent the remaining session time practicing what they would say to the classes.

During the same week, the map group began using the ratio of eight to one to enlarge the map. So that everyone would be responsible for some part of the map, each child chose a street or section he wanted to enlarge. Beginning with the northwest side of the map, the children made all the necessary measurements and computations. Then they began drawing on the Tri-Wall.

After about forty-five minutes of careful figuring, sketching and labelling it became obvious to me that there was no way that they could continue enlarging the map using that ratio. To draw their attention to the problem, I asked them where Route 496 and the northern portion of Michigan Avenue would go in relation to the part they had already drawn. After a short deliberation they realized that the map enlargement was out of proportion to the Tri-Wall. Instead of getting angry and trying to erase all their lines, they tried to figure out where they had made such a mistake. They spent ten minutes agonizing over the problem and finally decided to turn the Tri-Wall over and try again later.

After the survey had been given, I asked the class if they could remember what the results were. Most of the students responded in general terms, that most people have bikes, that most people wanted to ride and that most people thought their parents would give them permission to ride. I told the class to pretend that I was the principal and to convince me that I should allow bicycling. One child was appointed to act as the presentation committee. He began by presenting the same generalizations as the class had just done. Of course, I overplayed the part and kept demanding that he give me proof in numbers. Finally, two children suggested that he give me the surveys. One girl commented that the principal would never have the time to look through all the surveys and that they needed a quicker way of making total figures known.

The conversation turned to graphs as a means of transmitting information quickly and efficiently. I assigned a group of six students to tally the responses for each question and three people to record the tallying on the board. When the tallying was finished, I hung a tagboard grid and asked two girls to make a graph using the survey data. After a long time they finally decided to make a vertical bar graph. They assigned one square on the grid for each survey response. However, they discovered that they had seventeen "yes" responses to the first question and only fourteen squares. The problem was solved when someone suggested using a half square for each survey response. The rest of the graph was completed by other members of the class. When it was finished, I asked my aide, who had been out of the room, to interpret one of the columns on the graph. He said that the first column showed him that eight and one-half people owned their own bikes. The class was outraged and a key was developed.

We spent the remaining afternoon interpreting the graphs. The class was quite pleased with them. They felt that the positive responses looked very impressive when compared with the negative ones.* They were sure that they could move mountains with graphs.

The map group returned to their project after a week and a half break. During this interval I had attended the USMES Winter Workshop and obtained two good solutions to the scaling problem. One teacher suggested that we use the opaque projector machine to sketch the map onto the Tri-Wall from the enlarged image. Another teacher mentioned placing a grid on the map and a larger grid on the Tri-Wall. Using this method each child could be responsible for one square on the Tri-Wall.** I suggested both methods to the class, and it was as if a cloud had lifted. They became so excited with the first idea that nothing would do but to immediately obtain the opaque projector and begin. They decided to hold the grid idea in escrow in case the projector method failed.

The map was inserted into the projector and no fewer than eight people held the Tri-Wall. Four people copied the map, six people steadied the projector, and the remaining students shouted encouragement to the others.

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*Children can draw slope diagrams to compare results from different grade levels. For example, they can compare the proportion of bike riders in different grades having accidents that year. See Background Papers, *R1 Graphic Comparison of Fractions* and *R2 Geometric Comparison of Ratios*. Students may be referred to "How To" Cards, "How to Compare Fractions or Ratios by Making a Triangle Diagram" (now called slope diagram).--ED.

**The Background Paper, *R3 Making and Using a Scale Drawing*, and the "How To" Cards on scaling show another way.--ED.

When the drawing was completed, the map was the best done so far, but they were disappointed that several places seemed to be off-center. They reasoned that too many people were holding the Tri-Wall and that the projector had been shaken several times. A committee of four was appointed to draw the map again. They decided to tape the Tri-Wall to the chalkboard so it could not move and demanded that no one come near the machine while the drawing was taking place.

The map committee of four worked on the improved drawing for two days and finished it. The class marveled that it was remarkably accurate and very well done. We discussed what further things they wanted to do to the map. The group wanted to paint the surface, develop a key, draw in their proposed bike paths and add models of houses, signs and trees, making it into a three-dimensional model.

In order to make the signs for their model layout, the group had to survey the neighborhood to find out where signs were located and how many there were. Over one weekend each group member took a mimeographed map of the school district and covered one section of the district, marking on their maps where signs were located. Back in the classroom they tallied the number of each different sign. To their dismay, they found they had a total of forty-six signs. They felt that they would never be able to do a good job in the short amount of time that they had left, even if they distributed the labor. I asked if they needed all the signs. After they pondered that question for a while, they decided to eliminate the following signs: dead-end, slow-children, bus stop, and caution. The resulting total was substantially reduced. They decided that a height of one centimeter for the signs would be in proportion to the map size.* They spent several days working in the Design Lab making the signs and painting the model. The completed map was very well done.

While the Map Group was drawing, the rest of the class worked on graphing the survey data from the different classes. Each group took the data from one class and made a bar graph. Some of the groups discovered a way to color code the survey responses to eliminate the need for so much writing on the axes (Figure C2-6 shows their graph). Purple represented all "yes" responses, red represented "no" responses, and blue represented "maybe" responses. The

*By having the map drawn to scale, they could measure the height of a sign and figure out how tall the model should be.--ED.

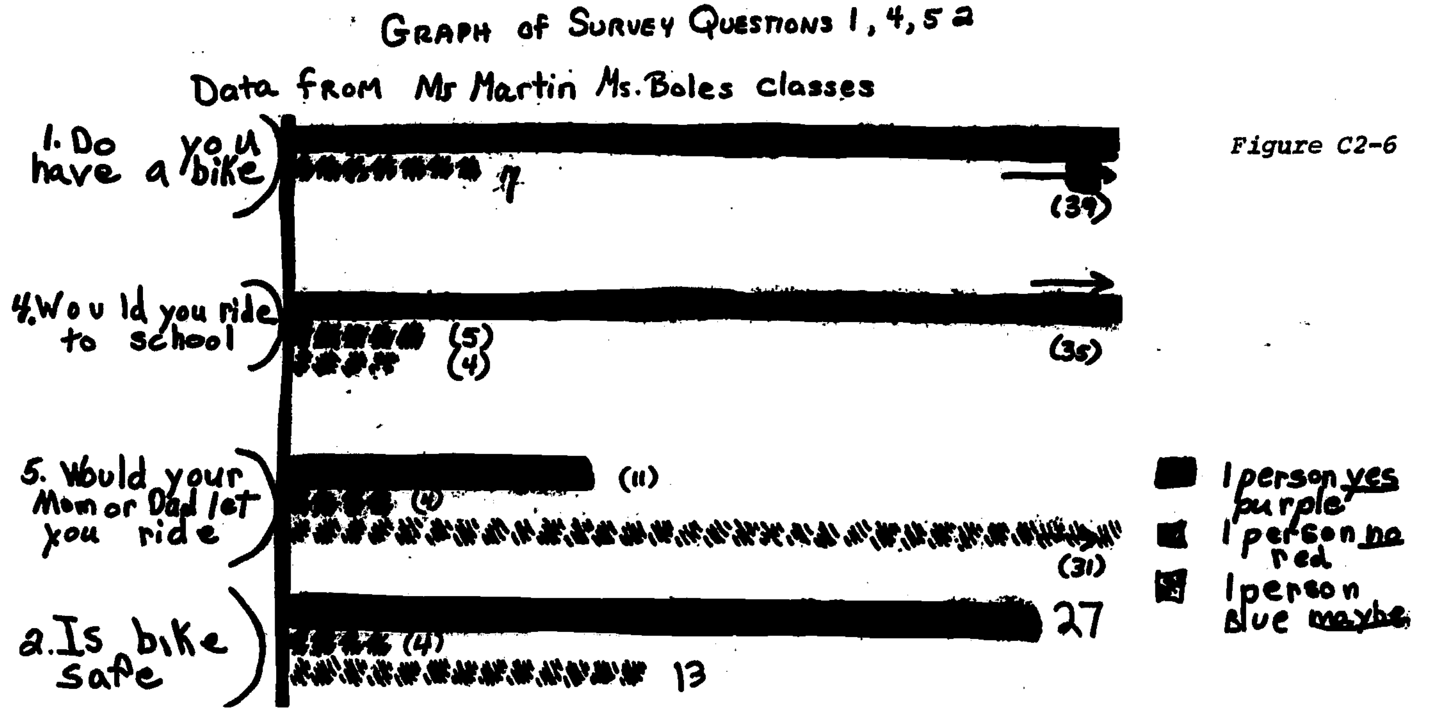

Figure C2-6

question "How would you lock up your bike?" presented a challenge for some of the groups because four alternative ways were offered. Two boys became very interested in this particular question and asked if they could graph the responses for all the classes. The other groups quickly consented and were relieved to be rid of the question. This exchange prompted another group to do some serious thinking about the way the questions were arranged on the survey. They decided that, if those two students were going to graph one question independently, why was it necessary to put all of the questions on each graph? They came up with the idea of clustering the questions around specific issues.

In planning the display graphs for the presentation, the class readily agreed to the idea of clustering the questions. They decided to make three graphs since the survey questions clustered around three topics (see survey in Figure C2-5): interest in riding bicycle (Questions 1, 4, 5), bicycle safety (Questions 2, 3, 7), and bicycle protection (Question 6).

Pooling the information from the seven classes took longer than I had anticipated. We decided that each group which had graphed the survey data for one class would report the total "yes," "no," and "maybe" responses for each survey question. A total for all seven classes would then be found and recorded on the large display graph. One student drew a chart form on the board to record the preliminary totals. On one side all seven teachers who had participated in the survey were listed. On the top, the survey question numbers were listed. Under each question one column was allowed for each type of response. It took nearly half an hour before a grand total was obtained for the first question.

The next step in the graphing process of the first question involved a little planning. One girl had very neatly made a vertical bar graph form on tagboard. I had purchased some bright green, red and blue dots with which they could record the survey responses. The class voted to have the red dots represent "yes" responses, blue "no" responses, and green "maybe" responses. In looking at the available space to place the dots on the graph form and the total responses to the first question, the children realized that there was no way they could put 116 red dots in a single vertical row and still have the graph look professional. Finally, it was decided that one dot would represent five responses because five was an easy number with which to divide. The totals were then divided. Practically all totals had remainders and these were represented by circles with chopped off portions (The cuts were based on intuition alone).*

An argument ensued following our discussion of the dots because the children were concerned about who was going to stick the dots on the graph. They wanted their graphs to be neat. Finally, two children with clean hands volunteered their services and the first question was graphed.

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*The students might be referred to the "How To" Cards on graphing for alternative ways to display their data.--ED.

Questions four and five in the first cluster of questions required less time to graph. The totals for the three questions were as follows:*

QUESTION NUMBER	RESPONSES		
	YES	NO	MAYBE
1. Do you have a bike?	116	31	-
2. Would you like to ride your bike to school?	88	37	17
3. Would your parents let you?	48	36	61

After the fifth question was graphed we talked for a few minutes about why there were many "no" and "maybe" answers when so many students had expressed such a high interest in riding their bikes to school. Some answers I received were:

STUDENT: When we were taking the survey, we didn't explain where they could park their bikes.

STUDENT: You'd have to be crazy to park your bike at Allen.

STUDENT: We don't have anywhere to park them here.

STUDENT: She (principal) wouldn't let us (ride) anyway.

When the first graph on "interest in biking" was completed, the class examined it. There was a general consensus that something was missing from it. One girl said that we needed a title so that the principal would know how much work we had done. The title chosen was, Bicycling Preference Graph. One boy felt the graph needed a grid. He was promptly booed. No one came up with the idea of a key. When it was put on, they were totally satisfied with the whole production.

*Students might note that there is a variation in the total number of responses to each question. They might discuss how much this difference would affect the use of the data. --ED.

Survey questions two, three and seven were then graphed. The total responses for these questions are as follows:*

QUESTION NUMBER	RESPONSES		
	YES	NO	MAYBE
2. Is your bike safe?	81	25	40
3. Do you have a license?	49	98	--
7. Would you park it in the bike parking lot?	103	32	13

The last graph (Question 6) was done by a group of three boys. They had already taken the initiative of gathering the responses from the other six groups. They only had to stick on the dots.

I raised the topic of bicycle security again since the problem had not been resolved previously. The class began thinking of places on the school grounds where bikes could be parked. Many locations were suggested. We listed all the possibilities and spent several sessions discussing each one at length. The following were their suggestions:

playground
by Marcus Street
near the outdoor learning center
parking lot
in the school
on blacktop, east of parking lot
against fence on Shepard Street
behind baseball diamond
on the Kalamazoo Street side of the school
Tastee-Freez parking lot
other people's houses
the side of the school, east near Shepard Street
against the school wall on the west side of the playground.

*Students might repeat the survey at the end of the year to see whether there was a significant difference in the results because of their work. For example, the second survey might show that more students feel that their bikes are safe as a result of the bike inspection.--ED.

Dear Miss Clark
We are studying Bikes in USMES. We would like to know if you could Come to our Meeting. We would like to know if we could have the meeting in the library at a time that is most Convenient for you at lunch or after school. We would also like some of the other teachers to Come. We will contact the teachers if you will Come

From Room 203
Ms McNerly
Class

Monday after school
✓ Tuesday lunch – after school 3:00
Wednesday – lunch – after school
Thursday – lunch – meeting is already scheduled Thurs. P.M.

Figure C2-7

We managed to agree on three suggested areas: the blacktop area east of the parking lot, other people's houses, and the west end of the playground near the wall.

The children decided to draw these three areas for the presentation. When the drawings were completed, the class voted on the three best.*

We then tackled the problem of arranging an appointment with the principal. We discussed things that should and should not be mentioned. The following is their list of items which they decided were relevant to the initial request for a meeting.

1. Ask for a meeting time which would be convenient for both the principal and other interested staff.
2. Times which they could consider: lunchtime, after school, during the day.
3. Tell her (principal) we need her help in an USMES unit.
4. Write her (principal) a letter.
5. Don't chew gum.
6. Don't spill the beans.

The last item referred to not blabbing about the meeting agenda. The children had a real fear that if the principal found out what they were doing before the meeting, she would not show up.

The next day the class wrote letters to the principal to arrange for a suitable time. The best letter was selected by the children (Figure C2-7 shows the letter that was sent to the principal). Two girls were picked to deliver the letter. The girls went down to the principal's office and returned in five minutes with an appointment for Tuesday of the following week at 3:00 p.m. after school. The class was ecstatic.

The class spent the week busily preparing, practicing and critiquing their presentation. The presentation was divided into several parts:

*The students might decide on a plan for parking bikes in each area and determine the number of bikes that could be parked in each.—ED.

introduction
explanation of the map (including how the map was made, explaining the proposed bike paths and pointing out safety considerations)
presentation of the graphs
presentation of the pictures of suggested parking places
question and answer period

Auditions were held for presentation speakers, and six children who showed the most poise and knowledge about the unit were selected by the class. The six children gave the whole presentation, and the class critiqued each speaker. The comments were generally negative, but no one was discourteous. There was a feeling in the air that the six students had better do a good job because nothing would be worse than having the proposal turned down because of a poor presentation.

