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ABSTRACT

This Unified Sciences and Mathematics for Elementary Schools (USMES) unit challenges students to improve the safety and convenience of a pedestrian crossing near a school. The challenge is general enough to apply to many problem-solving situations in mathematics, science, social science, and language arts at any elementary school level (grades 1-8). The Teacher Resource Book for the unit is divided into five sections. Section I describes the USMES approach to student-initiated investigations of real problems, including a discussion of the nature of USMES "challenges." Section II provides an overview of possible student activities with comments on prerequisite skills, instructional strategies, suggestions when using the unit with primary grades, a flow chart illustrating how investigations evolve from students' discussions of pedestrian crossing problems, and a hypothetical account of intermediate-level class activities. Section III provides documented events of actual class activities from grades 2, 4, 4/5, and 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 the activities. (JN)

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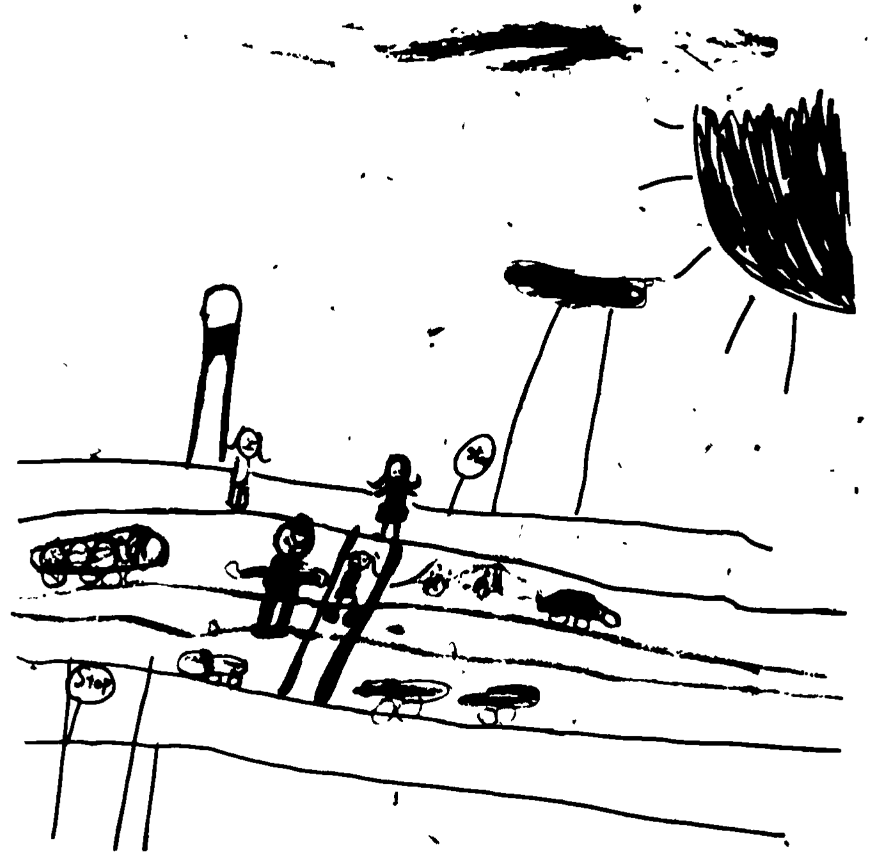
UNIFIED SCIENCES AND MATHEMATICS FOR ELEMENTARY SCHOOLS:
Mathematics and the Natural, Social, and Communications Sciences in Real Problem Solving



Pedestrian Crossings

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CHALLENGE: RECOMMEND AND TRY TO HAVE A CHANGE MADE THAT WILL IMPROVE THE SAFETY AND CONVENIENCE OF A PEDESTRIAN CROSSING NEAR YOUR SCHOOL.

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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.

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

Real Problem Solving

*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.**

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. <u>New Area of Learning</u>--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. <u>Group Work</u>--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. <u>Student Choice</u>--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 Pedestrian Crossings

1. OVERVIEW OF ACTIVITIES

Challenge:

Recommend and try to have a change made that will improve the safety and convenience of a pedestrian crossing near the school.

Children are aware from an early age that some pedestrian crossings are more dangerous than others. A child may be permitted to visit a friend only if he uses a specific, perhaps longer but "safer," route that avoids a particular intersection. Students going to and from school are urged to cross streets at locations where traffic police are on duty or where there are WALK lights.

The Pedestrian Crossings challenge might arise in a class in several ways. The challenge might be introduced through discussions of the safety of local pedestrian crossings or of problems children have getting to school in the morning. Other classes might become involved in the Pedestrian Crossings challenge while working towards the solution of another USMES unit, such as Traffic Flow or Getting There. For example, children gathering data on car speeds near an intersection might decide that the crossing is unsafe.

Initial class discussions will bring to light observations children have already made about crossing certain streets. If children have identified several intersections which they feel need improvement, they might design and conduct a survey of other children in the school to determine the most "dangerous" intersection or the intersection that is used most often. Before going out to collect data on the chosen intersection, the children discuss the kinds of information needed and divide into groups for making observations.

Motivated by their experiences and ideas for improvements, children observe traffic and pedestrian flow at designated intersections during different times of day. Collecting data at the intersections will enable children to assess the safety of the intersections and to make suggestions for improvements. The data collection scheme should be designated by the children with help as needed from the "How To" Cards. Classroom simulation of traffic and pedestrian flow is beneficial early in the unit as a means of testing data collection methods. It can also be used later in testing proposed improvements.

Data collected may include time intervals between cars arriving at an intersection and the time it takes students to cross the street. Histograms may be made of this data and children may determine how long they would have to wait in order to cross the street safely. If the crossing has a traffic signal, the students may time the signal to see if children can cross the street safely in the time the WALK light is on. Later, the data on car arrival times and student crossing times may be used to determine the correct timing of the light.

If fast-moving cars present a danger to pedestrians crossing the street, students may time cars passing between two points to determine their speed as they enter the intersection. Distance between the points may be measured with a trundle wheel constructed in the Design Lab or a string stretched between them. This data may be used to suggest changes in traffic regulations or to request installation of warning signs that would make an intersection safer for children.

Students may compare the data collected at a problem intersection with information gathered at a nearby "safe" crossing. They can then use the results to determine what safety features or traffic controls might be introduced to improve the hazardous crossing.

As the children collect their data, draw conclusions, and recommend certain improvements, they may see the need for more data or a different type of data such as sight distances and car braking distances. Other activities which the children may find helpful include the investigation of the cost of suggested improvements and the construction of model layouts and model traffic lights. In some classes the children might produce films for the safety education of children and motorists.

A single solution for the problem should not necessarily be sought, but each group of students should document as thoroughly as possible its suggested improvement. In most classes the unit culminates in some positive action. A written report to the proper authorities may help the children create awareness about a particular problem. In many cases, however, children may need to make formal presentations or hold informal meetings with officials in order to effect a proposed change.

Follow-up activities to the Pedestrian Crossings unit may lead students into the Traffic Flow challenge as they investigate solutions for improving flow of automobile traffic at a particular intersection. Campaigns to promote driver or pedestrian awareness in a city or locality may lead students into the Advertising challenge. Investigating costs of proposed changes may involve the class in a study of urban planning or economics.

Although many of these activities may require skills and concepts new to the children, there is no need for preliminary work on these skills and concepts because the children

2. CLASSROOM STRATEGY FOR PEDESTRIAN CROSSINGS

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 Pedestrian Crossings 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.

Each USMES unit revolves around a challenge--a statement that says, "Solve this problem." The success or failure of the unit 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 are likely to be disjointed and cursory.

The challenge as stated in the Pedestrian Crossings Resource Book is general enough to apply to many situations. Students in different classes define and reword the challenge to fit their particular situation and thus arrive at a specific class challenge. "Recommend and try to have a change made that will improve the safety and convenience of a pedestrian crossing near your school" has been restated by some classes in terms of specific intersections that have heavy or fast-moving traffic and are hazardous to pedestrians.

The Process of Introducing the Challenge

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

One technique is to turn a spontaneous discussion of a recent event relating to pedestrian safety or convenience toward the Pedestrian Crossings challenge. For example, the teacher might focus a discussion of an accident at a street crossing on the challenge by asking the children how the crossing might be made safer. A discussion of experiences with street crossings and traffic controls might be turned toward suggestions for improvements at specific intersections where children have long waits before crossing.

A fourth-grade class in Washington, D.C., held a discussion about pedestrian safety. Intersections near the school were discussed in terms of whether they were safe to cross or not. The children felt that two intersections in particular were hazardous to pedestrians: an uncontrolled intersection at the bottom of a hill and a controlled one which had a lot of traffic. The class visited the intersections and collected data to support their feelings that the intersections were unsafe.

Often work on one challenge leads to another. For example, students working on the Getting There challenge might become concerned with pedestrian safety at specific street corners while trying to overcome difficulties in getting from one place to another. This might lead to work on the Pedestrian Crossings challenge by either the whole class or a group within the class.

When a class works on two or more related USMES challenges at the same time, children divide into groups to conduct investigations on the various problems. However, there should be at least ten to twelve students working on any one challenge; otherwise, the children's work may be fragmented or superficial or may break down completely.

Sometimes the discussion of a broad problem may encompass the challenges of several related units. For example, a discussion of how they get to school can lead the students to the challenges for Bicycle Transportation, Pedestrian

Crossings, Traffic Flow, or Getting There as children 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 children 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 Pedestrian Crossings 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. This is particularly true if the teacher introduces a broad problem and does not encourage the children to delineate a specific challenge. Having no shared focus for their work, the children will lack the motivation inherent in working together to solve a real problem. As a result, they may quickly lose interest.

A fifth-grade teacher asked her class to discuss problems they experienced in getting to school safely. The children listed several problems, including dangerous intersections, absence of a bicycle pathway, and long and over-crowded bus rides. They divided into groups to work on the different problems. Within these groups, children collected data on crossing times and traffic flow, conducted surveys on crossing problems and problems riding school buses, constructed scale models of roadways, and worked on a slide-tape show for pedestrian education and a map of a bicycle pathway. However, since the problem was too broad and the groups were too small, the children's efforts tended to be fragmented. No significant changes resulted from their work.

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

In one fourth-grade class working on Pedestrian Crossings the teacher never presented a challenge to the children. The unit was started with a discussion of what a signal was and what different road signals meant. Other words related to the unit were defined, and the students were given a quiz on traffic signals. The class was then taken to an intersection and asked whether it was busy, controlled or uncontrolled, what types of signals were used, etc. They were then given stopwatches and asked to time children crossing the street. The children plotted graphs and were taught how to find averages. They then measured and calculated gap times. Some of these activities gained the interest of the students, but they were not initiating the activities themselves nor working towards any goal.

Initial Work on the Challenge

Once a class has decided to work on a Pedestrian Crossings challenge, the students list various aspects of the problem and possible approaches to solving it. This procedure is combined with or followed by preliminary observations of problem intersections and/or surveys of other children to identify difficult crossings.

Next, the students usually categorize their suggested approaches, grouping similar ideas together. The children then set priorities for the tasks they consider necessary to help solve the problem. Most of these tasks are carried out by small groups of children.

Sixth-graders in Lexington, Massachusetts, focused their attention on the crossing in front of the school and the busy intersection just one hundred feet away from the school. The area was examined and three factors which made safe crossing difficult at times were listed by the students: (1) the speed of the cars, (2) the number of cars, and (3) the time of day. The class investigated how they could prove that the area was unsafe for pedestrians crossing. Groups were formed to time the crossing times of cars. Other groups took measurements of the area to use in making a scale model.

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

Refocusing on the Challenge

As a class works on a Pedestrian Crossings challenge, the children's attention should, from time to time, be refocused on that challenge 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 on their investigations of crossing problems. Such sessions help the students review what they still need to do in order to recommend improvements for an unsafe crossing. These discussions also provide an opportunity for students to participate both in evaluating their own work and in exchanging ideas with their classmates. (Another consequence of having too many groups is that not every group can be given enough time to report to the class, thereby increasing the possibility that the children's efforts will overlap unnecessarily.)

A sixth-grade class in Arlington, Massachusetts, began work on Pedestrian Crossings by investigating a busy intersection near the school. The class divided into four groups to time light signals and pedestrians crossing the street, poll other children to find out if they regarded the crossing as safe, and take pictures of the problem at the intersection. After making their investigations the group reported to the class. During one class discussion children expressed dissatisfaction at the disorganization of the groups when they collected information in the field. The class decided that to collect data more efficiently, two members from each group should go out each time. The children felt that the data gathering went much more smoothly after this change had been implemented.

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 children to collect data on car arrival times, pedestrian crossing times, and length of time WALK lights are on, the teacher might ask the children what information they would need to prove that a crossing was unsafe. To help the children understand differences in measurements of road width taken by a tape measure and a trundle wheel, a teacher might ask, "Which method is more accurate?" Examples of non-directive, thought-provoking questions are given at the end of this section.

The teacher may also refer students to the "How To" Cards relating to Pedestrian Crossings for information about specific skills, such as using a stopwatch or drawing graphs. If many students, or even the entire class, need help in particular areas such as finding averages or medians the teacher should conduct skill sessions as these needs arise. (Background Papers on Pedestrian Crossings problems provide teachers with additional information on specific problems associated with the challenge. Other Background Papers on general topics may also apply to the unit.)

USMES teachers can also assist students by making it possible for them to carry out tasks involving hands-on activities. During work on the Pedestrian Crossings challenge children may need to collect data at street crossings or, if they are taking a survey, in other classrooms. The teacher can help with scheduling and supervising during such data-gathering activities. If the children's tasks require them to design and construct items, such as trundle wheels or scale models of street crossings or traffic lights, 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). A more detailed account of the Design Lab may be found in the USMES Guide.

Valuable as it is, a Design Lab is not necessary to begin work on Pedestrian Crossings. 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.

A fourth-grade class in Washington, D.C. worked successfully on the Pedestrian Crossings challenge without the use of the Design Lab. Crossing times were measured and analyzed at two intersections. A mock intersection was set up in the classroom with plastic strips of different colors to represent the curb, the grass, and the street, and the children simulated cars and pedestrian crossing the intersection. The class counted cars at three intersections on five different days, measured and calculated gap times, and graphed and compared their data.

The extent to which any Design Lab is used varies with different classes because the children themselves determine the direction of the investigations.

Culminating Activities

Student investigations on Pedestrian Crossings generally continue until the children have agreed upon and implemented some solution for their problem intersection(s). If the children find that a crossing is unsafe, they may write letters to traffic officials requesting installation of a control, change in timing of existing controls, reduction of the speed limit, etc. They may follow up their letter writing by making presentations or holding informal meetings to discuss their findings. If their findings show that a crossing is "safe" or that improvements are unfeasible, children may direct their efforts toward promoting driver or pedestrian awareness of safety measures.

After the students have implemented their solution, they evaluate the effects of their changes by observing, by measuring, or by conducting attitude surveys.

One second-grade class working on Pedestrian Crossings measured crossing times for pedestrians, gap times between cars, and the speeds of the cars at a problem crossing. Based on the children's data and recommendations, the traffic department had warning signs for motorists installed. The children returned to the crossing and observed that the cars were indeed travelling more slowly.

3. USE OF PEDESTRIAN CROSSINGS IN THE PRIMARY GRADES

Children in the primary grades may make significant progress with Pedestrian Crossings. Although they may not be able to carry out investigations as sophisticated as those conducted by older children, they will be able to conduct the measurements necessary to show the need for traffic controls and to make suggestions for other changes. Many of the activities described below require the ability only to count and add single-digit numbers.

The challenge may be introduced during a discussion of traffic safety or problems in getting to school. In one second-grade class the children went out to observe a crossing that one child had described as dangerous. After making initial observations, the children decided to collect data to show that the intersection was not safe.

Collecting data outdoors is an important activity during work on the Pedestrian Crossings challenge. The challenge is especially ideal for children in schools located in mild climates. In colder regions the children should start their observations and data gathering early in the fall. During the winter months, as they analyze their data, the children might go outdoors on bright days to make any additional measurements they deem necessary.

In order to show that a crossing is not safe, children will need to collect data on cars and pedestrians passing through the intersection. One third-grade class began their investigations by counting cars at several intersections near the school to find out where and when traffic was heaviest. If a specific crossing is identified as unsafe, children decide to make measurements of the time various children take to cross the street. Simulation of the activity in the classroom gives children the opportunity to practice using a stopwatch. Other practice uses are suggested in the "How To" Cards, "How to Use a Stopwatch." Children in the second-grade class practiced timing daily classroom activities, such as getting the milk and going to the lavatory, before going out to the intersection to collect data.

To make a picture of their data, children may construct simple bar graphs of car counts at different intersections or crossing times for different children. Reports from the third-grade class showed that many young children found graphing boring and often difficult until they made bar graphs of their own data; then they couldn't get enough of it. Construction of bar graphs showing crossing times for individual children may be followed by the construction of histograms showing the number of children crossing in certain times.

In discussing the length of WALK lights or "green" traffic lights, the class may want to know if most children have time to cross while the light is on. They can time the WALK light and compare that measurement with their data on crossing time. Calculation of the average crossing time is *not* necessary; the median can be found quickly and is accurate enough in most instances. Children in the second-grade class enjoyed finding the median crossing time for their data. Children may want to find out if a group takes longer to cross than an individual. They may ask about the times for children on crutches or old people crossing the street. Each activity stimulates new questions that should be investigated as thoroughly as possible.

If an intersection is uncontrolled, then the important question is "How far away should a car be in order for a person to cross safely?" Now that crossing times are known, the children can measure the time taken by different cars to travel from certain check points to the intersection. A series of histograms of car times could be made for the different check points. By comparing these graphs with the crossing time data the children decide where the car should be in order for them to cross safely.

Primary children may use the results of their investigations to make recommendations for traffic controls, warning signs, and other pedestrian safety features. Writing letters to transportation officials proposing specific changes provides an opportunity for children to practice language arts skills. Follow-up sessions with officials to present their findings enable young children to feel that they have been a part of the decision-making process. Primary classes might also use data gathered at intersections to help other young children learn how to cross the street safely or to educate parents and other adults on safe driving practices.

4. FLOW CHART

The following flow chart presents some of the student activities--discussions, observations, calculations, constructions--that may occur during work on the Pedestrian Crossings challenge. Because each class will choose its own approach to the challenge, sequences 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.

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

Challenge: *Recommend and try to have a change made that will improve the safety and convenience of a pedestrian crossing near your school.*

Optional Preliminary Activities:

Other USMES Units:

- *Traffic Flow*
- *Bicycle Transportation*

- *Getting There*

Possible Student Activities:

<u>Class Discussion</u>: What problems do you have crossing the street on the way to or from school?...To a friend's house? Are certain crossings safer than others? Do you have enough time to cross the street between cars? Do you have to wait too long? How can we find out which crossings could be improved?

Observation of controlled and uncontrolled pedestrian crossings.

<u>Data Collection</u>: Survey of other classes to determine most difficult intersections.

<u>Data Representation</u>: Tally and histogram of survey results.

<u>Class Discussion</u>: Report on observations; list hazards and existing controls. What information do we need before we can suggest improvements? How will we collect it?

Design and construction of measuring instruments ↔ Classroom simulation of measuring activities

<u>Data Collection</u>: Timing of pedestrians crossing, arrival times of cars, light sequences.

<u>Data Collection</u>: Time for cars to travel a certain distance (to determine speed).

<u>Data Collection</u>: Counting cars, trucks, bicycles that pass a certain point in a given time.

Calculation of gap times, median or average crossing times, etc.

Calculation of speed. Conversion to m.p.h.

Calculation of traffic volume.

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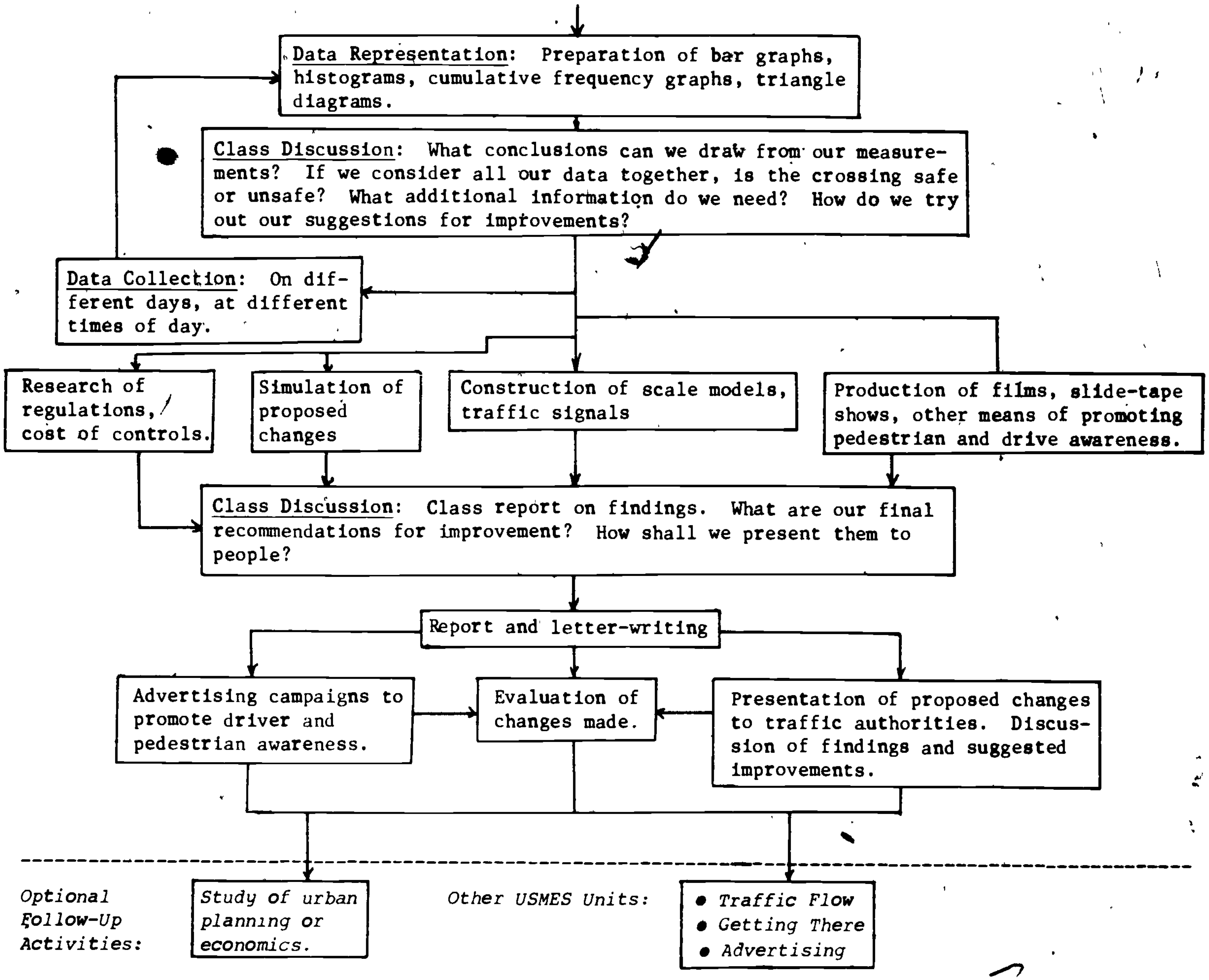
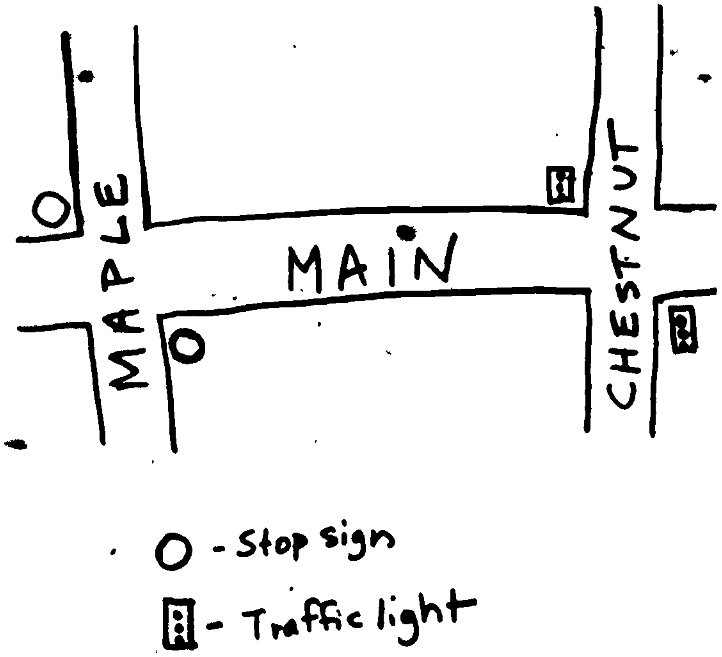

Data Representation: Preparation of bar graphs, histograms, cumulative frequency graphs, triangle diagrams.
Class Discussion: What conclusions can we draw from our measurements? If we consider all our data together, is the crossing safe or unsafe? What additional information do we need? How do we try out our suggestions for improvements?
Data Collection: On different days, at different times of day.
Research of regulations, cost of controls.
Simulation of proposed changes
Construction of scale models, traffic signals
Production of films, slide-tape shows, other means of promoting pedestrian and drive awareness.
Class Discussion: Class report on findings. What are our final recommendations for improvement? How shall we present them to people?
Report and letter-writing
Advertising campaigns to promote driver and pedestrian awareness.
Evaluation of changes made.
Presentation of proposed changes to traffic authorities. Discussion of findings and suggested improvements.
Optional Follow-Up Activities:
Study of urban planning or economics.
Other USMES Units:
Traffic Flow
Getting There
Advertising

5. A COMPOSITE LOG*

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

A teacher asks the children in her intermediate-level class what problems they encounter crossing streets on the way to school. The children discuss their experiences at several crossings. Two intersections in particular are described as hazardous or difficult to cross. Several students who cross Main Street at the corner of Main and Chestnut Streets think that the traffic light forces them to wait too long. Other students remark that they cross Main Street at the busy intersection of Main and Maple Streets to avoid going a long block out of their way. Here, there is only a stop sign on Maple Street to control the traffic.

