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Highway Safety Research Center
Chapel Hill, N.C. 27599-3430

EVALUATION OF A BICYCLE SAFETY EDUCATION CURRICULUM FOR ELEMENTARY SCHOOL AGE CHILDREN

Jane C. Stutts

William W. Hunter

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Acknowledgments

This is one of those situations where the acknowledgments could constitute a chapter in the report itself. We will try to be brief, but do want to give recognition to the many people whose efforts made this project possible (and hope that some are not overlooked!).

At the head of our list we wish to thank Alec French and Linda Fowler, physical education instructors for Alamance County Schools, who agreed to teach a curriculum that at the time did not even exist. The enthusiasm, dedication, and teaching skills that they brought to the project, more than any other factor, made it a success. We must also thank Larry MacDonald, physical education consultant in the N.C. Department of Public Instruction, for recommending Mr. French. From our perspective at this point, he could not possibly have made a better recommendation! We would like to thank the principals at E.M. Yoder and South Mebane schools, Marshall Kidd and Sondra Aheron; Alamance County School Superintendent Robert Stockard; and Assistant Superintendent for Instruction Chuck Morris for their support to the project. Also, the teachers and principals at North and South Graham, who even though not participating in the curriculum were willing to help us with the needed evaluation data. And finally, we want to thank all of the fourth and fifth grade students who eagerly participated, making this a fun and rewarding project for us all.

Obviously the project could not have existed without a curriculum, and for this we are indebted to Linda Tracy of the Bicycle Federation of America and John Williams of the Bikecentenniel organization and editor of *Bicycle Forum* magazine. The labor that they put into the curriculum development went far beyond their contract requirements with the N.C. Bicycle Program, and reflected both their years of experience in bicycling and their desire to make bicycling a fun and safe experience for every child.

We also celebrate with Mary Meletiou and Curtis Yates of the N.C. Bicycle Program their accomplishments in giving to the State a curriculum which should

put it at the forefront of bicycle safety education nationwide. Although many had input to the curriculum, Mary Meletiou deserves much credit for the final product, both from the standpoint of coming up with funding to support the curriculum development and the effort that she devoted to the project. Many others provided feedback along the way, including Ed Maxa with the N.C. 4-H program and Ann Ringland with the Office of Maternal and Child Health in DEHNR. All reviewed drafts of the curriculum, participated in the teacher training, and helped with the video that will accompany the final product.

We are grateful, too, for the local support given to the project. The Mebane Police Department, and in particular Chief Bumgarner and Kenny Edmonds, helped us all along the way, from locating and repairing bicycles to conducting the final rodeo event. The Explorer Scout troop sponsored by the Department donated several evenings to repairing bikes and helping at the rodeo. We would also like to thank Sergeant Jackie Sheffield with the Burlington Police Department for her support and for the extra effort she devoted to making some of that department's bicycles available to the project. Leanne Konopka and Bannister Allen with Burlington Schwinn and Fitness provided much support to the project, as did the local physicians and hospital emergency room personnel who assisted with the injury data collection.

Finally, we would like to say a special thank you to Cindy Lohr, who set aside her computer programming responsibilities at HSRC to help us with the lessons in Mebane; to her son Eric who proved to be invaluable as the project's resident bike mechanic; to Paula Hendricks who made many trips with us to Mebane to assist in various aspects of the project; and to Sandra Wortham, Ree Stewart and Pam Chilton for the extra time and energy they gave to the bicycle rodeo event.

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1. INTRODUCTION

The Need for School-Based Bicycle Safety Education

Bicycle crashes are a leading cause of injury to children. Nationally nearly 600 children die each year as the result of a bicycle crash, and many thousands more are seriously injured. In North Carolina, analysis of motor vehicle crash data shows that in 1989, 12 children under the age of 15 were killed in bicycle-motor vehicle collisions and an additional 149 children were seriously injured. For every child hospitalized as a result of a bicycle-motor vehicle collision, four more are hospitalized for bicycle injuries *not* involving a motor vehicle. A recent North Carolina study estimated that 800 children are hospitalized annually in the state for bicycle-related injuries, and an additional 13,300 children receive emergency room treatment (Stutts, Williamson, Whitley and Sheldon, 1990).

Bicycle crashes are also a leading cause of head injury in children (Ivan, Choo and Ventureyra, 1983). Among children treated in hospital emergency rooms for bicycle injuries, approximately one in three suffers head trauma. For hospitalized patients, this number increases to nearly two out of three. And for children fatally injured, three out of four die as a result of head injury (National Safe Kids Campaign, 1989).

Wearing a bicycle helmet can greatly reduce the risk of serious head injury for bicyclists involved in a crash. A recent study conducted at five major Seattle area hospitals showed that bicycle helmets reduce the likelihood of head injury by 85 percent and the likelihood of brain injury by 88 percent (Thompson, Rivara and Thompson, 1989). Helmets are only effective if worn, however. In the North Carolina study referenced above, helmet use among bicyclists treated at a statewide sample of hospital emergency rooms during the summers of 1985 and 1986 was found to be less than three percent overall, and even lower among school-age children.

In general, efforts to increase helmet use through mass media and community education campaigns have been only moderately successful. An intense helmet campaign in Seattle succeeded in increasing helmet use among riders of all ages to

only 16 percent over a recent two-year period (National Safe Kids Campaign, 1989). Perhaps more promising is a bicycle safety program begun in Australia in 1980. The program includes bicycle safety education taught in the public schools coupled with a strong emphasis on helmet use. As a result, helmet usage in the province of Victoria has increased to as high as 50-60 percent for children riding their bikes to school. At the same time, the head injury rate for bicycle accident victims has shown a steady and significant decline (Wood and Milne, 1988).

To summarize, bicycle accidents are a major cause of injury to children, and because of the high likelihood of head trauma, injury consequences are often severe and life threatening. Helmets can effectively reduce the risk of head trauma; however, current usage rates are low, especially among school-age children. Bicycle safety education programs have the potential for reducing bicycle-related morbidity and mortality in two ways: first, by teaching children to ride safely and competently in traffic; and second, by encouraging use of appropriate safety equipment, particularly helmets.

Purpose of Project

The purpose of this project was to evaluate a bicycle safety education curriculum for elementary school-age children. The curriculum, entitled "The Basics of Bicycling," was developed jointly by the N.C. Department of Transportation Bicycle Program and the Bicycle Federation of America. As this was a new curriculum, a major aspect of the current project was a field evaluation of its implementation in an actual school setting. Here we were interested in answering questions such as:

- Is this a reasonable curriculum to implement?
- How do teachers feel about the curriculum? administrators?
- What kind of training do teachers need before they can teach the program?
- What changes can improve the presentation of the curriculum?
- What logistical problems are there in teaching the on-bike lessons?
- Do children like the curriculum? etc.

Beyond this "process" evaluation of the curriculum, we also wanted to evaluate its effectiveness in terms of:

- increasing children's awareness and knowledge of bicycle safety issues;
- developing safe riding skills and practices;
- encouraging helmet use; and
- ultimately, reducing the likelihood of serious injury.

Measurements of these kinds of changes constituted our impact evaluation of the curriculum.

A final goal of the project was to work with the North Carolina DOT Bicycle Program staff to identify the major obstacles to implementing The Basics of Bicycling curriculum in 4th grade classrooms statewide, and to begin the process of addressing these obstacles.

The setting for the evaluation of the curriculum was two elementary schools in Mebane, North Carolina, a community of 3,800 residents located in the central piedmont region of the state. The curriculum was taught to nearly 300 fourth and fifth grade students attending the two schools. Two elementary schools in nearby Graham, North Carolina served as comparison sites. The evaluation activities were carried out during the spring and summer of 1990.

Report Format

The following chapter describes The Basics of Bicycling curriculum and presents some background on its development. Also included in the chapter is a description of our experiences in implementing the curriculum at our two selected schools. Chapter 3 describes the various evaluation activities and their outcomes. A final summary and discussion chapter includes recommendations for continued activities in North Carolina in regard to bicycle safety education for the elementary school-age child.