Officer Bannon, from the police department, was invited to listen to the class's presentation. After the presentation he asked several questions on safety which the children handled very well. He praised the children for their work and offered several suggestions for improvement. Before he left, he asked if the class would be willing to help him give the bicycle safety assembly for the school. The children heartily agreed, thinking that the more cooperative they were, the more cooperative adults would be in dealing with their proposal.

Five teachers and the principal were present for the presentation. The children were poised and very confident. During the question-and-answer period the principal put up every roadblock known to administrators, but the children were able to respond very well to all, except one, which pertained to an administrative problem. The principal was impressed with the children's work, but she felt that she needed some time to consider their proposal. We evaluated the presentation and the principal's reactions to it afterwards. The children were satisfied with the principal's noncommitment: "She didn't say yes, but she didn't say no."

With the presentation over we decided to list the things that we wanted to do in the remaining school time. The list included the following items:

1. Get permission slips out to parents to see if they would allow their children to ride bicycles to school for a bike rodeo.
2. Ask the city commission for permission to paint lines on the streets to indicate the bike paths.
3. Paint the paths, if permission is granted.
4. Call Fairview School to find out what their policy on bicycling is.
5. Keep working with the police department to obtain approval to ride bikes to school.
6. Call Mr. Orthner (administrator in charge of school safety) to see if he can help the class with the administrative angle of riding to school.
7. Keep working on the principal.
8. Organize a bicycle rodeo.

The class divided into groups to work on the above items. One girl called the Fairview School and was told that children living outside the city limits were allowed to ride their bikes to school. A parking lot for the bikes was located across the street; bike racks had been provided by the city's parks and recreation department. There was no real way for the school to check who rode their bikes. We discussed Fairview's situation and what it could mean in terms of our school.

I reported to the class my telephone conversation with Mr. Orthner. In summary, he informed me that he worked closely with the police department and abided by its recommendations. The children decided that all they really had to do was to convince the police department and all the rest would fall into place. Mr. Orthner suggested that the children use the bike rodeo as a means of acquiring permission.

The class worked with the police department on the bicycle safety program for the school assembly. The class's role was to demonstrate some of the bike traffic rules and to explain the city's new policy of ticketing bike riders for not following traffic regulations applicable to bikes. Eight students nervously presented this information, and the rest of the school seemed to be very attentive.

Because time was short until the end of school, bike rodeo tasks were divided among five groups: public relations, safety and maintenance, bike course development, written test and rules, and judges for the riding test. We decided to use all of the blacktopped area around the school

Dear Parents:

On Saturday, June 1, Ms. McNenly's class is sponsoring a bike rodeo from 1:00 p.m. until 4:00 p.m. At this time a small written and skills test will be given to each child in the rodeo to see if he or she is able to ride a bike safely. This is <u>not</u> to give a bike license or to register bikes. Small prizes or certificates will be given to the highest scores. Also, there will be a bike clinic to check the bikes for safety. If you would give your child permission to ride his bike and participate, please sign the form below and return it to school.

Sincerely yours,

Ms. McNenly

I give ____________________ permission to ride his (or her) bike to Allen St. School on Sat., June 1 between 1:00 p.m. and 4:00 p.m. in order to participate in the bike rodeo.

____

Figure C2-8

for the test course, and the written test and bike maintenance groups would use the outdoor learning center. We obtained permission from the principal to hold the rodeo on a Saturday. It was difficult for the children to decide the order in which the tests should be given because each group felt its area was the most important. It was finally decided that the maintenance people would check the bikes first in order to assess their riding condition. The next part would be the actual riding test on the course, and the third phase would be the written test. After the three tests, the judges would tally the scores and award certificates to those who passed.

A Public Relations Committee was formed to work on permission slips for students to take home. They wrote the slips and distributed them to the third through sixth grades. Figure C2-8 shows the permission slip that was sent home. They also contacted the police department for advice and the fire department to see if the department could have a person present at the rodeo to register bikes. They were not able to reach anyone at the fire department who could tell them anything. I called later and they said, "No."

The Maintenance Group made a long checklist of things to look for during the bike checkup and also submitted a list of necessary repair tools to the Design Lab manager to order for the rodeo. I went over the list with the group and together we worked out a shorter version.

The following was their list of bike parts they wanted to check. The method of judging is in parentheses.

1. Is the bike the right size? (Observation)
2. Air pressure in the tires. (Push down on bike and feel tires)
3. Spokes. (Using a pencil, go around spokes and listen for a dull sound--Visually check attachment to rim)
4. Cones or bearing. (Check if wheel wobbles)
5. Chain and chainguard. (Pick it up. Visually check for oil)
6. Grips. (Try to pull on them)
7. Bars. (Move them to check for tightness)
8. Seat. (Move it to check for tightness)
9. Brakes. (Do the skid test)
10. Reflectors. (Observation)

A trial run was done with my bicycle. The check took three minutes with a crew of two working simultaneously. They spent most of the time working out a more efficient way of handling all the checklist items and managed to do minor damage to my bicycle. It was later decided that they could only make repairs if the bicycle owner was willing to have them done.

The Bicycle Course Group made a list of ten tests which were intended to assess the following skills:

stopping
steering
skidding
intersection crossing
reaction times and general handling of the bicycle

They made up a model of the course in the Design Lab, and when they tried to figure out the spacing for various tests, they realized that there was not enough room for all of them. They were very disappointed and asked the police department for some assistance. The changes which were suggested consisted mostly of combining tests and eliminating the intersection problem since no one seemed very excited about it. In the end, the bicycle course consisted of four tests:

Test 1. Tested balance, steering and stopping ability.

Test 2. Serpentine course - tested steering ability

Test 3. Tested ability to push bicycle and steer at the same time.

Test 4. Tested the cyclist's reaction time.

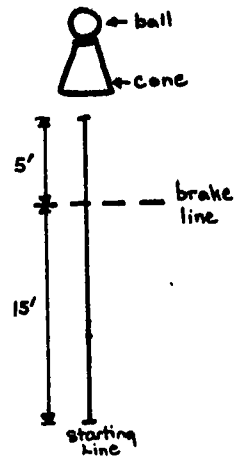
It took the Bicycle Course Group one week to set the course up. Sketches of the test were first drawn on the board. A test layout was not finalized until several trials had been made on it first. For example, the serpentine test was first laid out in the hallway. One child, using my bicycle, rode through the course, and based on this trial, the group decided that a larger turn-around was needed at the end. This second arrangement was found to be more feasible. The children then measured the distance between the cones and were able to set up the test outside in exactly the same manner.

The remaining three tests were set up outside. Blackboard chalk was used to mark on the asphalt. As soon as one test was laid out, members of the other groups used my bicycle to try it out. Recommendations were given and changes made accordingly. Two hours and seven miles later (as indicated on my bicycle odometer), the four test courses were set up as shown below.

TEST 1

This test was their own plan. It was designed to test balance, steering, and stopping.

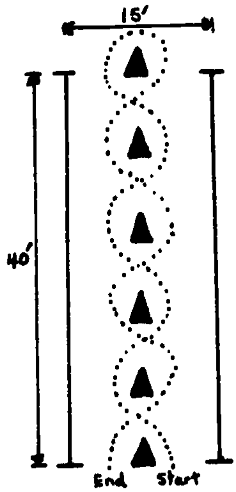
The rider starts pedaling twenty feet from a cone with a ball balanced on it. The rider must apply his brakes at the brake line and avoid knocking the ball off at the end of the cone.



TEST 2

This test was designed to test steering ability.

A forty foot serpentine course with a margin of fifteen feet to steer in. The child must steer around six cones and return to the starting point without touching or going over the line.



BIKE TEST

Circle the correct answer.

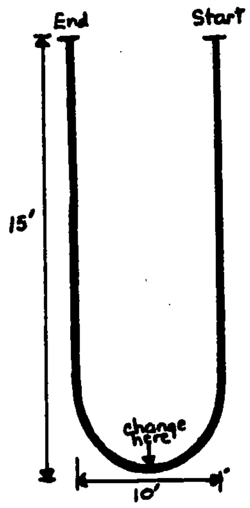
1.	Do you have to stop at red lights?	YES	NO
2.	Do you have to have a license to ride your bike in the street?	YES	NO
3.	If you have a bike made for one person, can you ride two people?	YES	NO
4.	Do you ride on the sidewalk or on the side of the street?	the street	sidewalk
5.	Should you have a light on your bike?	YES	NO
6.	Should you obey traffic signals?	YES	NO
7.	Circle the correct signal you would use to turn.	LEFT	RIGHT
8.	Do you have to go one way on a one-way street?	YES	NO
9.	What side of the street do you ride on?	right	left
10.	Can you ride on the sidewalk?	YES	NO
11.	Do you ride with traffic or against traffic?	with traffic	against traffic
12.	Do you have to use hand signals?	YES	NO
13.	Can you ride back and forth like this?	YES	NO
14.	Do you know how to change a flat tire?	YES	NO
15.	Is your bike the right size for you?	YES	NO
16.	Do you scare little kids by going close to them?	YES	NO
17.	Is your bike in good condition?	YES	NO
18.	Do you walk your bike across the street?	YES	NO

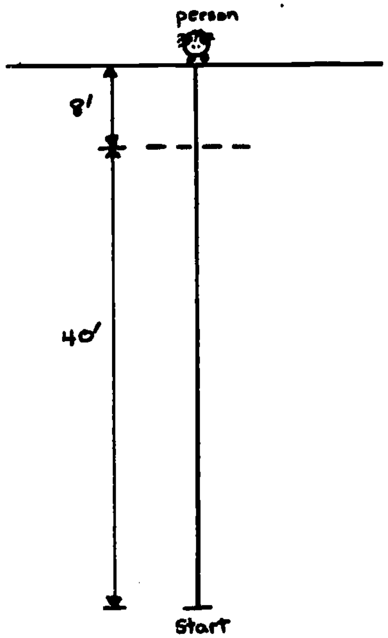
Figure C2-9

TEST 3

This test was designed to test one's ability to push the bike and steer at the same time.

The cyclist must keep one foot on the ground and travel on the line "scooter-style" until he reaches the bottom of the "U" where he changes feet and rides up again "scooter-style."





TEST 4

This test was designed to test reaction time.

The cyclist starts toward the person at the top of the "T." When the rider approaches eight to ten feet away, the person holds up a sign that tells the rider to stop, to yield or to turn either right or left. The cyclist must then make the appropriate hand signal and do whatever the sign says.

Figure C2-10

The group working on the written test went through reams of material, sifting and sorting out relevant information they felt cyclists should know. They wrote up the questions and had my aide type the test on a ditto after ten unsuccessful attempts of typing it themselves. The test was given to the rest of the class and answers were gone over. Their test is shown in Figure C2-9.

The committee of judges chose a form for the certificates that would be awarded to those who passed the various tests. The certificates were dittoed on yellow construction paper. Figure C2-10 shows the certificate. The children spent some time practicing their judging ability.

The bike rodeo was held on June 1. The time was from 1 p.m. to 4 p.m. I arrived at about 10 a.m. to start setting up and was surprised to find that the playground was filled with children and four members of my class. The rodeo got off to a rough start due to last minute organizational problems. One member of the Maintenance Group forgot about the time and arrived very late. By the time we started only nine children were left to take the test. The tests went beautifully and by 2:15 p.m. everyone had completed all four tests and been awarded their certificates. At 2:30 p.m. we closed up since no one else seemed to be coming.

The turnout was very disappointing to me, but the students took it all in stride. They simply told me that many children did not have bikes and that was it. Four students on bikes spent the whole afternoon around the course but did not participate because it was "stupid." So that was how it went!

3. LOG ON BICYCLE TRANSPORTATION

by Marcia Schroder Mertens*
Vista View Elementary School
Grades 4-6
Burnsville, Minnesota
(September 1974-January 1975)

ABSTRACT

The Bicycle Transportation unit was offered as a science class to these fourth through sixth graders, all of whom signed up voluntarily for the class. The students worked three times a week on their challenge of making cycling a safe and convenient way to travel in Burnsville, Minnesota. Cycling problems were first identified. To learn more about cycling rules and safety, the class took a bike trip to the police station, practicing safety rules they felt were important. Shortly after their trip the class learned that a referendum on a system of bike trails for recreation was voted down. The students were upset and wanted to do something to get the bill up for reconsideration. They formed four groups to investigate (1) rerouting of the paths, (2) lowering the cost of the paths, (3) why the referendum failed, and (4) procedures for getting a bill up for reconsideration. Several boys were interested in bike maintenance and repair and formed their own group. Later these boys shared their knowledge of bikes by preparing and presenting to other classes a bike maintenance and repair showcase. Another activity that the class later became involved with was a bike safety clinic because it was noted that students in the school did not observe safe cycling rules. The clinic involved taking a written cycling quiz and a riding test. The student with the highest combined score on both the written and riding tests received a camera. Other students who passed both tests received bike licenses.

At our first class meeting we shared our good and bad bike riding experiences. This discussion soon evolved into a discussion on cycling dangers because most of the students' experiences revolved around bike accidents and injuries. The students listed many cycling problems that they had encountered in the past. These problems included--

1. Bicycle breakdowns--having a flat tire or having the brakes fail.
2. Weather--having no protection from the cold, the wind, or the rain.

*Edited by USMES staff

3. Chain guards--pant legs always catch on them.
4. Ability to ride--sudden obstacles in your path are real problems if you're not good at steering and stopping.
5. Ripoffs--not being able to leave your bike unguarded for more than a few minutes or else it will be ripped off.
6. No place to ride--no bike paths, few sidewalks, inadequate road shoulders.
7. Carrying materials on the bike.
8. Bad visibility--cyclists unable to see cars coming around corners and over hills; similarly, cars cannot see cyclists well.
9. Cars--cars don't recognize that cyclists have rights, too; cars honk at cyclists; cyclists have trouble crossing streets due to cars.

Despite these problems the students felt that bicycles still had many advantages, such as causing no pollution, making people more physically fit, being easier to park, and saving on gasoline. I then asked the class what we could do as a class to make bike riding a safe and convenient way to travel in Burnsville.

The challenge prompted the class to think about what made a cyclist safe. Suggestions ranged from a properly equipped and maintained bike to proper riding habits to safe routes. An argument evolved over which side of the road a cyclist should ride on, with or against the traffic. After heated debate several students volunteered to call the police department to find out this information. One boy then wondered whether the class could ride to the police station to get booklets on cycling, get reflector tape, have an officer speak on safety, and maybe even register their bicycles. The students were quite excited but dubious about this idea. I told them that I would check with the principal.

The next day I told the class that the principal approved our idea of cycling to the police station. The class was ecstatic. I reminded them that the trip had to relate to our challenge of making cycling safe and convenient. The students immediately offered several reasons that the trip related to the challenge.

1. The trip would allow them to put into practice safety rules they thought were important.
2. Repair skills could be learned and practiced because the bikes could be checked before the trip.