Some children in one fourth-grade class in Washington, D.C., mentioned two intersections near the school that were especially bad: at 13th and Otis, cars speed down the hill, and there is no traffic light or patrol at the bottom; at 10th and Spring Road the patrols can't seem to get the children across. (See log by Audrey Robinson.)



While measuring gap times and distances at a problem crossing, the children in a sixth-grade class in Lexington, Massachusetts, noticed that cars often did not signal before they turned off Massachusetts Avenue onto Pleasant. They felt this was an important problem, and a group was formed to record the number of cars that signaled and the number that did not. (See log by Robert Farias.)

As difficult pedestrian crossing conditions are identified, the challenge is presented to the class: Recommend and try to have changes made that will improve the safety of the intersection at Main and Maple and the convenience of the intersection at Main and Chestnut.

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*Written by USMES staff

During the follow-up discussion, the children isolate specific complaints about each of the crossings and list problems and possible solutions on the board. The discussion begins with comments on the crossing without a traffic light.

"There isn't enough time to get across between cars."

"Cars don't slow down for us. There should be a warning sign about children crossing the street," another suggests.

"We should put in a traffic light."

"That costs a lot of money. It would cost less to have a policeman there when we're crossing," retorts a fourth student.

The children also list problems and possible changes that could improve the crossing at Main and Chestnut Streets (the intersection with a traffic signal).

"The WALK light takes too long to come on."

"Yeah, the WALK light should come on more often and stay on longer."

"But maybe the cars won't have enough time to get through and there will be a traffic jam."

All these statements and suggestions raise important questions about each of the crossings. At the crossing with a light, how long are the WALK and DONT WALK lights? How many cars will be waiting if the WALK light is on longer? How long does it take to cross the street at each of the crossings? At the crossing with a stop sign is there enough time between cars?

Children in a third-grade class in Watertown, Massachusetts, took a field trip to look at a problem crossing. Before going out, the class decided to list the things they needed to find out: number of cars, presence of a stoplight, policeman, etc. After returning and listing their observations, the children wrote down new questions that arose and needed to be investigated. (See log by Louise Lane.)

When they cannot give the answers to these questions, the children suggest a trip to the two intersections to count cars, to measure time intervals between cars, and to measure the time people take to cross the street. After some discussion they realize that they do not agree on how long the WALK light at the intersection of Main and Chestnut stays on and how long it takes to come on; they decide to time that also.

The rest of the session is spent organizing teams to take the various measurements and discussing how these measurements should be made. One group forms to time the traffic light cycle at the Main and Chestnut crossing. Another group decides to time people crossing the street. After much discussion, the children in this group decide to time both children and adults to get an accurate representation. They decide that it would be safer to take the measurements at the crossing with a traffic light, where people can cross at their own pace while the WALK light is on. (Everyone agrees that since the crossings are both on Main Street, the crossing times should be the same.) A third group forms to count the number of cars waiting at the red light in each direction. A fourth group decides to work at the other intersection to collect data on arrival times of cars. By subtracting these times they plan to find out how often intervals between cars would allow people to cross the street.

The next session is spent outside. Although the various groups have discussed data collection methods before going out, they find that some details could not be worked out until they are actually in the field. The groups timing pedestrians or cars discover that it is best to have one student read times from the stopwatch while another student records. The children take turns doing these tasks.

The Pedestrian Timing Group first times children going directly across Main Street at the intersection. One student who comes to school by this route every morning points out, however, that many people cross the street diagonally from one corner to another while the WALK light is on. Because they are sure that this distance is greater, the group decides that they need to time people walking diagonally as well as "straight across" the street.

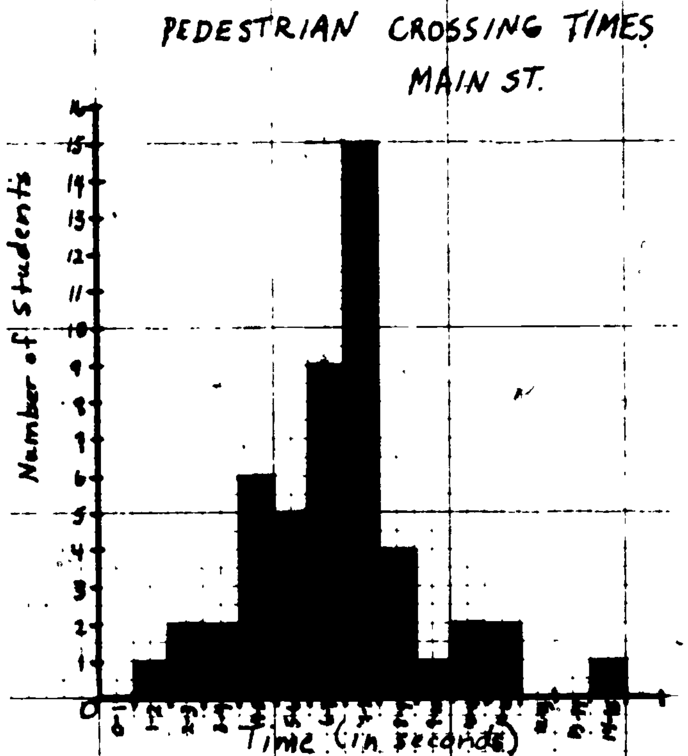
In the Washington, D.C., class the children made logs of the time it took them to cross the street at Spring Road and New Hampshire Avenue, a controlled intersection. Over a three-week period they counted the number of cars that passed the corners of Spring Road and New Hampshire Avenue and Spring Road and 10th Street for a certain observation period at 1:00 p.m. Each day for a week at 1:00 p.m. the children used a stopwatch to record arrival times of cars for a four-minute period at both intersections. (See log by Audrey Robinson.)

While discussing the crossing time data, the children in a combination fourth- and fifth-grade class in Lansing, Michigan, observed that groups of children would take longer to cross than individuals. Groups crossed daily in the morning, at lunch time, and on the way home in the afternoon. The children decided to time each other crossing in groups and to time groups of other children as they crossed on the way home. The class went to the intersection and timed groups of from one to six children. The next day the children again timed groups of different numbers of students. (See log by Janet Sitter.)

The group timing car arrivals first stations two children on each side of the street to observe and record times as cars enter the intersection. However, one child points out that they can find out whether there is enough time to cross between cars *only* if they count gaps between cars arriving from *both* directions. They decide to have only one person timing cars with a stopwatch as they enter the intersection from either direction while another person records this information.

Back in the classroom, the children are eager to share the information they've discovered with one another. The Traffic Light Timing Group is the first to report. Their spokesperson announces that the present traffic signal operates on a cycle of thirty-five seconds for cars to go in each direction followed by fourteen seconds for pedestrians to walk (a seven-second WALK sign followed by a seven-second flashing DONT WALK sign). The children in the group have added up the times and discovered that pedestrians could be forced to wait as long as seventy-seven seconds before crossing the street. When someone points out that this is only a little over a minute, students still agree: it is too long to wait. Several suggestions for changing the timing are made, but the other groups are anxious to report, and the class decides to hear all the information before proposing changes.

The Pedestrian Timing Group tells the class that they have timed fifty pedestrians going directly across the street at the traffic light and plan to finish timing fifty more crossing diagonally. One boy starts to read the data, but several children complain that they can't tell anything from the information presented this way. A discussion follows about how the data could be made clearer to other people.



Time (in Seconds)	No. of People
2	1
3	2
4	2
5	6
6	5
7	9
8	15
9	4
10	1
11	2
12	2
15	1

Figure B5-1

At this point the teacher introduces the USMES "How To" Cards on graphing. After reading them over the group decides to make a histogram of crossing times that would show the number of people who have crossed the street in certain times, e.g., two seconds, three seconds, etc. The histogram they make is shown in Figure B5-1. Other groups decide that they also need to find a better way to present their data, and the class discusses different kinds of graphs that can be used. The rest of the session is spent graphing the data from the other three groups.

When the graphs have been completed, the groups are ready to give their information to the rest of the class. The group counting cars at the traffic light have simply made bar graphs from their data, showing that in the first light cycle, a maximum of six cars were waiting at the red light; in the second light cycle, eleven were waiting; in the third cycle, six; etc. They have counted cars in ten light cycles in all and have found that the median number of cars waiting is 6.5. Someone suggests that the students in this group should check how many cars could not get through in one green light and are left waiting when the light turns red. The students agree that it would also be useful to make histograms of this information (collected for several light cycles) so that they can determine whether the light timing should be changed.

The group measuring the arrival times of cars at the intersection of Main and Maple have timed 61 cars during a five-minute period. To find gap times between cars, the children have subtracted arrival times; a sample of their arrival time data and gap time calculations is shown in Figure B5-2. They have also made a histogram showing the number of cars coming one second after the previous car, the number coming two seconds after, etc. The gap-time histogram has a range of gaps from one to twenty-four seconds.

The Washington, D.C., students constructed bar graphs of the crossing time data. The first graph represented each student's crossing time by a bar. Then a frequency histogram of the number of crossing times of a certain length was made. Using this experience with crossing-time histograms, the children made histograms of gap times from the data collected at Spring Road and New Hampshire Avenue. First, they had to subtract successive arrival times to find gap times. Some children had trouble remembering to "carry over"

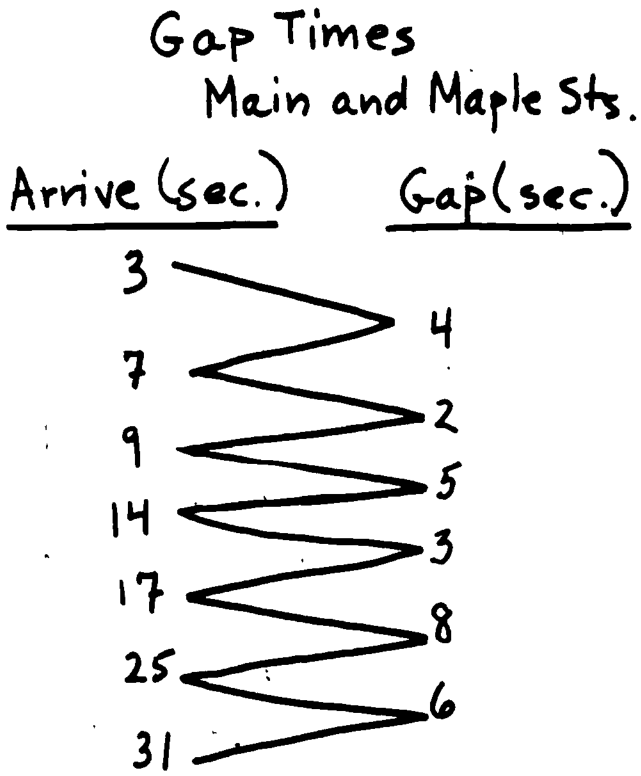


Figure B5-2

the seconds from the previous revolution of the stop-watch. After constructing gap-time histograms for three days in a row, the children started finding medians from approximately 50 pieces of data. They were surprised to find that the median gap time was three seconds for each day. (See log by Audrey Robinson.)

The group timing pedestrians has made two histograms, one of the first set of fifty street crossings and a second of the people who have crossed the street diagonally. (They finished taking this data after school.) They are unsure about which set will be of use, and so they have prepared both as evidence of the problem. In discussing crossing times, the class debates whether timing handicapped people would be a useful measurement.

As the class is examining the histograms on crossing times, the teacher asks the group whether they can tell how many people in all can go directly across Main Street in ten seconds or less. Several children add the number of people in each column of the histogram (of people going directly across Main Street) up to and including the ten-second column and discover that out of the fifty people timed, forty-five have been able to cross the street in ten seconds.

The teacher asks them whether it would be helpful to be able to find this information quickly from a graph. Most of the children feel that it would be useful, particularly in making a presentation to "authorities." The teacher shows them on the board how to make a cumulative distribution graph by using the running totals of the data from their histogram table. Here is the data they use for the new graph.

Number of Seconds	Running Totals Number of Students
2 or fewer	1
3 or fewer	3
4 or fewer	5
5 or fewer	11
6 or fewer	16
7 or fewer	25
8 or fewer	40
9 or fewer	44
10 or fewer	45
11 or fewer	47
12 or fewer	49
15 or fewer	50

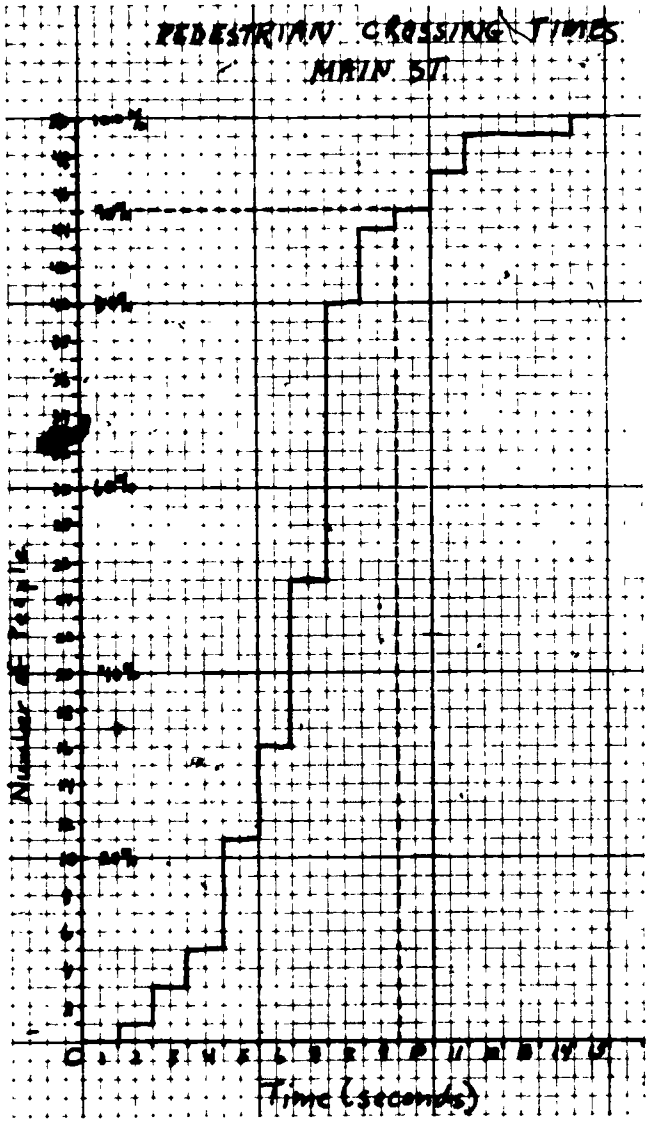


Figure B5-3

After the skill session with the teacher, the Pedestrian Timing Group makes a cumulative distribution graph like the one shown in Figure B5-3. They also make a cumulative distribution graph for the pedestrians who have crossed the street diagonally. In comparing the two graphs during another class discussion, the children note that nine out of ten pedestrians (90%) going "straight across" the street can cross in ten seconds or less, while nine out of ten pedestrians (90%) crossing the street diagonally can cross in fourteen seconds or less. They draw dotted lines on the graphs to show these facts.

The next discussion focuses on the question of how different their results would be if measurements were taken shortly before or after school. Comments include--

"There are more cars then."

"Maybe there are fewer delivery trucks."

"More little kids are trying to cross the road."

"Does the light timing change?

The class decides that additional measurements of car waiting times and gap times should be taken. They also decide to time groups of people crossing the street since more children will be crossing in groups just before or after school. A number of students make arrangements to meet the teacher before and after school to make these new measurements. After collecting the additional data, they graph the information from these later visits.

Children in the combination fourth- and fifth-grade class in Lansing, Michigan, timed children crossing the street in groups of various sizes. They found, after graphing their results, that larger groups of children took longer to cross the street than individuals or smaller groups. They found that the average crossing time for groups (which averaged ten children) was 10.4 seconds, whereas the average crossing time for individuals was 8 8/19 seconds. (See log by Janet Sitter.)

The Gap Time Group decides to use the new data taken just before school because they find that the number of cars timed on Main Street passing through the intersection during a five-minute period is greatest at this time (102). They also feel that it is important to use measurements from this time of day because the largest number of children would be using the crossing then.

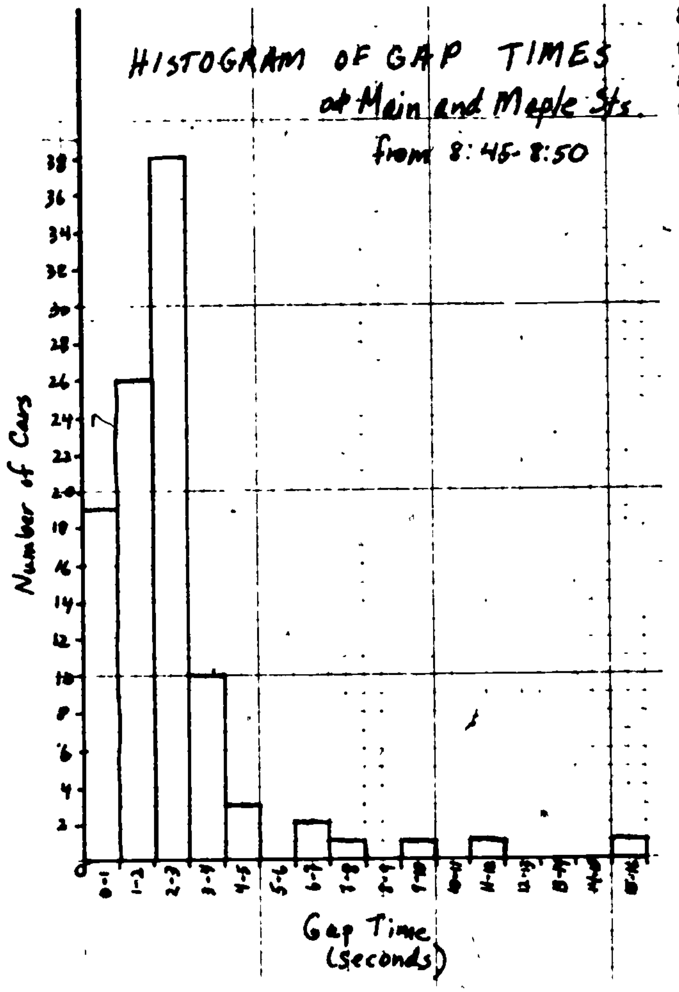


Figure B5-4

The data collected during the five-minute period around 8:45 is shown below. Figure B5-4 shows the histogram that the children have made from this data. The histogram shows a range of gaps from one to sixteen seconds and a median gap time of three seconds.

Table of Values

Gap Time (seconds)	No. of Cars
1	19
2	26
3	38
4	10
5	3
7	2
8	1
10	1
12	1
16	1

Once all the other groups have graphed their data and reported their information, the class is ready to discuss the problems at each intersection from the evidence they have gathered. First the children talk about the crossing at Main and Chestnut. One boy who is good at math has worked out a possibility for changing the light cycle. "Nine out of ten people get across in fourteen seconds, so if they left the fourteen-second WALK light but made the car moving time twenty seconds instead of thirty-five seconds, the cars would have to wait only thirty-four seconds instead of forty-nine seconds. So people would only have to wait at the most forty-seven seconds instead of seventy-seven."

"Huh?"

"Where do you get that?"

"Yeah, where do all those numbers come from?"

The boy explains how he has arrived at these figures. He says that they should use the times for the pedestrians crossing Main Street diagonally since a great many will be crossing this way when cars are stopped in both directions during the WALK light.

"And our cumulative distribution graph tells us that nine out of ten people can cross in fourteen seconds, the WALK time right now at the light."

"Okay. Now where do you get the twenty seconds?"

He explains that the number of seconds cars have to get through the light each way can be reduced and that twenty seconds seemed to be a good time all around. He shows on the board how he has added waiting time for the other cars to go (twenty seconds) and for pedestrians to go (fourteen seconds) to get thirty-four seconds waiting time for cars on either street. People waiting time, he says, is car times for *both* directions (forty seconds) plus seven seconds when the DONT WALK light has begun to flash and pedestrians should not start to cross--a total of forty-seven seconds. The other children check these figures and the present car and pedestrian waiting times; they agree that these suggested times would shorten the light cycle greatly.

One child argues that the car time should be increased, not decreased, so that more cars can get through the light in one cycle. However, the children from the Car Waiting Time Group have counted the number of cars that are left waiting after a green light and found that only two or three cars in every ten light cycles are unable to get through in one green light. They quickly affirm that *shortening* the cycle will not increase this number much, and most children agree that cars won't have to wait as long until the next green light if the timing is decreased. The boy who has suggested the twenty-second time for the cars to go says that it will be more fair to pedestrians, who don't need more crossing time, but less waiting time.

The children are generally satisfied with the new times suggested, but one child asks: "What about people who take longer than fourteen seconds to cross?"

"Cars would have to wait until people already in the road crossed. We could paint white lines for the crosswalk and put up a sign telling the driver to wait," another child replies.

The children are pleased with this suggestion and decide to include it in a list of recommendations that they plan to present later to traffic authorities.

The teacher asks about the crossing at Main and Maple Streets. "Are there gap times long enough for the school children to cross safely?" A student from the Gap Time Group says vehemently that there are not. The class decides to reexamine the histogram on gap times to see what they can learn from it. They remark that there are only three gaps of ten seconds or longer and one gap of fourteen seconds or longer during the five-minute timing period. (See Figure B5-4.) "That means that somebody going straight across the street would have only three chances to cross in five minutes, and somebody going diagonally would have only one chance," one girl explains. (She reminds the rest of the class that most pedestrians could make a "straight" crossing in ten seconds, and a diagonal crossing, in fourteen.)

After examining the data, the class decides that crossing the street diagonally is not safe at all at this intersection and is also not necessary since Maple Street has fewer cars and a stop sign. The childen are concerned, however, about pedestrians going straight across Main Street.

"There aren't enough times when it's safe to cross. That doesn't come out to even one chance every minute!"

"The city should put in a WALK light with a push button at least ten seconds long. It costs a few thousand dollars but it would cost that much to have a part time officer there for a year or two."

"Yeah, but people need jobs and anyway the light may cost a lot to repair. We need a cop to make sure cars are going slow enough."

The children in the fourth-grade class in Washington, D.C., constructed histograms of gap times from their data collected at 13th and Otis Streets, an uncontrolled crossing. They saw that there were many one-second gaps and very few larger gaps. The median was two seconds for each of the five days. On the basis of this information they decided to recommend to the city traffic department that a traffic light be installed at the intersection. (See log by Audrey Robinson.)

As some children feel that the problems and solutions they have proposed would be easier to talk about if they could be demonstrated, a new group of children forms to make a scale map of the intersection. Most of the class becomes involved in this undertaking when the group realizes that it is a much more complicated process than they expected. In order to make the map to scale, street distances must be measured outside. The teacher draws attention to the USMES "How To" Cards on using a trundle wheel; after several attempts at using a tape measure, the children decide that the distance is too great and that using a trundle wheel would indeed be the most practical method of measuring. A group of children constructs two trundle wheels (each with a circumference of one meter) in the Design Lab using the "How To" Cards.

The next few sessions are spent measuring and recording distances outside. Lengths as well as widths of streets between blocks are determined. The children take turns handling the trundle wheel and counting "clicks," which mark the number of rotations.

The block distances and road widths measured by children working outdoors are used by another group of children to make the large map. These children first examine the USMES "How To" Cards on scaling. They decide on a scale of 5m ⟷ 1cm, divide the measurements in meters by five to get the measurements in centimeters and begin drawing a map in pencil on a large piece of cardboard. Other children go over their outlines using brushes dipped in tempera paint. Still others make flat cardboard pieces for cars, lights, and people (after measuring or estimating heights and widths of these objects and scaling these measurements.)

Before beginning the scale model of the area outside, the children in the Lansing, Michigan, class worked on a floor plan, drawn to scale, of their classroom. Measurements were taken of the room and the furniture. The children made conversion tables to help them with the conversion of measurements. They decided on a scale for the model: 1 block represented 1 foot. The children located the north, south, east, and west sides of the classroom and labeled their floor plans accordingly. They placed the furniture pieces on the floor plan by using the same scaling system that they had developed to make the furniture pieces. After this project was completed the children followed the same procedures to construct a model of the crossing. (See log by Janet Sitter.)