2. The Basics of Bicycling Curriculum

About the Curriculum

The Basics of Bicycling is a bicycle safety education program targeted at fourth grade elementary school-age children. It was developed by Linda Tracy of the Bicycle Federation of America and John Williams, publisher of *Bicycle Forum* magazine and also with the Bikecentennial organization. While produced specifically for the North Carolina Department of Transportation Bicycle Program, the curriculum is intended to serve as a model for school-based bicycle safety education programs nationwide. Copies of the curriculum are being made available through the North Carolina Bicycle Program as well as the Bicycle Federation of America.

The actual development of the curriculum was initiated during the summer of 1989 with funding provided by a grant from the Federal Highway Administration. A number of individuals and organizations were involved in its planning, including Mary Meletiou and Curtis Yates from the N.C. DOT Bicycle Program; Jane Stutts and Bill Hunter with the UNC Highway Safety Research Center; Ed Maxa of the North Carolina Agricultural Extension Service ("4-H"); Ann Ringland with the Division of Maternal and Child Health, North Carolina Department of Environment, Health, and Natural Resources; and Bob Jamieson, chairman of the North Carolina Bicycle Committee.

The Basics of Bicycling is what its name implies -- an introductory course in the basic knowledge and skills needed for safe bicycling. Given the curriculum demands placed on today's elementary classroom teacher, we chose to limit the scope of The Basics of Bicycling to those aspects of bicycling that have been identified as most critical to children's safety when riding on the streets in their neighborhoods and communities. The lessons teach:

- use of appropriate bicycling equipment, especially helmets;
- checking the fit and mechanical condition of a bike before riding;
- knowledge of traffic laws and traffic signs;

- identifying and reacting to potentially hazardous roadway situations;
- riding cooperatively and communicating with other road users; and
- developing bike handling skills important for safety.

The curriculum consists of seven lessons, each requiring one 40-minute class period (a shorter time is possible, but not recommended). Each new lesson builds upon the previous lesson so that, for example, children learn how to check out their bike and fit a helmet during the first lesson, then practice these skills during each subsequent lesson. Similarly, the concept of searching or "scanning" the road environment for other traffic or road hazards is first introduced in Lessons 2 and 3, but is a skill used extensively in Lessons 5-7.

The first two Basics of Bicycling lessons are taught in a classroom setting, and the remaining five are taught "on-bike" in a simulated traffic environment. Figure 1 presents a brief description of each of the lessons. For Lessons 1 and 2, instruction focuses on choosing appropriate bicycle equipment (especially helmets), checking the fit and mechanical condition of the bicycle, and recognizing and responding to high risk situations such as a parked car blocking one's view upon entering a roadway. These lessons are taught with the aid of an instructive videotape provided with the curriculum.

The remaining five lessons are all "on-bike" sessions. Using masking tape, various courses are laid out on the school grounds, preferably in a parking lot or other large paved area. Figure 2 presents diagrams of these courses. Lesson 3 teaches straight line riding, stopping quickly without swerving out of the traffic lane, use of hand signals, and dodging hazards in the roadway (see Figure 2a). Lesson 4 provides opportunity to practice scanning and introduces the concepts of cooperative riding and communicating with other road users (Figure 2b). Lessons 5 and 6 provide opportunity for children to integrate and practice a wide variety of riding skills in a simulated traffic environment, skills such as negotiating a left turn in traffic, merging left around an obstacle in the roadway, and yielding to traffic that has the right-of-way (Figures 2c and 2d). Lesson 7 is a final review and evaluation session, using the course layout for Lesson 6.

LESSON 1 - INTRODUCTION
In-class lesson introduces students to appropriate bicycling equipment; checking the mechanical condition of their bicycles; traffic signs and lights, and their meaning; and the correct direction of travel.

LESSON 2 - HIGH RISK SITUATIONS
In-class lesson teaches students to recognize and respond appropriately to high risk situations and to predict behavior of other road users.

LESSON 3 - GETTING READY TO RIDE
In-class and on-bike session teaches students to check bicycle and helmet fit; check bike condition; ride in a straight line; avoid obstacles on the road; and use hand signals while riding.

LESSON 4 - BIKE HANDLING SKILLS
On-bike lessons teaches students to scan ahead and behind for traffic and to communicate with other road users while riding straight.

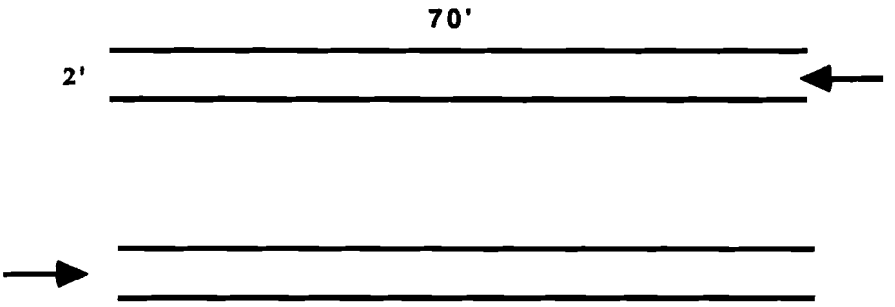
LESSON 5 - TRAFFIC SKILLS I
On-bike lesson builds on previous lessons and teaches students to ride on the right side of the road; avoid hazards without colliding with others; enter and exit a road; make left and right turns.

LESSON 6 - TRAFFIC SKILLS II
On-bike lesson that builds on previous lessons using a more complex version of the course from Lesson 5. Reviews and teaches students to negotiate an intersection as a "motorist" or as a "bicyclist" without colliding with others and to obey traffic signs and lights.

LESSON 7 - SUMMARY AND EVALUATION
On-bike lesson uses course from Lesson 6 to evaluate students' abilities to ride on the right side of the road, avoid hazards, enter and exit a road, negotiate an intersection, use and understand hand signals while riding, and scan ahead and behind for traffic.

Figure 1. Overview of lessons in The Basics of Bicycling.

2a. Lesson 3 - Straight Line Riding and Lesson 4 - "Car/No Car"



2b. Lesson 4 - "You Go First" and "Squeeze Box".