3. Routes along the way could be checked for possible bike paths.
4. Traffic could be observed along various roads.

We proceeded to list on the board good safety rules:

1. Ride single file
2. Ride with the traffic
3. Travel in small groups or with partners
4. No fooling around (e.g., "wheelies")
5. Obey all traffic rules (e.g., observe lights and stop signs)
6. Proceed cautiously through intersections

One boy suggested bringing some tools along in case someone's bike broke down. We listed the tools--crescent wrench, screwdriver, patching kit, bike pump--and several students volunteered to bring them from home. We then agreed to go on the ride the following week.

The day of our trip came and so did the rain. By the time the sun came out it was too late to go. After several minutes of disappointment we decided to make the best of the situation. We agreed that since everyone had their bikes here at school, we could practice our riding skills out on the playground. One group of students designed a simple course to test steering ability and the proper use of hand signals. Several volunteers went to get cones and jump ropes from the gym. While the course was being set up, several students began checking bikes.

Outside, each student practiced steering around the cones and signaling. Afterwards, we simulated our trip to the police station by riding single file around the playground. Only one mishap occurred while we practiced our riding when one girl's pant leg got caught in her bike chain.

Back in the classroom we evaluated our practice session. The class noted several problems and suggested the following solutions:

1. Problem: It's hard to follow single file behind a slow rider.
   Solution: Divide the class into groups according to riding speed preference. Have the faster riders begin first so that they do not have to pass anyone.

2. Problem: Some people tire sooner than others.
   Solution: Do exercises and ride your bike every day to get in shape.

3. Problem: It's hard to come to a dead stop or turn quickly when riding single file.
   Solution: Persons giving the hand signals should signal well in advance and should continue to signal for a time to ensure that everyone sees it and knows what to do.

4. Problem: It's hard to pedal when your tires are low on air.
   Solution: Find out and put the proper amount of air in your tires. Such information may be obtained by asking your dad, reading what's printed on the tire, going to the gas station, or reading the bike manual.

5. Problem: There are smart alecks in the group.
   Solution: Anybody who fools around should not go on the trip.

We then set another date for the trip.

During the week the class learned that a bike trails referendum had failed to pass at the polls. The students arrived at school the day after the election very upset. A heated and emotional discussion occurred.

"They'll have to wait till twenty kids get killed before they admit we need bike paths," said one child.

"They (adults) don't care about bike paths 'cause they have their cars and roads, and they can get anywhere they want," added another.

"They think their taxes are going to go up. What's twenty-five dollars a year!"

After several such emotional outbursts I asked the class to think seriously about why the voters had turned down the referendum. They came up with the following reasons:

1. Paths were not in the right places.
2. Taxes are too high.
3. They (adults) are afraid of noise. (The trails system also included snowmobile trails. Some people felt that the trails were too close to homes.)
4. Too many things were included on the referendum. (The bill also included hiking, horseback riding, snowmobile, minibike, cross-country skiing, and snowshoe trails.)
5. Trees have to be removed for the paths.

I asked the class whether there was anything we could do about the veto. After several comments like, "We can picket city hall," and "We can ride our bikes in the middle of Highway 13 carrying signs saying 'We have nowhere else to ride,'" we agreed that we needed to attract attention to make people aware of the need for bike paths. Because the bike trip was coming up shortly, we decided to begin our campaign by carrying signs stating "We need bike trails" on our bikes as we rode to the police station.

On the day of our trip, we met in the parking lot at 12:30 p.m. We organized ourselves into three riding-speed groups of ten students each, with the fast group leaving first. Each group was lead by a student teacher or the teacher. The person carrying the first-aid and tool knapsack rode at the end in case something happened ahead of him. A patrol flag was also brought along to assist the riders in crossing a busy intersection.

The class rode single file and used hand signals along the way. The hills were quite steep and many students were really tired. When we reached the station, there was a mad dash for the drinking fountain.

One police officer talked to the class about bike safety and answered their questions. Later, he asked the students questions about bike laws and was quite surprised that they knew them. The bikes were then inspected by several officers and the owners given bike licenses. While the licensing was going on, several students tried to fix one girl's brakes, which had given way on the last hill. They worked on the bike for forty minutes and discovered that they needed a cable. We decided to leave Marlene and her bike at the station and have one of the student teachers return in a car to pick her up.

For the return trip we once again organized into our three groups and staggered the starts. The last group had a slight mishap. One girl's bike chain slipped a link. The girl lost her balance and fell. Because she seemed to be in a great deal of pain, we sent one boy back to the police station to get help. A police officer came and took Patti and her bike home. (Later I learned that she had not broken any bones but had twisted her ankle. Needless to say, I was relieved!)

The next day we evaluated our trip. We compiled on the board a list of things we had learned.

1. Before crossing a street make sure there are no cars.
2. Walk your bike across a busy intersection.

3. Skinny tires are not good on rough terrain.
4. Before starting on a trip know some first-aid.
5. Always check the bike before going on a trip. (Both Marlene's and Patti's breakdowns could have been avoided.)
6. Know about bicycle maintenance.
7. Make sure you know the way.
8. Make sure the bike fits you properly.

We then returned to the bike trails referendum. The class agreed that they needed first to find out what people did not like about the bill by conducting an opinion survey. They could then try to correct what people did not like and submit the revised bill for reconsideration. The class felt they could investigate ways to lower the cost of the paths, in some cases rerouting some paths to shorten the total length of the system and placing them away from homes. The class decided to break into groups to investigate (1) why the paths bill failed, (2) ways to lower the cost of paths, (3) ways to reroute the paths, and (4) the procedures that are necessary to follow to bring a bill up for a revote. Several boys who were interested in bike maintenance formed their own group.

<u>Rerouting Paths Group</u>

The group began by going to the library to look for a map of Burnsville. Once they had located a suitable map, they had the librarian make copies for each member of the group. They decided to submit three bike trail plans to the class for a vote, plan A being the one that had just been rejected at the polls and plans B anc C being their own proposed routes. They proceeded to think about ways the present bike trails system could be improved and to note potential hazards that should be avoided when planning alternate routes to those in the present trails system.

After working two weeks on trying to prepare new bike routes, the group became quite frustrated because they soon realized that they did not have sufficient information. They agreed that they needed a car to get to various areas in Burnsville to determine the best locations for paths. They also wanted a nonexistent vegetation map of the area! They were extremely discouraged and decided to give up the whole idea of finding alternate bike routes. One group member suggested that they work on a bike safety clinic for riders in the school. This idea was readily accepted by all.

Cost Group

This group was to figure out the cost of the two alternate bike routes proposed by the Rerouting Paths Group. While they waited for the Rerouting Group to come up with these routes, the Cost Group spent some of their time studying the cost figures from several bike trails referendum pamphlets. Later they decided to write to some construction companies to inquire about the prices of an asphalt or concrete sidewalk. They thought that perhaps they could find someone to make the paths cheaper than that proposed by the city. They spent some time researching through language arts books for the proper way of writing a business letter. When the Rerouting Paths Group failed to come up with the alternate bike routes, the Cost Group decided to quit, too, and join other groups.

Reason for Failure Group

To determine why the trails bill failed at the polls, the group decided to conduct an opinion survey. A long discussion occurred over the best way to distribute and collect their survey. Door-to-door interviews and having students wait for respondents to complete their survey forms was turned down because the group felt that some people might not want the students to know how they voted. In the end it was decided that the easiest way to distribute and collect the surveys was to have other students take them home and return them the next day.

The group spent several class sessions writing a survey introduction and questions. They took great pains in wording the entire survey because they did not want to anger any parent. When the survey was finished, they began copying it onto a ditto master.

Because there had been many questions from the school faculty and administration about what my class was doing, I advised the group that they had better obtain permission from the principal to distribute their flyers (advertising the need for bike paths) and their survey. The group agreed, and one girl volunteered to take copies of the flyer and the survey to the principal and to explain the purpose of their activities.

A few days later the group learned that the principal approved the distribution of their flyer and survey provided that the school's name was deleted from them for political reasons. The principal also informed the students that the materials had to be distributed outside of school time. The Reasons for Failure Group passed this information on to the Political Procedures Group because they were designing

Dear Parents,

At vista veiw school we have a bicycle unit.

We feel that bike trails would be safer for children and adults.

We we would like to know how you feel about it. Please ~~fed~~ sign out the following survey and return it with your child.

THANKS FOR Your cooperation

Did you like where the bike trails were going to be? Yes ☐ No ☐

Do you think one of the problems is the taxes? Yes ☐ No ☐

Do you think that bike trails are necessary for the safety of children? Yes ☐ No ☐

Do you think the bike trails would have passed if they were seperated from the ~~iceer~~ ice rink and the swimming pools? Yes ☐ No ☐

Do you think you would of gotten any use out of it? Yes ☐ No ☐

Do you think there were too many bike trails? Yes ☐ No ☐

Do you think there weren't enough bike trails? Yes ☐ No ☐

If you have any ideas ~~please~~ on why they failed please tell us.

Thank You

Signed,
Miss Shroder's
~~bycitte~~ bicycle class

Figure C3-1

a petition to be circulated. The survey was then revised accordingly. Figure C3-1 shows the final survey that was distributed.

Distribution plans were altered slightly. Rather than having students in the school take the survey home, the group determined who in our class lived in different areas of the school district. Each student was then given a pile of surveys and flyers to distribute in his area. The class thought that the other students could bring the surveys back to school.

Over the four-day weekend the students busily distributed the surveys and flyers. Several mothers commented to me that they were quite impressed with the students' work. The group had even taken the time to color the flyers! When the class returned from this long weekend, the group shared with the class their experiences with the survey.

As the surveys were returned, the group tallied the responses and kept a running list of comments that respondents had written on their surveys. (See Figure C3-2.) They were disappointed that many of the surveys were not returned and decided to make more and have students in other classes take them home.

After a week the Reasons for Failure Group had seventy-nine returned surveys. Although this amount was still disappointing to them, they decided to tally and graph the results. The response totals are shown in Figure C3-3. (Their graph is unavailable.)

When this task was completed, one group member wondered what they should do with the results. The group decided to send the results to one of the guest speakers (see Political Procedures Group) who had shown an interest in what their class was doing. They felt that his environmental group could perhaps use the data in reevaluating the trail system. They composed the letter and typed and mailed it with their data.

Several days later one of the members excitedly told me and the group that Mr. D. had phoned her to thank the group for their letter and data. He was very impressed with their work and encouraged the class in its efforts to bring the trails bill up for a revote.

With their work completed members of the Reasons for Failure Group joined other groups.

Political Procedures Group

The group called city hall to ask about procedures for getting a bill up for a revote. They were simply told to get a petition signed. As no one in the group knew what a petition was or how to make one, they decided to call the

comments
of people

1. not enough personal contact, also thinks that the other two proposals at the same time helped to defeat the trails.
2. Would like it without sidewalks.
3. People are to cheap.
4. If it came up by itself.
5. No snowmobiles!
6. without other issues.
7. Taxes are already high enough.
8. Up for vote again.
9. didn't know about the bike trails
10. "Do you think your old enough to run off surveys?
11. "Did your parents run these off.
12. "I hope you get through and get them up for vote again."
13. "I hope you get the vote up because were all for it". "And good Luck.
14. "Did you do this all yourself?
15.

Figure C3-2

police station for help. However, they received no assistance from the officer and became very frustrated. When they came to me for help, I asked them to think of someone in Burnsville who knew something about city government procedures. After some thought, they decided a political science teacher at the high school would know this information. Two girls looked in the faculty and staff directory for a political science teacher. They found one and copied down his name and home phone number. The group then asked me to call him after school because they felt that he would listen to me more than to them. I agreed to do this for them.

A few days later I reported to the group. The political science teacher had given me numerous materials and information about petitions. I explained to the group that a petition must be signed by a minimum number of people (Mr. K. was unsure of the minimum number of signatures) before it can be presented to the Village Council. The council decides if the issue is important enough to bring up for a revote. Mr. K. also suggested that if the students wished more information on the bike trails, they should get in touch with the people whose names he had written down for them. I gave this list to the group. They then proceeded to examine this list as well as the sample petitions and surveys his high school class had done.

After I left the group, the members picked from the list the people they wished to invite to speak to the class. One girl volunteered to make the telephone calls, and three people agreed to come to our class.

The first speaker was a current member of the Village Council. Before entering our classroom she remarked to me that she was surprised and rather impressed with the fact that a student had called her. She explained to the class how the council worked and what her role was. She also explained in detail the procedure for bringing an issue up for a revote. She concluded her talk by recommending that the students write editorials to the local newspapers, interview adults, and get students in other schools involved by having them take petitions around their neighborhoods. The class was really excited by this last idea.

Several days later Burnsville's Director of Parks and Recreation came to speak to the class. He began by explaining what his duties included as director and explained that he had been working with a committee on the trails system proposal for three years. He showed the class the master plan of the trails system, told them the total cost of the system and the individual cost per taxpayer, and clarified the many misunderstandings parents and students had about the trails. He felt that the reason the bill had failed at

Did you like where the bike trails were going to be? Yes [51] No [16]
Do you think the bike trails are necessary for Burnsville? no comment [6] Yes [60] No [illegible]
Do you think one of the problems was that the taxes were too high? no comment [illegible] Yes [50] No [25]
Do you think childrens lives are endangered by riding in the streets of Burn.? no comment [illegible] Yes [64] No [11]
Do you think that there was not enough information knowing about the trails system for the people to vote yes? no comment [illegible] Yes [43] No [22]
If the trails system was up to vote again do you think it would pass? no comment [14] Yes [64] No [35]
no Comment [10]

Thank

You

Figure C3-3

Dear Mrs. Ms. Majeski
Thankyou for coming to our bicycle class. Your talk was interesting. And thankyou for answering our questions.

from
Miss Schroder's
Bicycle class.

Figure C3-4

the polls was that many voters were not knowledgeable about the proposal. He ended his talk by commenting on how well the class was working and encouraged them by saying that if they went through the right channels, they just might succeed in getting the trails.

The final speaker was a leader of an environmental group in the city. He reviewed the trails system proposal and pointed out that a strong argument for the bike trails was that two cyclists were recently killed on county roads similar to the county road in front of our school. He also showed slides on all the different stages of planning the trails system and passed out maps showing the proposed forty-eight miles of paths. He was extremely supportive of what the class was doing and told the students that he wished to hear from them later on their progress.

Following all the guest speakers, the Political Procedures Group divided to do the three major tasks that were facing them: preparing the petitions, writing thank-you letters to our visitors, and writing editorials to send to the local newspapers.

When the thank-you letters were finished, the boys who had written them used the telephone book to look up the visitors' addresses. When they saw the long list of surnames, they suddenly realized that they did not know the visitors' first names. They were ready to give up when one boy figured out that they could eliminate many names by rejecting all those who lived outside of Burnsville. Because they had each visitor's phone number, they were able to find the correct people. Figure C3-4 shows one of their thank-you letters.

Students writing editorials first consulted the language arts books to find out how to write a good editorial. But when it actually came to writing them, they really did not know what they wanted to say or how to say it! I then suggested that they look at some of the editorials in the local papers. They obtained some old papers and read several editorials. When their articles were completed, the students picked the paper to which they wanted to submit their editorials. One boy came to school quite excited one day; his article had been published in one of the local papers. Figure C3-5 shows his letter to the newspaper.