The children in the Lexington, Massachusetts, class made scale maps of the streets near the school for use in their videotape on pedestrian safety. They measured distances outside with trundle wheels constructed in the Design Lab. They then decided to make a scale model of an average-sized car and one of an average-sized first grader in order to portray graphically to primary-grade children how difficult it is to see them at crossings. One group measured ten cars, calculated the average size, and made a model car out of Tri-Wall and papier mache. Another

> *group made a height chart, measured a group of first-grade children, figured their average height, and made a model child of papier mache. The group reported that the average height of the first graders was three feet, the average length and height of the cars were fifteen feet and six feet and that the models were made on a scale of 3 feet ⟷ 1 foot. They added that to determine these figures they had to practice converting inches to feet. (See log by Robert Farias.)*

While the group finishes the scale map, other children form groups to gather additional information. One group decides to obtain more detailed information on the cost of buying and servicing traffic lights and on the wages of traffic police so that the class can decide which to recommend at the uncontrolled corner. Another group looks up accident information for the crossings and researches local traffic laws and enforcement procedures.

After several more working and planning sessions, the students decide to recommend in a letter to traffic officials that a push button WALK light with a *minimum* ten-second WALK time be installed at the crossing at Main and Maple. They explain comparative costs, assuming that the light will last for twenty years. They decide to point out that the four pedestrian accidents that have occurred at the corner over the past five years might have been avoided had there been a WALK light.

If the town won't install the light immediately, the children recommend the following minimal program: stationing a police officer at the intersection before and after school so that children going to and from school can cross safely.

For the crossing of Main and Chestnut, the class suggests that the minimum time for cars be reduced from thirty-five seconds to twenty seconds. Since the pedestrians will not have to wait so long, fewer will take a chance on running across as the light is changing.

The group researching local traffic laws has found that the town traffic department is the agency that makes and enforces decisions on traffic policy. The children in this group recommend writing the traffic department. The class decides to write a letter to the traffic department listing the above recommendations. In the reply to their letter they are told that a representative will visit the class to discuss their findings.

The official is very polite and interested in the children's findings when she visits their classroom. She examines the children's model carefully and listens while they explain each change. She then tells them that further study is needed to see whether the timing of the light at Main and Chestnut Streets should be changed, as they recommend. A light will probably be installed at some time in the future at the uncontrolled intersection at Main and Maple, as it is one of several in the vicinity where accidents have occurred. She promises that a police officer will be assigned as soon as possible to direct traffic at the corner before and after school. The children are a little impatient with the slowness of official decision-making, but most are satisfied that their recommendations will be considered seriously.

Looking over the data they had collected, the children in the Lansing, Michigan, class concluded that their initial hypothesis was correct: the crossing was not safe. They then turned their attention to how to make it safe. Their suggestions included the following ideas:

1. *Build a skywalk over the street to replace the light.*
2. *Build a skywalk at Kalamazoo and Allen (1 block west).*
3. *Build under-road passageway.*
4. *Make WALK light longer.*

The disadvantages of each were discussed and the class decided to ask the other children in the school which alternative they preferred. Two police officers visited the class to discuss the children's work and findings with them. The officers told them that changing the timing on the traffic light would be the most practical solution, and they discussed changing it only during school hours. (See log by Janet Sitter.)

While working on the Traffic Flow challenge, a fifth-grade class in Arlington, Massachusetts, decided that altering the flow of traffic near an unmarked crossing was not a practical solution because of the heavy volume of traffic. After studying the situation, the children recommended that a pedestrian

overpass be constructed at the crossing. Their solution coincided with the recommendations of the city traffic department, and the following year the overpass was built. (From log by Bernard Walsh.)

The students decide to inform children in other classes that they may have to wait a long time at the intersection of Main and Maple before crossing safely. They make posters warning children to look both ways when crossing the street. The class receives permission from the principal to display their posters along with their large scale map of the intersection in the large showcase in the main lobby of the school.

The school safety officer of the Lexington, Massachusetts, Police Department visited the class, and the children made a presentation of their findings. They recommended that a sign by posted to remind drivers to signal before turning. In responding that state approval was required for new types of signs, the Department of Public Works advised the children to turn their efforts toward educating the public on safety rules. The children then focused their attention on making a videotape about pedestrian safety for the younger children at the Adams School. (See log by Robert Farias.)

6. QUESTIONS TO STIMULATE FURTHER INVESTIGATION AND ANALYSIS

- What problems do you have getting to school?
- Which streets on the way to school are difficult to cross?
- What do you think makes certain streets difficult to cross?
- What information do you need to find in order to show that a problem really exists?
- How could you organize yourselves to best collect the data you need?

- How could you find out what other pedestrians think of this problem?
- What is a good way to measure the flow of traffic?
- What is a good way to find out how long it takes to cross the street?
- How can you find out if a traffic light gives a pedestrian enough time to cross the street?
- How can you determine how fast cars are going through an intersection? What measurements do you need to take?
- What is a good way to keep a record of your data?
- How can you make a picture of your data?
- Are there big differences between the times various people take to cross the street or cars arrive at the intersection at different times of day? If so, what could you do about these differences?
- What possible solutions can you suggest to the problem of crossing the street?
- How could you try out your ideas for solving the crossing problem without going out there?
- How could you make an accurate representation of the intersection for trying out suggested improvements? What measurements are needed?
- What will help you convince other people your recommendations will work?
- Who would be a good person to discuss your recommendations with?
- How could you convince other people that they should walk or drive more safely?

C. Documentation

1. LOG ON PEDESTRIAN CROSSINGS

by Louise Lane*
Hosmer School, Grade 2
Watertown, Massachusetts
(September 1972-March 1973)

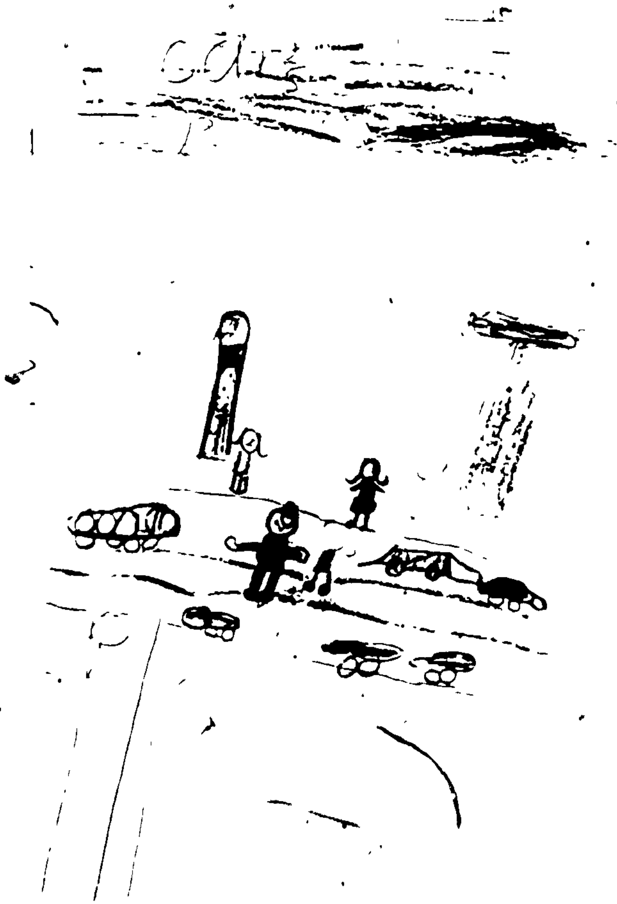


Figure C1-1

ABSTRACT

During a class discussion, one child mentioned a dangerous crossing near her home. The entire class went to observe this crossing and to take notes on what they saw. They then discussed their observations, the data to be collected, and the method of recording their data. They made tally sheets, returned to the crossing, and collected data on crossing times. Back in the classroom, they calculated the average and the median crossing times, displayed the data on line graphs, and discussed their findings. The children discussed their recommendations for changes with a local policeman, who suggested that they write a petition to have their changes implemented. The class sent in their petition, and within a week warning signs were placed near the crossing. Returning to the crossing, the students observed that the cars were indeed travelling more slowly.

My second-grade class was introduced to Pedestrian Crossings through a discussion of a record we had heard with the theme of "Neighbors." One girl told the other children that she had to cross a "big, dangerous" street when she came to school. As a follow-up activity to her comment and a natural way to lead into a Pedestrian Crossings challenge, we planned a walk to the girl's (Ellen's) crossing by the entire class to see if it were dangerous. The crossing, located on Mt. Auburn Street at Winthrop Street, will be referred to as "Ellen's crossing."

Before starting on our field trip to Ellen's crossing, we discussed why we were going and what we were going to do when we got there. Our objectives were to see if the class agreed that Ellen's crossing was indeed dangerous and to collect as much data as possible. The class decided that the data should include:

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1. The number of cars
2. Whether or not a policeman was assigned to the crossing
3. Whether or not there was a crosswalk
4. Whether or not there was a light
5. Whether or not there was a stop sign.

One pupil suggested that we take notes or draw a picture so that "we would remember what we saw." The children took paper, books to write on, and pencils along with them on our walk. One child's drawing of the crossing is shown in Figure C1-1.

Later in the day when we were back in the classroom, the children and I talked about what we had seen and listed our observations on the board. They included the following:

1. A lot of cars
2. A policeman to cross the children
3. A crosswalk
4. No lights
5. A stop sign at the end of Winthrop Street near Mt. Auburn Street
6. A bus stop very near the crosswalk
7. Mt. Auburn Street with two way traffic--four lanes and Winthrop Street with two way traffic--two lanes
8. When kindergarten children and Lunch Aides were crossing we noted that everyone waited for the signal from the policeman and walked inside the crosswalk lines.

Only three questions that needed investigation were raised by the children:

1. How long is the policeman on duty?
2. How fast do the cars go?
3. How would you cross if a policeman weren't there?

The class decided that we would work on answering some of these questions. But first, we needed folders in which to store the information we would collect--our drawings, observations, and data. We used sheets of paper which were twelve by eighteen inches and cut them in half the short way to make six by eighteen inch folders.

At this point, the children became involved in experimenting with various tools and skills which would be useful for making observations at Ellen's crossing. A trundle wheel left in the room sparked curiosity; two girls were determined to find out what it was. After a certain amount of play that took place with the instrument failed to establish its purpose, I tried to subtly direct them to the "How To" Cards. They took the hint and quickly located the cards. Using the cards, the trundle wheel, and a yardstick Susan and Ellen discovered that the trundle wheel was a yard measure. In their spare time the two girls helped other classmates discover the trundle wheel.

Since both girls' interest was extremely high, I felt that it would be a good time to let them experiment with a stopwatch to discover how it works as well as how and when to use it. Together, the girls were able to do this. Once the girls understood the stopwatch, they helped others in the class to understand it and use it. The children discovered that one minute equals sixty seconds. Students were busy timing any activity that took place, for example, getting the milk, getting the lunches, trips to the bathroom, etc.

Out of concern for the youngsters' safety while on a field trip to a main street, I felt the need to show two films on safety and working with others. The viewing of the films and the discussions that followed helped the children to see the problems created by busy streets and to try to solve them.

In mid-October the children became involved in mapping activities. Children were given magnetic compasses without being told what they were. After eliminating the possibility of their being tools to measure the temperature of air and establishing that they were waterproof, I suggested that they take the compasses home to figure out their use. One student in the class discovered what his compass was before the day was over; others learned of their use at home.

Children constructed directional signs for the classroom using the compass. The entire class used the compasses to determine where the signs should be placed. Many repeated the activity in their homes. Activities did not stop there; one student used a compass to determine which direction windows that were used for growing plants faced in his parents' home.

We decided to make another trip to the crossing to use some of the skills we had learned for making observations. Since we were going to collect data on crossing times, I showed the children how to make a tally sheet listing the names alphabetically on the left of the paper and marking ½ inch intervals across the top from point A. Lines were drawn and the number of seconds marked along the top. (These numbers were later changed by the children when they began to time the crossings.) All of the children were extremely interested in the project; excitement spread as the children began to realize that each one of them would be timed crossing the street.

We made trips to the crosswalk for three half-hour time periods over three days. On the third day the children completed their tally. They strongly urged that I be timed crossing the street. I complied! During the time it took for the class to make the tally, some of the children made certain observations:

1. From the east there is a bend in the road that makes it difficult to see cars coming towards you

2. There is a tree and a pole which interferes with vision when crossing the street north to south

3. A "non-stop" bus jets down Mt. Auburn Street from the west

4. The Watertown/Harvard Square local stops very near the crosswalk--sometimes on the crosswalk!

5. More accurate results are obtained when all the kids are working on "one new job"

6. A policeman is at the crossing when students arrive in the morning and leave in the afternoon. He is also there when the kindergarten children arrive and leave.

The children made a list of problems still to be solved. These included questions such as: How many cars travel east and west during a given period of time? How fast are cars travelling? How much time between cars?

During the next session in the classroom the children used their individual tally sheets to find the median and the average crossing times. I read the "How To" Cards aloud and explained what we were finding. The children decided that we should add five numbers at a time. I did the computation at the blackboard and encouraged all those who were able to do the same at their places. The average time needed to cross was 11 seconds.

11 sec.	+ 10 sec.	+ 11 sec.	+ 12 sec.	+ 14 sec.
9	9	9	13	10
9	11	9	17	11
9	14	9	14	
12	10	10	10	
50 sec.	54 sec.	48 sec.	66 sec.	35 sec.

50 sec.
54 sec.
48 sec.
66 sec.
+ 35 sec.
253 sec.

23 people) 253 seconds = 11 seconds (average)

The children had difficulty finding the average but understood and enjoyed the process of finding the median, which turned out to be 10 seconds. Again I read the "How To" Cards to them. Splendid questions grew out of this activity. For example:

- Were ten people more observant in their crossing than one person alone?
- What happened to the boy who took 17 seconds to cross?
- If ten people took less than 11 seconds, could more people cross in less than 11 seconds?

The next sessions were spent graphing the results of the field trip to the crossing. In a directed lesson the class discussed and reviewed how to make a line chart. An example of their work is shown in Figure C1-2. Discussions showed the following:

1. Students had discovered that the line chart is much easier to read than the tally sheet.

2. Something was wrong with Raffi's timing (17 seconds); perhaps the person handling the stopwatch failed to stop it on time.

3. Children checked the chart to see that all "like" amounts of seconds were placed correctly.

1	2	3	4	5
11	10	11	12	14
9	9	9	13	10
9	11	9	17	11
9	14	9	14	35
12	12	10	10	
50	56	13	66	
		49		

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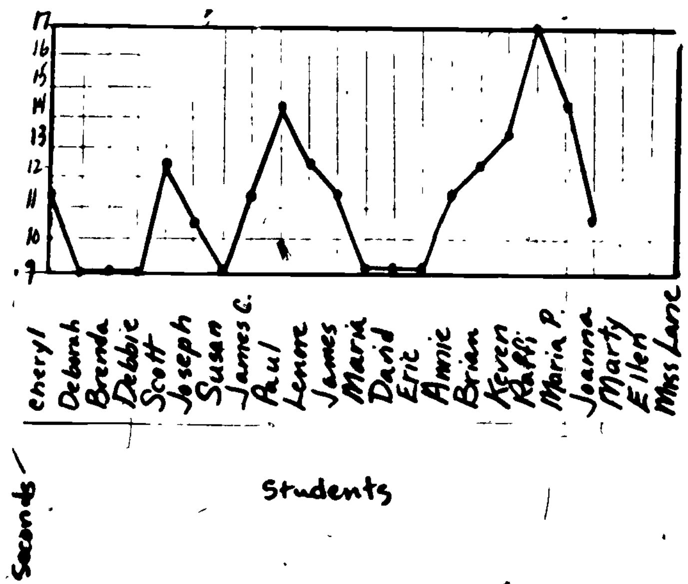


Figure C1-2

4. Children decided that 14 seconds to cross the street was too long according to the facts. They attributed that time to walking slowly or to waiting for cars that didn't stop.

5. Most students decided that 11 seconds sounded reasonable for an average. They understood at this point that the average means the time it took most people to cross that particular crossing.

The youngsters were very pleased with their work. Some boys and girls took their graphs home, and others shared them with other classes.

After Winter Recess the class reviewed the work that had been done on the challenge and made a list of recommended changes for the crossing:

1. The crosswalk on Mt. Auburn Street and Winthrop Street should be changed to the other side of Winthrop Street.

2. A warning sign should be posted on the north side of Mt. Auburn Street facing the cars coming from the east.

3. A warning sign should be posted on the south side of Mt. Auburn Street facing the cars coming from the west.

The class scheduled a visit with Police Lt. Kelly of the Traffic Division to make a presentation describing our activities from September to January as well as our recommendations. Lt. Kelly listened to the children as they explained the reasons for their recommendations:

1. The crosswalk should be moved because there is a bus stop right next to the crosswalk. The buses stop on the safety crossing which is dangerous for the children who have to cross the street.

2. There are no signs to warn drivers of a crosswalk or school crossing; some should be posted. It is difficult to see oncoming traffic due to a bend in the road in one direction and trees and poles in the other direction.

Lt. Kelly praised their work and explained the reasons for the placement of the crosswalk. The crosswalk was placed next to the bus stop on purpose. It was felt that more people would use it to get to and from the bus stop as well as to the stores which were nearby.

He asked the children to write a petition of their requests for changes and send it to him; he promised that he would take action from there. At the end of February the petition was sent. A copy of the petition is shown in Figure C1-3.

HOSMER SCHOOL
CONCORD ROAD
WATERTOWN, MASSACHUSETTS 02172
PHONE 924-5531
JOHN J HARRIS, PRINCIPAL

February 26, 1973

To Whom it may Concern,

We, pupils of Room 111 of the Hosmer School, wish to present the following petition:

1. We ask to have the crosswalk on Mt. Auburn St. and Winthrop St. changed to the other side of Winthrop St.

2. We ask to have a warning-crossing sign on the north side of Mt. Auburn St. facing the cars coming from the east.

3. We ask to have a warning-crossing sign on the south side of Mt. Auburn St. facing the cars coming from the west.

******

(1) From our observation and collecting data, we have observed the Watertown Square bus, going east, stopping on the crosswalk when using the bus stop. On the north side of the crosswalk there is a private garage. The owner's car backs onto Mt. Auburn St. right across the safety walk. When we tried to cross the walk, we had a long wait, since autos from both directions are many and travel so fast. No cars, at anytime, stopped to let us cross. On the north side of the crosswalk, there is a bend on the road before the crosswalk, thus making the pedestrian's job of seeing on-coming cars almost impossible. At the same place, there are three trees and one pole that block the view of the pedestrian who is crossing to the south side.

Figure C1-3

(2+3) There are no signs on either side of Mt. Auburn St. to warn the drivers of a crosswalk, or children crossing, or the like.

We feel this change and these additions will make the crosswalk safer for pedestrians.

Thank you.

Brenda Arone Susan Catalano
Kevin Nugent Brian McCarthy Joanna Psychoghios
Ellen Walsh Deborah Alger
Scott Beaupre Cheryl Abreu
Paul DeGuglielmo Murty Thomas
Annie Manjelikian David Kearsley Debbie-Boams
Joseph Bonaccolto James Higgins
Raffy Orchanian Maria Kefalas Lenore Doria
James Craig Maria Pergantis Lisa Louise Lane

The children had an immediate response to their petition. Lt. Kelly issued orders to have a warning sign for drivers placed near St. Theresa's church on the NE side of Mt. Auburn Street. This was done within days. On March 16th the class walked to Ellen's crossing. We observed that cars slowed down as they neared the intersection, whereas before the sign was posted, they had continued at a fast speed. We all walked towards the east and looked at the new sign. The children were very proud that their efforts had brought about a change. A second "used" warning sign had been posted near the crosswalk. In the spring the crosswalk lines were freshly painted.

2. LOG ON PEDESTRIAN CROSSINGS

by Audrey Robinson and
Gloria Downs*
Raymond School, Grade 4
Washington, D.C.
(February-June 1971)

ABSTRACT

In this class the challenge was introduced during a discussion of the safety features and hazards of street crossings near the school. The children studied both a controlled intersection (stop sign) and an uncontrolled intersection. They collected data on the time students took to cross and on the arrival times of cars and calculated gap times between cars. The data was then displayed on bar graphs, histograms, and line charts, and average and median times were found. The students simulated the activity at one intersection by marking it on the floor and having class members act as pedestrians and as cars. They discussed the effects of age and physical handicap on crossing times and offered recommendations for alleviating these situations. They discussed the differences between the controlled and the uncontrolled intersections and the implications of these differences for pedestrians. The class presented their findings to the city Department of Traffic but were told that their proposal to have a traffic light installed at the uncontrolled crossing was not feasible.

Data Collected at Georgia Ave. and New Hampshire Ave.

Traffic Logs

Time	Time to Cross
3:00	Lee 7 seconds
	Kim 5 seconds
	Sharon 5 seconds
	Randall 9 seconds
	Bernice 8 seconds
	Karen 8 seconds
	Toyer 5 seconds
	Leland 5 seconds
	Jackie 8 seconds
	Daryl 9 seconds

Figure C2-1

During the second half of the school year, we asked our fourth-grade class to comment on the problem of pedestrian safety at street corners. Reasons for obeying traffic signals and signs, crossing streets only at corners, and not playing in the street were discussed. The class was asked to think about the particular corners around the school: Do you know anything about the streets you cross when you are coming to school? What makes a "bad" street?

Some children mentioned two intersections near the school that were especially bad: at 13th and Otis cars speed down the hill, and there is no traffic light or patrol at the

*Edited by USMES staff

Data Collected at Spring Road and New Hampshire Ave.

Time	Time to Cross
1:15	Cheryl 10 seconds (walking slowly)
Bernice	8 seconds
Leland	5 seconds.
Kim	5 seconds
Sharon	5 seconds.
Karen	7 seconds
Lee	7 seconds
Toyer	5 seconds
Jackie	8 seconds
Randall	12 seconds

Figure C2-2

bottom; at 10th and Spring Road the patrols have difficulty in helping the children to cross. We decided our future course of action would be to make a list of the problem crossings, then actually visit them to see if we could find out what was causing a pedestrian hazard.

A list of questions to be explored evolved from our discussion:

What light should we use to cross the street?
What do the red, yellow and green lights mean?
How should we look before crossing the street?
Why do we have one-way streets?
How do drunk drivers keep their licenses?
What does a U-turn mean?
Should we obey the traffic laws?
Do we have school signs?
What is the speed limit?
Are stop signs necessary?
Do our patrolboys help?
Should we check our cars before taking a trip?

During the next few weeks the class visited nearby intersections to collect data. The children kept logs of the time it took them to cross the street at the intersection of Georgia and New Hampshire Avenues and at the intersection of Spring Road and New Hampshire Avenue, and each student made a graph showing the latter data. The individual was represented by a block on the vertical axis; the crossing time in seconds by a number on the horizontal axis. The traffic logs are shown in Figures C2-1 and C2-2, and one of the student's graphs is shown in Figure C2-3.

After discussing our observations, most of the class seemed to think a traffic light instead of a stop sign should be placed at the corner of New Hampshire Avenue and Spring Road. They also expressed the opinion that the time for pedestrians crossing at Georgia and New Hampshire Avenues should be lengthened.

The next week, the class simulated cars and pedestrians at an intersection. A mock intersection was set up by using plastic strips; a gray strip represented the curb; a green strip, grass; a white strip, the street. The class decided our intersection was an uncontrolled corner because it had no light or stop sign. We reviewed terminology--pedestrian, police officer, uncontrolled vs. controlled corner--and then asked one student to play a pedestrian and two students to be cars. Our pedestrian crossed the street safely but was criticized for her failure to look both ways.

Data Collected at Spring Road and New Hampshire Ave.

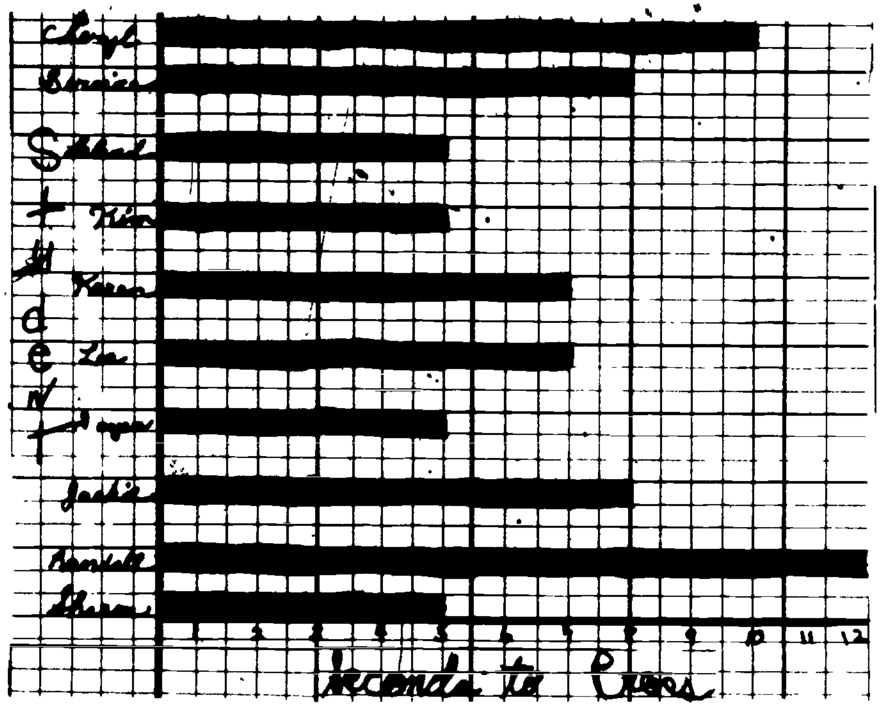


Figure C2-3

The cars were instructed to keep moving, bringing up the problem: How will our pedestrian be able to cross the street in heavy traffic? The class suggested that a traffic light might be installed at the corner. A model traffic light had been constructed by the teachers* and was now brought out and "installed" at the corner. Obeying the traffic signal, several more pedestrians and cars crossed the intersection.