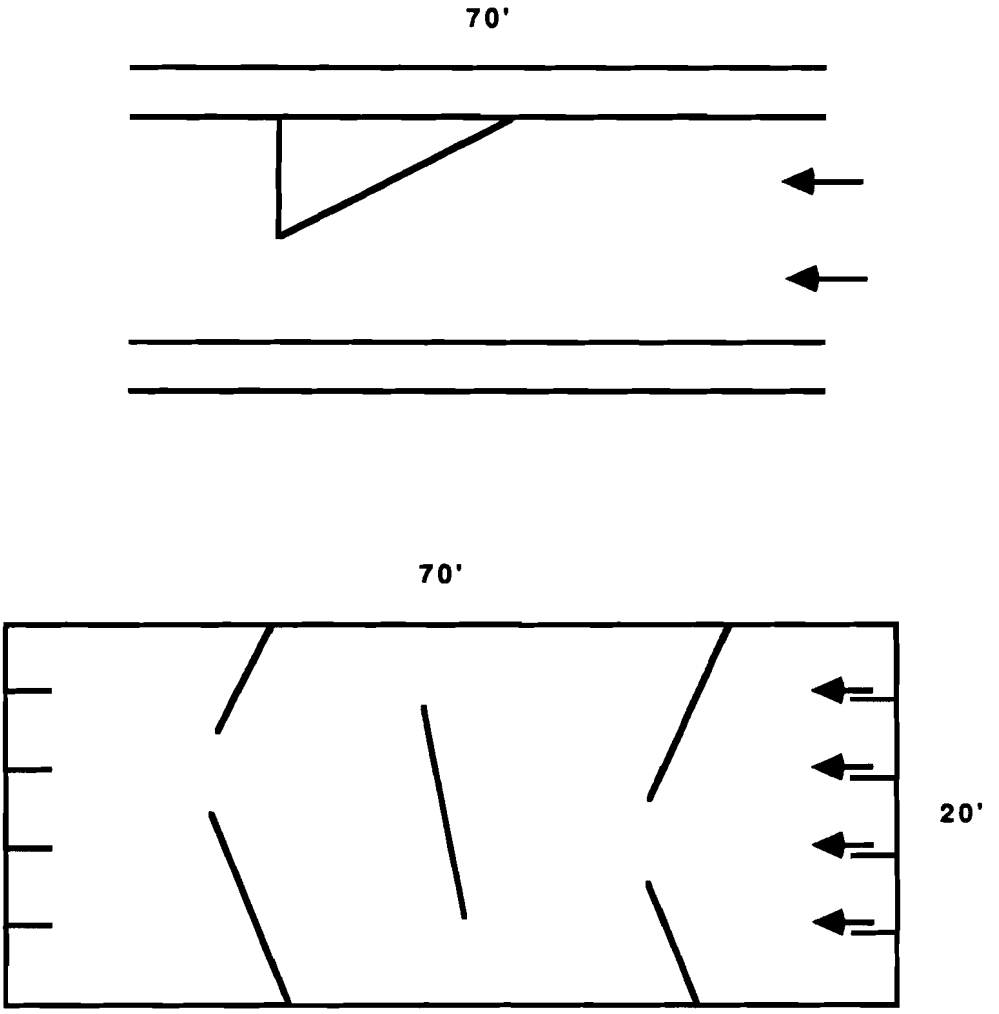
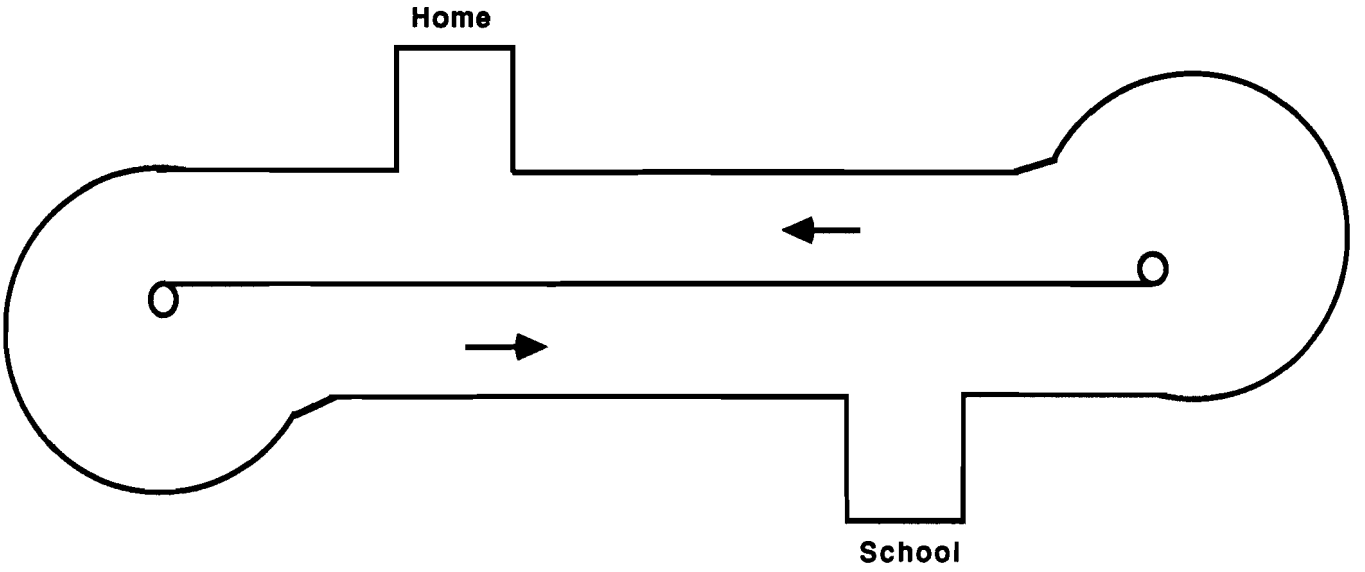


Figure 2. Course layouts for Lessons 3 through 6 of The Basics of Bicycling (cont. on next page).

2c. Lesson 5 - Simulated Road Course.



2d. Lesson 6 - Advanced Simulated Road Course.

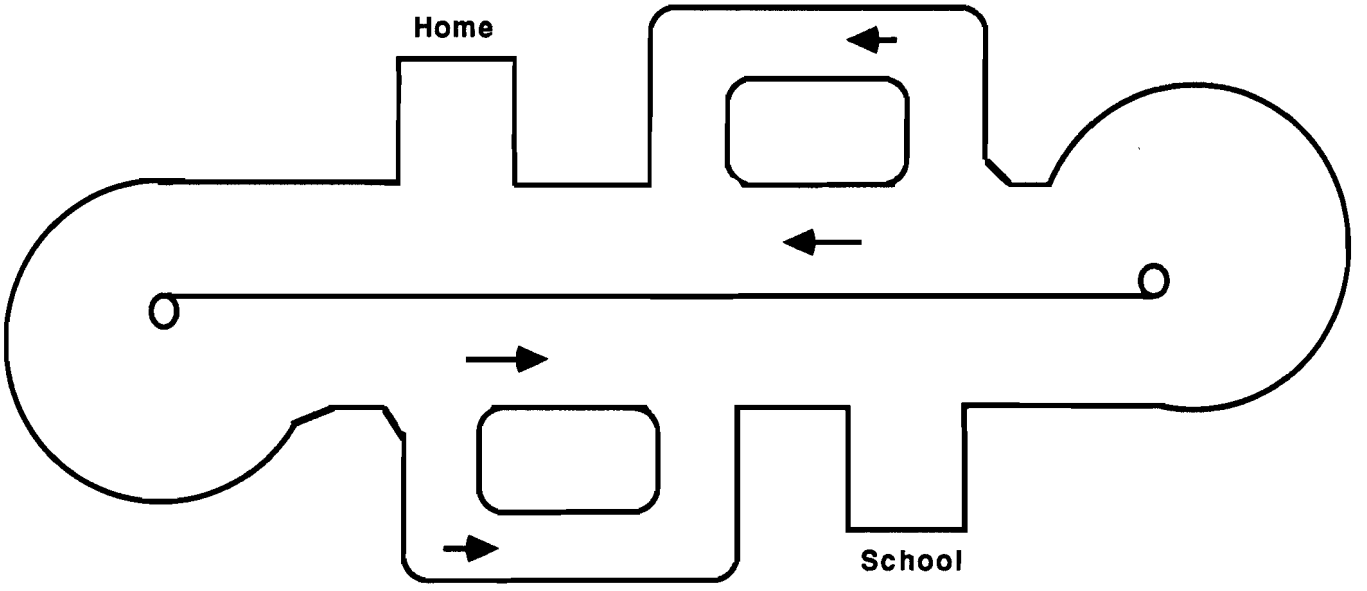


Figure 2 (cont.). Course layouts for Lessons 3 through 6 of The Basics of Bicycling.

Detailed instructions for teaching the lessons are presented in the curriculum guide (N.C. DOT Bicycle Program, 1990). The guide also identifies any other program requirements and gives instructions for creating the needed props and laying out the various courses. Although not available for the field testing, the final version of the curriculum includes a videotape that contains segments for the Lessons 1 and 2 in-class instruction and an instruction module for the teacher.

Preparations for Implementing the Curriculum

Prior to the actual field evaluation of The Basics of Bicycling curriculum, a number of activities needed to occur. These included the selection of experimental and control schools, developing support within the community, obtaining equipment and materials needed to conduct the program (primarily bicycles and helmets, but also bike tools, course props, etc.), and teacher training. Each of these areas is addressed in the sections that follow.

Site Selection. From the outset a goal of the project was to solicit input from the variety of individuals and organizations in the state supportive of school-based bicycle safety education and to involve them in the project. One of our first activities was to contact the North Carolina Department of Public Instruction (DPI) to invite their participation in the curriculum development and to ask their recommendation regarding possible project sites. (The Healthful Living Section of DPI had, during the previous year, evaluated implementation of a bicycle education program at schools in Wilmington, North Carolina). Mr. Larry McDonald, physical education consultant in the Healthful Living Section, strongly recommended that the curriculum be taught by physical education instructors, and suggested Alamance County Schools as a potential site. Specifically, he recommended Alec French, a physical education teacher at E.M. Yoder Elementary School in Mebane as well as demonstration teacher for the Alamance County system.

Following Mr. McDonald's recommendation, we contacted Mr. French and explained the nature of the project. At this point (which was in late May, 1989, still

four months before the official start of the project), we knew only that the curriculum would be on-bike and that it would require 6-10 class periods. Nevertheless, Mr. French was enthusiastic about the possibility and agreed to pursue the matter with school administrators. The project was officially approved the following fall, following a meeting with the Assistant Superintendent for Instruction for Alamance County Schools and the principals and physical education teachers at the two Mebane schools where the curriculum would be taught (Mr. French at E.M. Yoder and Ms. Linda Fowler at South Mebane).