<u>Bike Maintenance Group</u>

After spending several weeks reading pamphlets and books on bike repairs and maintenance and practicing their skills on broken bikes, the Maintenance Group decided to share their knowledge with other students in the class and school.

Jay Krell
1200 Vista Drive
Burnsville Minn.
Oct. 16 1974

Dear Editor:,
We are a scherl in Burnsville.
We are concerned about the safty of Burnsville bike riders.
This year a little girl got hurt riding her bike on the street.
So thats why we need the Burnsville traile.
Would you please put a editorial in your newspaper.
Send us your O.K. and we will send you the column.

Jay Krell.

Figure C3-5

To accomplish this, they decided to design and set up a bike showcase.

At their first meeting the group brainstormed ideas for displays. Their plans included--

1. a diagram of a bike with important parts labeled
2. a diagram of how to keep a bike in good working order
3. a diagram of how bike gears worked
4. a demonstration table of how to fix a flat tire
5. posters showing what to consider when purchasing a bike
6. a guest speaker (from a bike shop) to talk on the different kinds of bikes that are available and ways to ensure that a bike fits properly

The group spent several weeks preparing the showcase. Posters were drawn; lists, such as important bike parts, were made and typed up. When a group member needed a break from his task, there usually was a broken bike awaiting repair. Over one weekend one group member phoned a bike shop owner to invite him to speak at their showcase. Because the owner could not, this activity was dropped from the agenda.

When all the posters, charts and demonstrations had been completed and assembled, the group organized the program and decided who would present each piece of information. Their outline is shown below.

1. Introduction
   a. Tom introduces members of the group.
   b. Todd explains what the entire class is doing on bikes.
   c. Lenny explains why their group decided to do a bike showcase on bike maintenance and repair.

2. Bike Maintenance (Todd and Lenny)
   a. Explain the parts of the ten-speed bike.
   b. Demonstrate how to tighten bike parts.
   c. Demonstrate what the proper bike height is for various individuals.
   d. Demonstrate how to repair bike links.

3. Bike Repair and Parts (Tom and Lenny)
   a. Pass out ditto copy on parts of a bike.
   b. Demonstrate how to put certain bike parts together.
   c. Show how to adjust the chain, seat, and handlebars.

4. Study of Bike Parts (total group)
   a. After giving students plenty of time to study handout, have them return it.
   b. Have students examine the various bike parts on the display table.
   c. Point to bike parts on an unlabeled bike and ask the class to name them.
   d. Tom holds up different bike parts and asks the class to tell him the part name.

I went over their outline with them and commented on how well they had prepared for the showcase. I reminded them about the fifty-minute time limit (length of time for our class) they would have and asked them what they could do to ensure adequate time. All immediately agreed that if the posters were hung and the demonstration tables set up before the presentation, they would save a lot of time. One boy then asked whether the group could practice the showcase in front of the class before presenting it to other classes. I agreed, stating that the class would provide good feedback. We decided that we would tape this presentation so that the group could evaluate themselves afterwards.

On the day of the bike showcase for our class, the Maintenance Group quickly set up. Tom began their presentation by introducing the members of the group. He then directed the class's attention to the bike diagram with the labeled parts. While Tom pointed out various bike parts on the diagram, Todd passed out the dittoed bike diagrams to the class.

The bike parts on the demonstration table were shown next. Tom explained the importance of bearings and showed the difference between various bearings. He showed the purpose of the axle and cautioned that it should be kept well-greased.

Todd then lifted a ten-speed bike onto the table. (This really impressed the class!) He pointed out bike parts that were found only on ten-speed bikes and parts that were found on all bike styles. He explained how the different gears worked, what their effect was on pedaling ease, and how the gears may be stripped. The importance of the derailleur was explained as well as the brake cable and the amount of tension that was needed in the cable for safe operating brakes. Todd also told the class the way to check for suitable bike size.

Lenny stressed the importance of checking the bike periodically to make sure all parts were in good working order. He reminded everyone that some parts needed to be greased occasionally and other parts tightened. He also stressed the importance of using the right tools to repair the bike.

After a question and answer period (where the students asked very good questions!) Tom directed the class to study their handout on bike parts. After about five minutes he asked the class to come up to look at the bike parts assembled on the table. He then tested the class by holding up a part and asking them to tell him what its name was.

After the showcase was finished, it was quite evident that the class was really impressed with this group's work. The class was particularly impressed with one group member who had earned the reputation of being a class goof-off and troublemaker. The students could not believe how much he knew about bikes and how well he and the rest of the group had organized this showcase.

Several days later the Maintenance Group and I listened to their taped session with the class. After they got over how their voices sounded, they listened attentively and critically. Some of their reactions were as follows:

"We were all nervous."

"We kept repeating 'and.'"

"We laughed too much."

In the remaining time left in the semester the Maintenance Group was able to make a presentation to another class.

Bike Safety Clinic

Members of the old Rerouting Paths Group listened to one girl's reasons for organizing a bike safety clinic. According to her, she had frequently seen kids riding in the middle of the street, dodging cars, and ignoring safety rules in general. She explained that until Burnsville gets some bike paths, kids will have to continue riding in the streets, and they should at least be made aware of the cycling rules. She concluded that in many cases adults were justified in honking at bike riders when they acted stupidly.

The group agreed with the girl that a bike safety clinic would benefit all riders. They discussed what made a rider safe and identified key elements of the clinic. They decided that a written test should be given to test a rider's knowledge of safety rules and that an obstacle or road test would test the cyclist's riding ability. Most of the students thought it would be great to make the road course as near to a real street situation as possible, including cardboard cars and ticket-giving policemen. They made a list of traffic signs they felt were important for cyclists to know: "Yield," "Stop" (signs and lights), speed limits, railroad, "Slippery When Wet," "School Crossing," "Curve," "Bump," "Slow," and "One Way."

Several members expressed a concern for student interest in the clinic since it was the middle of November, but others felt that if they could use the cafeteria for the clinic and do a lot of publicity, students would come. One student suggested giving points and then rewarding those with the highest score with prizes. Someone else suggested driver's licenses instead of prizes. One girl felt that the Maintenance Group should be present at the clinic to inspect and repair bikes before the rider took the riding test. With all these ideas the group realized that they needed to form groups and that they would need more students to help. They decided first to identify major tasks.

During the next group meeting the members devised a list of major tasks that needed to be done by small groups. With each major task smaller tasks were also identified. All their ideas were later put on a ditto and each group received a copy. The following is their list of tasks:

1. Road Signs
   a. Figure out what size is suitable for the course
   b. Examine real signs, their color and shape
   c. Figure out how many of each sign are needed
   d. Draw signs on paper first
   e. Figure out what materials and tools you'll need to make the signs
   f. Construct the signs

2. Posters
   a. Decide on poster design
   b. Figure out what materials are needed
   c. Sketch posters
   d. Paint or color the posters

3. Bike Licenses
   a. Decide on license design (shape, size)
   b. Decide what information should be on the license
   c. Figure out what materials are needed
   d. Make as many licenses as you need

4. Cafeteria Floor Plan Model
   a. Obtain permission to use the cafeteria
   b. Measure perimeter of cafeteria
   c. Make floor plan to scale
   d. Put in course (obtain this information from the Road Design Group)

5. Cardboard Car
    a. Decide how many are needed
    b. Draw car design, decide size
    c. Figure out what materials are needed
    d. Construct the cars

6. Bike Registrations
    a. Decide how to register riders
    b. Decide how points will be given

7. Road Design
    a. Design road test (including intersections and using signs) to test cyclist riding skills
    b. Identify riding skills to be tested

8. Written Test

At the next class meeting the Bike Safety Clinic Group explained to the class their plans for the clinic and asked for assistance in carrying out the eight major tasks. Several students asked how the group was going to manage all the riders and their bikes, particularly if the clinic was held in the cafeteria. The group explained that they were going to ask ten students with different-sized bikes to bring them to school. Students taking the test would then use one of the ten bikes. The eight tasks were then written on the board and members of the class signed up. (Since most of the other group activities were near completion or at a standstill, the class was more than willing to help with the clinic.)

<u>Poster Group</u>

To get ideas for their posters, the group looked through several bike pamphlets. With designs in mind the group went to the paper room to begin sketching. I asked them what size paper they wanted. After a brief discussion they concluded that a tiny poster on a large wall would look "dumb," and so they chose large sheets of paper. They spent several weeks drawing and coloring the posters. These were then hung in the hallways.

<u>Road Design Group</u>

In order to lay out the roads, the group first got the list of traffic signs that were to be included in the road course. The roads were then arranged so as to test the rider's knowledge of what the sign meant. When they showed me their final layout, I noticed that some signs were not in the appropriate places, showing that they really did not know what the signs meant. For example, a "Yield" sign was placed along a straight road. When I pointed out this situation, they agreed that they needed to find out what some of the signs meant.

A few days after the group had redesigned the road plan to fit the signs more appropriately, someone brought in an American Automobile Association (AAA) book on bike road-test skills. The group looked through the book and decided that it would be good if they could incorporate some of the AAA skill tests into their road plan. As a result, they spent the next several days revising the plans. Figure C3-6 shows their final plan.

Bike Registration Group

A registration form was designed that requested the following information from the rider--name, age, classroom number, road test score, written test score. The group explained the registration process to me. When a student registers for the tests, he gives his name and age. Age is important because seven-year old riders will not be expected to ride as well as twelve-year old riders, and the scores will be adjusted accordingly. Each registered rider then receives a piece of paper with a large number on it. (Numbers ranged from one to ten--only ten cyclists can ride through the course at the same time because there are only ten bikes.) The cyclist pins his number on his back so that the scorers at various checkpoints along the course can assign points to the appropriate rider. After the ten riders have completed the riding course, they return their numbers so that the next ten riders can begin. The scorers will then turn in the scores for the various tests for all the riders, and one person will determine each rider's total score.

To decide on points for each skill test on the course, the Registration Group got together with the Road Design Group. After compiling the points, they figured out a passing total and a total for rating a rider as an expert rider. Both groups agreed that a participant needed to pass both the written and the road test to obtain a license. Figure C3-7 shows the points for the various skills and the total needed to pass.

Balance test 10pts
Maneuvering-Weaving 15 pts.
Straight line Control 15 pts.
Stop sign 5 pts.
Circling 15 pts.
15ft. stop ability 10pts.
Signal Right 5pt
Signal Right 5pt.
" " "
Signal Left 5pts.
" " "
100
Signal Right 5pts
~~Car~~ Stop 5pt.
Right turn "
Left " "
Left " "
" " "
Right " "
Car stop sign 20 pt

Total 155pts.
To pass atleast 120pts 155pts is expert

Figure C3-7

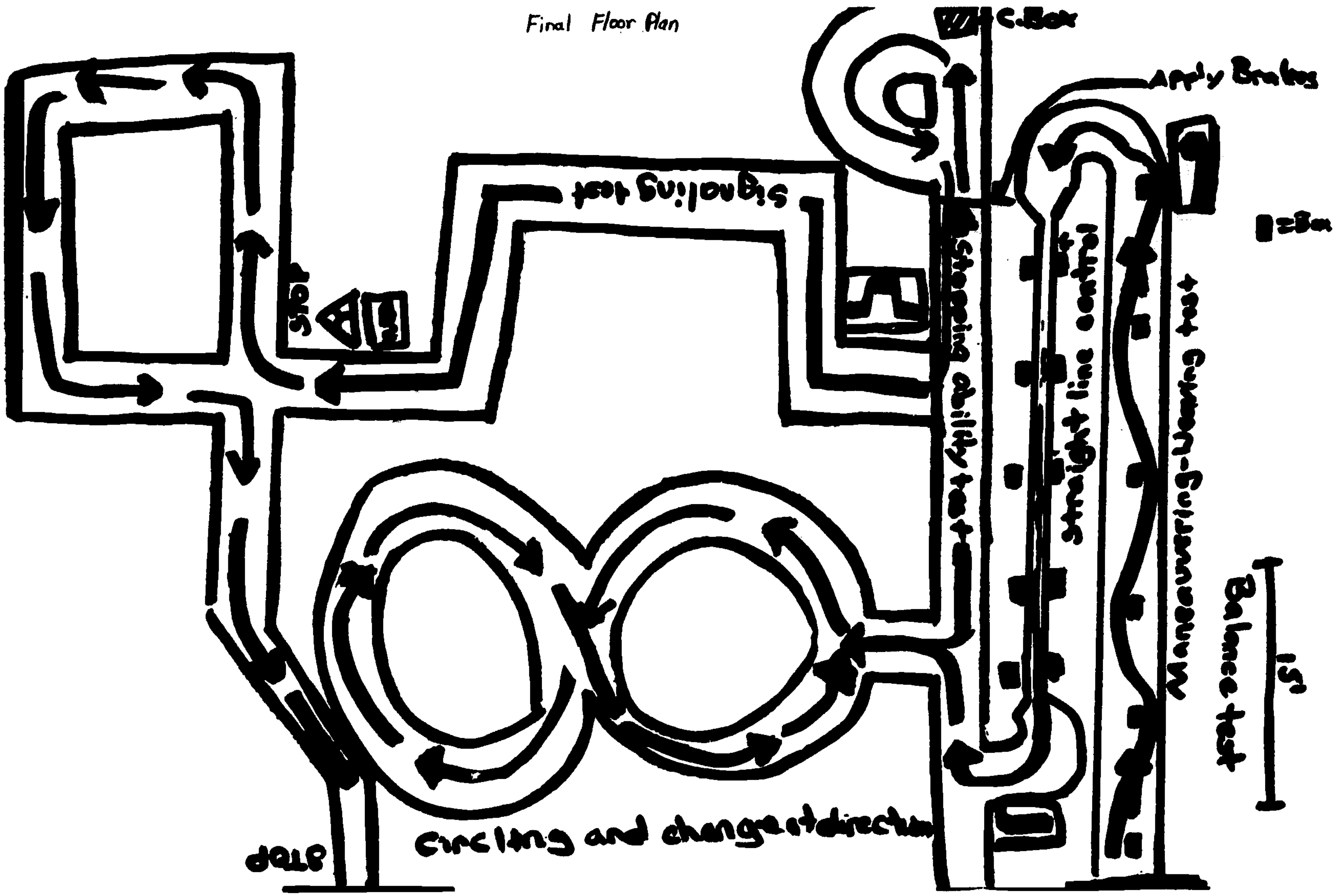

Final Floor Plan
C.Box
Apply Brakes
=Box
signaling test
steering ability test
straight line control
Balance test
15'
circling and change of direction
Stop

Figure C3-6

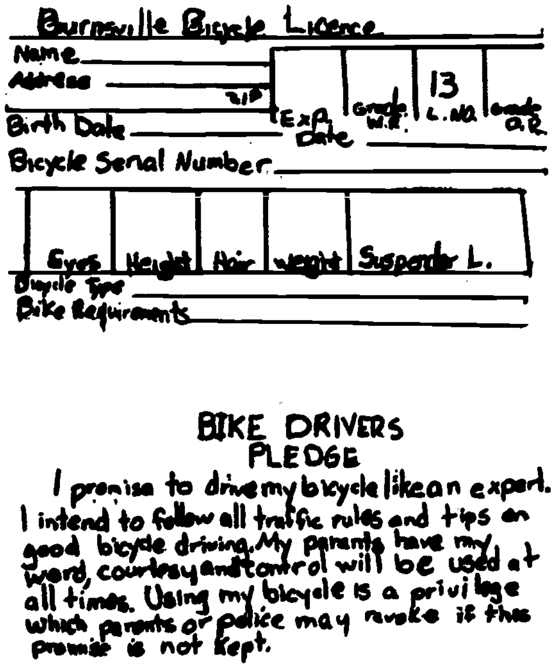


Figure C3-8

Bike Licenses Group

After looking at my driver's license, the group decided to put the following information on the bike licenses:

Name	Color of Hair
Date of Birth	Color of Eyes
Address	License Number
Height	Expiration Date
Weight	Safety Check Date

On the back of the license the group put a Bike Rider's Pledge that someone had found in one of the bike pamphlets.