We had previously drawn a graph on the chalkboard showing how long it took the children to cross an intersection. We asked them to look at that graph now and find the longest amount of time. They found that three students had each needed nine seconds. We then discussed the following problem: If the length of the proposed WALK light was only a little longer than nine seconds, how would a handicapped or slow-moving person be able to cross this street safely? The class offered these recommendations:

*The children might also consider constructing one: See log of Robert Farias.--ED.

1. Have a patrolman at every corner.
2. Have a walk button for pedestrians.
3. Have islands for all streets to help handicapped people.
4. Lengthen WALK lights.

A visiting police officer discussed the feasibility of these recommendations with the class.

The children spent quite a bit of time over a three-week period collecting data on the number of cars that passed the corners of Spring Road and New Hampshire Avenue, New Hampshire and Georgia Avenues, and Spring Road and 10th Street:

Spring Road and New Hampshire Avenue

Monday	16
Tuesday	28
Wednesday	43
Thursday	32
Friday	19

New Hampshire and Georgia Avenues

Monday	43
Tuesday	45
Wednesday	63
Thursday	40
Friday	62

Spring Road and 10th Street

Monday	26
Tuesday	14
Wednesday	13
Thursday	15
Friday	16

This data was used to learn averages. The children were shown how to find the average by adding all the quantities in a given set of numbers to get the sum, and then dividing the sum by the total number of quantities.* A sample of one student's work is shown in Figure C2-4.

*The average rate of traffic flow can be calculated by dividing the average number of cars by the observation time. --ED.

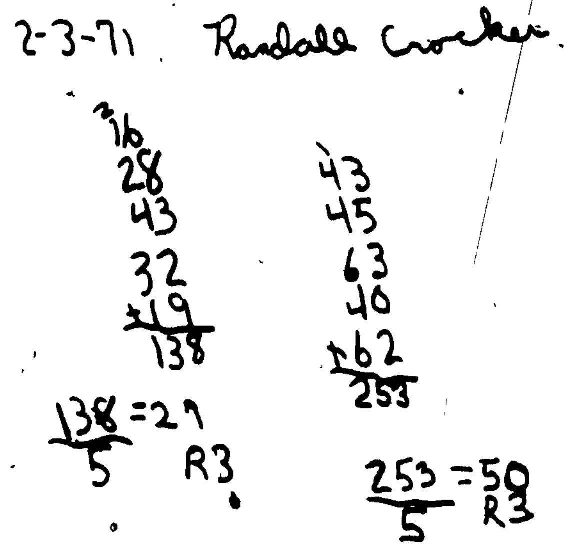
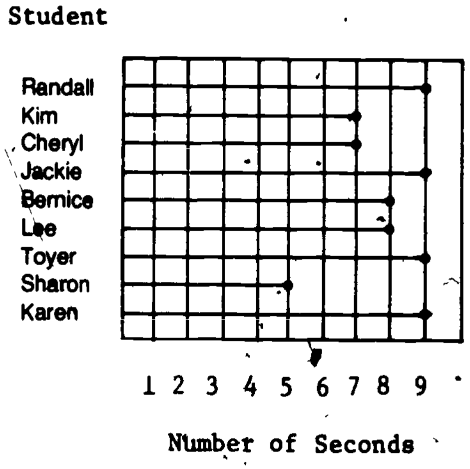


Figure C2-4

The children were also asked to find their average crossing time by looking at a graph previously drawn on the board:



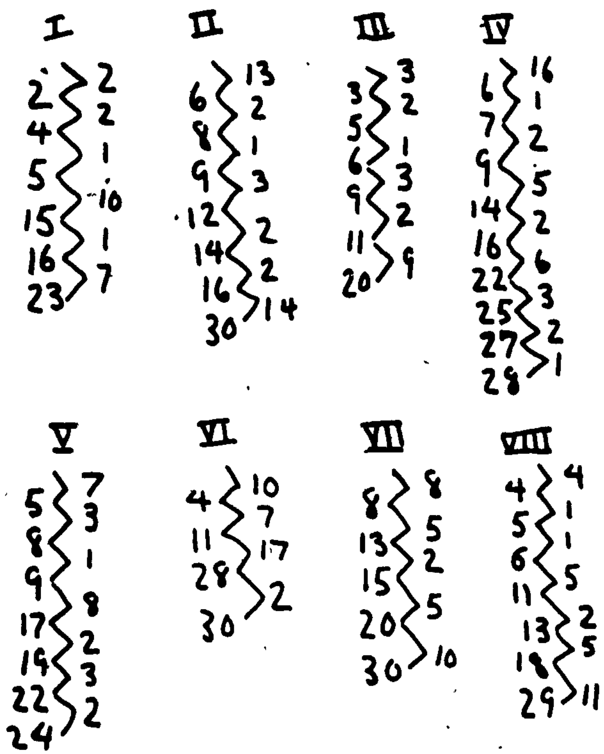
As expected, most children were unable to estimate simply by examining the graph. They found the average by adding and dividing as they had done with the number of cars crossing the three intersections.

The following week data collected at Spring Road and New Hampshire Avenue was used to extend the children's ability to construct graphs. We asked the children how many seconds it took each one to cross and wrote those numbers on the board:

8	9	10	8
7	7	8	7
10	6	9	8
10	8	10	9
10	10	9	6

The children were asked, How many children crossed the street in six seconds? They responded, two children. How many crossed in seven seconds? They responded, three; eight seconds, five children; nine seconds, four children; ten seconds, six children.

Each child was given a piece of graph paper and asked to rule from 1 to 10 on each axis. The horizontal numbers would represent seconds; vertical numbers would represent the number of children that crossed the street. They were



Left columns show arrival times; right columns show gap times. The first gap time in each column includes the remainder of thirty seconds left in the previous column.--ED.

Figure C2-6

asked to find on the vertical axis the number of children crossing, to follow that line across the paper, and to stop at the number on the horizontal axis showing the seconds it took them to cross. When this was done for all the numbers, the children shaded in their bars with crayons. Referring to the histogram, they answered these questions: How many children crossed the street in nine seconds? They responded, four children. How many crossed in six seconds? They responded, two children; ten seconds, six children; seven seconds, three children; eight seconds, five children. What is the total number of people that crossed? The children replied, twenty people. A sample histogram is shown in Figure C2-5.*

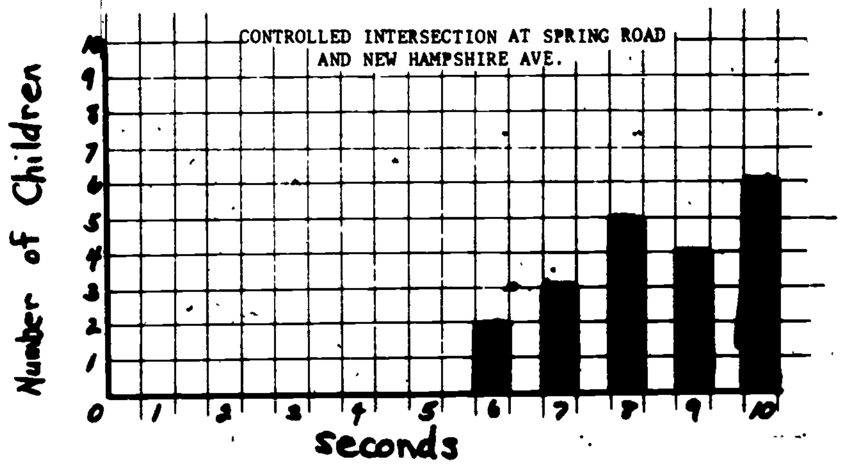


Figure C2-5

Two weeks later, starting on a Monday, the children again visited the intersection at Spring Road and New Hampshire

*At some point in the unit the children will have to calculate the average or median time needed for a person to cross the street in order to apply this data to the problem of finding out whether a control is needed at the intersection. The median crossing time is much easier to find than the average; for the above data it is the 10th crossing time in order of size, namely 8 seconds. A comparison of this median crossing time and the median gap time between cars is a good basis for planning a control. --ED.

1. 9
2. 15
3. 6
4. 1
5. 5
6. 1
7. 3
8. 2
9. 1
10. 3
11. 1
12. 0
13. 1
14. 1
15. 0
16. 1
17. 1

50 cars

There are actually fifty-one cars in this list. --ED.

Figure C2-7

Avenue (an intersection with a stop sign) each day at 1:00 p.m. for the week. They used a stopwatch to record data on arrival times of cars during a four-minute period at the crossing across from the stop sign. Each day, after returning to the classroom, the data on arrival times was put on the chalkboard and gap times were calculated by subtracting successive arrival times. The data given in Figure C2-6 is for Thursday of that week.

Once gap times were calculated, the children had to tally to see how often each gap occurred. They found the largest gap time, numbered on the chalkboard from one to that number, and proceeded to tally as shown in Figure C2-7.

Each child was given a piece of graph paper to make a picture showing the gaps in traffic for that day. One student's histogram is shown in Figure C2-8.

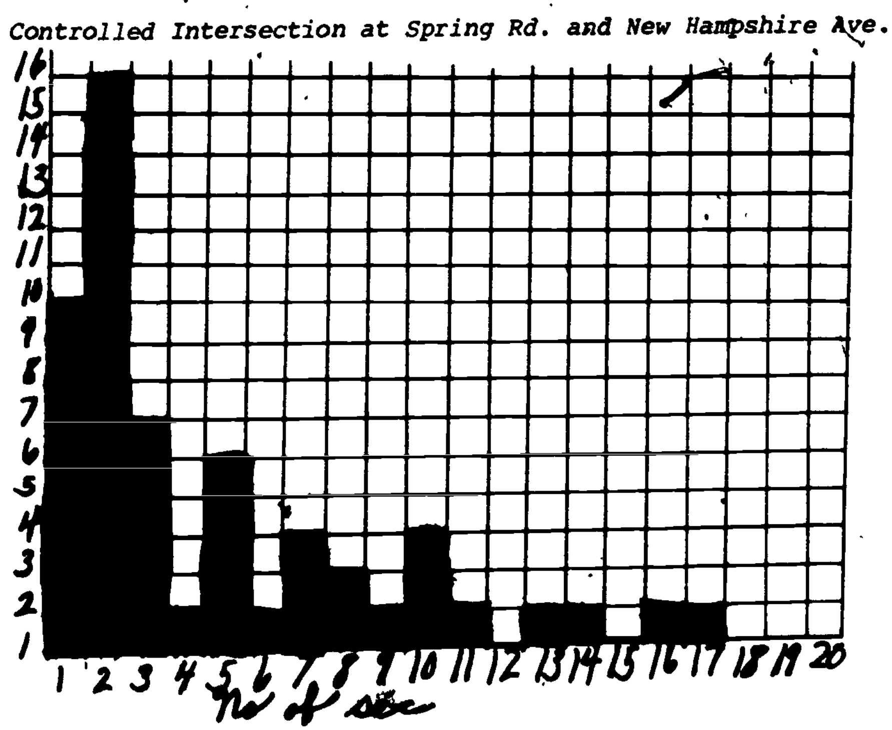


Figure C2-8

1	2	2	5	10
1	2	2	5	10
1	2	3	5	11
1	2	$\boxed{3}$ → median	6	13
1	2	3	7	14
1	2	3	7	16
1	2	3	7	17
1	2	3	8	
1	2	4	8	
2	2	5	9	
2	2	5	10	

Figure C2-9

We followed this procedure each day for the week, waiting until Wednesday to introduce the concept of median. After the children's graphs were completed, we asked them to look at all the gaps and see if they could tell which number would be the middle number. They made several guesses. How could we find out for sure? One suggestion was to look at the numbers and pick the middle number. After some discussion we introduced and explained the concept of median (see Glossary). The children suggested that we write down in order all the numbers, counting to find out how many we had. The number in the middle would then be the median. Thursday's data is shown in Figure C2-9.

The fact that there were a number of items in our list presented a problem. The class decided that if the numbers in the middle were the same, then we could use either number. The medians for the five days were all three seconds.

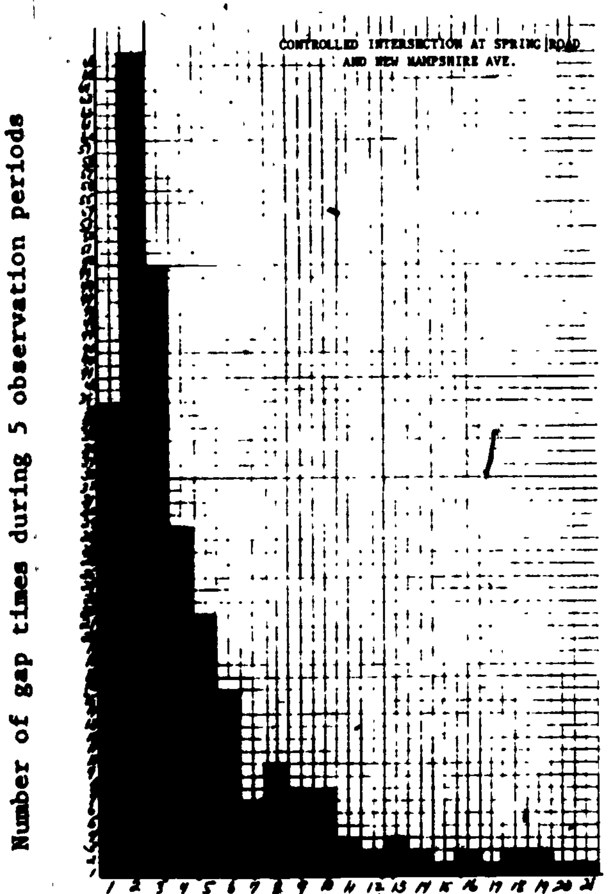
In comparing their crossing times with gap times, the children realized by looking at the daily histograms that there were several gap times equal to or larger than 8 seconds when they could cross the street.*

The following week the class wanted to make a large histogram showing what traffic looked like at 1:00 p.m. for four minutes during the five-day period. Each day's tally of gap times was put on the board and totalled to obtain a cumulative frequency:

---

*To make a recommendation for a traffic control for the intersection, the children will want to find out if the traffic pattern varies according to the day and to determine an average pattern. A certain gap time or range of gap times could be studied. Since the median crossing time was 8 seconds, a range of gaps of 8 seconds or more would indicate possible crossing opportunities. A question to ask the student is, "About how long do you have to wait for a long enough gap to cross?" The number of gap times of 8 seconds or more for five days from the chart on the next page is as follows: Monday, 8 gaps; Tuesday, 10 gaps; Wednesday, 10 gaps, Thursday, 11 gaps; Friday, 3 gaps. When these numbers are arranged in order of size (3, 8, 10, 10, 11), the median number is the third: 10 gaps. That means that on most days a person who takes 8 seconds to cross the street would have ten opportunities during the observation period of four minutes at 1:00 p.m.

The children might also compare gap times and crossing times by making a slope diagram. (See Glossary and "How To" Cards.)--ED.



Gap times in seconds

Controlled Intersection at Spring Road and New Hampshire Ave.

Figure C2-10

	Mon.	Tues.	Wed.	Thurs.	Fri.	TOTAL
1 sec.	5	+ 4	+ 11	+ 9	+ 9	= 38
2	16	10	16	15	9	66
3	14	11	10	6	8	49
4	7	5	6	1	9	28
5	7	2	5	5	2	21
6	5	3	5	1	1	15
7	1	1	0	3	1	6
8	3	1	2	2	1	9
9	0	3	2	1	1	7
10	1	0	3	3	0	7
11	1	1	0	1	0	3
12	0	1	0	0	1	2
13	0	2	0	1	0	3
14	0	0	0	1	1	2
15	1	0	0	0	0	1
16	0	0	1	1	0	2
17	0	0	0	1	0	1
18	1	0	1	0	0	2
19	0	2	0	0	0	2
20	0	0	1	0	0	1
21	1	0	0	0	0	1
	m=3	m=3	m=3	m=3	m=3	266 cars

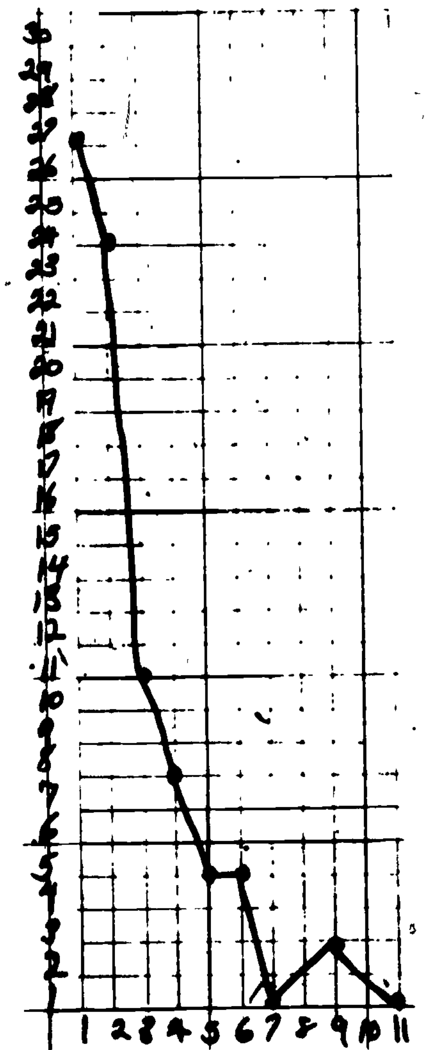
The actual histogram the class made is too large for reproduction here, but a small version appears in Figure C2-10. The class reviewed the meaning of median and agreed that with numerous pieces of data the median is easier to calculate than the average.

The principal attended this session and expressed concern about the safety of the intersection at Spring Road and New Hampshire Avenue. She agreed to take a report on this situation from the students to higher authorities to see if something could be done about the problem.

Since most of our data so far had been collected at Spring Road and New Hampshire Avenue, an intersection controlled by a stop sign, we decided to make a survey of an uncontrolled intersection, 13th and Otis Streets. The children had pinpointed this intersection as particularly bad because it is at the bottom of a hill down which cars speed. Our objective was to write and forward another report to the Department of Traffic in Washington, D.C., to see if we could get some type of control for this intersection.

We spent five lunch hours at 13th and Otis timing car arrivals for four minutes at the intersection. We followed the same procedure as described for Spring Road and New Hampshire Avenue, calculating and tallying gap times and finding the median when we returned to the classroom each

Day Four Gap Times at 13th and Otis Streets



Jacqueline Richardson

Figure C2-11

day. The following data shows cumulative frequency of gap times at 13th and Otis Streets, an uncontrolled corner, at 1:00 p.m. for four minutes over a five-day period:*

	Mon.		Tues.		Wed.		Thurs.		Fri.		TOTAL
1 sec.	16	+	30	+	5	+	27	+	11	=	89
2	14		18		12		24		32		100
3	5		10		9		11		7		42
4	4		3		5		8		11		31
5	2		5		4		5		4		20
6	2		6		3		5		3		19
7	2		0		4		1		0		7
8	0		0		2		0		1		3
9	1		0		2		3		1		7
10	1		0		2		0		0		3
11	3		1		3		1		0		8
12	1		0		0		0		0		1
13	0		0		0		0		1		1
14	1		0		0		0		1		2
15	0		0		1		0		0		1
16	0		0		0		0		1		1
17	0		0		0		0		0		0
18	0		0		0		0		0		0
19	0		0		0		0		0		0
20	0		0		0		0		0		0
21	0		0		0		0		0		0
22	0		0		1		0		0		1
23	1		0		0		0		0		1
24	1		0		0		0		0		1
	m=2		m=2		m=3		m=2		m=2		338 cars

Rather than making histograms of the information, the children made line charts such as the one shown in Figure C2-11.

*This data can be compared with the data from the controlled intersection by noting that the median gap time for each day is 2 seconds compared to the median gap time of 3 seconds for the intersection with the stop sign. Another comparison can be made by finding the median number of gaps equal to or more than the median crossing time for the five days. Assuming that the median crossing time is again 8 seconds, the number of such gaps for the five days are respectively, 9 gaps, 1 gap, 11 gaps, 4 gaps, 5 gaps. The median number of gaps equal to or more than 8 seconds is 5. This means that a person would have only five opportunities to cross this uncontrolled intersection in the observation period of four minutes.--ED.

We compared daily line charts of 13th and Otis with histograms made several weeks earlier of Spring Road and New Hampshire Avenue, discussing differences in frequency of gap times between the controlled and uncontrolled intersections and what that might mean for the pedestrian attempting to cross.

The children organized their statistics and sent them along with a letter to the city Department of Traffic. Before the end of the school year, the traffic department sent a representative to talk with the children about their proposed changes. The official told the class that since the uncontrolled intersection at 13th and Otis Streets was located at the bottom of the hill, it would not be feasible for cars to stop in time for a traffic light at the speed they would be travelling. He suggested that the class should inform other children in the school to cross at the next intersection, which had a traffic control and was therefore considerably safer.

3. LOG ON PEDESTRIAN CROSSINGS

by Janet Sitter*
Allen Street School, Grades 4, 5
Lansing, Michigan
(November 1971-June 1972)

ABSTRACT
In their study of a busy street and a controlled crossing near their school, this class first counted the number of cars passing in each direction on two different streets and compared the median and average number of cars for each street. They discussed representing the data on a pictograph but decided a bar graph was more accurate. They measured student crossing times, both for individuals and groups, and compared the median and average times with the time the WALK light was on. They represented the data on both bar graphs and line charts. In the Design Lab they constructed trundle wheels that were used to obtain measurements of the crossing area for the scale model that the class later constructed. They discussed their methods of measurement and the accuracies of each and constructed a conversion chart for measurements. They listed suggestions to make the crossing safer, including a pedestrian overpass, and discussed the advantages and disadvantages of their recommendations with local policemen. The class decided that further study was needed and that lengthening the duration of the WALK light was the best alternative for the expense involved.

During about six months of the 1971-72 school year, my class of fourth and fifth graders worked on the Pedestrian Crossings challenge. We normally worked in forty-five minute sessions, three times a week.

We started by discussing Kalamazoo Street, which is the street most children have to cross to get to school. The children argued about whether or not Kalamazoo Street was a "busy" street. They decided that in order to judge, they would count the number of cars which traveled the street. They suggested also counting the number of cars on Michigan Avenue, the main street in town and a six-lane road. The two sets of data could then be compared.

*Edited by USMES staff

Before going outside we discussed how we wanted to collect and record the data. The children decided to break into four groups so that two groups could count the cars in each direction and check the accuracy of each other's counting. We also discussed recording the date, time, and location each time we collected data.

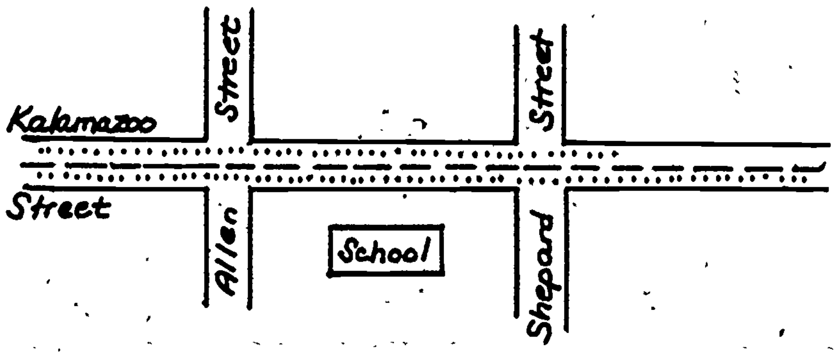
Once outside, two groups stationed themselves about 500 feet apart on the north side of Kalamazoo Street and counted the cars heading west, while the other two groups stood 500 feet apart on the south side and counted the traffic traveling east. After counting for thirty minutes, we went back to school and examined our data.

The children were upset to discover discrepancies in the totals. One group keeping track of cars going west counted fifty-two and the other counted forty-one; the groups counting traffic heading east counted seventy-nine and fifty-six. After some discussion it became apparent that the groups were using different criteria to decide whether or not to count a vehicle. For example, some groups counted bicycles and some counted cars as soon as they appeared, even though they sometimes turned before reaching the children. The class then discussed how they could be more accurate when collecting data in the future.

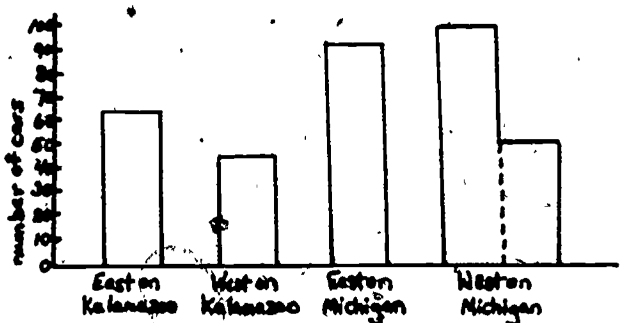
The children discussed what to do with the two figures they had for each direction and decided to take the middle number (median). Then we talked about averages, and they decided that taking an average would be better in this case. They found the averages to be forty-seven cars heading west and sixty-five cars heading east during the half hour of observation. They discussed why more cars were traveling east; the university, the freeway, and the shopping center were offered as likely destinations.