At the same time that our experimental schools were selected, we selected two schools in nearby Graham (also Alamance County schools) to serve as comparison sites. Like the two Mebane schools, the Graham schools (North and South Graham) served children living within the community as well as the surrounding rural area. Graham's population is approximately 10,000, compared to the 3,800 for Mebane. Although a separate community, Graham is adjacent to the much larger urban area of Burlington, North Carolina (population 39,000).

Community Support. Once the site selection was finalized, we began to make additional contacts in the community for assistance with the project. The Mebane Police Department was contacted to let them know about the project, to obtain information on community bicycle safety activities either ongoing or planned, to obtain their cooperation in providing hard copies of police reports for accidents involving young cyclists, and to see if they could assist us in obtaining bicycles for the program. The Department readily gave its support to the program, helping particularly with securing bicycles and with the rodeo event held at the conclusion of the program (both are described further in later sections of the report).

In addition to the police department, contacts were made with local family practitioners and pediatricians serving children in the Mebane/Graham area. A total of six physicians/practices was identified. Each was contacted first by letter and then by a follow-up telephone call and asked to assist in the project by providing information on children treated for a bicycle-related injury. Only one physician

chose not to participate. We were also able to establish contact with records personnel at the two hospital emergency rooms servicing the area, and they agreed to forward to us information on any bicycle-related injuries to children. A more detailed accounting of the role played by the medical community in the injury data collection aspect of the project is given in the results chapter that follows.

Finally, we felt that local bicycle shop owners and bicycle club enthusiasts could serve as a valuable resource to the project and should be contacted. There was, however, no bicycle shop or club in either Mebane or Graham. The nearest bicycle shop was a Schwinn dealership in Burlington, 10-15 miles away. Nevertheless, store managers were contacted and proved to be a valuable asset to the overall effort. Again, their role is best detailed in the section below focusing on equipment and material needs.

A final community contact was the local recreation and parks office. This office cooperates closely with the Mebane police and was able to provide space for the bicycle rodeo event held in the spring.

Equipment and Materials. As noted above, a major task that had to be addressed before The Basics of Bicycling curriculum could be implemented was obtaining bicycles for use in the on-bike portion of the program. Since the vast majority of the children attending schools in Mebane are transported by bus, principals were reluctant to ask the children to bring their bikes to school for the program. There was also the issue of liability for the bikes and a problem of storage if bikes were not taken home at the end of each day. Since our plan was to teach the curriculum to all fourth and all fifth grade classes concurrently, there was also the potential for 150 bicycles at a school on a given day! For these reasons and others, the decision was made for the program to provide one set of bicycles that could be used by all classes participating in the program at both schools.

Since no funding was earmarked in the project to purchase the bicycles, and since we did not want to actively involve ourselves in fundraising at the community level, we opted to try to obtain a serviceable fleet of bicycles from those that

were found or recovered but not claimed at local police departments. As noted above, we initially pursued this with the Mebane Police Department. Although the Chief readily supported our efforts, fewer than a half dozen bicycles were available, with several requiring extensive repair work. Calls to the Alamance County Sheriff's office and several other local police departments in the area failed to produce additional bicycles.

Finally, we contacted the City of Burlington Police Department where we were referred to Sgt. Jackie Sheffield in the Juvenile Division. Unlike their smaller neighbors, the Burlington Police Department had a large number of bicycles that could potentially be used by the project. Sgt. Sheffield identified 15 bicycles that were in reasonably good condition and that would fit a fourth or fifth grade child. Actual permission to use the bikes required obtaining a court order, since legally they were to be held as unclaimed property until a time that they would be sold at public auction. In spite of this additional "red tape," Sgt. Sheffield was able to make the bicycles available to the program with minimal delay.

Once we had the bicycles "in hand," we were still faced with the task of carrying out the necessary repairs to make them serviceable. (During the course of the program, faced with a bike with less than perfect brakes, or with a pedal that refused to stay on or a seat that could not be adjusted, we often questioned the wisdom and irony of teaching a bicycle safety course using bicycles that were not always in the best mechanical condition. This issue is addressed further in the final summary and discussion chapter.) In most instances repairs were minor, requiring only that tires be fixed or replaced or that brakes be adjusted. Some of the bikes, however, required more extensive repair work. To assist in these efforts, we relied on volunteer help from the Explorer Scout troop sponsored by the Mebane Police Department, with backup support from the Burlington Schwinn bike shop. The Scouts agreed to take on the repair of the bicycles as a community service project, and also helped out later with the bicycle rodeo held at the completion of the course. Along with the Scouts, the son of an HSRC staff person with a special talent (and zest!) for repairing bikes provided valuable assistance at this stage of the project.

Another major item of equipment needed to teach The Basics of Bicycling is helmets. In this case, money was available in the project to purchase 30 bicycle helmets. These were obtained through the Schwinn dealership and passed on to the project essentially at cost. Since school administrators expressed some concern over the possible health consequences of children sharing helmets, we also purchased cycling caps that could be worn under the helmet. A cap was purchased for each child and worn during each on-bike session. At the conclusion of the program children were allowed to retain their caps, whereas the helmets were kept by the schools for their future use.

Other equipment and supplies needing to be acquired before teaching The Basics of Bicycling were associated with the riding courses used in the curriculum and included masking tape for laying out the various courses, traffic cones, and a variety of props. The props include "car fronts" which turned some of the bicycles into motor vehicles, and traffic signs, fences, etc. These are all identified in the curriculum guide, and an appendix to the guide gives diagrams and dimensions along with tips for creating. For this initial field testing of the curriculum, the North Carolina Bicycle Program staff printed a copy of the various designs on photographic paper, which we were then able to color and mount on cardboard. Concerning the other major requirement for the course, that of masking tape, the curriculum manual recommends 12 rolls of 2" wide tape for laying out all of the courses for the five on-bike lessons.

A final category of miscellaneous equipment and material items included bike repair tools, spare tire tubes, tape measures, chalk, etc. Again, these are all identified in the curriculum guide. The guide also recommends that the on-bike lessons be videotaped and the tapes incorporated into the lessons as diagnostic tools. While we recorded the lessons during our field evaluation, this was done primarily for evaluation and documentation purposes and not for teaching.

Teacher Training. Once the sites and instructors had been selected and all equipment and materials gathered, a final activity that needed to occur prior to

implementing The Basics of Bicycling was teacher training. In this case, it was not only the physical education instructors at our two schools who needed to learn how to teach the new curriculum, but also HSRC project staff who would be evaluating the program and others who were interested in previewing the "final product."

The training session was scheduled at E.M. Yoder Elementary in Mebane a week prior to the actual start date for teaching, and was led by the curriculum's authors, Linda Tracy and John Williams. The training included a general introduction to the importance of bicycle safety education and the necessity of on-bike training, an overview of the curriculum, and a step-by-step run-through of each of the seven lessons. Participants learned how to fit a helmet, how to check the mechanical condition of their bikes, about the importance of proper clothing and safety equipment, and about the most common causes of bicyle crashes. They also practiced laying out the various courses used in the curriculum and actually rode their own bikes through the exercises. All agreed that this "hands-on" experience with the curriculum was essential preparation for teaching.

Conducting the Field Evaluation

The field evaluation of The Basics of Bicycling curriculum was carried out during the months of April and May, 1990, first at E.M. Yoder Elementary School in Mebane and then at South Mebane Elementary School. Although targeted to fourth grade children, the curriculum was taught to both fourth and fifth graders at each school. This was done to examine the effective age range for the curriculum and to increase the sample size for the evaluation. As already noted, a total of approximately 300 children participated.

All of the children were required to have a parent or guardian sign a permission form to allow participation in the on-bike portion of the curriculum. While some of the children were late in returning the forms and missed one or more on -bike sessions as a result, only a couple of the children were unable to participate in the on-bike lessons. One of the children had suffered a serious injury on a bike earlier in the year and his parents were not allowing him to ride at the time. A few

other children had only minimal riding skills at the start of the program, but with some one-on-one instruction during the first on-bike lesson were quickly able to join the rest of the class.