In order to fit all the above information on the license, the group saw that it could not be wallet size. They designed a larger size, figuring that the kids could always fold it to put it in their wallet or pocket.

The licenses were produced in an assembly line manner because the group realized that their tiny printing was too small for the ditto machine to pick up if they printed on a ditto master. One member outlined the license while another cut it out. Two people printed on the front and back. Later the Registration Group members helped out. Figure C3-8 shows the bike license.

Road Signs Group

The group used various references from the library and bike pamphlets to determine traffic sign shape and color. Each group member then chose two signs for which he or she would be responsible. Sketches of the signs were made first on paper. Because we could not find any sheets of cardboard, the group used the sides of boxes obtained from the maintenance room. Sign size was determined by the size of the side of the cardboard box. Once the sign had been sketched and cut out, it was painted.

Cardboard Car Group

The purpose of the cardboard car was to show a rider the danger of disobeying a traffic sign. If a rider did not obey a particular Stop sign (the Road Design Group made sure a Stop sign was placed near a door so that the cardboard car could be hidden), the cardboard car would come out suddenly.

The boys designing the car immediately agreed to make a Rolls-Royce. While one boy sketched designs on paper, the other boy made a list of needed materials. Figure C3-9 shows the list and one car design. The boys picked the design that would be the easiest to cut out on cardboard. Again, because there were no sheets of cardboard available, Cardboard Car Group [illegible]

we decide that

members
1. Scott
2. Rich
3.
4.

our car is going to be a Rolls Royce (see picture) We decide that we will need these materials

1. a big sheet of cardboard
2. different colors of paint
3. Paint brushes
4. Cardboard clippers

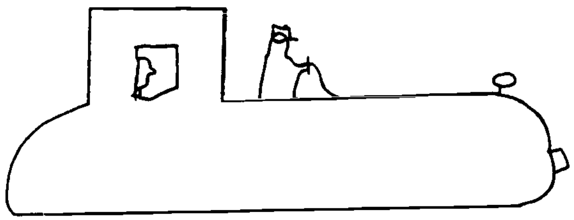


Figure C3-9

the boys had to use boxes and the car had to be pieced together.

Written Test

One boy found a bike safety quiz in one of the reference books on bikes. He typed it and showed it to the class. The class approved it and decided that clinic participants should take this written test before the road test.

A point system was devised by one boy. He decided that the younger students should have a separate scoring system. Two systems were then devised, one for eight-year olds and older and one for seven-year olds and younger. For the older students he assigned one point to each question that he felt was fairly easy and two points to the more difficult ones. The total number of points was twenty-one. For the younger students, more questions were judged to be difficult. The total number of points was twenty-six. Figures C3-10 and C3-11 show the written test and the scoring systems for each age category.

Floor Plan Model Group

Several girls thought it would be helpful for clinic participants to know what the riding test involved before taking it. They decided to make a model of the course. They measured the cafeteria perimeter, and then came to me for assistance in scaling the measurements down. I explained what a scale drawing was, and we did a few scale problems on the board. They then decided to use the scale of one inch represents one foot of the actual measurements.

While they waited for the maintenance man to bring some boxes, the group began to make the model traffic signs. Several members went to the Sign Group to find out what signs were being used on the course. The Sign Group sent them to the Road Plan Group. (The class was quickly learning how dependent groups were on each other, and to accomplish a goal successfully, we all had to work together.)

After finding out what signs to make and their shapes, they asked me how big to make them. I told them "to scale." The kids then returned to the Sign Group to find out how big they were going to make the signs for the course. Because the Sign Group had not really decided yet, the Model Group members sat right down with them and helped them to decide. They agreed on a height of five feet for sign height (including the post). The Model Group then figured that the model's signs had to be five inches high.

The cardboard (from boxes) for the model was painted white so that the lines outlining the various course tests

BICYCLE SAFETY TEST

1. A bicycle is considered a vehicle and should be ridden on the right hand side of the street. T F
2. Bike riders should try to crowd ahead between cars at a stop sign so they can be in front when the light changes. T F
3. Bicycle riders should observe and obey all traffic signs, stop signs and signals and other traffic control devices. T F
4. Pedestrians do not have the right of way on sidewalks or crosswalks. T F
5. The signal for a right turn is extending the right arm straight out. T F
6. Night riding without a white headlight and red tail light or reflector is unsafe. T F
7. Bicycle riders hitching a ride on another vehicle can easily have an accident. T F
8. It is safe and proper for a bike rider to carry a passenger. T F
9. A bike in poor mechanical condition is safe if the rider is skilled. T F
10. It is safe to ride bikes three abreast when riding in a group. T F
11. Avoid riding on or off curbs; every shock seriously affects your bikes
    a. beauty   b. operating ability   c. finish
12. Pay attention to any noises your bike makes while you are riding, they may mean
    a. your hearing is going bad   b. broken or worn parts   c. the road needs repair
13. Keep all moving parts thoroughly cleaned and properly
    a. lubricated   b. labeled   c. waxed
14. At least twice a year, your bicycle should be
    a. lubricated   b. stolen   c. waxed
15. The correct hand signal for a right turn is
    a. right arm straight out   b. left arm straight out   c. left arm up

Figure C3-10

Points for Written Test

Nov. 20

Mark Larson

Bycycles

	8 and up	7 and under
1	1 pt.	2 pts.
2	1 pt.	1 pt.
3	1 pt.	1 pt.
4	1 pt.	2 pts.
5	1 pts.	1 pt.
6	1 pt.	1 pt.
7	1 pt	2 pts.
8	2 pts.	2 pts.
9	2 pts.	2 pts.
10	2 pts.	2 pts.
11	2 pts.	2 pts.
12	1 pts.	2 pts.
13	1 pt.	2 pts.
14	2 pts.	2 pts.
15	2 pts.	2 pts
	21 pts	26 pts.

Figure C3-11

would show up clearly. When the paint had dried, the group obtained the road layout from the Road Design Group. Some of the Road Design Group members wanted to draw the plan, and the Model Group consented, reminding them to use their scale. One member of the Model Group noticed that the cafeteria lunch counter and milk table had been forgotten. She went to the cafeteria to measure these two fixtures to include in the model.

The nearly completed model was shown to the class. One student asked why the "Slippery When Wet" sign was included in the course plan, pointing out that water on the cafeteria floor could be pretty dangerous. The class agreed and this sign was removed from the model and the test course.

The class then proceeded to do some serious thinking about actually setting up the course in the cafeteria. To delineate the roads, they decided to use bright-colored tape, which would also readily distinguish the road lines from lines already on the cafeteria floor. Tape would also be used to make arrows, showing the cyclist the direction to go.

Because the traffic signs had no bases, the class debated the easiest and cheapest way to hold them up. The idea of making wooden bases was thrown out because there was no wood readily available. Buckets filled with sand were also seen as impractical because there weren't ten buckets handy. They finally decided to have children hold the signs. This plan would also allow for more students to participate in the clinic.

Critical points along the course were identified and checkers were posted. Small boxes were obtained for the steering test. (The rider steered around these boxes.) We agreed on a day to hold the clinic, choosing a day that kids would not mind staying after school to attend. As a lure, we offered as a prize for the person with the highest combined score on both the riding and written test a camera that I had received as a present but had never used.

Before the class broke into their groups to make final preparations, someone asked, "Whatever happened to the bike trails?" It was learned that the petitions had never been circulated and additional surveys were not returned. One girl felt that the class simply lost interest waiting for the petition to be retyped or more surveys to be returned. Another girl felt that transportation was to blame because students were unable to distribute the materials more widely without a car. In many cases students lived in the same neighborhood. Someone lamented that all their work was wasted. I asked them whether this was really the case, that in fact, they had learned quite a lot. The class agreed.

"Yeah, that it takes a lot of time and hard work to get a referendum passed and that a few people can really put a damper on the project."

"Also, that most people get real gung-ho on a cause but when it gets down to doing all the work that's involved, they soon lose interest."

"We also learned how to get something up for a vote and all the hard work it takes to get it passed."

The day of the clinic the class had to work really hard to get everything set up. They had not anticipated this amount of work at all! About thirty students of various ages showed up to take both tests. Groups of ten participants registered, took the written test and then the riding test.* The class was quite satisfied with the clinic.

*The students might analyze the results of the tests according to grade level. If children in certain grade levels score low on certain skills, the class might set up a program to help them learn those skills.--ED.

D. References

1. LIST OF "HOW TO" CARDS

Below are listed the current "How To" Card titles that students working on the Bicycle Transportation challenge might 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.

GEOMETRY

G 3 How to Make a Circle Which is a Certain Distance Around

GRAPHING

GR 1 How to Make a Bar Graph Picture of Your Data
GR 2 How to Show the Differences in Many Measurements or Counts of the Same Thing by Making a Histogram
GR 3 How to Make a Line Graph Picture of Your Data
GR 4 How to Decide Whether to Make a Bar Graph Picture or a Line Graph Picture of Your Data
GR 5 How to Find Out If There is Any Relationship Between Two Things by Making a Scatter Graph
GR 6 How to Make Predictions by Using a Scatter Graph
GR 7 How to Show Several Sets of Data on One Graph

MEASUREMENT

M 1 How to Use a Stopwatch
M 2 How to Measure Distances
M 3 How to Measure Large Distances by Using a Trundle Wheel
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 (Median)
PS 5 How to Find the Median of a Set of Data from a Histogram

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 in 1976:

How to Round Off Data
How to Compare Two Sets of Data by Making a Q-Q Graph
How to Design and Analyze a Survey
How to Choose a Sample
How to Compare Two Sets of Data by Using Interquartile Ranges
How to Map a Large Area
How to Design an Experiment
How to Make and Use a Cumulative Distribution Graph

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.

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 Bicycle Transportation. 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.

DESIGN PROBLEMS

DP17 *Bicycle Test Course* by Frank O'Brien

GROUP DYNAMICS

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

GRAPHING

GR 1 *Notes on the Use of Histograms for Pedestrian Crossings Problems* by Percy Pierre and Donald Coleman
GR 2 *Notes on Data Handling* by Percy Pierre
GR 3 *Using Graphs to Understand Data* by Earle Lomon
GR 4 *Representing Several Sets of Data on One Graph* by Betty Beck
GR 6 *Using Scatter Graphs to Spot Trends* by Earle Lomon
GR 7 *Data Gathering and Generating Graphs at the Same Time (or Stack 'Em and Graph 'Em at One Fell Swoop!)* by Edward Liddle.

MEASUREMENT

M 3 *Determining the Best Instrument to Use for a Certain Measurement* by USMES Staff
M 4 *Measuring the Speed of Cars* by Earle Lomon
M 5 *Electric Trundle Wheel* by Charles Donahoe

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 Method by Lorraine Denby and James Landwehr

PS 6 Examining One and Two Sets of Data Part II: A Graphical Method for Comparing Two Samples 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 books are general references that may be of some use during work on Bicycle Transportation. The teacher is advised to check directly with the publisher regarding current prices. A list of references on general mathematics and science topics can be found in the *USMES Guide*.

Resource Books for Teachers

Buck, Lindy, Hauser, Dorothy E., and Heldreth, Harold E. *All About Bikes*. Chicago, Illinois: National Safety Council (425 North Michigan Avenue, 60611), 1972.

A program that teaches basic knowledge about bicycle safety. Learning experiences (in the form of work sheets) are matched directly to the content outline. The program is for both beginning and advanced riders. The program consists of the Teaching Guide, fifty-eight visual aids in the form of printed originals that can be made into transparencies or mimeograph sheets, a case file of thirty-six bike incident case histories, and basic and advanced versions of individual student workbooks.

Coles, Clarence W. and Glenn, Harold T. *Glenn's Complete Bicycle Manual*. New York: Crown Publishers, Inc., 1973.

A thorough reference book on bicycle maintenance and repairs.

Cuthbertson, Thomas. *Anybody's Bike Book--An Original Manual of Bicycle Repairs*. Berkeley, California: Ten Speed Press, 1971. ($3.00 paperback)

A simplified bicycle repair book written in a very light and humorous way. The illustrations are also amusing.

Resource Books For Children

Fichter, George S. and Kingbay, Keith. *Bicycling*. New York: Western Publishing Company, Inc. (A Golden Handbook), 1972.

A readable reference book for children with many illustrations. Topics range from bike repairs and safety to bike clubs and events. Many color pictures.

4. GLOSSARY

The following definitions may be helpful to a teacher whose class is investigating a Bicycle Transportation 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.

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.

Brake Distance — The distance a vehicle (e.g., bicycle, car) travels from the time the brakes are applied to the time it stops.

Centripetal Force — An inward force on an object that causes it to move in a curved path. For example, the tendency for a bike to fall inward, going around a corner.

Comparative Shopping — A method for determining the best buy(s) by comparing the costs, quantities, and qualities of different brands of products. For example, comparing building materials for bike paths.

Congestion — A traffic flow problem that exists when the volume or density of traffic affects average speed to the point where normal traffic flow is reduced sharply.

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.

Cost The amount of money needed to produce or to purchase goods or services.

Data Any facts, quantitative information, or statistics.

Density See *Traffic*.

Distribution The spread of data over the range of possible results.

Event A happening; an occurrence; something that takes place. Example: one accident.

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.

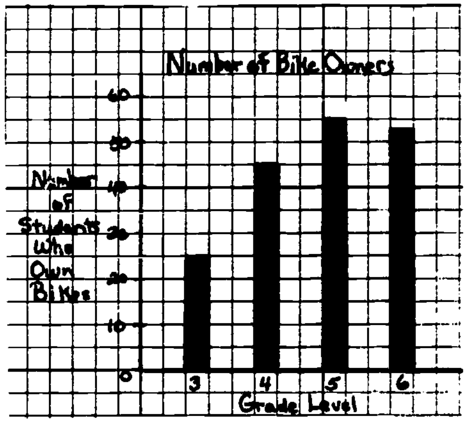
Friction, Sliding A force between two rubbing surfaces that opposes their relative motion.

Gap Time The time interval between successive arrival times of vehicles at an intersection.

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. Example: number of students in grades 3, 4, 5, 6 who own bikes.