The following day, the children counted cars on Michigan Avenue. They were better organized and counted more accurately. They counted a total of 249 cars during a half hour's observation, 96 traveling east and 153 traveling west. They compared these figures with the totals for Kalamazoo Street and concluded that although Kalamazoo was busy, Michigan was still busier. They enthusiastically agreed with the child who commented, "And now we know for sure; we have *proof*!"

Back in the classroom, the class discussed ways of presenting their data. The children first suggested drawing a street with forty-seven cars heading one way and sixty-five cars heading the other. After discussing the difficulty of drawing so many cars, they suggested representing each car with one dot and had the teacher drawing the following picture on the blackboard:



The children were dissatisfied with this picture of their data. They commented that the dots were confusing and required as much work as writing out the information. Finally, several students suggested making a graph. After much discussion, they settled on a bar graph like this:*



*The children might discuss whether another scale on the vertical axis would show the data more clearly. This problem arises in many USMES units. See Background Paper, GR 3 *Using Graphs to Understand Data*.--ED.

The class discussed the controlled crossing at Kalamazoo and Shepard Streets, focusing on why they felt it was unsafe and what they thought could be done to improve it. They were certain the light was not long enough to allow for crossing safely. They estimated crossing times, but their guesses were widely divergent and considerably off base. For example, here are some of their *estimated* crossing times:

Roger	1 second
Kevin	5 minutes
Lydia	1 minute
Mary	30 seconds

Finally, they agreed that they should find out how long it actually took to cross by timing each other. They felt that they ought to time the light as well.

The discussion progressed to things that help us cross safely. The list included the following items:

1. Traffic lights.
2. WALK - DON'T WALK lights.
3. Traffic signs such as "Stop" and "Yield."
4. Crosswalks.
5. Crossing guards or policemen.
6. Skywalks (pedestrian overpasses).
7. Pedestrian tunnels under the street.

After using the "How to Use a Stopwatch" cards to learn about stopwatches, a group of children went outside to time each other crossing the street and to time the light. They discovered that while the WALK sign was on for eight seconds, three of the eight children in the group took longer than that to cross. Here is the crossing time data they gathered:

Barbara	10 seconds
Monte	9 seconds
Fred	8 seconds
Vicky	9 seconds
Sheila	7 seconds
Ernie	8 seconds
Jim	8 seconds
Mary	7 seconds

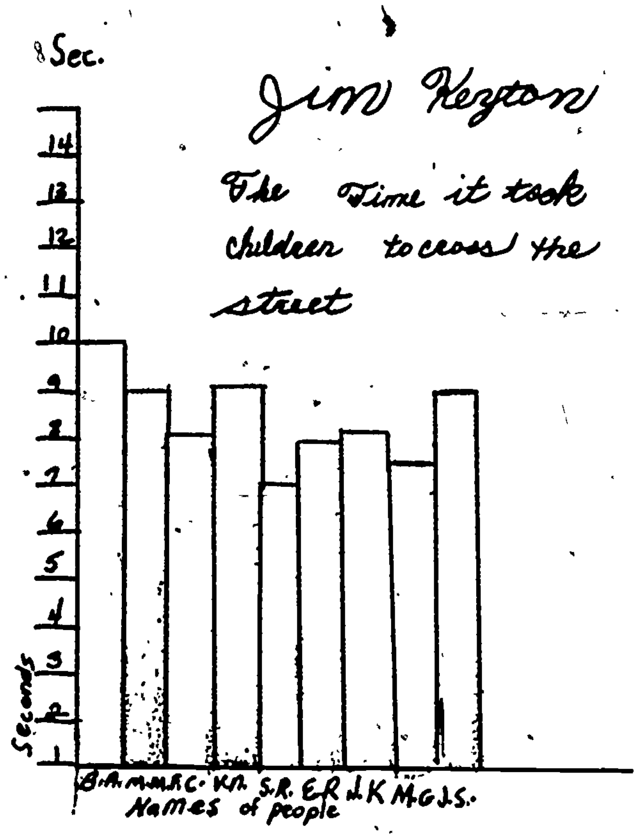


Figure C3-1

The next day another group timed each other as they crossed Kalamazoo Street and obtained similar results.

After examining both sets of crossing time data, the children computed the median and the average and discussed the difference between the two. They felt that finding the median was easier. They discovered that the median crossing time was 8½ seconds and the average, 8 8/19 seconds, both slightly more than the time the WALK sign stayed lit. Then each child graphed the crossing times for his group and wrote an explanatory "white paper" to accompany the graph. They knew what data they wanted to include in the graph, but only after much discussion did they figure out how to set it up. Figure C3-1 shows one of their graphs of individual crossing times.*

While discussing the crossing time data, the children observed that a group of children would take longer to cross than an individual and that groups crossed daily in the morning, at lunch time, and in the afternoon when it was time to go home. They decided to time each other crossing in groups and also to time groups of other children as they crossed on their way home.

The class went out to the intersection and timed groups ranging in size from one to six children. Here is their data:

1 person	9½ seconds
2 people	8½ seconds
3 people	10 seconds
4 people	10½ seconds
5 people	9½ seconds
6 people	13½ seconds

In the classroom they graphed their results and wrote accompanying "white papers". One child's line graph of these group crossings is shown in Figure C3-2.

The children also timed groups of different numbers of students crossing Kalamazoo Street after school ended the next day. They figured that the average number of children in a group was ten and that the average crossing time was 10.4 seconds.

*The children might pool their data and construct a bar graph of the number of children versus crossing time.--ED.

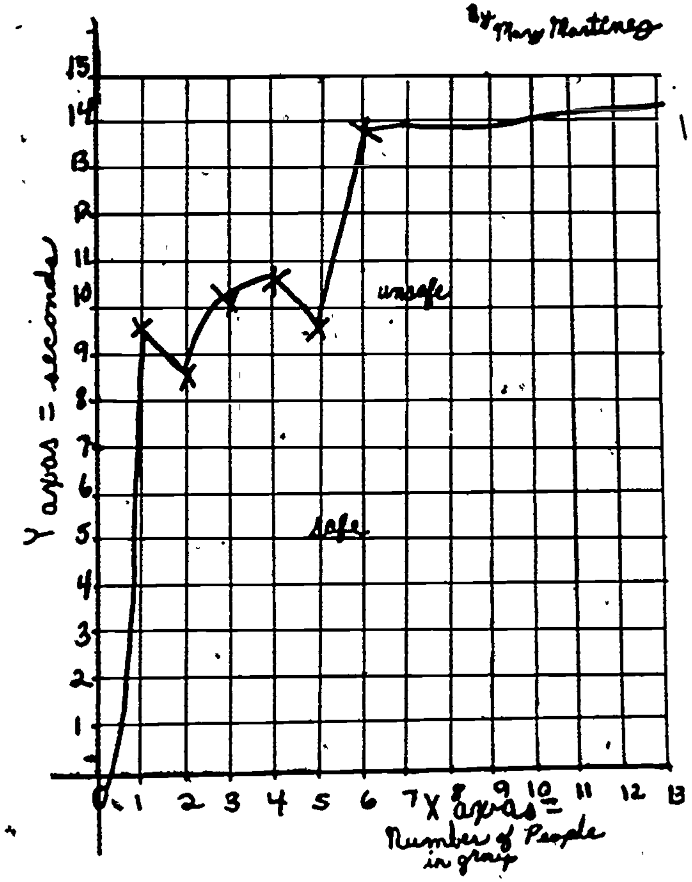


Figure C3-2

Here is the data they collected on these groups:

Group	No. of Children	Time (seconds)
1	5	4
2	8	8
3	12	5
4	11	12
5	13	15
6	15	16

They made graphs of these crossing times, also.*

Looking over the data they had collected, the children concluded that their initial hypothesis was correct: the crossing was not safe. They then turned their attention to how to make it safe. Their suggestions included:

1. Build skywalk over street to replace light.
2. Build skywalk at Kalamazoo and Allen (one block west).
3. Build under-road passageway.
4. Make WALK light longer.

The disadvantages of each suggestion were discussed. The children decided that problems with the skywalk were:

1. Some children would be afraid to use it and would cross the street anyway.
2. Some children would push and shove as they used it and someone might fall off.
3. Some people can't climb stairs.
4. It could break.

Disadvantages to the tunnel were:

1. It would be dark and people would be afraid to use it.
2. Dope pushers and muggers might hang out there.
3. Some people can't climb stairs.

*The children might look for a way to present both sets of data on one graph. See Background Paper, GR4 *Representing Several Sets of Data on One Graph*.--ED.

Finally, making the light longer had the following problems associated with it:

1. Cars would anticipate the light change and move too soon anyway.
2. When only one person had to cross, cars would have a long wait for no reason.
3. Too many cars would be lined up waiting to move.

One child suggested that we ask the other children in the school which of the three alternatives they preferred. Another child proposed that we make a drawing or a model of the area, including the skywalk, the tunnel, and the traffic light so that we could show the other classes what we were talking about. The other children liked the idea of making a model. They began to think about how to measure distances outside so that they could construct a model to scale. They discussed using rulers, yardsticks, tape measures, and string to measure distances, and then talked about what sorts of things should be measured outside.

The children's discussion about how they could measure the width of Kalamazoo Street went like this:

S: Use a tape measure!
S: That's too short.
S: Tie some together.
S: That's too hard and no good for measuring.
S: How about yardsticks?
S: Are you kidding? We'd get killed it'd take so long.
S: I got it! Tie a string around a pole on one side and then pull it across and tie around a pole on the other side. Then measure the string.
S: No good! The cars would break it when they went by.
S: Put the string up high so they can go under it.
S: What about trucks and buses then?
S: So use a ladder and get way up.
S: Never mind the poles. When you tie it to a pole you make it longer than the street.
S: That takes too long.
S: I know! One person holds one end on one side and someone else walks across the street with the other end. Then put the string down and let the cars go over it until the light changes again and then you can wind it up.

S: Then what?
S: Bring it back into the room and measure it!
Others: Okay!....Guess so....That's the best idea yet.

The next day I brought in a trundle wheel, and it didn't take long for the children to figure out what it was for. They examined it thoroughly and then measured the room and hall. Then they decided to make trundle wheels in the Design Lab and use them to measure distances outside.

The children worked on making trundle wheels in the Design Lab for several weeks. After cutting circles out of Tri-Wall they measured around them using different materials. They started using yarn and string but noticed that it stretched and gave different measurements each time. One student then suggested using wire, and they all agreed it was best. Most of the circles were within a half inch of thirty-six inches, but the children were not satisfied, so they planed and sanded them down. After attaching the circles to the stick handles and trying them out, the children discovered that some of the wheels were wobbly. They decided that they had made the axle holes too big, and they drove pegs through the holes alongside the axle to correct the problem. One student also tried to find a way to attach a counter to the trundle wheel which would automatically keep count of the number of revolutions.

A group of children also worked on making angle finders in the Design Lab to use while gathering measurements outside for their scale model of the school area. They looked at the cards on "How to Find the Height of a Building or a Tree" for information on possible methods of measuring high objects. Then they worked on making several angle finders.

The children worked in the Design Lab about once every two weeks for an hour or so. They finished their trundle wheels and angle finders in about five sessions--or ten weeks.*

During several sessions two groups of children experimented with different measuring devices outside.** One

*More time in the Design Lab is recommended at certain periods during the unit so that the children's data collecting plans are not held up for lack of measuring tools. --ED.

**The children might discuss which devices were accurate as well as easy to use. See Background Paper, *Determining the Best Instrument to Use for a Certain Measurement* for details on a way to compare accuracy of different measuring tools.--ED.

group measured the north side of Kalamazoo Street between Allen and Shepard with a trundle wheel and then with two yardsticks. The other group measured the south side using a trundle wheel and then string. They gathered four slightly different measurements and encountered some difficulties with each device.

The group using yardsticks had trouble remembering to keep track of how far they had measured before moving the sticks. They measured the distance to be 96 yards 30 inches. The other group found that their string was not long enough to measure the entire distance. Finally, they decided to pull the string as far as they could and mark that spot, then lay out the string to the end and mark the distance on the string. They measured the string, added the figures and got 97 yards 23 inches.

The screw which clicked off the rotations on the trundle wheel came out, and the children couldn't get it back in so that it would click. They solved this problem by carefully keeping track of each time the screw passed the metal strip on the wheel, since they knew this was the point where it would have clicked. The group on the north side measured 91 yards 18 inches and the south side group, 92 yards 20 inches. At this point, one boy examined the trundle wheel and announced that it really measured 37 inches instead of 36 inches at each rotation. The others carefully looked over the trundle wheel and finally concurred. They next tried to correct their trundle wheel measurements. After much discussion they decided that since it was really measuring one yard and one inch each time, they had 91 inches too many in one case and 92 inches too many in the other. They had a hard time deciding whether to add or subtract these amounts, but finally subtracted.*

After examining the measurements taken by the different measuring methods the children discussed how each method was inaccurate. One child suggested taking an average of all measurements for each side of the street. The other children agreed that this would best represent the real distances. They figured the averages to be 94 yards 18 inches

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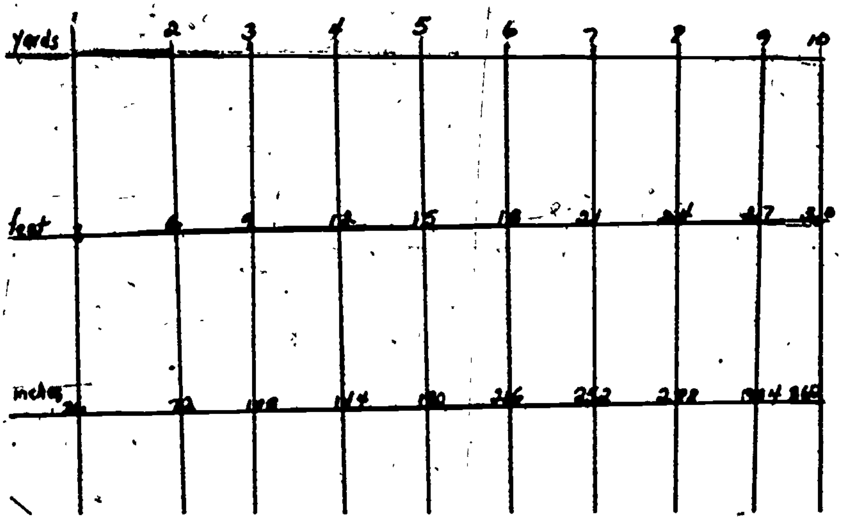
*If the wheel had been 36" in circumference instead of 37", it would have turned more times to cover the same distance. Therefore, their distances are too short: the 91 and 92 inches should be added, bringing the trundle wheel measurements closer to the string measurements.--ED.

(south side) and 94 yards 12 inches (north side). This activity required good reasoning and figuring on the part of the children.

Before beginning the scale model of the area outside, we worked for several weeks on a floor plan, drawn to scale, of our classroom. The children measured the room and the furniture. After measuring, we began talking about converting measurements from one unit of measure to another. Since the children had a hard time conceptualizing conversions, we made tables like the one below which showed the equivalencies between inches, feet, and yards. The children used the charts to practice converting the measurements they had taken around the room from one unit of measure to another.



After becoming experienced in converting measurements, the children examined the large paper they were going to use for the floor plan and discussed what scale to use. Students suggested having one block equal one inch or one yard, but others protested these choices as too small or too large. Finally, after carefully considering the dimensions of the room, they decided to have one block represent one foot. They discussed the fact that each block measured one inch in the paper and made the following distinctions:

1 block equals 1 inch
1 block represents 1 foot
1 inch represents 1 foot

They converted the room measurements to feet and cut their paper to the right size. They pasted the paper onto cardboard and began converting the original measurements from yards or inches to feet and fractions of feet. Then, using their scale, they changed the converted measurements to blocks (inches), measured these dimensions on an appropriately colored piece of construction paper, and cut out the scale representation of the pieces of furniture. When they had inches left over after converting an original measurement into feet, they divided a block into twelve equal parts, and counted off as many parts as they had inches to find the right measurement. As they finished each piece of furniture they commented on its size. They thought most were too small until they discovered that when they placed several beside each other on the floor plan, the pieces looked right after all. They developed a sense of proportion in this way.

The children located the north, south, east, and west sides of the classroom and the NE, NW, SE, and SW corners. They labeled their floor plans and began using the direction when talking about the location of the different pieces of furniture in the room. They played guessing games using the directions as clues to particular student, desk, blackboard, etc., they were thinking of.

The children used the same measuring, converting to feet and scaling to blocks (inches), sequence that they had used to make the furniture in order to accurately locate the pieces on the floor plan. The project turned out to be very time-consuming; although we were proud of the results, we grew anxious to return to the real issue of pedestrian safety. The children said they wished they could have started on an outdoor model immediately, but they weren't sure if they could have handled it without the knowledge gained from working on the classroom floor plan.

Two police officers visited the class. They showed a film on pedestrian safety and then asked the children about their work. The children told them that the crossing in front of the school was not safe, that the average person took slightly longer to cross than the length of time the WALK light was on, and that groups often took considerably longer. They pointed out that having the light timed for the "average" person may mean high risks for quite a few people. The police explained that a person has time to finish crossing when the DON'T WALK sign is flashing, and that it is not safe to cross only when the DON'T WALK sign is constant and not flashing. We had not realized that the WALK--flashing DON'T WALK sequence was timed with the red traffic light and the solid DON'T WALK sequence with the green. The children decided the crossing was not as dangerous as they thought, but suggested collecting new data to be sure. The police officers also discussed the children's proposed solutions to the problem. They told them that a skywalk costs about $30,000 and that a tunnel would be even more expensive since it would have to go under the sewers. The officers told them that changing the timing on the traffic light would be the most practical solution, and they discussed changing it only during school hours. The children understood the realities of the situation and enjoyed a spirited discussion with the officer about the crossing and pedestrian safety in general.

Inspired by their discussion with the police officers, the children worked hard making a model of the controlled crossing at Kalamazoo and Shepard Streets. They scaled down the street measurements taken outside at the crossing, built the model out of Tri-Wall in the Design Lab, and added toy cars, trees, and figures. Using their model the children took turns simulating pedestrians crossing the street and cars stopping at lights for different light sequences. In this way they hoped to arrive at a light sequence that would provide a long enough WALK light for everyone to cross but not too long a red light for waiting cars. The year ended, however, before the children could complete their trials and make their final recommendations for changing the timing of the WALK light.

4. LOG ON PEDESTRIAN CROSSINGS

by Robert Farias*
Adams School, Grade 6
Lexington, Massachusetts
(September 1971-April 1972)

ABSTRACT

This class worked on several different aspects of the Pedestrian Crossings challenge. They measured the crossing under study and constructed a scale model of the area. They measured the gap times of cars and the crossing times of students, displayed the data on histograms, and calculated the average times. The class then discussed the implications of the average gap times for pedestrian crossing times. During this time the students also surveyed the number of cars that signaled for a turn at the intersection. They constructed signs asking drivers to use their turn signals and noted a marked increase in those doing so. After a discussion of traffic and safety rules with a local policeman, they wrote to the state traffic survey team. From their reply, the students found that they had followed most of the proper procedure for traffic survey. However, they found that signs asking drivers to signal for turns were not posted. They decided to extend their investigation to cover all four intersections near the school, collecting data on them, comparing their results, and discussing reasons for any differences. Working in the Design Lab, they constructed a model traffic signal and trundle wheels to measure distances. Using their scale model, scale model cars, the traffic signal, and traffic signs that they had made, the students made a videotape on pedestrian safety for the lower grades. In addition they made, edited, and voice dubbed a film on their methods of safe data collection. They finished by making a survey of traffic in the school driveway and parking area and submitted their recommended changes to the principal.

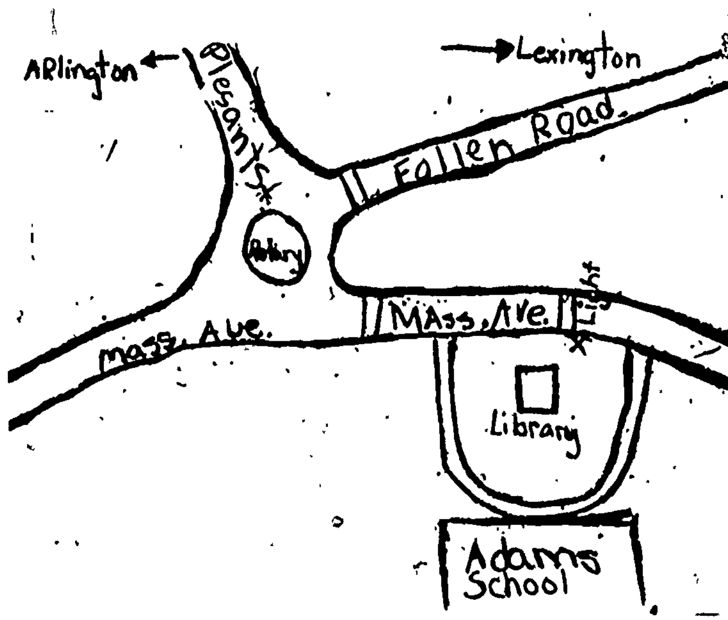


Figure C4-1

During the first half of the 1971-1972 school year, my sixth-grade class worked almost daily on exploring the problems of pedestrian crossings. We began by discussing what routes children used to walk to school and what problems

*Edited by USMES staff

they encountered crossing streets along the way. We talked about the crossing in front of the school and the busy intersection 100 feet away. The children were eager to investigate and try to solve the problems they thought were involved. They went out and examined the area and then suggested three factors which make crossing safely difficult at times:

1. speed of cars,
2. number of cars,
3. time of day (heavy/light traffic).

The discussion led to how they might make the school crossing safe and how they might prove that it wasn't safe. Suggestions included gathering information on:

1. the number of cars going by in one minute,
2. the crossing time of pedestrians,
3. the number of cars using their blinkers when turning,
4. the timing of the traffic light.

The children decided to divide into groups to investigate different aspects of the problem.

After the first visit to the crossing all the children made diagrams of the school area such as the one in Figure C4-1. One group then decided that they wanted to make a scale model of the area, and they spent about three weeks on this activity. First, they went to the "How To" Cards on scaling for information. When they first went out, they measured distances at the crossing with their feet, but then they realized that they needed more accurate measurements. They discussed different measuring devices and afterwards went out and used rulers, yardsticks and balls of string. When they compared their data, they found big differences. This led to a discussion of the need to be accurate when measuring and the accuracy of different measuring devices for different purposes. They measured the distances outside again with the same devices until they were substantially in agreement. After recording the measurements they discussed what scale to use and decided on 20 feet $\leftrightarrow$ 1 inch. They drew a blueprint for the model and then began making the model itself out of Tri-Wall and papier mache. Other children expressed a desire to make their own models. The scaling group briefed them on scaling procedures. The children then took measurements of the class model and made their own models one-fourth of the scale of the class model.

Another group decided to time the gaps between cars traveling through the intersection. They used the "How to Use a Stopwatch" cards and discussed how to record the gap times. During the next several days they went out to the intersection once a day for about 45 minutes. While two small groups recorded the arrival times of cars traveling along Massachusetts in one direction, two other groups did the same for the traffic heading the other way. Back in the classroom they subtracted the arrival times to get gap times, tallied the gap times, and then made bar graphs of them. Figures C4-2 and C4-3 are examples of their tally sheets and bar graphs. The upper figure is part of one child's tally sheet; it shows arrival times on the left of each double column of figures and the gap times figured on the right of the column. The lower figure is a histogram of tallied gap times for one day's observation. Shown in Figure C4-4 is part of another tally sheet; it shows how some children tallied the number of gap times of different lengths.