Each of the seven Basics of Bicycling lessons is designed for a 40-minute class period. At both Yoder and South Mebane, the normal time allotted for a physical education class is 30 minutes, and although we could extend some class periods on occasion, we basically had to work within this time constraint. Classes met two to three times a week, so that at each school the lessons were taught over a two to three week time period.

For the field evaluation of the curriculum, in addition to the physical education instructor who taught the course (Alec French at E.M. Yoder and Linda Fowler at South Mebane), two to three members of the HSRC project staff were available to assist with the lessons, help with minor bike repairs and adjustments, fit helmets, etc. DOT Bicycle Program staff were also present for some of the lessons at E.M. Yoder, and provided much assistance while documenting the program on film. Occasionally we had the help of a parent volunteer. The curriculum guide recommends that two to three parents or other adults be recruited to assist with the on-bike lessons, the third person operating a camcorder for lessons 5-7. We certainly agree that, particularly for the beginning instructor, the additional help can make the lessons run more smoothly. (We videotaped all of the on-bike lessons but were unable to incorporate them into the class instruction due to the shortness of the class periods. However, an edited version of the videotapes has since been used in presentations of the curriculum to interested audiences.)

Although we followed a rather hectic schedule (sometimes teaching five half-hour classes back-to-back), we feel that the lessons went well. Response from the children was extremely positive. And, as will be documented in the following chapter, we feel that they learned a great deal about safe bicycling. Now that a new school year has begun, we are told that last year's third graders are already approaching the physical education teachers and asking, "Are we going to get to ride bikes this year?"

3. Curriculum Evaluation

The effectiveness of The Basics of Bicycling curriculum was evaluated at several levels. At one level we examined the children's knowledge concerning safe bicycle riding practices. We also observed children's actual riding behaviors on courses set up to simulate the road traffic environment. Finally, data were collected regarding helmet ownership and use and injury experience, both prior to the implementation of the curriculum and during the summer following the curriculum implementation. The data were collected from the fourth and fifth grade children at the two Mebane schools that participated in the program as well as fourth and fifth graders at our two comparison schools in nearby Graham, North Carolina.

Following is a more detailed description of the evaluation activities that took place and their results.

Baseline Survey Data

As a first step in the evaluation we developed a survey to establish baseline data on bicycle ownership and use, helmet ownership and use, and accident/injury experience. The survey was distributed to all fourth and fifth grade classrooms at the two Mebane (experimental) and two Graham (comparison) schools. Response rate for the Mebane children was virtually 100 percent, since we required that they complete the survey before participating in the on-bike portion of the program. Response rate for the Graham children varied from one classroom to another but averaged about 70 percent. Appendix A contains a copy of the survey. The survey was designed so that it could be completed by the child, but we asked that the child have his parent look over the survey and sign it as well.

Results of the survey are summarized in Table 1. They show a high level of bicycle ownership and use at all four schools: overall, 96 percent of the children owned or had use of a bike, and 78 percent reported riding at least once or twice a week. Slightly fewer children at North Graham owned bicycles and rode regularly, but those who did were more likely to ride longer distances from home and out

Table 1. Baseline survey of bicycle use and injury experience at the two experiemental and two comparison schools.

Baseline Survey Questions	Experimental Schools		Comparison Schools		Total
	E.M. Yoder (N=117)	South Mebane (N=160)	North Graham (N=70)	South Graham (N=57)	
Percentage of children owning bikes	95.7 %	97.5 %	91.1 %	98.6%	96.3 %
Type of bicycle owned					
One speed (regular or BMX frame)	55.7	52.7	47.9	47.0	51.9
More than one speed, hand brakes	35.9	34.7	31.3	39.4	35.4
Other (hand and foot brakes, etc.)	8.5	12.7	20.8	13.6	12.7
Frequency of riding *(p=.06)*					
Every day or almost every day	53.2	60.0	44.2	50.8	54.3
3 or 4 times a week	15.3	9.0	11.5	9.0	11.2
Once or twice a week	15.3	11.0	11.5	14.9	13.0
Several times a month	10.8	11.0	9.6	17.9	12.0
Never, or hardly ever	5.4	9.0	23.1	7.5	9.6
How far from home usually ride					
One block or less	40.5	53.0	33.3	45.5	45.4
2 - 3 blocks	19.8	14.6	23.5	24.2	19.0
1/2 - 1 mile	17.1	14.6	21.6	16.7	16.6
1 - 2 miles	12.6	11.3	5.9	9.1	10.6
More than 2 miles	9.9	6.6	15.7	4.6	8.4
Where usually ride					
Yard, driveway, sidewalk, parking lot	32.4	38.3	16.0	26.5	31.6
Neighborhood street - low to med. traffic	44.1	39.6	52.0	45.6	43.6
Other two-lane road - low to med. traffic	11.7	7.8	16.0	16.2	11.5
Other two-lane road - med. to heavy traffic	6.3	8.4	10.0	10.3	8.4
Other	5.4	5.8	6.0	1.5	5.0
Own helmet	11.8	12.2	14.9	13.6	12.7
Needed to see doctor for bike-related injury	11.1	12.0	21.7	15.6	13.6
Fallen from bike and hit head	22.2	27.2	34.6	35.9	28.3

onto streets in the neighborhood. With the possible exception of frequency of riding, which had a p-value of .06, the differences between the schools were not statistically significant, and there were no significant differences when the two Mebane schools were grouped and compared with the two Graham schools.

Approximately half of the bicycles owned and ridden were of the one-speed or BMX variety, and a third were more than one speed with hand brakes. Here there were some differences by grade level, with fifth graders owning more of the multi-speed bicycles (p=.10). The remaining category consisted mostly of BMX-style bikes that had both hand brakes and pedal brakes.

For the majority of fourth and fifth graders, bicycling is still an activity that takes place very close to home. Nearly a third of the children indicated that most of their riding occurred in their own yard or driveway, and 45 percent said that they usually rode less than a block from their home. Still, children this age are beginning to venture into traffic. Nearly half rode on neighborhood streets with low to medium traffic, and 20 percent rode on other two-lane roadways. Over a third of the children also indicated that they travelled more than half a mile from their home. (While one could speculate that children's self-reported distances might be exaggerated, the children were encouraged to ask a parent or teacher for help if they had difficulty with this particular question, and parents were asked to review and sign the form.) There were no significant differences between fourth and fifth graders in their responses to these question about riding distances and street types, and again no significant differences between students at the two Mebane and two Graham schools.

Results concerning helmet ownership and use were also consistent across the schools and grade levels. Overall only 48 (13 percent) of the children indicated that they either owned a helmet or had one that they could use. Of these, only 18, or one-third, indicated that they wore the helmet every time or almost every time they rode. In fact, nearly half of the helmet owners indicated that they *never* wore the helmet! When asked if they had worn the helmet the last time they rode their bike, over 60 percent of helmet owners responded that they had not.

Two final questions on the survey asked about injuries resulting from a bicycle crash. In response to these questions, 49 (14 percent) of the children indicated that they had at some time seen a doctor or received treatment at a hospital for a bicycle-related injury. The most frequently cited injuries were broken arms and injuries to the mouth or lips (cuts requiring stitches, chipped or knocked out teeth). Concerning the cause of the crash, cars were only mentioned in a few instances. In only two cases was it clear that either the child or his bike actually struck the car, and neither of these involved serious injuries. The majority of the crashes and injuries were reported to be caused by objects in the road (rocks, bricks, holes) or by friends or other bike riders ("my brother," "my sister," and "this girl" were all cited). A final category of crashes resulted from unsafe riding behaviors and included riding backwards, riding down steps, and jumping over a skateboard. None of the children noted bicycle mechanical failure as a cause for their crash.

Apart from injuries requiring that they see a doctor, 28 percent of the children reported that they had fallen and hit their head while riding a bike, and over half of these children had done so on more than one occasion. None indicated that they had been wearing a helmet at the time.

To summarize, these survey results reinforce what we already know about children and bikes, namely, that bicycling is a popular activity of children and that it sometimes results in injury. For our sample of approximately 400 children, one in eight reported having been injured seriously enough to require medical attention, and one in four had fallen and struck their head. Even though the fourth and fifth grade children in our survey had begun to venture out onto neighborhood streets and into traffic situations, the vast majority of their injuries had resulted simply from falls -- the unexpected rock in the roadway, a friend pulling up too close or stopping too quickly, a curve that was too sharp. Only about 13 percent of the children owned a helmet, and less than half of these children regularly wore their helmet when riding.