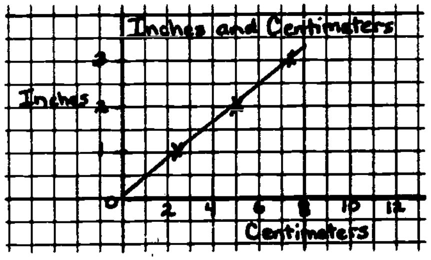
Grade Level	Number of Bike Owners
3	25
4	45
5	55
6	53



Conversion Graph

A line graph that is used to change one unit of measurement to another. For example, converting inches to centimeters.

Inches	Centimeters
1	2.54
2	5.08
3	7.62



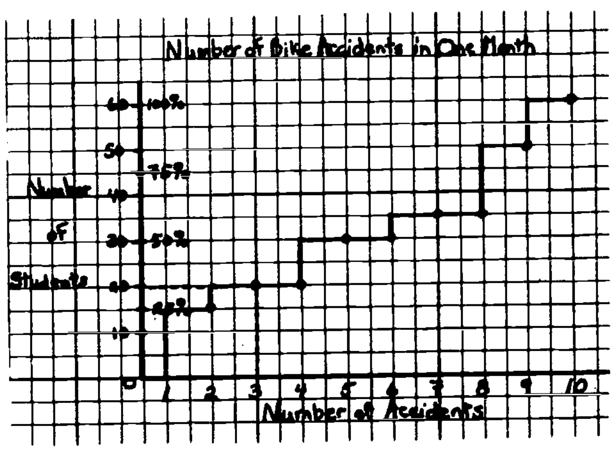
Cumulative Distribution Graph

A graph that can be constructed from a histogram by computing running totals from the histogram data. The first running total is the first value in the histogram data (see Table of Values). The second running total is the sum of the first and second values of the histogram, the third is the sum of the first, second, and third values, and so on. The horizontal scale on the graph is similar to that of the histogram; the vertical scale goes from 0 to the total number of events observed or samples taken (in the example, the total number of students who had three or fewer cycling accidents in one month).

Each vertical distance on the graph shows the running total of the number of samples taken that are less than or equal to the value shown on the horizontal scale; thus the graph below indicates that twenty students, or about 33%, had three or fewer accidents in one month.

Table of Values

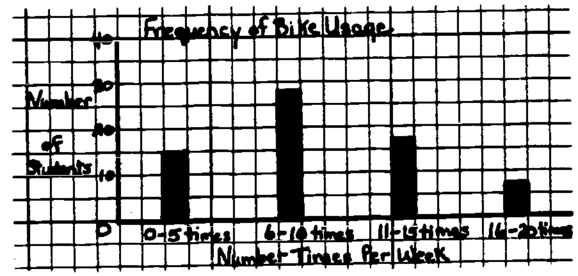
Number of Accidents	Running Totals
1 or fewer	0
2 "	15
3 "	20
4 "	20
5 "	30
6 "	30
7 "	35
8 "	35
9 "	50
10 "	60



Histogram

A type of bar graph that shows the distribution of the number of times that different measures or counts of the same event have occurred. A histogram always shows ordered numerical data on the horizontal axis. Example: the number of students who use their bikes certain numbers of times per week (0-5 times, 6-10 times, 11-15 times, 16-20 times).

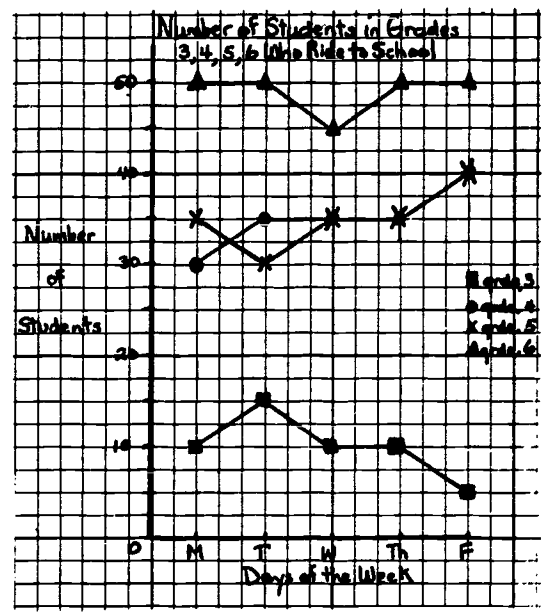
No. of Times per Week	No. of Students
0-5	15
6-10	28
11-15	17
16-20	7



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: number of students in grades 3, 4, 5, 6 who ride their bikes to school each day for one week.

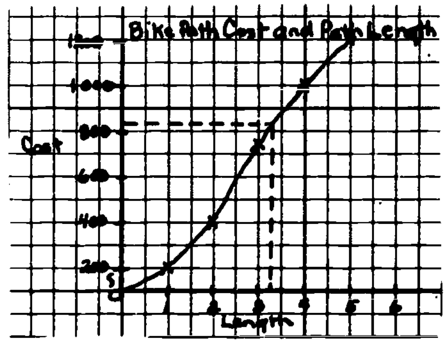
Grade Level	No. of Students M	T	W	Th	F
3	10	15	10	10	5
4	30	35	35	35	40
5	35	30	35	35	40
6	50	50	45	50	50



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*). Example: cost of a bike path vs. length of the path. This is a line graph since the cost of a particular path length can be found by looking at the graph, even though the length was not actually measured. (dotted line)

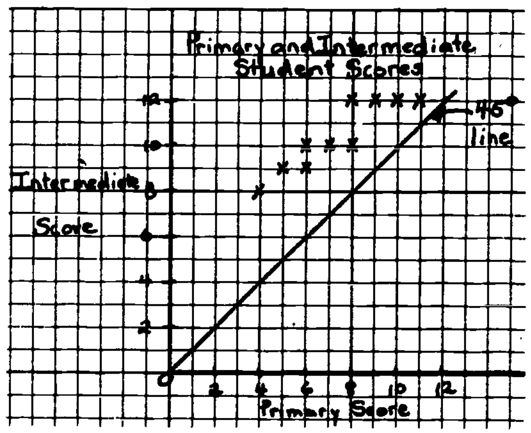
Path Length in miles	Path Cost in dollars
1	$200
2	$400
3	$750
4	$1000
5	$1200



Q-Q Graph

A graph that shows the comparison between the same type of data collected from two groups of people,...from two different situations. Example: comparing test scores for two groups of students, primary and intermediate students. The data for each set is ordered and the smallest measurement of one set plotted against the smallest of the other set, the second smallest against the second smallest, and so on. The scatter of points is compared to a reference line, a dashed 45^{o} line that represents data from two identical sets.

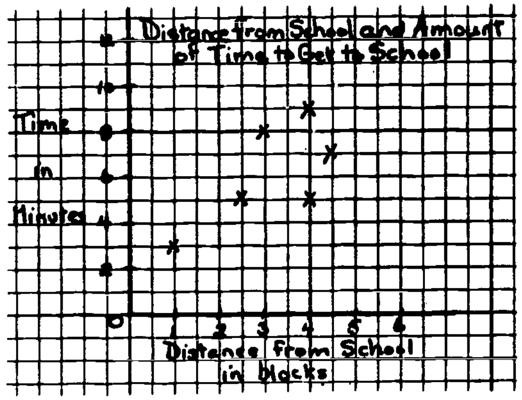
Primary Scores	Intermediate Scores
4	8
5	9
6	9
6	10
6	10
7	10
8	10
8	12
9	12
10	12
11	12
11	12



Scatter Graph

A graph showing a scatter of points, each of which represents two characteristics of the same thing. For example, in the graph below, each point represents one student: the position of the point indicates how far the student lives from school and the amount of time it takes him to get to school.

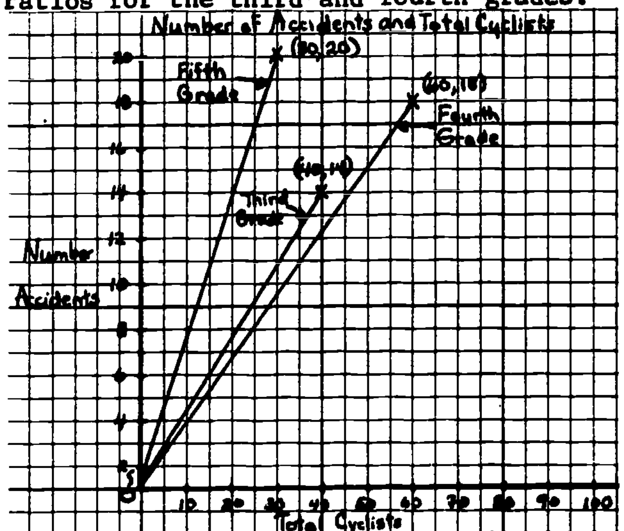
Distance From School	Time to Get to School
1	3
2½	5
3	8
4	5
4	9
4½	7



*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 several lines, different ratios can be compared; the steeper the line, the larger the ratio. For example, in the graph below showing the ratio of bike accidents to total bike riders, the ratio of accidents to total cyclists for the fifth grade is larger than the ratios for the third and fourth grades.

Grade	Total Cyclists	Number Accidents
3	40	14
4	60	18
5	30	20



*Formerly called Triangle Diagram

Histogram — See *Graph*.

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

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

Investment — The outlay of money for a future financial return.

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.

Mode — The element or elements in a set of data that occur most often.

Momentum — The momentum of an object in the direction of its motion is the product of its mass and speed in the direction of its motion.

Ordered Set — A set of data arranged from smallest to largest.

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.

Population — Any group of objects (e.g., people, animals, items) or events from which samples are taken for statistical measurement.

Probability — The likelihood or chance (expressed numerically) of one event occurring out of several possible events.

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.

Quartile	
First	The first quartile is the value of the quarter-way piece of data in an ordered set of data.
Third	The third quartile is the value of the three-quarter-way piece of data in an ordered set of data.
Interquartile Range	The range or length of the middle 50% of an ordered set of data; the difference between the first and third quartile.
Range	Mathematical: the difference between the smallest and the largest values in a set of data.
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 bike accidents to total number of bike riders might be $\frac{\text{10 accidents}}{\text{360 cyclists}}$ or 10 accidents:360 cyclists.
Retail Price	The price level of goods sold in small quantity to the consumer.
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 of the school district part of a city map and the whole city map).
Scale Drawing	A drawing whose dimensions are in direct proportion to the object drawn.
Scale Map	A map whose dimensions are in direct proportion to the dimensions of the area represented.
Scale Model	A three-dimensional representation constructed to scale.

*Slope Diagram**	See *Graph*.
Speed	A measure of how fast something is moving. The distance covered divided by the elapsed time.
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 record of the number of times one or more events occur. Example: tallying opinion survey data.
Traffic	The number of vehicles on a fixed length of roadway at a given instant.
Traffic Volume	The number of vehicles passing a fixed point on a roadway in a given period of time.
Travel Time	The time required by a vehicle to cover a given distance on a roadway.
Wholesale Price	The price level of goods sold in large quantity to a merchant for resale.
Work	Work is done when a force is exerted through a distance. Work is the product of the force exerted and the distance moved.

*Formerly called triangle diagram

E. Skills, Processes, and Areas of Study Utilized in Bicycle Transportation

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 Bicycle Transportation 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 Bicycle Transportation 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 Bicycle Transportation 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 conside. . 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 Bicycle Transportation. 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 Bicycle Transportation.

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

SCIENCE	Overall Rating
Processes	
Observing/Describing	1
Classifying	2
Identifying Variables	2
Defining Variables Operationally	2
Manipulating, Controlling Variables/ Experimenting	2
Designing and Constructing Measuring Devices and Equipment	1
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	1
Motion	1
Force	1
Mechanical Work and Energy	1
Solids, Liquids, and Gases	3
Electricity	-
Heat	-
Light	-
Sound	-
Animal and Plant Classification	-
Ecology/Environment	3
Nutrition/Growth	-
Genetics/Heredity/Propagation	-
Animal and Plant Behavior	-
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	2
Inferring/Predicting/Formulating, Testing Hypotheses	2
Collecting, Recording Data/Measuring	1
Organizing, Processing Data	1
Analyzing, Interpreting Data	1
Communicating, Displaying Data	1
Generalizing/Applying Process to Daily Life	2
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	2
Geography/Physical Environment	3
Political Science/Government Systems	1
Recent Local History	3
Social Psychology/Individual and Group Behavior	3
Sociology/Social Systems	2

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	3
Written Language	
Spelling	1
Grammar: Punctuation, Syntax, Usage	1
Composition	1
Study Skills	
Using References and Resources	1
Outlining/Organizing	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 BICYCLE TRANSPORTATION

Identifying and Defining Problems

- Students note that many bicycle accidents are due to students riding recklessly.
- Students observe that many bicycle accidents are caused by faulty bike parts, such as loose handlebars.
- See also SOCIAL SCIENCE list: *Identifying Problems, Variables.*

Deciding on Information and Investigations Needed

- Students decide that they need to investigate city and school rules on cycling and give a written test on rules to students.
- Students decide that they need to set up a bicycle riding course to test the riding ability of students.
- Students decide that they need to investigate how to repair and maintain different kinds of bikes.

Determining What Needs to Be Done First, Setting Priorities

- Students working on the written bike test decide first to investigate city and school rules on cycling before designing the test.
- Students working on the riding test decide first to draw the course before setting it up outside.

Deciding on Best Ways to Obtain Information Needed

- Students decide that the local bike store is the best place to obtain needed information on bike repairs.
- Students decide that riding through the course is the best way to determine suitable distances for each riding skill test.

Working Cooperatively in Groups on Tasks

- Students work in groups to design a written test, a riding test, and a maintenance program.

Making Decisions as Needed

- Students decide what bike riding skills should be tested on the riding course.
- Students decide how to administer the riding and written tests.
- Students decide how to schedule students taking the two tests.