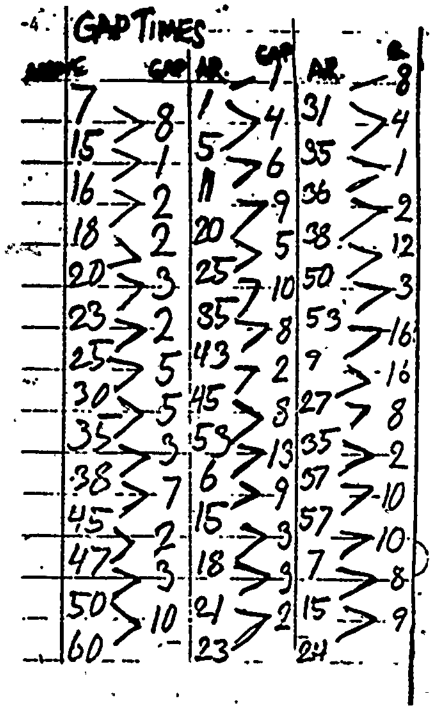


Figure C4-2

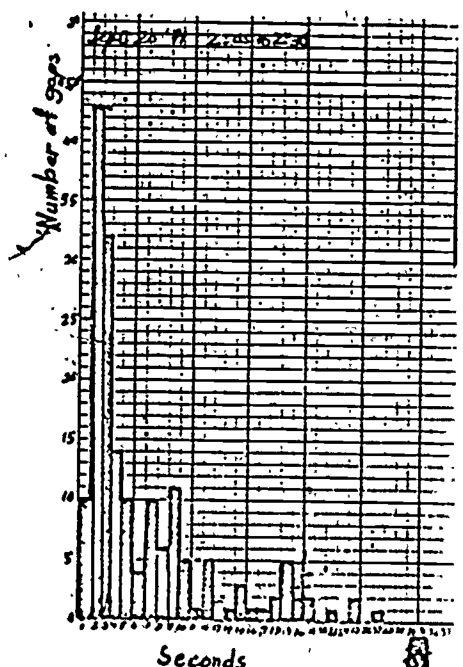


Figure C4-3

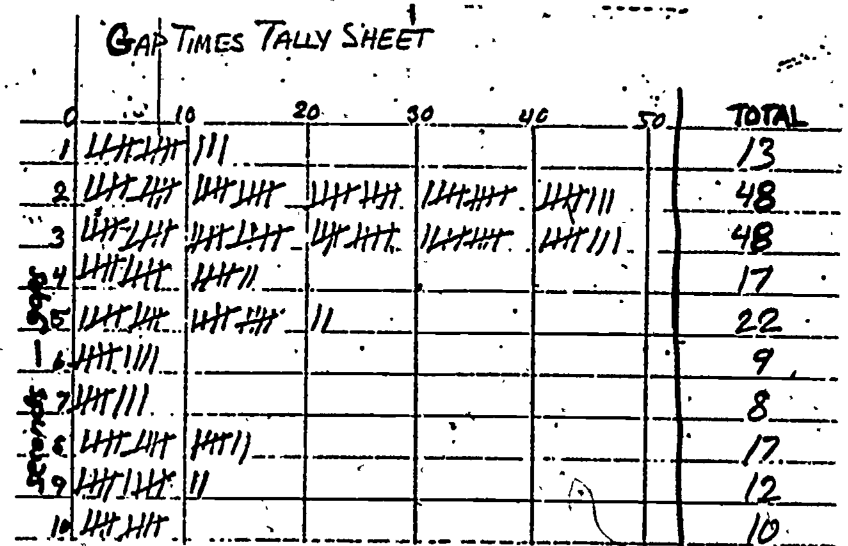


Figure C4-4

After examining the data and calculating averages, the group reported to the class that 70% of the gap times were less than five seconds. In the course of the class discussion, the children came to realize that this meant the crossing times of pedestrians would have to be a lot less than five seconds in order for the crossing to be considered safe. The gap time group then decided to investigate crossing times. They timed each child as he or she crossed and then figured the average crossing time. Here is the data they gathered:

Duane	10 secs.
Laurie	9
Jason	7½
Fenley	9½
James	7½
Brenda	10
Debbie	6½
Sandra	9
Dawn	6

They reported that the children took an average of 8-1/3 seconds to cross. They also timed the traffic light at the school crossing and reported that the red-and-yellow WALK signal remained on for 13 seconds, giving children enough time to cross the street.

While measuring gap times and distances at the crossing, the children noticed that cars often did not signal before they turned off Massachusetts Avenue onto Pleasant Street. They felt that this was an important problem, and a new group was formed to record the number of cars that signaled and the number that did not. Observing for short periods daily for one week, they discovered that out of 257 cars turning left at the intersection, 100 (or 41%) did not use their blinkers or hand signals. Out of 458 cars turning right at the intersection, 247 did not signal.* This is the data they collected over a five day period.

*The children might check to see if the difference in traffic flow at various times of day affected the use of blinkers.--ED.

Arlington to Lexington	Time	Did Use Blinker	Did Not Use Blinker
Sept. 15, 1971	1:35 - 2:05	35	28
Sept. 16, 1971	9:40 - 10:10	30	13
Sept. 17, 1971	1:30 - 2:00	39	27
Sept. 20, 1971	2:10 - 2:40	25	15
Sept. 21, 1971	1:45 - 2:15	28	17
		157	100

Lexington to Arlington	Time	Did Use Blinker	Did Not Use Blinker
Sept. 15, 1971	1:35 - 2:05	42	49
Sept. 16, 1971	9:40 - 10:10	36	51
Sept. 17, 1971	1:30 - 2:04	62	68
Sept. 20, 1971	2:00 - 2:30	30	37
Sept. 21, 1971	1:40 - 2:10	31	42
		211	247

Because of the location of the traffic island at the intersection, the children were not sure that the drivers turning right on Pleasant Street were required to signal. They decided to disregard the data that they had collected on the traffic turning right (Lexington to Arlington traffic) until they had looked up the traffic law. They were still concerned about the number of cars which did not signal when turning left. Consequently, they decided to experiment to see if they could get more drivers to use their signals. They made two signs which read "Please use your blinkers" and held one 100 yards and one 20 yards before the intersection. After collecting data for three days, the children reported to the class that when the signs were held, 95% of the drivers signaled before turning.

After the safety officer's visit, the class wrote to the state traffic survey team for information on how to get a sign posted which would remind drivers to signal. They also requested information about the state's survey techniques. The letter is shown in Figure C4-5 which may be found on the following page.

The class discussed the effect of having children hold the blinker signs. The children decided to post the signs for a week to see if drivers continued to signal more often than when the signs were not held.

The school safety officer of the Lexington Police Department visited the class and the children made a presentation

Dear Sirs,

We are studying the intersection in front of the Adams School in Lexington. We found that of 257 cars who took a left turn from Mass. Ave. (from Arl. to Lex.) to Pleasant Street, 41% did not use their blinker. We then put up a sign and of the next 101 cars 95% used their blinkers. We then would like to know what information we need to get a sign placed at the intersection. Also, how do you people go about taking your surveys and what do you look for when seeing if a corner is safe? We are

Sincerly
Yours,
Mr. Farias
6 grade class

Figure C4-5

of their findings. They prepared transparencies for use on the overhead projector which showed maps of the area and data collected by the signal group, the gap time group, and the crossing time group. They used the scale model to illustrate their points. They recommended a sign reminding drivers to signal before turning be posted, but the officer told the class that only the state was authorized to post signs. During a question and answer period the class learned about traffic conditions in Lexington and safety rules.

In the course of the class discussion one group of children decided to construct model traffic lights which could

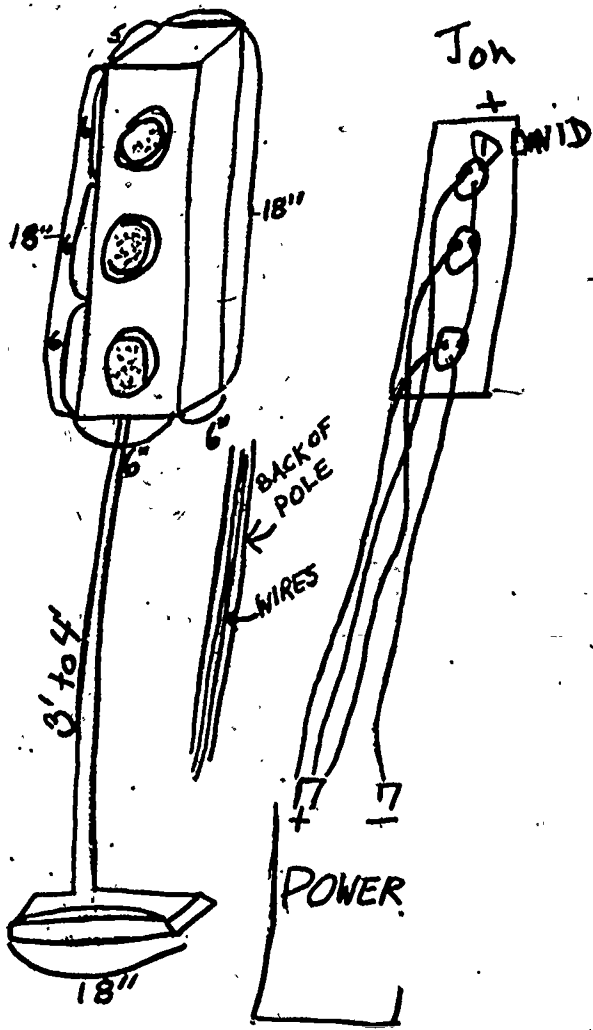


Figure C4-6

be used in simulations of the traffic patterns at their crossing. The traffic light group took measurements of the light outside, sketched designs and wiring plans, and experimented with batteries and bulbs before moving into the Design Lab to begin work on their lights. The children tried a variety of ways to connect the three lights together. After they had connected the three in parallel circuit, they realized they couldn't control the individual lights. Of the group of twelve children, four arrived at a similar solution to this problem. They connected the three lights together with one of the wires and attached that wire to the battery. Then they attached individual wires to each bulb and left the ends free, so that any of the three wires could be touched directly to the battery to complete the circuit and light that bulb. One of the boys used the different colored wires to good advantage, attaching a red wire to the "stop" light, a green one to the "go" light and a yellow one to the "caution" light. The boys' sketches of the traffic light and wiring plan showing all three wires attached to the positive battery terminal are reproduced in Figure C4-6.

The children worked at different levels in making the traffic lights. Some made simple models, while other models were more elaborate. Some lights were able to control traffic in both directions of a given street and could flash a WALK-DON'T WALK sign which was synchronized with the traffic signal.*

During class discussion, another group was formed to make trundle wheels to help with measuring. This group made trundle wheels of different sizes. They drew circles with a compass and cut them out of Tri-Wall. Then they placed a string around the circles and measured the string with a ruler to get the circumference. They noted that in order to measure the same distance, the smaller trundle wheels would require more turns (revolutions) than the larger trundle wheels, and that to find the distance measured they would always multiply the number of turns by the circumference.

The class viewed the videotape of the microteaching activities for Pedestrian Crossings from the 1971 summer workshop, and it stimulated a lot of discussion. The children observed that the average crossing time reported by the children on

*A group might be interested in investigating traffic light timing for the intersection with the most traffic. How many cars would line up at a light with 30 sec. timing? 60 sec.? etc. How far down the street would the line extend? Could all the cars pass the intersection on the "go" phase? --ED.

the videotape was several seconds longer than our average crossing time, and they concluded that the street must be wider. They also noted that when a man in the tape started to cross without waiting for traffic to subside, it took him 29 seconds to get to the other side. They discussed the fact that people have to wait varying amounts of time at the curb before traffic slows sufficiently for them to cross safely. They realized that gap times have to be taken for cars going in both directions in order to determine how long a person might have to wait before crossing safely.

As an outgrowth of this discussion, the class decided to compare the crossing times at all four crossings near the school and to find the reasons for any differences.* Since we had data on the controlled crossing on Massachusetts Avenue in front of the school, we concentrated on three other nearby crossings. We took turns crossing at the three new crossings and kept a record of the time for each pupil. Here is a data the children collected at the four crossings.

	Mass. Ave. Controlled	*Mass. Ave. Uncontrolled*	*Follen Road*	*Pleasant Street*
Tommy	7	8	14	11
Kim	6	10	12	14
John K.	8	9	16	15
Leslie	7	7	11	12
Bobby	9	8	14	13
Laurie	6	8	11½	11
Joe P.	8	9	15	14
Sandra	8	7	12	12
Dennis	7	7	11	9
Dawn	7	8	12	12
Ellen	7	8	13	15
Debbie	8	8½	11	11
Kevin	7	8	15	14
Joe S.	6	9	15	14
Tenely	5	7	11	11
John B.	8	8	14	15
Bernie	7	7	12½	10
Patty	6	8	12½	12
Duane	7	6	12½	10
Jim	7	8	12	11
David	7	8	16	15
Jason	6½	7	12	11
Averages:	7	7 19/22	12 21/22	12 8/22

*The children might be asked how long they would have to wait at each intersection for a gap long enough to cross safely. See Background Paper, *GR1 Notes on the Use of Histograms for Pedestrian Crossings Problems*, for suggestions on comparing crossing times and gap times.--ED.

The children took turns timing each other and made some on-the-spot speculations about the reasons for different crossing times. They agreed that (a) the crossings varied in length, (b) traffic forced us to walk faster at some, (c) we had more time crossing at the controlled crossing. The children figured out the average crossing time for each crossing. Then they made tally sheets from which they were able to compute the median easily by counting to the middle number. The children enjoyed finding medians and thought it was easier than figuring averages. One of their tally sheets, followed by a histogram of number of children vs. crossing time made from data collected at the four crossings,* is shown in Figures C4-7 and C4-8.

The class received a reply from the Massachusetts Department of Public Works concerning traffic surveys. They were told that signs which informed drivers of basic rules and regulations, such as signaling before turns, are never posted and that, their recommendation could not be implemented. The children were intrigued with the DPW's suggestion that they turn their efforts toward public education concerning safety rules, however. They were also pleased to discover that they had already investigated in some way most of the factors studied by the state when conducting a traffic survey at an intersection. Here is the list of factors the DPW included in the letter and the children's comments on each:

1. The turning movements as well as the through traffic. We have dealt with this.
2. The movement of pedestrians. We have taken crossing times.
3. The approaching speed of vehicles to the intersection. This is an area that will have to be investigated.
4. The physical hazards of the intersection. These will have to be defined by us.
5. The physical layout. We have made a model.
6. Sight distance problems. We will investigate.
7. The sequences of signalization. We are having a tough time figuring out this one.
8. Weather

*A composite graph of crossing times vs. street widths for several students may point to hidden factors. See Background ~~Paper,~~ *GR4 Representing Several Sets of Data on One Graph*.--ED.

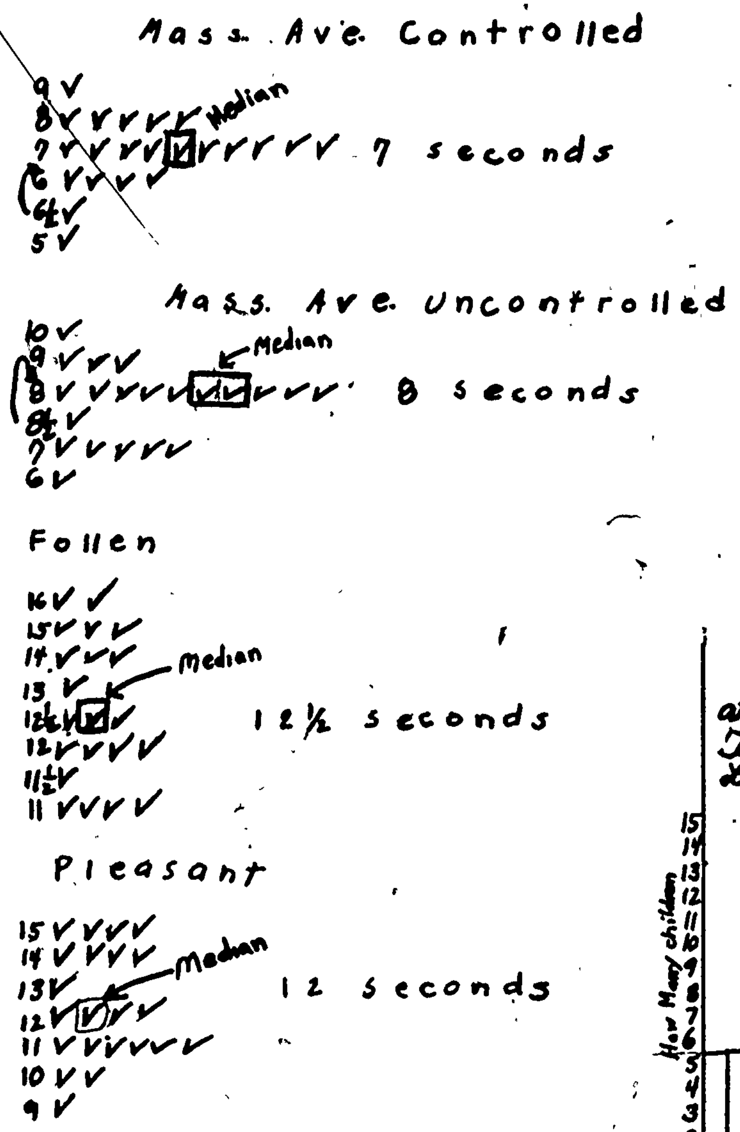
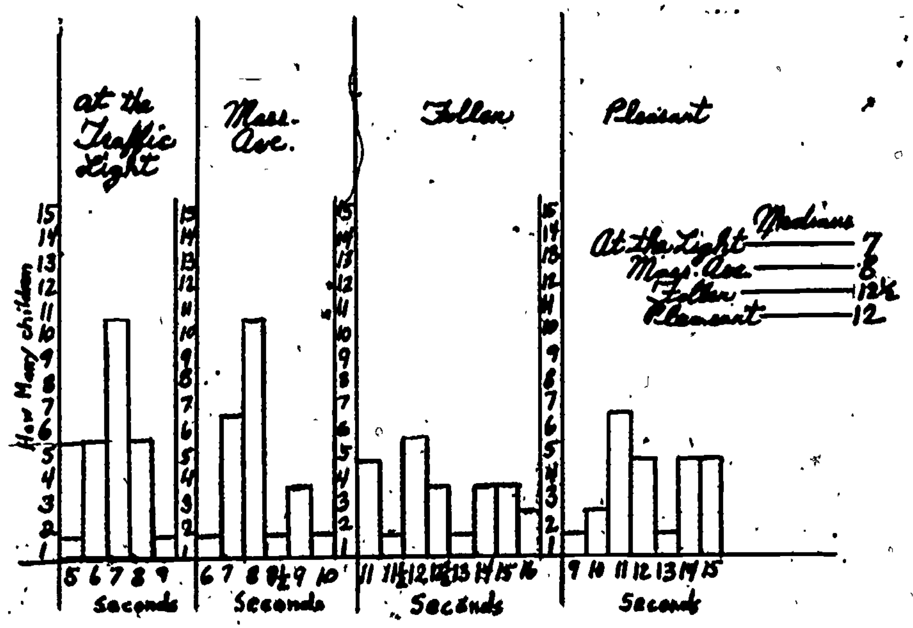


Figure C4-7



It would be easier to compare crossing times if the range on the horizontal axis of each graph were the same and the column time intervals were uniform.--ED.

Figure C4-8

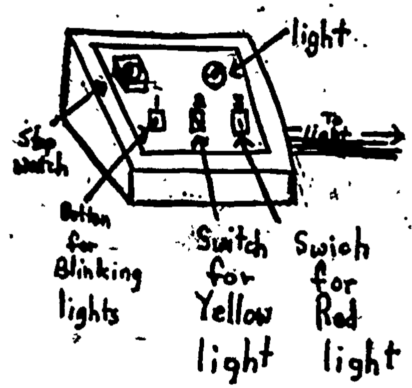


Figure C4-9

9. Hours when survey conducted. We always kept a record.
10. The concern of traffic generators ? on this one, too.
11. Vehicle classification. Under investigation.

After much discussion, the children decided to focus their efforts on making a videotape about pedestrian safety for the younger children at the Adams School. In order to get an idea of how to start, one child suggested that we film one of the uncontrolled crossings and then study the film. Another felt that we should film how the motorists view the crossing. The class concurred with both ideas. Thus, using two Super 8 movie cameras, we filmed both sides of the same scene. One camera was in a car driven by our student teacher; the other camera was stationed at the crossing pointed in the direction of the traffic. We filmed the sequence of the children crossing three times and then filmed them crossing at the controlled crossing. We viewed the film and the class came to the following conclusions: (1) At the uncontrolled crossing, while one car heading in one direction might eventually stop, there was no guarantee that the car heading in the opposite direction would do so at the same time. (2) Cars parked (legally) near the crossing prevented the motorist from seeing pedestrians on the sidewalk. The children decided that these two points should be stressed in our training film for the younger children.

The children decided to make scale models of an average-sized car and an average-sized first grader in order to graphically portray to primary grade children how difficult it is for drivers to see them at crossings. One group measured ten cars, calculated the average size, and made the model car out of Tri-Wall and papier mache. Another group made a height chart, measured a group of first grade children, figured their average height, and made a model of papier mache. The group reported that the average height of the first graders was 3 ft., the average length and height of the cars were 15 ft. and 6 ft., and that the models were made on a scale of 3 ft. ↔ 1 ft. They added that to get their figures they had needed to practice converting inches to feet.

The children also decided to make an exact replica of the traffic light at our crossing so that they could use it to instruct younger children on how a light works. The group that had made the scaled versions of the light made the full-sized one. Figure C4-9 shows designs for the switch box

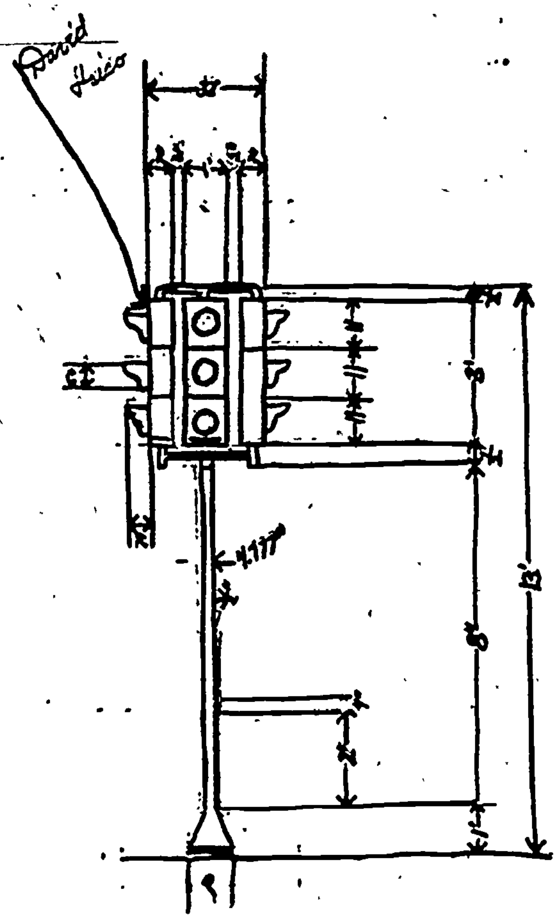


Figure C4-10

while Figure C4-10 shows the design and measurements for the light.

In order to gather additional information on crossing times, the class timed a group of first graders at the controlled crossing and did the same for an equal number of sixth graders. Here is their data:

First Grade		Sixth Grade	
Paul	12	Brenda	8½
Beth	6	Dawn	7½
Denise	8	Dennis	8
Patty	10	Tenley	6½
Kathy	9	Jason	6
Abby	8	Bobby	7
Doriah	8	James	7
Ralf	9	Bernie	7
Doyle	9½	Pattie	7
Steven	11	Jon	6

They discovered that the average crossing time of the first graders was about two seconds longer than that of the sixth graders. However, they observed that the main reason was not necessarily that the small children walked slower but that they took more time to look both ways as they were crossing.

The children showed both results on a line chart of individual crossing times. One of the charts is shown in Figure C4-11.

The class also decided to make scale maps of the neighborhood that would include everyone's house and that they could use in their videotape. Every night five children took home trundle wheels to measure the distance between school and home. The children also made individual maps such as the one shown in Figure C4-12.

After much class discussion, the children decided what information to convey to the younger children in the videotape and how to present it. They planned how to use their scale model, the traffic light, and the model car and child, and they wrote a script for the videotape. The actual filming was delayed because of problems with the equipment but was finally completed during several hours one morning in June.