While offering these insights into the riding experience of fourth and fifth grade children, the primary purpose of this initial survey was to determine whether

the children at our experimental (Mebane) and comparison (Graham) schools were similar in their riding experience and behaviors, and to provide baseline data for subsequent comparison following implementation of The Basics of Bicycling. Based on the Table 1 results, the two samples of children appear reasonably comparable. Results pertinent to the impact of the educational curriculum will be discussed later in this chapter.

"What Do You Know About Bicycling?" Quiz

The Basics of Bicycling curriculum does not incorporate a formal written pre- and post-test to evaluate changes in children's knowledge about safe bicycling. Rather, emphasis is placed on observed changes in actual riding (and preparation for riding) behaviors. The curriculum does include, however, a true/false "What do you know about bicycling?" quiz that was given to the students at the outset of the program. The results of this quiz are summarized in Table 2. (These results are for South Mebane only, as Yoder students were inadvertently told that they could take their quizzes home with them.)

There were three areas in which the children showed a clear lack of knowledge concerning safe bicycling practices. Most importantly, nearly half of the children agreed with the (false) statement that "It's better to ride your bike facing traffic so you can see what's coming" (Question #1 on the survey). Analysis of crash data shows that wrong-way riding is a factor in up to 23 percent of bicycle-motor vehicle crashes (Williams, 1981). Another frequently missed question concerned the need for lights when riding at night (Question #4). Here, 30 percent of the students (falsely) agreed that you don't need lights at night if you already have reflectors. A final question which posed difficulty for the children concerned the correct size of a bicycle (Question #10). One-fourth of the children responded that it was "O.K." for their bike to be a little too big now so that it would fit them next year.

For many of the questions there were strong grade level differences, with fifth graders much more likely to respond correctly. One possible explanation is that the fourth graders had a more difficult time reading and responding to the true/false

Table 2. Responses of 4th and 5th grade students at South Mebane to the "What do you know about bicycling?" quiz (N=158).

Question	Percentage Correct Responses		
	4th Graders	5th Graders	Total
1. It's better to ride your bike facing traffic so you can see what's coming. (False)	37.2	68.8	53.2
2. When you ride your bike, you must stop at all stop signs and red lights just like cars do. (True)	93.6	98.8	96.2
3. Bicycle riders don't have to stop when they hear a siren from an ambulance, police car, or fire truck. (F)	84.6	97.5	91.1
4. You don't need lights on your bike at night if you already have reflectors. (False)	59.0	81.3	70.3
5. Bicycle riders can safely carry packages in one hand because they can steer with the other. (False)	91.0	100.0	95.6
6. Bicycle riders must give hand signals before making a turn. (True)	91.0	100.0	95.6
7. Bicyclists should only look for cars straight ahead when crossing an intersection or riding out of a driveway. (F)	91.0	92.5	91.8
8. It's OK for two people to ride on a bike if one sits on the seat and the other sits on the handlebars. (False)	100.0	98.8	99.4
9. You should wear a bike helmet even if there aren't any cars where you ride your bike. (True)	89.7	100.0	94.9
10. Your bike can be a little too big for you now so that it will fit you next year. (False)	60.3	87.5	74.1

questions, regardless of whether they knew the correct answer. Another explanation would simply be that as children mature they accumulate knowledge about safe bicycling with or without receiving formal instruction. Both of these explanations likely play some role in the results.

Finally, it should be noted that the "What do you know about bicycling?" quiz was not developed to meet rigorous test construction standards. Rather, it was developed and incorporated into the curriculum primarily as a teaching tool. A separate version of the test was given to the students to take home and administer to a parent or older sibling, along with a key for scoring. For these reasons no comparable post-test was developed.

On-Bike Evaluations

As described in Chapter 2, The Basics of Bicycling curriculum focuses on:

- Use of appropriate bicycling equipment, including a correctly sized bicycle in sound mechanical condition and a correctly sized and worn helmet;
- Recognizing and responding to potentially hazardous roadway situations;
- Knowledge of traffic laws and signs;
- Communication and cooperation with other road users; and
- Development of bike handling skills important for safe operation of the bicycle, such as scanning and signaling turns.

The major thrust of our evaluation was directed at assessing how well students who had completed The Basics of Bicycling course understood and practiced these objectives. For this part of the evaluation, we relied on one-on-one questioning and observation of the children. To aid in the evaluation, we utilized the checklists shown as Figures 4 and 5. (These checklists are included with Lessons 6 and 7 of the curriculum.)

Basics of Bicycling Intermediate Skills Checklist

At the end of Lesson 5, the students will be able to do the following:

Scoring: 2-good 1-pass 0-needs work

1. Check basic mechanical condition of bike															
Test tires for pressure															
Bounce bike for rattles															
Twist and rock handlebars and saddle															
Spin wheels looking for wobbles or bad spots on the tires															
2. Check bike fit															
Test frame size (stand over)															
Test saddle height (leg almost straight)															
3. Check helmet for fit and size															
Helmet is right size (uses pads to fit snuggly)															
Helmet sits level on head															
Strap is snug but not too tight															
4. Identify key traffic signs and what they mean															
"Stop" sign means stop and wait for cross traffic															
"Yield" sign means slow and wait for cross traffic															
"One way" means traffic must go that direction															
"Do not enter" means no traffic should go in															
"Red light" means stop															
"Yellow light" means stop if you can; go quickly if you're in the intersection															
"Green light" means go with caution															
TOTAL															

Class: _____

Figure 4. Intermediate Skills Evaluation for The Basics of Bicycling.

Basics of Bicycling Final Skills Checklist

At the end of the course, the students will be able to do the following in a simulated traffic envrisonment:

Scoring: 2-good 1-pass 0-needs work

1. Cross Traffic Safely																
Stop before entering traffic stream																
Scan to either side																
Wait for a gap in traffic																
Cross traffic without interfering with others																
End in right lane position																
2. Enter traffic safely																
Stop before entering traffic stream																
Scan to either side																
Wair for a gap in cross traffic																
Signal the correct turn																
Join traffic without interfering with others																
End in right lane position																
3. Merge left safely around an obstacle																
Scan ahead for obstacles																
Scan behind when they see one																
Negotiate if there's anyone close behind																
(signal, wait for response)																
Move left around the obstacle																
Move back to the right																
4. Left turns																
Scan behind as approach																
Negotiate if there's anyone close behind																
Move left to proper left turn position																
Scan for cross traffic and on-coming traffic																
Signal turn																
Wait for gap in traffic																
Turn without interfering with anyone																
End in right lane postion																
TOTAL																

Class: _____

Figure 5. Final Skills Evaluation for The Basics of Bicycling.

Intermediate Skills Evaluation. The intermediate skills checklist (Figure 4) allowed us to directly assess each child's knowledge and understanding of how to check out the basic mechanical condition of their bike, how to check to see that the bike is the correct size, how to adjust and wear a helmet, and what is the meaning of key traffic signs and signals. For example, we would ask a child to demonstrate to us how she would go about checking out the mechanical safety of her bike, at the same time questioning her about the importance of each item. For the helmet check, we gave the children helmets with all sizing pads removed and instructed them to show us that they knew how to adjust and wear the helmet. We then checked to see that the helmet fit the child's head snugly, that it was positioned level on the head, and that the chin strap was snug but not tight. For the road sign evaluation, we showed the children pictures of the various signs and asked them to explain their meaning for a bicyclist.

Due to the constraint of having only one 30-40 minute class period to conduct the evaluation, we were not able to cover all items with all children. One decision made fairly early was to eliminate the signs test, since virtually all of the children were responding with near 100 percent accuracy, and this was also something that could be evaluated behaviorally later in conjunction with the riding course assessment. To the extent possible, however, we tried to check each child for correct helmet use. About 85 percent of the children at E.M. Yoder were evaluated for at least helmet fit, bike check, and bike fit, while at South Mebane, all (except for a few absences) of the children were checked for helmets, and just under half for bike check and bike fit.