Utilizing and Appreciating Basic Skills and Processes	• Students measure the total area available to them to set up the bike riding course. • Students use the stopwatch to determine total riding time through the course. • Students recognize that a bike safety program benefits cyclists. • Students prepare advertisements to remind students about the bike tests. • See also MATHEMATICS, SCIENCE, SOCIAL SCIENCE, and LANGUAGE ARTS lists.
Carrying Out Data Collection Procedures--Opinion Surveying, Researching, Measuring, Classifying, Experimenting, Constructing	• Students conduct an opinion survey to determine cycling popularity, frequency and severity of bike accidents, etc. • Students investigate the city and school rules on cycling. • Students use reference books or local bicycle businessmen to investigate types of bikes available and ways to repair and maintain these bikes. • Students experiment with different ways to test various cycling skills. • Students construct items such as pylons and signs for the riding course. • 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	• Students question whether bicycle safety is a concern to students in the school and infer from the opinion survey results that it is. • Students wonder how many students can ride bicycles safely. They infer from the riding test that quite a few children do not use proper signals when riding. • Students wonder whether taking the tests will improve bicycle riding ability. They infer from improved scores on second tests that ability has improved. • 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 the local bike shop is a good source for information on ways to maintain and repair different kinds of bikes. • Students decide that passing a riding test is a factual indication of a student's ability to ride a bicycle while his/her opinion is not.
Evaluating Procedures Used for Data Collection and Analysis, Detecting Flaws in Process or Errors in Data	• Students evaluate the written and riding tests to determine whether they test what they want them to test, whether they are fair. • Students compare measurements taken with different measuring instruments. • See also MATHEMATICS list: *Estimating/Approximating/ Rounding Off.*
Organizing and Processing Data	• Students record test data on a chart. • Students arrange the test results by grade level. • See also MATHEMATICS list: *Organizing Data.* • See also SCIENCE and SOCIAL SCIENCE lists: *Organizing, Processing Data.*
Analyzing and Interpreting Data	• Students calculate average score on each test for each grade level. • Students interpret the graphs they make. • Students determine the percentage of students who passed the written test, who passed the riding test. • See also MATHEMATICS list: *Comparing; Statistical Analysis; Opinion Surveys/Sampling Techniques; Maximum and Minimum Values; Graphing.* • See also SCIENCE and SOCIAL SCIENCE lists: *Analyzing, Interpreting Data.*
Predicting, Formulating Hypotheses, Suggesting Possible Solutions Based on Data Collected.	• Students hypothesize that a written test, a riding test, and a bike inspection will reduce bike accidents among students in the school. • 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 decide that conducting written tests and bicycle riding tests is possible after school and on Saturdays.
- Students decide that taking part in the bike tests will help students improve their bike knowledge and skills.

Trying Out Various Solutions and Evaluating the Results, Testing Hypotheses

- Students observe bike riders to see whether they use proper hand signals, obey riding rules, etc.
- Students conduct a second series of tests to see whether knowledge of rules and ability to ride safely was improved by their program.
- Students conduct an opinion survey to determine opinions on the bike safety program.
- 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 draw bar graphs to show average scores of students on the tests according to grade level.
- Students draw a line chart to show improvement in tests.
- Students diagram the bike riding course to help explain the riding skills involved.
- 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 administer the written and riding bike tests and the bike inspection.

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

- Students recognize that bike safety also depends on car traffic, that some streets are always safer than others for cyclists and pedestrians.
- Students apply skills acquired in giving tests and conducting surveys to similar activities in other USMES units.
- Students apply process of solving real problems to personal and community problems.
- See also SCIENCE list: *Generalizing/Applying Process to New Problems.*
- See also SOCIAL SCIENCE list: *Generalizing/Applying Process to Daily Life.*

ACTIVITIES IN BICYCLE TRANSPORTATION UTILIZING MATHEMATICS

Basic Skills

Classifying/Categorizing	• Categorizing opinion survey responses according to problems stated. • Classifying bikes according to number of gears (one-speed, three-speed, ten-speed). • See also SCIENCE list: *Classifying.* • See also SOCIAL SCIENCE list: *Observing/Describing/Classifying.*
Counting	• Counting hand votes to determine priorities of tasks. • Counting the number of students who wish to work on various tasks. • Counting opinion survey data on cycling problems. • Counting cars, traffic signs, potential hazards on streets. • Counting to read scales on measuring instruments, such as tape measure or trundle wheel. • 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, e.g., total length of proposed bike route. • Adding one- or two-digit whole numbers to find total test score. • Adding one- or two-digit whole numbers to find total number of students who want to participate in the bike safety program. • Adding one- or two-digit whole numbers to find total number of minutes and seconds it takes cyclists to ride through the course. • Subtracting one-, two-, or three-digit whole numbers to reduce total length of proposed bike route. • Subtracting one- or two-digit whole numbers to find ranges of results for bike tests. • Subtracting one- or two-digit whole numbers to determine the amount an individual's test score deviated from the class mean score.

Computation Using Operations:
Multiplication/Division

- Multiplying or dividing one-, two-, or three-digit whole numbers to convert from one unit of measure to another, such as meters to centimeters, inches to centimeters, and vice versa.
- Multiplying one-, or two-digit whole numbers to increase measurements for a scale map of the school district.
- Dividing one- or two-digit whole numbers to determine mean test score for each grade level.
- Dividing one-, two-, or three-digit whole numbers to determine percentage of students in the school who are concerned about specific cycling problems.
- Dividing by one-digit whole number to determine the number of tasks to be done by each group in order to meet the date set for the bike tests.
- Dividing one- or two-digit whole numbers to find unit cost (per mile) of proposed bike route.

Computation Using Operations:
Fractions/Ratios/Percentages

- Using mixed numbers in adding, subtracting, multiplying, or dividing measurements, bike path measurements, riding course measurements.
- Changing fractions to higher or lower terms (equivalent fractions) to add, subtract, multiply, or divide measurements.
- Using fractions and ratios to convert from one unit of measure to another, e.g., centimeters to meters and vice versa.
- Using a ratio to increase to scale the school district part of a city map; using a ratio to decrease traffic sign measurements for a scale model; calculating actual measurements from the scaled map, e.g., calculating total length of proposed bike path.
- Using a slope diagram to compare ratios, e.g., total number of accidents in one year to total number of bike riders.
- Calculating percentage of students who are concerned with different cycling problems, who own different speed bikes, who ride their bikes to school, etc.

Computation Using Operations:
Business and Consumer Mathematics/
Money and Finance

- Adding and subtracting dollars and cents to perform cost analysis on proposed bike paths.
- Multiplying and dividing to find total cost or cost per unit length of a bike path.

Business and Consumer Mathematics/ Money and Finance (cont.)	• Gaining experience with finance: sources, uses, and limitations of revenues for city recreational facilities. • Comparing prices of building materials, including this information in the cost analysis of the bike path(s).
Measuring	• Using standard units (centimeters, meters) of measure to measure bike routes, distances on the riding course. • Converting from one unit of measure to another, e.g., meters to centimeters, vice versa. • 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. • Comparing routes (distances, streets taken) students use to ride to school and to other areas in the school district. • Comparing riding routes with walking routes, comparing distances and timings. • Comparing streets and areas in the school district in terms of safety, e.g., comparing numbers of cars to determine busy streets, also numbers of traffic lights, stop signs, etc. • Comparing riding and written test scores and riding times through the course among the grades. • Comparing areas in the school yard for a bike rack. • Comparing measurements taken on the riding course using different measuring instruments. • Comparing opinion survey responses using a bar graph. • Comparing fractions and ratios using a slope diagram. • See also SCIENCE and SOCIAL SCIENCE lists: *Analyzing, Interpreting Data*.
Estimating/Approximating/Rounding Off	• Estimating the number of students who will participate in the bike safety program, who will bring their bikes to be registered, etc. • Estimating the cycling needs of the community, e.g., how often people cycle now and how often they would if new routes were established or paths constructed. • Estimating total length, cost, and surface area of proposed paths.

Estimating/Approximating/Rounding Off (cont.)

- Estimating the amount of time to do various tasks in order to set a date for the tests.
- Approximating the amount of space required for a certain number of parked bikes.
- Estimating where to place posters and sign-up sheets on the school corridors.
- Approximating when constructing materials for the course in the Design Lab, e.g., pylons.
- Determining when a measurement is likely to be accurate enough for a particular purpose.
- Rounding off measurements while measuring the riding course, bicycle routes, or materials for the course (e.g., pylons, signs).

Organizing Data

- Tallying opinion survey data, e.g., number of students who view various cycling problems as urgent.
- Ordering real numbers on a graph axis.
- See also SCIENCE and SOCIAL SCIENCE lists: *Organizing, Processing Data.*

Statistical Analysis

- Interpreting graphs, e.g., bar graphs, histograms, scatter graphs, and charts on city bike accident statistics.
- Finding and comparing means, e.g., mean test scores among the different grades.
- Determining how much an individual's score or riding time deviates from the mean score or mean time.
- Comparing scores on tests for two groups, boys and girls or primary and intermediate grades, by making a q-q graph.
- Assessing predictability of a larger sample (grades three through six) based on opinion survey results of a smaller sample (five students from each class in grades three through six).
- See also SCIENCE and SOCIAL SCIENCE lists: *Analyzing, Interpreting Data.*

Opinion Surveys/Sampling Techniques

- Conducting opinion surveys to determine cycling popularity; defining data collection methods, makeup and size of sample.
- Devising methods of obtaining quantitative information about subjective opinions, e.g., calculating a preference rating for each bike problem listed on the survey.

Opinion Surveys/Sampling Techniques (cont.)	• Evaluating survey methods, data obtained, size and makeup of sample. • See also SCIENCE and SOCIAL SCIENCE lists: *Analyzing, Interpreting Data*.

Graphing	• Using alternative methods of displaying data, e.g., scaled map to show proposed routes.
	• Using graphs to display data. Making the graph form--dividing axes into parts, deciding on an appropriate scale.
	• Representing data on graphs.
	  • Bar graph--number of students in grades three through six who own bikes.
	  • Line chart--number of students in each grade (three through six) who ride their bikes to school each day for one month.
	  • Line graph--cost of bike path vs. length of path.
	  • Histogram--Student times on the riding test.
	  • Cumulative distribution graph--number of students who had a certain number of accidents or fewer in one month.
	  • Conversion graph--converting inches to centimeters.
	  • Q-Q graph--scores on a test for primary grades vs. intermediate grades.
	  • Scatter graph--time to get to school vs. distance from school.
	  • Slope diagram--number of bike accidents occurring in the city per year vs. total number of bike riders each year.
	• Obtaining information from graphs.
	• See also SCIENCE and SOCIAL SCIENCE lists: *Communicating, Displaying Data*.

Spatial Visualization/Geometry	• Drawing and building materials for the riding course, e.g., pylons, traffic signs; using rulers and compasses. • Using standard mensurational formulas when calculating areas required for each riding skills test, calculating total area of course, calculating total surface area of proposed paths. • Comparing different areas in the schoolyard for a bike rack.

Areas of Study

Numeration Systems	• Using the metric system (decimal system) when measuring and when calculating cost of building materials for the proposed bike paths. • Using the English system (other bases, such as fractions) when measuring. • See *Computation Using Operations: Fractions/Ratios/Percentages*.
Number Systems and Properties	• See *Computation Using Operations: Adding/Subtracting; Multiplication/Division; Fractions/Ratios/Percentages*.
Denominate Numbers/Dimensions	• See *Measuring*.
Scaling	• Making a scale map to record proposed routes. • Finding an appropriate scale (ratio) for the scale map.
Accuracy/Measurement Error/Estimation/Approximation	• See *Measuring* and *Estimating/Approximating/Rounding Off*.
Statistics/Random Processes/Probability	• See *Statistical Analysis*.
Graphing/Functions	• See *Graphing*.
Fraction/Ratio	• See *Computation Using Operations: Fractions/Ratios/Percentages*.
Maximum and Minimum Values	• Determining the shortest and safest bike route to school and to other places of interest. • Determining the shortest riding time through the test course.
Equivalence/Inequality/Equations	• See *Comparing* and *Computation Using Operations*.
Money/Finance	• See *Computation Using Operations: Business and Consumer Mathematics/Money and Finance*.

ACTIVITIES IN BICYCLE TRANSPORTATION UTILIZING SCIENCE

Process

Observing/Describing

- Observing cycling problems in the school district.
- Observing traffic in various areas of the school district, noting existing and potential hazards.
- Observing existing bike routes and paths in the city.
- Observing riders on bicycle test course.
- Observing and comparing bicycle types, ways to maintain and repair them.
- See also SOCIAL SCIENCE list: *Observing/Describing/ Classifying*.

Classifying

- Identifying safe and unsafe cyclists, safe and unsafe areas in the school district for cyclists.
- Identifying and classifying important cycling rules and riding skills that students should know.
- Classifying cycling problems, tasks that need to be done, etc.
- See also MATHEMATICS list: *Classifying/Categorizing*.
- See also SOCIAL SCIENCE list: *Observing/Describing/ Classifying*.

Identifying Variables

- Identifying variables that affect amount of time it takes students to cycle to school: routes that they take (number of times they must walk the bike), distance they live from school, time spent waiting at traffic lights, type of bike they own.
- Identifying variables that affect measurement, such as measuring instrument used.
- Identifying different bike styles (number of speeds, hand vs. foot brakes) as a variable that affects riding skill and test score on the riding test.
- Identifying length of test course as a variable that will affect time of rider through course.
- Identifying costs of building materials and labor as variables affecting cost analysis for each proposal for bike paths.
- See also SOCIAL SCIENCE list: *Identifying Problems, Variables*.

Defining Variables Operationally	• Defining time to ride to school as time measured by a stopwatch, beginning when the cyclist leaves his driveway and ending when cyclist arrives at school. • Defining time through test course as time measured by a stopwatch for a rider to ride completely through the course. • Defining a passing score for both riding and written tests, e.g., 85% correct. • Defining a safe street as one that has fewer than a certain number of hazards and fewer than a certain number of cars passing through. • Defining a good main bike route as one that accommodates 75% of the cyclists in that area. • Defining a safe bike as one that passes all criteria on the inspection list. • Defining a safe cyclist as one who observes traffic rules, uses hand signals and maintains his/her bike in good order.
Manipulating, Controlling Variables/Experimenting	• Conducting trial runs on getting from one place in the neighborhood to school, timing each run, noting hazards, traffic, etc. • Making certain that students use bicycles similar to their own in taking riding test. • Making certain that the bicycle test course is laid out exactly the same way each time. • See also SOCIAL SCIENCE list: *Manipulating, Controlling Variables/Experimenting*.
Designing and Constructing Measuring Devices and Equipment	• Designing and constructing materials for the riding course: traffic signs, pylons, ramps. • Constructing trundle wheels to use in measuring bicycle routes.
Inferring/Predicting/Formulating, Testing Hypotheses/Modeling	• Inferring from improved scores on second tests that students' riding abilities have improved. • Predicting number of children who will pass written test. • Hypothesizing that certain streets in the area would be more hazardous during certain times of the day (when a factory shift gets out) and certain days of the week (weekends, especially near shopping center). Comparing accidents that happen and time spent waiting to cross streets at these times with those at other times.

Inferring/Predicting/Formulating, Testing Hypotheses/Modeling (cont.)	• Using the scaled map of the school district to identify safe bike routes. • Conducting trials of the riding skills tests to determine the best ways to test skills, to determine appropriate times for tests, to determine difficulty of tests. • See also SOCIAL SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses.*
Measuring/Collecting, Recording Data	• Using standard units (centimeters, meters) of measure to measure distances on the course and bike routes in the neighborhood. • Using different measuring instruments to gather distance measurements, e.g., trundle wheel, meter stick, tape measure. • Using the stopwatch to time cyclist riding through the bike course, to compare different bike routes, to compare walking time with riding time. • Reading measuring instruments accurately. • Recording measurements in an organized manner. • Tallying cars on various streets, tallying number of existing and potential hazards along routes. • Collecting information on bicycle repairs: needed tools and mechanics of repairing. • See also MATHEMATICS list: *Measuring.* • See also SOCIAL SCIENCE list: *Collecting, Recording Data/Measuring.*
Organizing, Processing Data	• Ordering tasks that need to be done in terms of priority. • Ordering streets in terms of some criterion: safest, most frequently used. • Ordering walking or riding times from shortest to longest, e.g., to compare several routes from one area to the school. • Listing building materials for bike riding course in order of some criterion, e.g., easiest to work with, most durable, etc. • See also MATHEMATICS list: *Organizing Data.* • See also SOCIAL SCIENCE list: *Organizing, Processing Data.*
Analyzing, Interpreting Data	• Comparing various bike routes in terms of safety (number of cars, number of existing and potential hazards) and convenience (timings for each route).