Before the videotape was finished, however, USMES asked the class to make a film showing how the children collected data safely. The students decided they wanted to stress the dangers of an uncontrolled crossing. Half the movie was to

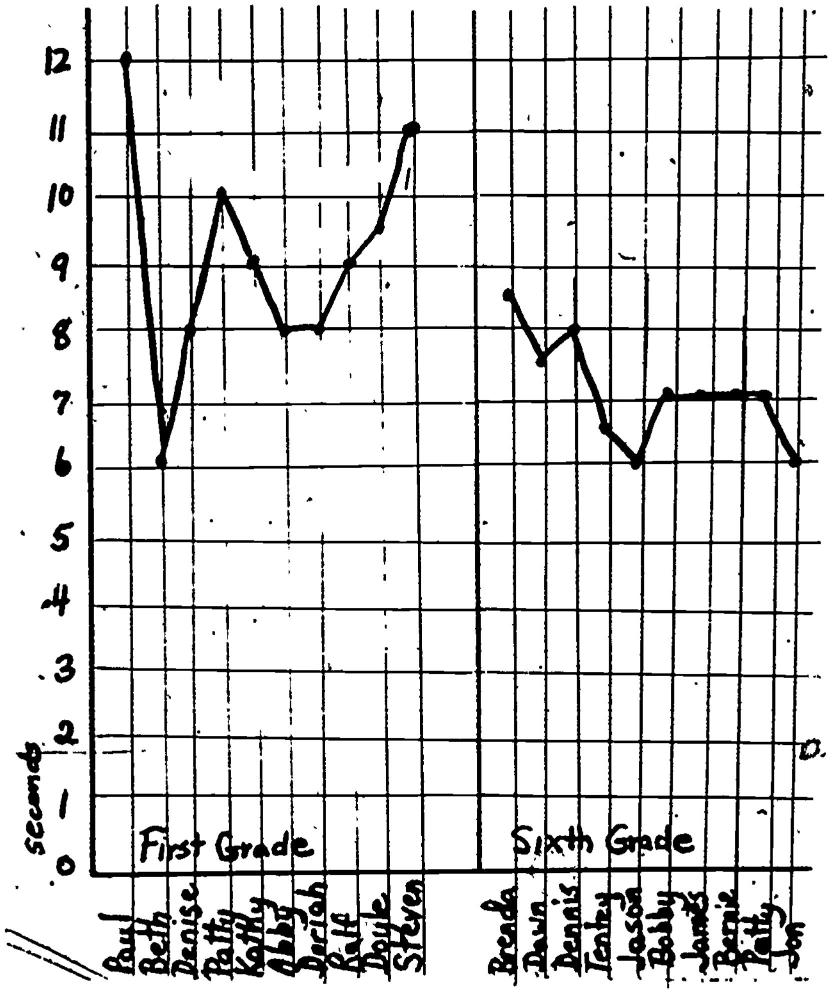


Figure C4-11

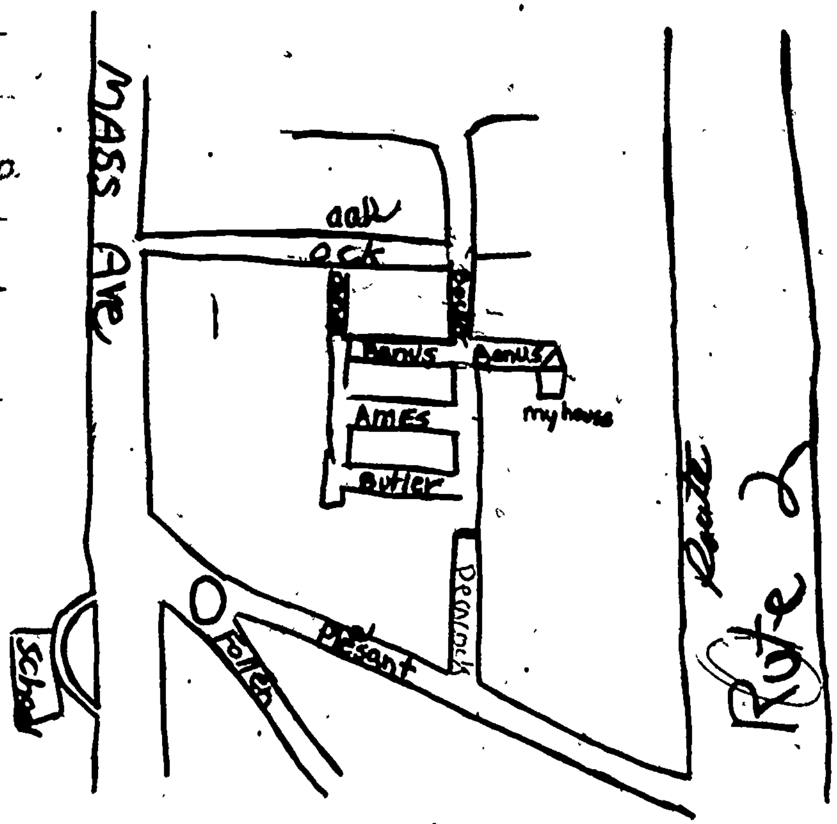


Figure C4-12

focus on the controlled crossing and half on the uncontrolled one. The class wrote a script and devised a plan for the shots they wanted to film. About two weeks were spent on filming. The film showed how they used both the traffic lights and the policewoman to gather their information safely at a controlled crossing. In the film, children explained how they measured gap times, crossing times, and number of motorist signals before turning; how distance could be measured with feet, rulers, and trundle wheels was also discussed.

The class benefited from their earlier experience with filming by not trying to include too many topics. In this film they allowed a greater space between segments and spent a longer time filming each segment, moving the camera slowly. The class viewed the film and tried to judge which parts were the best. The children expressed their views on what they felt made a good frame (content, clarity of the picture, effectiveness of the message) and discussed the purpose of the film. They wrote a brief outline to use when editing the film. A group of children learned how to splice film. After several days of editing they were ready to dub the voice. The students viewed the film a few times and took notes on the sequence of the film parts. They found that when they stopped the recorder and the projector and then restarted them, they lost synchronization. The children decided that a continuous monologue would be more effective than stopping the film at various points to change narrators. They chose one person to be the narrator. Standing with the mike at the back of the room away from the noise of the projector, he attempted to ad lib along with the film by using the tape recorder. The class decided that an information sheet explaining starting procedures should be included to ensure that the film and the tape recorder are synchronized. (This turned out to be a difficult process.)

We also conducted an advertising campaign for pedestrian safety. The class integrated music, art, and language arts into this unit by writing safety songs and making safety signs. We called this our "Madison Avenue" approach to educating the public. The children used music from popular commercials for some of the songs and wrote their own music for others. For example, using the tune from the Pepsi Cola ad, they sang:

Reason School
Time 2:05
Type Chevelle Malibu
Use of blinker No
Speed of car Fast

Reason School
Time 1:30
Type of vehicle Chevy II Nova
Use of blinker No
Speed of car Slow

Figure C4-13

"It's the safety generation, coming at you,
driving strong.
Put yourself behind the wheel of a safe
new automobile.
You've got a lot to live,
So signal when you make a turn.
You've got a lot to live,
So signal when you make a turn."

The class sent some of the jingles to the National Safety Countil hoping that they might use them in their advertising. The children also chose one song as background music for their Super 8 safety film.

Before they made signs, the children discussed their value, the type of signs we presently see, and how the signs could be more effective. They made their own signs and judged them according to message, visual quality, and imagination. Some of the children's signs reflected the ambiguity in the wording of many current signs. One child made a picture of a school crossing the street with a caption "School Crossing." It was decided that the "Watch Out" sign which had two big eyes and the words "watch out" written underneath was the most effective.

The class decided that as a final project they would move away from pedestrian crossings and focus on the related problems of the school driveway and parking area. A group of children conducted a survey of vehicles using the driveway and collected data for a week on type of vehicle, time of day, reason for visit, estimated speed, and whether they signaled or not before turning into the drive.* In Figure C4-13 is part of one child's record of survey data. Figure C4-14 shows a bar graph of the kinds of vehicles using the drive and a line graph of the speed of the vehicles. The children estimated speed by whether or not they could run faster than the vehicle was moving.

Another group decided to make scale models of the parking area and the teachers' cars. They measured the parking area with their trundle wheels and the cars with string and made models out of Tri-Wall and papier mache. The class used the

*This data may be used for comparison by other classes in coming years if any of the children's recommendations are implemented.--ED.

models to explore the viability of different solutions to the parking problems. After much discussion, they decided to offer the following suggestions to the principal concerning the parking area and drive:*

1. Paint parking lines
2. Assign parking spaces to staff
3. Make traffic one way through drive
4. Post slow signs
5. Limit hours for use of drive.

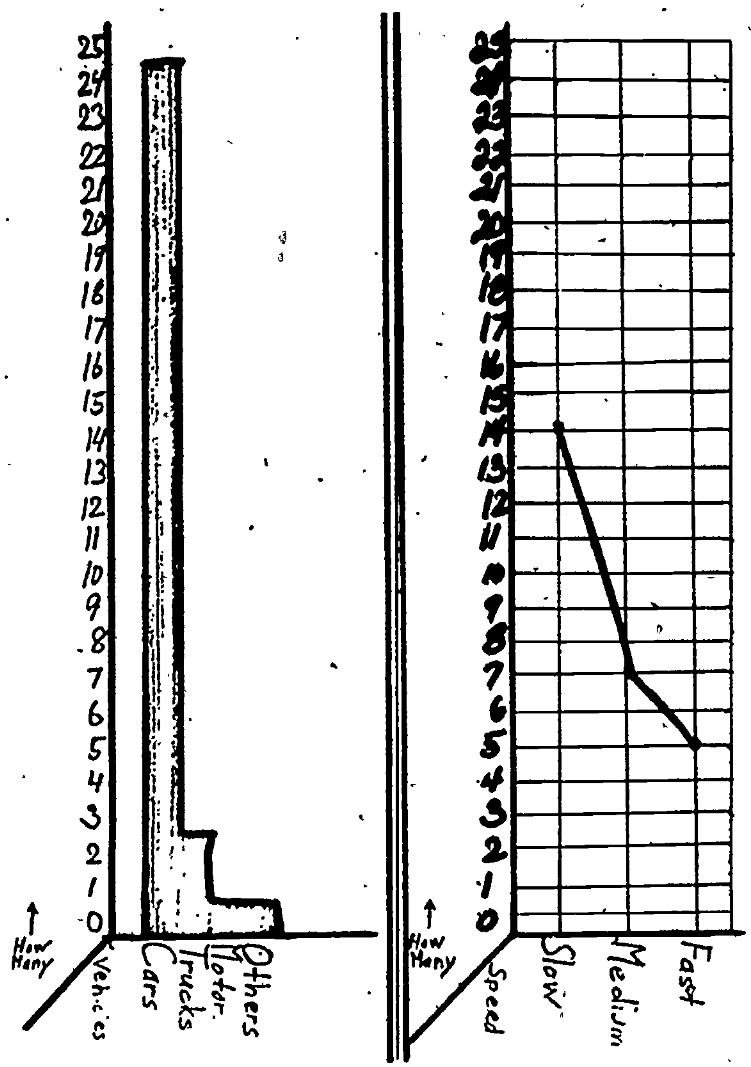


Figure C4-14

*If time had permitted, the collection of data for these recommendations might have made an interesting lead-in to the Traffic Flow challenge.--ED.

D. References

1. LIST OF "HOW TO" CARDS

Below are listed the current "How To" Card titles that students working on the Pedestrian Crossings 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.

ELECTRICITY

EC 1 How to Make Simple Electric Circuits
EC 2 How to Check a Circuit by Tracing the Path of the Electricity
EC 3 How to Make Good Electrical Connections
EC 4 How to Find Out What Things to Use in an Electric Circuit
EC 5 How to Make a Battery Holder and Bulb Socket
EC 6 How to Make a Battery and Bulb Tester
EC 7 How to Find Out Why a Circuit Does Not Work
EC 8 How to Turn Things in Electric Circuits On and Off
EC 9 How to Find Out Why a Bulb Sometimes Gets Dim or Goes Out When Another Battery is Added to the Circuit
EC10 How to Connect Several Things to One Source of Electricity
EC11 How to Draw Simple Pictures of Electric Circuits

GEOMETRY

G 3 How to Construct 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 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 6 How to Find the Speed of a Car
M 7 How to Find How Many Feet per Second is the Same Speed as 60 Miles per Hour
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 Design and Analyze a Survey
How to Choose a Sample
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.

*Presently called Slope Diagram.

2. LIST OF BACKGROUND PAPERS

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

Below are listed titles of current Background Papers that teachers may find pertinent to Pedestrian Crossings. 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

DP 8 *Traffic Flow at Pedestrian Crossings* by James Kneafsey

DP10 *The Need for Traffic Signal Synchronization in Urban Areas* by James Kneafsey

ELECTRICITY

EC 1 *Basic Electric Circuits* (based on suggestions by Thacher Robinson)

EC 2 *Trouble Shooting on Electric Circuits* (based on suggestions by Thacher Robinson)

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 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 2 *Measuring Heights of Trees and Buildings* by Earle Lomon

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 Methods* by Lorraine Denby and James Landwehr
RATIOS, PROPORTIONS, AND SCALING	R 1	*Graphic Comparison of Fractions* by Merrill Goldberg
	R 2	*Geometric Comparison of Ratios* by Earle Lomon
	R 3	*Making and Using a Scale Drawing* by Earle Lomon
SIMULATION ACTIVITIES	SA 4	*Simulation/Modeling as a Tool in Assessing Various Solutions* by Ludwig Braun and Betty Beck

3. BIBLIOGRAPHY OF NON-USMES MATERIALS

The following references on traffic and road design may be of some use during work on Pedestrian Crossings. A list of references on general mathematics and science topics can be found in the *USMES Guide*.

Baerwald, John E., ed. *Traffic Engineering Handbook,* 3rd ed. Washington, D.C.: Institute of Traffic Engineers, 1965.

A technical guide to traffic in the U.S., including chapters on pedestrians, signals, survey methods, and traffic administration. Pedestrian chapter contains a section on school crossing protection.

Charles Eliot Junior High School Ecology Club, *Eyeballing Traffic Flow: An Environmental Awareness Study.* Cleveland, Ohio: Institute for Environmental Education, 1973.

Short paper on measuring traffic flow at various times of the day by counting cars at an intersection. Useful for both teachers and students.

Matson, Theodore *et al*. *Traffic Engineering.* New York: McGraw Hill, 1955.

A guide for traffic engineers of traffic flow characteristics and administrative procedures. Contains sections on control devices, intersection design, and planning for traffic flow.

Maps showing traffic flow patterns may be obtained from state government agencies, e.g., Massachusetts Department of Public Works.

A list of available government publications concerning pedestrian crossings and traffic flow may be obtained by writing to the Superintendent of Documents, Washington, D.C.

4. GLOSSARY

The following definitions may be helpful to a teacher whose class is investigating a Pedestrian Crossings 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.

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

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

Circuit — A path through which electricity can flow if the path is continuous.

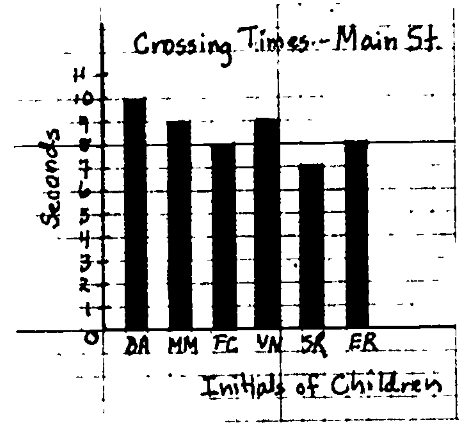
- *Closed Circuit* — A circuit that provides a continuous path for electricity.
- *Open Circuit* — A circuit that does not provide a continuous path for electricity.
- *Parallel Circuits* — A circuit in which two or more electrical components (such as bulbs and buzzers) are connected so that the electricity divides into two or more paths.
- *Series Circuit* — A circuit in which the electricity flows through all components along a single path.
- *Short Circuit* — A low resistance path resulting in too much current that may damage those components in the path.

Conductor	Material that offers very little opposition to the flow of electricity, and therefore is used to carry or conduct electricity.
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.
Current	The flow of electric charge. Technically, the rate of flow of electric charge through a conductor: how much electric charge passes through a given point in a circuit in a given amount of time. Measured in amperes (amps).
Alternating Current (AC)	Electric current that flows first in one direction and then in the opposite direction in regular cycles. Most household current is AC.
Direct Current (DC)	Electric current that flows in only one direction. Current from batteries is DC.
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: Student crossing an intersection.
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.

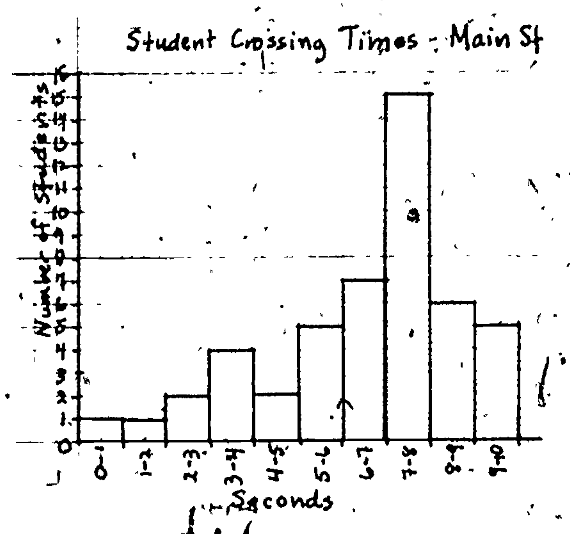
Bar Graph — A graph of a set of measures or counts whose sizes are represented by the vertical (or horizontal) lengths of bars of equal widths or lines. Example: the time it took children to cross Main Street.

Initials of Children	Time in Seconds
BA	10
MM	9
FC	8
VN	9
SR	7
ER	8



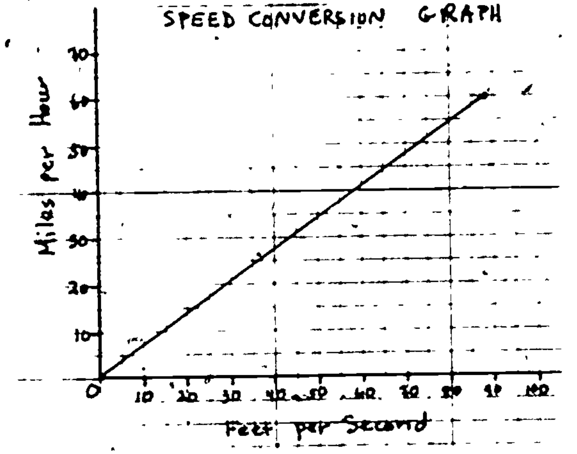
Histogram — A type of bar graph that shows the distribution of the number of times that different measures or counts of the same event have occurred. A histogram always shows numerical data on the horizontal axis. Example: the different numbers of children who crossed the street in different amounts of time.

Crossing Time (sec.)	No. of Students
1	1
2	1
3	2
4	4
5	2
6	5
7	7
8	15
9	6
10	5



Conversion Graph

A line graph that is used to change one unit of measurement to another. For example, changing feet per second to miles per hour.

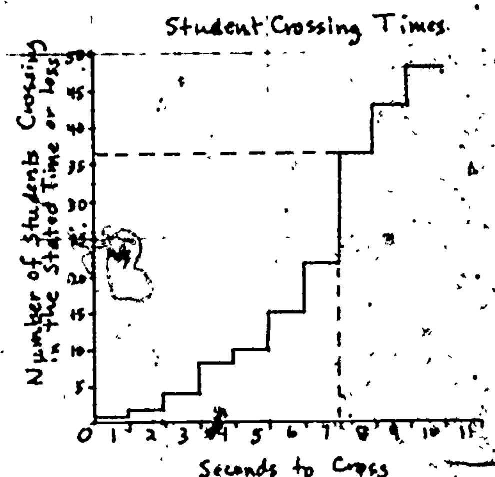


Cumulative Distribution Graph

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 were timed crossing an intersection). Each vertical distance on the graph shows the running total for the value shown on the horizontal scale; thus the graph below indicates that thirty-seven students have a crossing time of eight seconds or less.

TABLE OF VALUES.

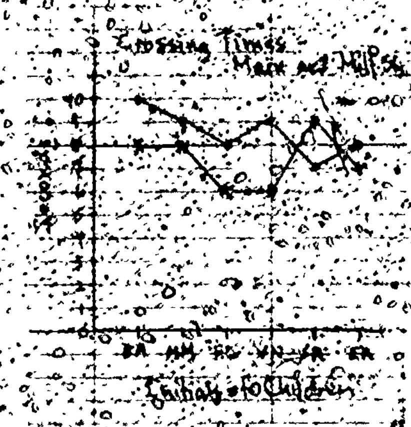
Time (sec.)	Running Totals
1 or fewer	1
2 " "	2
3 " "	4
4 " "	8
5 " "	10
6 " "	15
7 " "	22
8 " "	37
9 " "	43
10 " "	48



Line Chart

A bar graph that is represented by circles, triangles, or crosses with lines connecting them so that it has the appearance of a line graph. (See *Line Graph.*) This is a useful representation when two or more sets of data are shown on the same graph. Example: the time it took children to cross two different streets, Main Street and Mill Street.

Initials of Children	Time to Cross Main St.	Time to Cross Mill St.
BA	10	8
MM	9	8
FC	8	6
VN	9	6
SR	7	9
ER	8	7



Line Graph

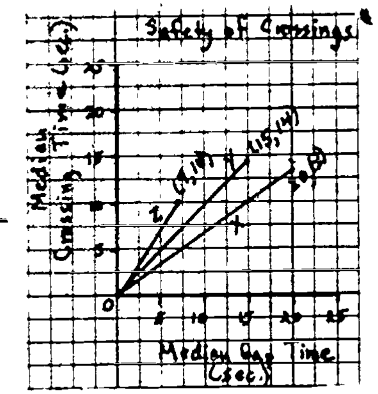
A graph in which a smooth line or line segments pass through or near points representing members of a set of data. Since the line represents an infinity of points, the variable on the horizontal axis must be continuous. If the spaces between the markings on the horizontal axis have no meaning, then the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

*Slope Diagram**

A graphical means of comparing fractions or ratios. To represent the ratio a/b, plot the point (b,a) and draw a line from (b,a) to the origin, (0,0). The slope of this line represents the ratio a/b. By comparing slopes of different lines, different ratios can be compared; the steeper the line the larger the ratio. For example, in the diagram on the next page showing the ratio of crossing time to gap time at different crossings, the ratio of crossing time to gap time for Crossing Z is larger than for Crossings X or Y. Therefore, Crossing Z is less safe to cross than the others.

*Formerly called Triangle Diagram.

Crossing	Median Crossing Time (sec.)	Median Gap Time (sec.)
X	13	20
Y	14	15
Z	10	7



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.

Insulator — A material that offers much opposition to the flow of electricity.

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 per cent = 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	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 the median crossing time to median gap time at an intersection might be $\frac{9 \text{ seconds}}{10 \text{ seconds}}$.
Resistance	The opposition that a device or material offers to the flow of electricity, measured in ohms.
Sample	A representative fraction of a population studied to gain information about the whole population.
Sample Size	The number of elements in a sample.
Scale	A direct proportion between two sets of dimensions (as between the dimensions in a drawing of an intersection and the actual intersection).

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.
Schematic	A circuit diagram in which components are represented by symbols.
Sight Distance	The maximum distance from a given point at which a vehicle can be seen.
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.
Switch	A device for opening and closing a circuit.
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: number of cars passing a certain point in a given period of time.
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.
Visibility	A measure of how clear the atmosphere is. Technically, the horizontal distance at which an object can be recognized by the unaided eye.
Voltage	A measure of the electrical energy per unit charge in a circuit. For a given circuit, as the voltage increases, the current increases.

Watt — A unit of measurement of power (energy per unit of time or work per unit of time). Although light bulbs are rated in watts, the wattage indicates both heat and light output.

Wire Gauge — AWG (American Wire Gauge)--a system for numbering wire sizes; the larger the AWG number, the smaller the diameter of wire.

Work — Work is done when a force is exerted through a distance. Work is the product of the force exerted and the distance moved.

E. Skills, Processes, and Areas of Study Utilized in Pedestrian Crossings

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

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

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

Following the rating charts are the lists of explicit examples of real problem solving and other subject area skills, processes, and areas of study learned and utilized in Pedestrian Crossings. 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 Pedestrian Crossings.

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

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

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

REAL PROBLEM SOLVING	Overall Rating
Identifying and defining problem.	1
Deciding on information and investigations needed.	1
Determining what needs to be done first, setting priorities.	2
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
Evaluating procedures used for data collection and analysis. Detecting flaws in process or errors in data.	1

REAL PROBLEM SOLVING	Overall Rating
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	3
Graphing	1
Spatial Visualization/Geometry	2
Areas of Study	
Numeration Systems	2
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	-
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	3
Mechanical Work and Energy	3
Solids, Liquids, and Gases	3
Electricity	3
Heat	-
Light	-
Sound	-
Animal and Plant Classification	-
Ecology/Environment	-
Nutrition/Growth	-
Genetics/Heredity/Propagation	-
Animal and Plant Behavior	-
Anatomy/Physiology	-

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

SOCIAL SCIENCE	Overall Rating
Process	
Observing/Describing/Classifying	2
Identifying Problems, Variables	1
Manipulating, Controlling Variables/ Experimenting	3
Inferring/Predicting/Formulating, Testing Hypotheses	2
Collecting, Recording Data/Measuring	2
Organizing, Processing Data	2
Analyzing, Interpreting Data	2
Communicating, Displaying Data	2
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	-
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	2
Critical Reading: Comprehending Meanings, Interpretation	2
Oral Language	
Speaking	1
Listening	1
Memorizing	3
Written Language	
Spelling	1
Grammar: Punctuation, Syntax, Usage	1
Composition	1
Study Skills	
Outlining/Organizing	1
Using References and Resources	2
Attitudes/Values	
Appreciating the value of expressing ideas through speaking and writing	1
Appreciating the value of written resources	3
Developing an interest in reading and writing	2
Making judgments concerning what is read	2
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

Identifying and Defining Problems	• Students identify a problem pedestrian crossing and decide that it is unsafe. • See also SOCIAL SCIENCE list: *Identifying Problems, Variables*.
Deciding on Information and Investigations Needed	• During a discussion students decide to collect data on student crossing times, car arrival times (gap times), car counts, and car speeds. • After analyzing gap times, students decide more data at different times is needed. • Students decide to research costs of installing various traffic controls at the problem intersection.
Determining What Needs to Be Done First, Setting Priorities	• Children decide to observe the crossing first and then to collect data before trying to propose solutions.
Deciding on Best Ways to Obtain Information Needed	• Children decide that one child will operate the stopwatch and another will record the times when measuring crossing times and gap times. • Children conduct opinion surveys to determine whether others consider the crossing unsafe and to obtain suggestions for improvement. • Children plan to find out about local traffic and pedestrian laws by asking a policeman to discuss them with the class.
Working Cooperatively in Groups on Tasks	• Students form groups to collect data on crossing times, gap times, number of cars, etc., and to take measurements for making a scale map of the intersection.
Making Decisions as Needed	• Students decide to work in groups so that more can be accomplished. • Students decide to propose a pedestrian WALK light as a solution. • Students decide to make a presentation to local traffic officials explaining their suggestions for new controls.