The results of these evaluations were extremely positive. Over 90 percent of the children correctly identified and demonstrated all four of the items listed under "bike check," with many identifying additional items as well. Similarly, the children had no difficulty in explaining and demonstrating to us how to check out a bike to determine whether it was the correct size. (Here we were primarily looking for correct saddle height, since the frame sizes of the bikes were suitable for the majority of the children and none of the bikes had crossbars.)

The percentage of children who were able to correctly size and fit a helmet on their head was also approximately 90 percent. Choice of padding and adjustment of the chin strap posed the greatest problem, but even here adjustments were only required for 6-7 percent of the children. Only three percent of the children wore helmets tilted too far back on their heads. Since chin strap adjustment of bicycle helmets can be difficult, we evaluated this by having the children fit the helmet to their head as best they could, then telling us whether or not any adjustment of the strap was needed.

These very positive results are perhaps not surprising, as by this point in the program the children had gone through the process of fitting helmets and checking out bikes on at least three occasions. They also were being evaluated using helmets and bicycles with which they were very familiar. These points should be kept in mind when we later present results pertinent to the comparison schools. Nevertheless, the results of this evaluation do seem to show that important learning has taken place.

Final skills evaluation. The final skills evaluation occurred during the last class session (Lesson 7). The layout of the course was identical to what had been used in Lesson 6. Children were instructed to ride their bicycles on the course, making left and right turns, crossing traffic, entering and exiting driveways and streets, and safely avoiding obstacles. As the children rode, the physical education instructors observed as many of these maneuvers as possible for each child. (Although most children were observed performing all of the maneuvers, a few had incomplete evaluations due to time constraints.)

Not all of the children performed all of the maneuvers correctly all of the time. For example, a child might forget at some point to signal, or fail to look over his left shoulder when merging into the roadway to avoid a "parked Mercedes." In scoring, we usually tended to give a child "the benefit of the doubt" if we knew that we had seen him/her successfully execute a particular maneuver on several previous occasions. Overall, almost all of the children demonstrated that they could

satisfactorily perform the maneuvers listed. Review of the videotape made during the final lessons generally confirms that the vast majority of the maneuvers identified on the checklist were being executed correctly.

Comparison Site Evaluations

To the extent possible we set up similar evaluation situations at our two comparison schools, North and South Graham. Although we were not able to exactly mimic the conditions at our test schools, the same basic approach of one-on-one questioning and observation of riding behaviors was employed.

For this part of the evaluation we arranged to work with children from one fourth and one fifth grade class at each of the comparison schools. The evaluation was conducted on school grounds during regular school hours and required about one hour of time per class. A series of "stations" was set up for the children to cycle through, beginning with a helmet check station. Here an HSRC staff person was wearing a helmet that was too large, sitting too far back on the head, and too loosely fastened. The child was asked to tell us if he thought the helmet was being worn correctly and why or why not. Each child was then fitted with his own helmet to wear during the remainder of the evaluation.

At the second station, children were questioned about turn signals and the correct position of a bicyclist on the roadway. They were asked to demonstrate left, right, and slowing/stopping hand signals. They were then shown a diagram of a two-lane roadway with cars travelling in both directions, and asked to point out where on the roadway a bicyclist should ride.

At the bike check station children were told to select a bike for use in the on-bike portion of the evaluation. As part of the selection process, we asked each child about how they determine whether a bike is too large or too small, and what parts of a bike they thought were important to check out before riding. For the bike fit check the key concept was that feet (or toes) needed to be able to touch the ground when seated on the saddle (none of the bicycles had crossbars.) For the bike mechanical check we were looking for some mention of brakes, tires, wheels, handlebars, seat,

chain, etc., and some indication that the child knew how the condition of each could be checked before riding.

A final station was a simulated roadway course similar to that used in The Basics of Bicycling final evaluation. Children were shown the route they were to take and told to pretend that they were riding on a real street. They were instructed to show us that they "knew how to ride safely on streets with cars and other traffic." As the children rode through the course one at a time, we checked off whether or not they performed the required safety maneuvers -- stopping at stop signs, checking for traffic before entering a roadway, signalling turns, etc.

Results of all these evaluations are summarized in Table 3. Children at the comparison schools responded quite well to the questions on **helmet fit and use**. Ninety-four percent noted that the helmet our staff person was wearing was too far back on her head and that it was fastened too loosely under her chin. Somewhat fewer (64 percent) correctly noted that it did not fit the head snugly. In retrospect this part of the evaluation might have been better handled by having the children fit helmets on themselves, as was done for the helmet evaluation at the Mebane schools. At the time, however, we thought this would put the Graham children at an unfair disadvantage, since most would be unfamiliar with the use of pads to size a helmet and unfamiliar with the buckle system on the helmet's chin strap. Still, it is difficult to compare the responses of children in the experimental and comparison schools and draw any conclusions regarding the effectiveness of the curriculum in teaching correct helmet use. What the evaluation does show is that whether from pictures, common sense, experience with bicycle or other types of helmets, or whatever, children this age have developed some knowledge of how a helmet should fit on the head. The larger issue, of course, is convincing children (and their parents) of the importance of wearing helmets in the first place. As we saw from the baseline survey, there is still much to be accomplished in this regard.

Results from the **turn signal check** show that less than half of the children evaluated at our two comparison schools could successfully demonstrate a left-hand turn, and less than one in five a right-hand turn. Even fewer, one in seven, knew

Table 3. Bicycle safety knowledge and skills evaluation at the two comparison (Graham) schools.

Comparison Site Evaluation Items	Percent Correct	Percent Partially Correct	Percent Incorrect
Helmet Fit Evaluation (N=97)			
Fits head snugly	63.9	19.6	16.5
Sitls level on head	93.8	3.1	3.1
Chin strap snug	93.8	5.2	1.0
Signal & road position check (N=97)			
Left turn signal	45.4	9.3	45.4
Right turn signal	18.6	22.7	58.8
Slow/stop signal	14.4	6.2	79.4
Ride on right with traffic	65.0	6.2	28.9
Bike check (N=95)			
Bike fit	82.1	11.6	6.3
Bike safety check	34.7	32.6	32.6
Riding on bike course (N=95)			
Driveway stop (1)	16.8	2.1	81.1
Stop sign stop (2)	64.2	26.3	9.5
Scanning (4)	19.0	41.1	40.0
Signal (3)	4.2	16.8	49.0
Lane position	60.0	26.3	13.7

the signal for slowing or stopping in traffic. As expected, these results carried over to the on-bike evaluation when the children had the opportunity to use hand signals when riding. In contrast, we have noted that virtually all of the children who participated in The Basics of Bicycling curriculum could successfully execute left and right turns using the correct hand signal.

Concerning our questioning about the **correct lane position** for a bicyclist riding in traffic, two-thirds of the children correctly indicated the right hand travel lane, riding with traffic. Nearly a third, however, thought that the bicyclist should ride facing traffic. (Recall that a true/false version of this question on the "What do you know about bicycling?" pre-test was missed by nearly half of the South Mebane children.) Again, there is no direct comparison to the population of children completing the curriculum, except to note that riding with traffic with "cars on the left, bikes on the right" was one of the first concepts introduced by the curriculum and was demonstrated by all riders throughout the course.

For the **bike size check**, full credit was given for any response indicating that a bike was too large if toes or feet could not touch the ground when seated on the saddle; partial credit was given for other, often more general responses, such as "it just feels too big or little when you ride". The vast majority of the children responded adequately to this question. Children were much *less* able to identify **parts of the bike that should be checked** before riding to see if they are working correctly and are not broken. Here we counted as a "correct" response identification of four or more items from a list that included brakes, wheels, tires, handlebars, seat, chain and pedals. A partially correct response indicated three of these categories, and an incorrect response two or fewer items. Using this breakdown, approximately a third of the students at our comparison schools fell into each category. In contrast, after five Basics of Bicycling lessons, over 90 percent of the Mebane school children correctly identified four or more items.

A major focus of the comparison site evaluations was the assessment of the children's **actual riding behavior** on the simulated street course described earlier. Here we were most interested in whether they stopped at the stop signs and before

entering a roadway; looked both directions for traffic before entering or crossing a street; used appropriate hand signals; and rode on the right side of the road. Results of these evaluations are summarized at the bottom of Table 3. Since several of the behaviors could be observed on more than one occasion, a "correct" response here was defined as always performing correctly (e.g., stopping at both of the two stop signs), a "partially correct" response as performing correctly on some occasions but incorrectly on others (e.g., stopping at the first stop sign but not the second); and "incorrect" as never demonstrating the desired behavior (e.g., not stopping at either stop sign).