Analyzing, Interpreting Data (cont.)

- Analyzing the bike riding course timings, computing the mean time for each grade level.
- Analyzing city statistics on bike accident frequency.
- See also MATHEMATICS list: *Comparing; Statistical Analysis; Opinion Surveys/Sampling Techniques; Graphing; Maximum and Minimum Values.*
- See also SOCIAL SCIENCE list: *Analyzing, Interpreting Data.*

Communicating, Displaying Data

- Reporting data to the class using graphs, charts, maps.
- Showing proposed routes on a map.
- See also MATHEMATICS list: *Graphing*
- See also SOCIAL SCIENCE list: *Communicating, Displaying Data.*
- See also LANGUAGE ARTS list.

Generalizing/Applying Process to New Problems

- Applying scientific inquiry process (e.g., identifying a problem, identifying important aspects of the problem, etc.) to tackle other real problems and other USMES challenges, such as Pedestrian Crossings, Traffic Flow, Protecting Property.
- See also SOCIAL SCIENCE list: *Generalizing/Applying Process to Daily Life.*

Areas of Study

Measurement

- Understanding the concept of a unit of measure.
- Using standard units of measure, e.g., meters, centimeters.
- Choosing the best instrument to measure distances, e.g., using the trundle wheel for large distances, using a tape measure for small distances.
- Timing, using the stopwatch; noting the difference between seconds and minutes.
- See also MATHEMATICS list: *Measuring.*

Motion

Speed/Velocity

- Observing the speed of cars and bikes.
- Observing that electrically-run machines (saber saws) are faster than hand machines.
- Observing the effects of ramps on speed.

Circular Motion	• Observing that the up and down leg motion of bike pedaling changes into the circular motion of the rear wheel which then changes into the forward motion of the bike. • Observing that the circular motion of car wheels changes into the forward motion of the car.
Acceleration	• Observing that bikes gradually gain speed as they start from a stop and slow down as they are stopped.
Force	• Observing that saber saws are faster and require less effort to operate than hand saws for cutting Tri-Wall or lumber and multiply the force that is exerted. • Observing that force must be exerted to hammer nails into wood, that the hammer multiplies the force they exert. • Observing that force is required to start or to stop a bike and that this force results in an acceleration. • Observing that the harder one pedals, the faster the bike goes.
Centripetal Force	• Observing that, when cycling around a corner, there is a tendency to fall outward and that one has to lean inward to balance the force. • Observing that the less curve there is in the bike path, the less tendency there is to tip over.
Momentum/Inertia	• Observing that objects at rest do not move until a force acts upon them. • Noting that bikes stay in motion at a constant speed unless an outside force acts upon them. • Observing that they can coast a greater distance if their initial speed is greater because of their greater momentum.
Friction	• Observing that bikes skid more easily on wet than dry spots, that grass and sand offer more resistance to riding than pavement.
Mechanical Work and Force	• Observing that work is involved when riding a bike, when hammering nails into wood.

Mechanical Work and Force (cont.)	• Observing that a bike is easy to pedal in low gear but that it doesn't go far in one turn of the pedals; that the bike is hard to pedal in high gear, but it goes much farther in one turn of the pedals. • Observing that stopping a bike's motion results in hot tires as mechanical energy is transformed into heat energy. • See also Motion and Force.
Solids, Liquids, and Gases	
States of Matter	• Observing that glue is available in liquid or solid form with different properties. • Observing that a solid stick of glue is turned into a hot liquid glue by using a hot glue gun.
Properties of Matter	• Noting the capabilities and limitations of using and working with various materials (lumber, Tri-Wall). • Observing that glues, lumber, paper, and other materials have particular odors.
Ecology/Environment	• Considering the environment when planning bike routes and paths, noting if trees will have to be cut down to make room for the path.
Anatomy/Physiology	• Noting the biological effects of cycling, e.g., uphill cycling tires one out quickly. • Noting that those who ride their bikes regularly don't tire as easily while riding.

ACTIVITIES IN BICYCLE TRANSPORTATION UTILIZING SOCIAL SCIENCE

Process

Observing/Describing/Classifying	• Observing and comparing student riding habits (frequency of bike use, observance of cycling rules) and accident rate and severity. • See also MATHEMATICS list: *Classifying/Categorizing.* • See also SCIENCE list: *Observing/Describing; Classifying.*
Identifying Problems, Variables	• Identifying the lack of safe bike routes and paths in the school district. • Identifying the problem of unsafe bikes and unsafe riding habits. • Identifying age and experience as variables affecting riding test scores. • Identifying cost and need as variables affecting acceptance of a bike path proposal. • Identifying differences in opinion on which bike route is the best, the shortest, or the safest. • See also SCIENCE list: *Identifying Variables.*
Manipulating, Controlling Variables/Experimenting	• Recording age and experience as part of riding test. • Designing a written test to test a person's knowledge of important cycling rules. • See also SCIENCE list: *Manipulating, Controlling Variables/Experimenting.*
Inferring/Predicting/Formulating, Testing Hypotheses	• Inferring from opinion survey results which cycling problems are most urgent, that most students are interested in cycling, etc. • Predicting that more students would cycle if there were safe paths or routes available throughout the school district. • Hypothesizing that a bike safety program (written test on rules, riding test, and bike inspection) would make students more aware of cycling safety and reduce accidents. • See also SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses.*

Collecting, Recording Data/Measuring	• Conducting an opinion survey on cycling problems. • Investigating cost and need for different bike paths. • See also MATHEMATICS list: *Counting; Measuring.* • See also SCIENCE list: *Measuring/Collecting, Recording Data.*
Organizing, Processing Data	• Ordering survey data results, e.g., ordering student opinion on cycling problems from most to least urgent, ordering bike types from most to least popular. • See also MATHEMATICS list: *Organizing Data.* • See also SCIENCE list: *Organizing, Processing Data.*
Analyzing, Interpreting Data	• Evaluating opinion survey results, comparing student preference for bike types, etc. • Analyzing test score data according to age and experience of students. • See also MATHEMATICS list: *Comparing; Statistical Analysis; Opinion Surveys/Sampling Techniques; Graphing; Maximum and Minimum Values.* • See also SCIENCE list: *Analyzing, Interpreting Data.*
Communicating, Displaying Data	• Reporting group activities to the class, showing work done. • Representing survey data on preferences on graphs. • See also MATHEMATICS list: *Graphing.* • See also SCIENCE list: *Communicating, Displaying Data.* • See also LANGUAGE ARTS list.
Generalizing/Applying Process to Daily Life	• Using one's knowledge of opinion surveys on other surveys. • Applying one's knowledge of cycling safety to one's own bike riding. • Applying one's knowledge about cycling safety to other problems concerning safety in the school area, other USMES challenges such as Pedestrian Crossings and Traffic Flow. • See also SCIENCE list: *Generalizing/Applying Process to New Problems.*

Attitudes/Values

Accepting Responsibility for Actions and Results	• Working in small groups to perform tasks, making sure tasks get done. • Arranging schedules with other classes for convenient times for opinion surveys. • Being responsible for class trips (e.g., bike shop, areas in the school district): writing a list of questions and needed materials, arranging convenient times for both teachers and students, obtaining the necessary permissions, etc. • Scheduling and giving a presentation to school or city officials.
Developing Interest and Involvement in Human Affairs	• Seeking ways to make cycling more convenient (bike routes and paths) and safer (bike safety program) for students in the school.
Recognizing the Importance of Individual and Group Contributions to Society	• Recognizing that their proposed bike routes or paths will make their community a better and more enjoyable place to live and will be useful to many others. • Recognizing that their bike safety program will help prevent injuries due to bike accidents.
Developing Inquisitiveness, Self-Reliance, and Initiative	• Conducting group sessions with some teacher assistance. • Learning to use different ways of obtaining needed information, e.g., letter writing, opinion surveys, telephoning. • Increasing their knowledge of possible resource places, e.g., library, retail stores. • Resolving procedural problems that may arise during the course of activities. • Choosing and designing the best way of presenting their proposed paths to city authorities.
Recognizing the Values of Cooperation, Group Work, and Division of Labor	• Recognizing the efficiency that small group work provides. • Finding that work proceeds smoothly when everyone cooperates.
Understanding Modes of Inquiry Used in the Sciences, Appreciating Their Power and Precision	• Identifying and defining the problem; being able to distinguish it from related but secondary problems.

Understanding Modes of Inquiry Used in the Sciences, Appreciating Their Power and Precision (cont.)	• Identifying important aspects of the problem and setting priorities. • Using data and graphs to support their proposal for bike paths in a certain area of the school district. • See also MATHEMATICS and SCIENCE lists.
Respecting the Views, Thoughts, and Feelings of Others	• Considering all suggestions and ideas and assessing their merit. • Recognizing differences in values according to age, experience, occupation, income, interests, culture, race, religion, ethnic background. • Considering the opinions of others; conducting opinion surveys to determine urgency of particular cycling problems.
Being Open to New Ideas and Information	• Considering suggestions and ideas from all students, considering other ways of doing various tasks. • Recognizing the importance of information obtained from different sources, e.g., library, retail stores, city planners, neighbors, etc.
Learning the Importance and Influence of Values in Decision Making	• Recognizing that people's values and feelings are equal to or more important than cost considerations when proposing change. • Recognizing that opinion differences reflect value differences. • Recognizing that motorists and cyclists have different values that affect their preferences for certain physical aspects of the road, e.g., road width; that both values must be considered in any solution.

Areas of Study

Economics	• Using economic terms and concepts, e.g., cost, retail and wholesale price when considering bike paths. • Investigating the economics (cost analysis) of several proposed bike paths. • Gaining experience with finance: sources, uses, and limitations of revenues for the purchase of materials. • Gaining experience in comparative shopping for materials.

Geography/Physical Environment	• Assessing different areas in the school district in terms of traffic, bike path feasibility, etc. • Making and using a map of the school district to plan safe bike routes.
Political Science/Government Systems	• Investigating systems of administration and control in the school and city; deciphering role of governing body over the body that is governed. • Finding appropriate city agency to petition for bike paths. • Contacting school authorities to obtain permission to carry out a campaign for bicycle paths in the community.
Recent Local History	• Investigating previous attempts to establish bike paths.
Social Psychology/Individual and Group Behavior	• Recognizing and using different ways of approaching different groups, e.g., teachers, school officials, city planners, retail store business people. • Analyzing the effects of the class's decision and actions on bike paths on a larger group (the community). • Recognizing the need for leadership within small and large groups; recognizing differing capacities of individuals for various roles within groups.
Sociology/Social Systems	• Considering the community as a whole (physical environment as well as people living in it) as an important factor in proposing change (bike routes and paths); considering problems that may arise due to the proposed change. • Working within established social systems to promote change, e.g., school, community, city. • Recognizing different social systems in different social groups, e.g., students, adults, men, women. • Recognizing that there are many different social groups and that one person belongs to more than one social group. • Devising a system of working cooperatively in small and large groups.

ACTIVITIES IN BICYCLE TRANSPORTATION UTILIZING LANGUAGE ARTS

Basic Skills

Reading: Literal Comprehension--Decoding Words, Sentences, and Paragraphs	• Decoding words, sentences, and paragraphs while reading cycling rules, drafts of letters and opinion surveys, the yellow pages of the telephone book, list of cycling rules, city reports, reference books on bikes, etc.
Reading: Critical Reading--Comprehending Meanings, Interpretation	• Reading and evaluating the city's statement on bike accidents. • Reading and interpreting cycling rules; comparing cycling rules with automobile rules. • Reading and evaluating drafts of letters, opinion surveys. • Reading and interpreting student statements that may have been written on the opinion survey. • Reading city planners' "assessment of community needs" report. • Reading references on bike repairs and maintenance.
Oral Language: Speaking	• Offering ideas, suggestions, and criticisms during class discussions. • Carrying on small group discussions. • Reporting to class on small group activities • Making arrangements with other teachers in the school to conduct opinion surveys in their class. • Using the telephone to obtain information. • Making a presentation to school or city officials. • Using rules of grammar in speaking.
Oral Language: Listening	• Listening to other students' ideas, suggestions, and criticisms during class discussions, while conducting a poll in other classes. • Listening to questions posed by the principal or city officials during the presentation. • Listening to resource people (e.g., policemen, retail store business persons), their suggestions, recommendations, and instructions.

Oral Language:
Memorizing

- Memorizing parts of a presentation.

Written Language:
Spelling

- Using correct spelling in writing, e.g., in writing letters, in labeling graphs, on signs for the riding course, etc.

Written Language:
Grammar--Punctuation, Syntax, Usage

- Using rules of grammar in writing.

Written Language:
Composition

- Writing to communicate effectively:
  - preparing written reports and letters using notes, data, graphs, etc.
  - preparing signs for the riding course.
  - writing down opinion surveys; devising questions to elicit the desired information; judging whether a question is relevant and whether its meaning is clear.

Study Skills:
Using References and Resources

- Using the local stores, police department, city hall, and their personnel as resources for ideas.
- Using the library to research information on bikes, bike paths, etc.
- Using various written resources, e.g., telephone book, bike repair manual; using book indexes and table of contents properly.
- Using the city map.
- Using the "How To" Cards on specific skills when needed.

Study Skills:
Outlining/Organizing

- Taking notes when visiting areas in the school district, when listening to ways to repair bikes, while on the telephone.
- Organizing data for inclusion in a letter or presentation.
- Planning and preparing letters, presentations.
- Making a list of tasks that need to be done; setting priorities to tasks.

Attitudes/Values

Appreciating the Value of Expressing Ideas Through Speaking and Writing	• Finding that a written letter or a phone conversation evokes a response from people, e.g., city officials, the principal. • Finding that a good presentation (oral or written) may produce the desired response from officials.
Appreciating the Value of Written Resources	• Finding that desired information can be found in written resources, e.g., repair manuals, telephone book, newspapers and magazines, reports, etc.
Developing an Interest in Reading and Writing	• Willingly looking up information on bikes, bike regulations, bike accidents, etc. • Seeking out newspaper and magazine articles on how other cities are planning bike paths or routes. • Maintaining a continued interest in bicycling, seeking out catalogs on bikes to note new bike gadgets, new bike styles, etc., reading with interest bike advertisements.
Making Judgments Concerning What is Read	• Deciding how reliable the city's statement on bike accidents is. • Evaluating drafts of letters, opinion surveys. • Evaluating city planners' "assessment of community's needs" report.
Appreciating the Value of Different Forms of Writing, Different Forms of Communication	• Finding that the telephone is a useful and efficient tool to obtain information from local businesses, the police department, etc. • Finding that letters are a good means of obtaining information from far away places, e.g., letters to other cities.