Utilizing and Appreciating Basic Skills and Processes	• Students use stopwatches to time pedestrians crossing the street. • Students divide to obtain measurements for scale layout. • Students recognize that improving the safety of the crossing will help many people besides themselves. • Students write letters to local traffic officials. • See also MATHEMATICS, SCIENCE, SOCIAL SCIENCE, and LANGUAGE ARTS lists.
Carrying Out Data Collection Procedures--Opinion Surveying, Researching, Measuring, Classifying, Experimenting, Constructing	• Students measure crossing times and car arrival times. • Students measure streets at intersection for making a scale map of the area. • Students conduct opinion survey to find whether others consider the crossing unsafe. • 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 ask whether a nearby crossing is unsafe and infer from data collected that it is. • Students ask which of several alternative traffic control measures to recommend. They infer that the cheapest one will be most acceptable to authorities. • 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 the qualitative aspects of obtaining data from opinion surveys as distinct from data they gather at a particular problem crossing. • Children find that counting cars in addition to measuring gap times is irrelevant at a problem crossing. • Students recognize that policemen and women are reliable sources for information on traffic laws and that the city traffic department is a good place to obtain information on costs of various controls.

Evaluating Procedures Used for Data Collection and Analysis, Detecting Flaws in Process or Errors in Data.

- Students evaluate the manner in which crossing times, car speeds, and car arrival times were measured.
- Children decide that they can measure the width of a street more quickly by using a trundle wheel rather than a tape measure.
- See also MATHEMATICS list: *Estimating/Approximating/Rounding Off.*

Organizing and Processing Data

- Students order and group measurements of crossing times and car gap times to draw histograms.
- See MATHEMATICS list: *Organizing Data.*
- See SCIENCE and SOCIAL SCIENCE lists: *Organizing, Processing Data.*

Analyzing and Interpreting Data

- Students find median crossing time and median gap time.
- Students find that 82% of the people surveyed think that the crossing is unsafe.
- See MATHEMATICS list: *Comparing; Statistical Analysis; Opinion Surveys/Sampling Techniques; Graphing.*
- See SCIENCE and SOCIAL SCIENCE lists: *Analyzing, Interpreting Data.*

Predicting, Formulating Hypotheses, Suggesting Possible Solutions Based on Data Collected

- After investigating, students predict that a light installed at a crossing will prevent pedestrian accidents.
- 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 evaluate costs of installing a new traffic signal, warning sign, or crossing guard.

Trying Out Various Solutions and Evaluating the Results, Testing Hypotheses

- Students use simulation to model the crossing situation in order to evaluate their proposed change.
- If a new control is installed at a problem crossing, the children collect data to determine the effect of the change.
- 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 histograms to show student crossing times and car gap times.
- Students draw a bar graph to show results of opinion survey.
- Students draw scale layout of problem crossing.
- 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 make presentation of proposed pedestrian crossing changes to traffic authority or police.

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

- Students working on Pedestrian Crossings apply skills acquired to work on Traffic Flow.
- Children use graphing skills developed while organizing data on crossing times for displaying data on other problems.
- See also SCIENCE list: *Generalizing/Applying Process to New Problems.*
- See also SOCIAL SCIENCE list: *Generalizing/Applying Process to Daily Life.*

ACTIVITIES IN PEDESTRIAN CROSSINGS UTILIZING MATHEMATICS

Basic Skills

Classifying/Categorizing	• Categorizing characteristics (number of cars, pedestrians, or streets intersecting) of pedestrian crossings where accidents have occurred. • See also SCIENCE list: *Classifying.* • See also SOCIAL SCIENCE list: *Observing/Describing/Classifying.*
Counting	• Counting survey data on opinions of pedestrians. • Counting number of seconds, number of inches, number of pedestrians while collecting data. • Counting by sets to find scale for graph axes. • Counting votes for determining what solution to recommend.
Computation Using Operations: Addition/Subtraction	• Adding one- or two-digit whole numbers to find total tally of cars or total measurement of street length. • Adding minutes and seconds when timing cars. • Subtracting to find differences between crossing times before and after a traffic control is installed. • Subtracting one- or two-digit whole numbers to find ranges for graph axes or for measurement data. • Subtracting medians to compare sets of data.
Computation Using Operations: Multiplication/Division	• Multiplying whole numbers to find total tally of cars, total measurement of road length. • Multiplying and dividing to convert feet per second to miles per hour. • Dividing to calculate average crossing time, gap time, speed. • Dividing to calculate ratios of crossing time to gap time, percentage of children crossing in a certain time or less, etc. • Using multiplication and division to increase or decrease measurements for scale drawings, scale models.

Computation Using Operations: Fractions/Ratios/Percentages

- Using mixed numbers in making a scale model.
- Changing fractions to higher or lower terms (equivalent fractions) to perform operations such as addition and division.
- Using ratios and fractions to convert from feet per second to miles per hour.
- Using ratios to increase or decrease measurements for a scale drawing or model of an intersection.
- Using fractions in measurement, graphing, graphic comparisons, scale drawings or models.
- Calculating percentage of people favoring particular controls.
- Using slope diagrams to compare ratios of crossing times to gap times.
- Calculating actual measurements from scale maps of an intersection using ratio of scale map.
- Calculating percentage of students that crossed the street in ten seconds or less, percentage of cars that signalled when turning, etc.

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

- Adding and subtracting dollars and cents to perform cost analysis on alternative traffic controls.
- Multiplying and dividing to perform cost analysis on alternative traffic controls.
- Gaining experience with finance: sources, uses, and limitations of revenues for traffic controls.
- Investigating costs of traffic control equipment vs. use of equipment.

Measuring

- Converting from yards to feet, inches to feet, centimeters to meters.
- Using different standard units of measure to measure distances of roadways.
- Using different measuring tools to measure lengths, widths of roadways.
- Reading stopwatches, meter sticks, tape measures, trundle wheels accurately.
- See also SCIENCE list: *Measuring/Collecting, Recording Data*.
- See also SOCIAL SCIENCE list: *Collecting, Recording Data/ Measuring*.

Comparing	• Comparing quantitative data on crossing times, gap times, traffic volume, average speed gathered at intersections with information gathered by traffic officials. • Comparing qualitative information on a problem intersection, gathered from various sources, such as people's observations and opinions. • Comparing qualitative data gathered from an opinion survey with quantitative data gathered at the crossing. • Comparing estimated and actual measurements on crossing time, street length. • Making graphic comparisons of times to cross different streets. • Making graphic comparisons of ratios of crossing time to gap time at different times of day. • Comparing costs of various alternative solutions. • Using the concept of *greater than* and *less than* in making comparisons of crossing times or gap times. • See also SCIENCE list: *Analyzing, Interpreting Data*. • See also SOCIAL SCIENCE list: *Analyzing, Interpreting Data*.
Estimating/Approximating/ Rounding Off	• Estimating error in qualitative judgments on crossing problems when collecting survey data. • Estimating the number of people who will wait for the WALK light before crossing if a traffic light is installed. • Estimating crossing times before collecting data or costs of traffic controls before checking with authorities. • Estimating traffic flow by eyeballing. • Determining when a measurement of street distance is likely to be accurate enough for a scale map. • Using approximation in constructing scale models of traffic lights. • Rounding off data while measuring length, crossing time, gap time. • Rounding off data after measuring length, crossing time, gap time.
Organizing Data	• Tallying on bar graphs, histograms. • Ordering real numbers on graph axis. • Ordering the steps in the process of collecting data. • Ordering survey results on opinions about a pedestrian problem. • Ordering centimeters, seconds, etc.

Organizing Data (cont.)	• Ordering quantitative data on distances, crossing times, gap times. • See also SCIENCE list: *Organizing, Processing Data.* • See also SOCIAL SCIENCE list: *Organizing, Processing Data.*
Statistical Analysis	• Finding the median in an ordered set of data on crossing times, gap times. • Taking repeated measurements of street widths and using the median measurement. • Assessing accuracy of estimate of crossing times for all pedestrians based on results from student crossing times. • Finding quartiles from ordered data or histogram of crossing times. • Determining the interquartile range of crossing time data. • See also SCIENCE list: *Analyzing, Interpreting Data.* • See also SOCIAL SCIENCE list: *Analyzing, Interpreting Data.*
Opinion Surveys/Sampling Techniques	• Conducting opinion surveys about crossing problems; defining data collection methods, makeup and size of sample. • Devising methods of obtaining quantitative information about subjective opinions on pedestrian problems. • Evaluating survey methodology, data obtained, size and type of samples. • See also SCIENCE list: *Analyzing, Interpreting Data.* • See also SOCIAL SCIENCE list: *Analyzing, Interpreting Data.*

Graphing	• Using alternative methods of displaying data on crossing times.
	• Making a graph form--dividing axes into parts, deciding on an appropriate scale.
	• Representing data on graphs.
	  • Bar graph--plotting individual crossing times.
	  • Histogram--plotting the number of children who cross the street in certain times.
	  • Conversion graph--plotting feet per second vs. miles per hour.
	  • Slope diagram--plotting crossing time vs. gap time at various crossings.
	• Obtaining information from graphs on crossing times, gap times.

Graphing (cont.)

- Representing several sets of data on one graph, e.g., crossing times for individual children at different intersections.
- See also SCIENCE list: *Communicating, Displaying Data.*
- See also SOCIAL SCIENCE list: *Communicating, Displaying Data.*

Spatial Visualization/Geometry

- Drawing or constructing a map or model of a problem intersection.
- Constructing and using a circle when making a trundle wheel.
- Using standard mensurational formulas such as circumference (of trundle wheel) = π x diameter.
- Measuring and constructing a scale model using rulers or meter sticks.
- Using spatial arrangements to convey information about an intersection.

Areas of Study

Numeration Systems

- Using metric system in measuring distances.
- Using fractions in measuring feet.
- Using decimal system in making cost analyses of solutions.

Number System and Properties

- See *Computation Using Operations.*

Denominate Numbers/Dimensions

- See *Measuring.*

Scaling

- Deriving information from scale maps or scale models of a problem intersection.
- Finding an appropriate scale for the scale map or model.
- Using a scale to draw and make representations in the scale map or model.
- Making a scale map or model of a problem intersection.

Symmetry/Similarity/Congruence

- See *Spatial Visualization/Geometry.*

Accuracy/Measurement Error/
Estimation/Approximation

- See *Measuring* and *Estimating/Approximating/Rounding Off.*

Graphing/Functions	• See *Graphing*.
Fraction/Ratio	• See *Computation Using Operations: Fractions/Ratios/ Percentages*.
Maximum and Minimum Values	• Use slope diagrams to find which crossing is most dangerous by comparing crossing to gap time ratios. • Finding the traffic control measure that will solve the problem at minimum cost.
Equivalence/Inequality/Equations	• See *Comparing* and *Computation Using Operations*.
Money/Finance	• See *Computation Using Operations: Business and Consumer Mathematics/Money and Finance*.

ACTIVITIES IN PEDESTRIAN CROSSINGS UTILIZING SCIENCE

Process

Observing/Describing	• Observing and describing various pedestrian problems in the vicinity of the school. • Noting that it is harder to cross at certain times of day. • Describing various kinds of traffic controls and how they are suited to different intersections. • See also SOCIAL SCIENCE list: *Observing/Describing/Classifying.*
Classifying	• Classifying intersections as safe or unsafe. • Categorizing traffic controls by expense, efficiency, etc. • See also MATHEMATICS list: *Classifying/Categorizing.* • See also SOCIAL SCIENCE list: *Observing/Describing/Classifying.*
Identifying Variables	• Identifying pedestrian crossing times, car gap times, car speed, etc., as things to measure for determining the safety or convenience of a crossing. • Identifying car speed or gap time as factors to change to make the crossing safer. • Identifying time of day and weather as factors to be held constant. • See also SOCIAL SCIENCE list: *Identifying Problems, Variables.*
Defining Variables Operationally	• Defining gap time as the time between the arrival of two consecutive cars at an intersection. • Defining time, distance, speed, etc., as used in data collecting.
Manipulating, Controlling Variables/Experimenting	• Measuring times of cars or pedestrians at various times of the day and at different crossings. • Measuring crossing times for different age groups. • See also SOCIAL SCIENCE list: *Manipulating, Controlling Variables/Experimenting.*

Designing and Constructing Measuring Devices and Equipment	• Constructing trundle wheels for measuring distances outside. • Constructing model traffic lights.
Inferring/Predicting/Formulating, Testing Hypotheses/Modeling	• Inferring from the data collected that a crossing is unsafe. • Predicting that installing a traffic light will improve the safety of a crossing. • Designing simulations to try out various possible solutions. • See also SOCIAL SCIENCE list: *Inferring/Predicting/ Formulating, Testing Hypotheses.*
Measuring/Collecting, Recording Data	• Using a stopwatch to measure crossing times for pedestrians or arrival times for cars and recording them. • Measuring distances at the intersection in order to make a scale map or model of the area. • Collecting and recording data obtained from simulations. • See also MATHEMATICS list: *Measuring.* • See also SOCIAL SCIENCE list: *Collecting, Recording Data/Measuring.*
Organizing, Processing Data	• Ordering crossing time and gap time data from smallest to largest. • Tabulating measurements of the intersection before making a scale map or model. • Ordering data obtained from simulations. • See also MATHEMATICS list: *Measuring.* • See also SOCIAL SCIENCE list: *Organizing, Processing Data.*
Analyzing, Interpreting Data	• Calculating the average or median crossing time or gap time. • Determining that a crossing is unsafe from the ratio of gap time to crossing time. • Determining that a particular solution is best from results of simulations. • See also MATHEMATICS list: *Comparing; Statistical Analysis; Opinion Surveys/Sampling Techniques.* • See also SOCIAL SCIENCE list: *Analyzing, Interpreting Data.*

Communicating, Displaying Data	• Showing data on various types of graphs. • Showing problems and solutions on a scale map or model of the intersection. • See also MATHEMATICS list: *Graphing*. • See also SOCIAL SCIENCE list: *Communicating, Displaying Data*. • See also LANGUAGE ARTS list.
Generalizing/Applying Process to New Problems	• Using knowledge acquired from working on a crossing problem to help solve other problems involving traffic. • See also SOCIAL SCIENCE list: *Generalizing/Applying Process to Daily Life*.
Areas of Study	
Measurement	• Using stopwatches to measure arrival times for cars, speed of cars, and crossing times for pedestrians. • Measuring distances with trundle wheels, meter sticks, yardsticks, and tape measures. • See also MATHEMATICS list: *Measuring*.
Motion	
Speed/Velocity	• Observing and calculating the speeds of cars and of pedestrians crossing the street.
Circular Motion	• Noting that the circular motion of car wheels is changed to the forward motion of the automobile.
Acceleration	• Observing deceleration and acceleration when cars slow down for a red light and gather speed as they start up again. • See also *Force*.
Force	• Observing that force must be used to push a trundle wheel or use a hand saw.
Momentum/Inertia	• Noting that cars take longer to stop if their initial speed is greater because of their greater momentum. • Observing that objects at rest do not move until a force acts upon them. • Noting that cars stay in motion at a constant speed unless an outside force acts upon them.

Friction	• Observing that the road surface becomes heated when cars stop quickly because friction between the two surfaces generates heat. • Observing that cars skid more easily on wet spots or icy patches because smooth surfaces generate less friction than rough ones.
Mechanical Work and Energy	• Observing that pushing trundle wheels or hand saws or hammering nails requires energy. • Observing that saber saws require less human work to use than hand saws because they transform electrical energy into mechanical energy. • See also *Motion* and *Force*.
Solids, Liquids, and Gases	
Properties of Matter	• Comparing the properties of lumber and Tri-Wall before constructing scale models, trundle wheels, or models of traffic lights. • Considering effects of time, weather, and usage when assessing various traffic controls.
Electricity	• Observing that electricity can light bulbs and that electrical energy can be transformed into light energy. • Causing a bulb to light by making a circuit (when constructing a model traffic light). • Observing that electricity does not flow through the insulation on a wire. • Noting that the light goes on when the switch is closed and goes off when the switch is open. • Observing that chemical energy stored in a battery can be transformed into electrical energy. • Observing that no current flows when both positive or negative ends of two batteries with the same voltage are placed together. • Observing that bulbs burn brighter when more batteries with the same voltage are placed together. • Observing that electricity can be transformed into mechanical energy (saber saw), into heat energy (glue gun), into chemical energy (battery charger).

ACTIVITIES IN PEDESTRIAN CROSSINGS UTILIZING SOCIAL SCIENCE

Process	
Observing/Describing/Classifying	• Organizing and classifying sets of ideas or information. • Observing and classifying problems of people trying to cross the street. • See also MATHEMATICS list: *Classifying/Categorizing.* • See also SCIENCE list: *Observing/Describing/Classifying.*
Identifying Problems, Variables	• Identifying problems of people crossing the street. • Identifying factors that affect drivers, pedestrians (weather, late for school or work, etc.). • See also SCIENCE list: *Identifying Variables.*
Manipulating, Controlling Variables/Experimenting	• Conducting opinion survey at different times of day or under different conditions to see if there is a change. • See also SCIENCE list: *Manipulating, Controlling Variables/Experimenting.*
Inferring/Predicting/Formulating, Testing Hypotheses	• Inferring that a particular intersection is most dangerous, based on results from surveys of pedestrians. • Inferring that a particular type of traffic control is preferred, based on preference surveys of pedestrians. • See also SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses.*
Collecting, Recording Data/Measuring	• Using a voting procedure to determine who is in what group (if there is a conflict). • See also MATHEMATICS list: *Counting; Measuring.* • See also SCIENCE list: *Measuring/Collecting, Recording Data.*
Organizing, Processing Data	• Tallying votes to determine which solution to recommend. • Tallying questionnaire survey data on a problem crossing or on preferences for a solution. • See also MATHEMATICS list: *Measuring.* • See also SCIENCE list: *Measuring/Collecting, Recording Data.*

Analyzing, Interpreting Data

- Comparing qualitative information gathered from interviews of various groups of people.
- Evaluating survey methodology.
- See also MATHEMATICS list: *Comparing; Statistical Analysis; Opinion Surveys/Sampling Techniques.*
- See also SCIENCE list: *Analyzing, Interpreting Data.*

Communicating, Displaying Data

- Representing survey data on pedestrian problems or solutions on graphs or charts.
- See also MATHEMATICS list: *Graphing.*
- See also SCIENCE list: *Communicating, Displaying Data.*
- See also LANGUAGE ARTS list.

Generalizing/Applying Process to Daily Life

- Using knowledge acquired from taking opinion surveys of pedestrians to help solve other problems where attitudes are important.
- Using knowledge acquired while conducting a pedestrian safety campaign to get people concerned about other problems, such as litter.
- See also SCIENCE list: *Generalizing/Applying Process to New Problems.*

Attitudes/Values

Accepting Responsibility for Actions and Results

- Making sure that various tasks, such as data collecting, making scale models, trundle wheels, etc., are done.
- Scheduling and giving presentations to persons in authority (principal, traffic department officials).

Developing Interest and Involvement in Human Affairs

- Attempting to have warning signs or a crossing guard placed at an unsafe pedestrian crossing.

Recognizing the Importance of Individual and Group Contributions to Society

- Recognizing that their improvement of the safety of a pedestrian crossing helps others.
- Assessing the effects of group action on school or city government regulations.

Developing Inquisitiveness, Self-Reliance, and Initiative

- Conducting group sessions.
- Finding solutions to problems encountered in addition to the main problem of the challenge.

Developing Inquisitiveness, Self-Reliance, and Initiative (cont.)	• Using the telephone to find information, to get in touch with officials, etc. • Choosing and developing the best way of presenting to traffic authorities a plan for improving a crossing.
Recognizing the Values of Cooperation, Group Work, and Division of Labor	• Finding that work on a crossing problem progresses more rapidly and smoothly when they work in groups. • Eliminating needless overlap in work. • Finding that work is fun when people cooperate.
Understanding Modes of Inquiry Used in the Sciences, Appreciating Their Power and Precision	• Using scientific modes of inquiry to investigate and solve a problem with a dangerous crossing. • Convincing others through use of supporting data, graphs, and maps that their improvements to a crossing are needed and desirable. • Seeing that various crossing improvements can be simulated by using a scale model. • See also MATHEMATICS and SCIENCE lists.
Respecting the Views, Thoughts, and Feelings of Others	• Considering all suggestions and assessing their merit. • Considering the opinions of others when proposing a change for a problem crossing. • Recognizing and respecting differences in values according to age, experience, occupation, income, interests, culture, race, religion, ethnic background.
Being Open to New Ideas and Information	• Considering other ways of doing various tasks. • Conducting library research on traffic laws, economics of controls, etc. • Asking other people for opinions, ideas, and information by conducting interviews or surveys.
Learning the Importance and Influence of Values in Decision Making	• Realizing that cost effectiveness alone is not sufficient in considering a solution; effects on people, communities must also be considered. • Realizing that pedestrians and motorists have different values that affect their preference for light timings and that both must be considered in any solution.

Areas of Study

Economics	• Investigating and analyzing costs of various traffic controls. • Investigating cost of traffic control equipment vs. use of equipment and budget constraints. • Gaining experience with finance: sources, uses, and limitations of revenues for traffic controls.
Geography/Physical Environment	• Investigating differences in problems due to differences in topography of a region (e.g., problem of putting a traffic light on a steep hill where cars have difficulty stopping).
Political Science/Government Systems	• Investigating systems of administration and control; deciphering role of governing body over the body that is governed. • Investigating traffic and pedestrian rules and regulations. • Working with school and traffic authorities to discuss improvements to a problem intersection. • Finding the most effective way to influence decision making about a pedestrian crossing.
Recent Local History	• Investigating previous attempts to improve a dangerous crossing. • Investigating frequency and causes of previous accidents at a crossing.
Social Psychology/Individual and Group Behavior	• Developing a gimmick for advertising the need for pedestrian awareness in crossing the street. • Finding the most effective way to approach traffic authorities about a crossing problem. • Recognizing need for leadership within small and large groups. Recognizing differing capacities of individuals for various roles within groups. • Analyzing the effects of a small group making decisions for a larger group. • Recognizing differences in behavior when crossing the street due to differences in age and other factors. Recognizing that crossing times will vary according to these factors.

Sociology/Social Systems

- Investigating problems and making changes that affect not only themselves, but other students and people in the community.
- Devising a system of working cooperatively in small and large groups.
- Working within established social systems--the school or community--to promote changes in a crossing.
- Recognizing that there are many different social groups and that one person belongs to more than one social group.

ACTIVITIES IN PEDESTRIAN CROSSINGS UTILIZING LANGUAGE ARTS

Basic Skills

Reading: Literal Comprehension--Decoding Words, Sentences, and Paragraphs	• Decoding words, sentences, and paragraphs while reading information on traffic regulations, traffic controls, etc.
Reading: Critical Reading--Comprehending Meanings, Interpretation	• Obtaining factual information about traffic controls, regulations, costs of equipment, etc. • Understanding what is read about traffic controls, regulations, costs of equipment. • Interpreting what is read, such as rules and regulations, costs of equipment.
Oral Language: Speaking	• Offering ideas, suggestions, and criticisms during discussions in small group work and class discussions on problems and proposed solutions. • Reporting to class on data-collecting, graphing, map-drawing activities of small groups. • Responding to criticisms of activities. • Preparing, practicing, and giving effective oral presentations as part of the solution to the challenge. • Preparing, practicing, and giving skits, slide/tape shows, public address announcements, etc., promoting pedestrian safety. • Using the telephone properly and effectively to obtain information about crossings, traffic controls, costs, etc. • Conducting opinion surveys on crossing problems. • Using rules of grammar in speaking.
Oral Language: Listening	• Conducting interviews of pedestrians, merchants, authorities. • Following spoken directions.
Oral Language: Memorizing	• Memorizing portions of oral presentations on a crossing problem and proposed solutions.

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Written Language: Spelling	• Using correct spelling in writing reports, letters to authorities proposing solutions to a crossing problem.
Written Language: Grammar--Punctuation, Syntax, Usage	• Using rules of grammar in writing reports or letters.
Written Language: Composition	• Writing to communicate effectively: • preparing written reports and letters using notes, data, graphs, etc., communicating need for proposed changes at a problem crossing • writing slogans, skits, videotape skits, posters, etc., promoting pedestrian safety • writing opinion surveys for pedestrians, devising questions to elicit desired information; judging whether a question is relevant and whether its meaning is clear.
Study Skills: Outlining/Organizing	• Taking notes when consulting authorities or books about traffic controls, traffic rules, costs, etc. • Developing opinion survey for pedestrians; ordering questions around central themes, such as crossing problems or possible solutions. • Planning presentations, data collection schemes, etc. • Planning and preparing drafts of letters, reports for critical review by the class before final copy is written. • Organizing ideas facts, data for inclusion in letters, reports, presentations, etc.
Study Skills: Using References and Resources	• Using the library to research information on traffic controls, laws, etc. • Inviting a traffic authority to speak to the class and answer questions for them. • Using indexes and tables of contents of books to locate desired information. • Using "How To" Cards for information on graphing, using a stopwatch, etc.
Attitudes/Values	
Appreciating the Value of Expressing Ideas Through Speaking and Writing	• Finding that traffic officials may be persuaded to install a crossing guard or warning sign when presented with definite, documented reasons for doing so.

Appreciating the Value of Written Resources

- Finding that certain desired information can be found in books on regulations, traffic, etc.

Developing an Interest in Reading and Writing

- Willingly looking up information on costs, regulations, etc.
- Looking up more detailed information on costs, regulations, etc.
- Showing desire to work on drafting letters, reports, scripting skits, videotapes, etc.

Making Judgments Concerning What is Read

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

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

- Finding that how information can be best conveyed is determined in part by the audience to whom it is directed.
- Finding that certain data or information can be best conveyed by writing it down, preparing graphs or charts, etc.
- Finding that certain data or information should be written down so that it can be referred to at a later time.
- Finding that spoken instructions are sometimes better than written instructions, and vice versa.