Children were most likely to stop at the posted stop signs (64.2 percent) and to ride on the right side of the roadway (60.0 percent). Only 9.5 percent of the children failed to stop at either stop sign, and 13.7 percent consistently rode either in the middle or in the left-hand lane of the roadway. Children were much less consistent in their scanning behavior -- 40 percent never scanned at all, and 41 percent scanned only some of the time (e.g., before crossing one of the intersections, but not before entering the roadway from a driveway). Only a few children gave hand signals, and fewer still stopped before entering the roadway. In contrast, these were all maneuvers that were consistently performed by children in the final on-bike evaluations at the experimental (Mebane) schools.

As a final comment on this aspect of the curriculum evaluation, we recognize that differences in the course layout and in some cases the manner in which the evaluations were carried out preclude direct comparisons between those children who had been exposed to The Basics of Bicycling curriculum and those who had not. We tried to make the evaluation conditions as comparable as possible, but also had to work within the time and scheduling constraints imposed by the school setting.

In an effort to address some of these limitations we planned and held a **bicycle rodeo** in Mebane that was advertised in both of our elementary schools. The intent was to collect additional evaluation data on those children who had participated in the program in a setting other than the classroom. In addition to the usual "fun"

events such as the bike slalom and slow race, the rodeo incorporated most of the "stations" that had been set up for our comparison school evaluations, including an expanded version of the neighborhood street course. Unfortunately, several days of rainy weather prior to the rodeo and rescheduled little league baseball games contributed to a low turnout at the rodeo (only about 15 children). The data we were able to collect on these children was very encouraging, especially in comparing their performance on the simulated road course to the performance of the children not exposed to the course. However, the number of participants was simply too few to draw any conclusions from this effort.

Follow-up Student Survey

A shorter version of the survey that was given to the Mebane and Graham students in the spring before implementation of the course was distributed to the same students the following fall. Response rates for this follow-up survey were lower (approximately 70 percent for Mebane students and 60 percent for Graham students), due primarily to a lower response rate from (former) fifth graders who had graduated to a junior high school. In order to contact these older students, we mailed surveys to their homes in envelopes that they had self-addressed before leaving school in the spring.

Questions on the follow-up survey asked about how often they had ridden a bicycle during the summer months; whether they had had any falls or injuries during the time; if they had a helmet and, if so, when did they obtain it (during the summer or before); and their opinion about teaching bicycle safety courses in school. (See Appendix A for a copy of the survey.) Survey results are presented in Table 4.

For this follow-up survey, reported **frequency of riding** was greater for the Mebane students who had participated in the education program than for the Graham students who had not ($p<.001$). (Mebane students had also reported riding more frequently in the baseline survey, although the differences here were not statistically significant.) Mebane respondents were much more likely to report that they rode their bike every day or almost every day (57.4 percent, compared to 38.5

Table 4. Follow-up survey of bicycle use and injury experience at the experiemental and comparison schools.

Follow-up Survey Questions	Experimental Schools (Mebane) (N=195)	Comparison Schools (Graham) (N=117)	Total
Frequency of riding *(p=.01)*			
Every day or almost every day	57.4	38.5	50.3
3 or 4 times a week	11.8	12.0	11.9
Once or twice a week	11.3	7.7	9.9
Several times a month	6.7	11.1	8.3
Never, or hardly ever	12.8	30.8	19.6
Falls or injuries over summer? *(p=.05)*			
No falls or injuries	71.7	60.3	67.4
One or more falls, no injuries	14.1	25.0	18.2
Injuries treatable at home	12.6	11.2	12.1
Injuries requiring a doctor	1.6	1.7	1.6
Injuries requiring a stay in hospital	0.0	1.7	.7
Own a bicycle helmet? *(p=.11)*	8.5	12.7	9.4

percent for Graham students); Graham students, in turn, were more likely to report that they never rode their bike (30.8 percent, compared to 12.8 percent for the Mebane students).

Despite their greater frequency of riding, Mebane students were less likely to have been **injured** in a bike crash over the summer -- 71.7 percent reported no injuries, compared with 60.3 percent for Graham children. Two injuries occurred that were serious enough to require hospitalization, both involving (former) fourth grade Graham children: one was described as "cracked chest bones," the other as a "busted open head." Four other injuries requiring doctor or emergency room treatment were reported. These included a broken wrist and hurt spine (Graham); a bad cut on the foot (Graham); an unspecified leg injury (Mebane), and another unspecified injury (Mebane). One additional case appeared to involve a motorized bicycle or motorbike and was not counted in the total.

Based on these data, it appears that the injury experience of those children who were *not* exposed to The Basics of Bicycling curriculum was somewhat worse than that of the children who were exposed to the curriculum. However, it is not possible to draw definitive conclusions from these data, due to the small number of injuries and large number of non-respondents, particularly for the Graham students.

Three additional questions on the follow-up survey asked about **helmet ownership, purchase, and use** over the summer. The overall reported helmet ownership rate of 9.4 percent was lower than the 12.7 percent rate reported from the initial baseline survey. The difference was primarily from the Mebane students, who earlier had reported a 12.0 percent ownership rate but in the follow-up survey reported only an 8.5 percent ownership rate. This occurs despite the fact that a third of the respondents to the follow-up survey stated that they had purchased their helmet *after* the education program. One explanation might be that what the children had thought was a bicycle helmet at the time of the initial survey they now recognized as *not* a bicycle helmet, or at least not an ANSI or SNELL approved helmet as was stressed in the course. Children owning these "non" bicycle helmets may have been

less likely to report helmet ownership on the follow-up survey. It could also be the case that fewer helmet owners chose to respond to the survey, although there is no apparent reason for this kind of differential response rate.

Thirteen of the 15 helmet owners at both sites provided information on **frequency of use**. For the Mebane children seven (54 percent) said that they wore the helmet every time they rode, while four (30.8 percent) of the Graham students said that they did so. This represents an increase in helmet use by both groups -- in the earlier survey, only 27.3 percent of the Mebane helmet owners and 11.8 percent of the Graham helmet owners reported wearing their helmets every time they rode. Again, however, these numbers are small, and the lower response rate both overall and for the Graham students in particular weakens the data.

Physician Reports

A final potential source of evaluation data that was explored for this project was information from local pediatricians and general practice physicians on children treated for bicycle-related injuries. For this aspect of the evaluation we first identified six physicians/practices (including one large orthopedic clinic) most likely to serve the students attending our four elementary schools. All but one agreed to assist with the study. Personnel at two local hospital emergency rooms also agreed to participate.

Appendix A contains a copy of the survey form developed for this aspect of the evaluation. Physicians were given the option of either completing the survey form themselves or obtaining consent and contact information so that HSRC staff could call and obtain the desired information directly from the child or a parent. This aspect of the evaluation was directed at all children under 15 years of age treated for a bicycle-related injury during the period June 1, 1990 - August 31, 1990.

Even though follow-up contacts with the physicians over the summer assured us that all cases coming to their attention were being reported, only a few cases were actually identified using this approach. There were nine cases total, ranging in age from 4 to 14. One nine-year-old and one ten-year-old were reported,

neither of whom attended school in Mebane or Graham. Two of the children (the nine-year-old and a four-year-old) were involved in car-bike collisions, but suffered only minor injuries. The most serious injury was a closed head injury to a 14-year-old BMX rider practicing on an off-rode course.

Although numbers are small, the data support the conclusion that children who were exposed to The Basics of Bicycling curriculum were less likely to be injured while riding than children who were not exposed to the curriculum. Clearly, though, to carry out a valid assessment of the curriculum's effectiveness in terms of reducing the frequency and severity of injury, many more children would need to be followed over a longer period of time.

4. Summary and Discussion

The Basics of Bicycling is a new, on-bike curriculum designed to give fourth grade elementary school-age children the basic knowledge and skills they need to be responsible and safe bicyclists. The purpose of this project was to conduct an evaluation of this curriculum. The evaluation included a field assessment of the implementation of the curriculum in an actual school setting and an evaluation of its effectiveness in increasing children's bicycling knowledge and riding skills. It also examined the impact of the curriculum on children's injury experience over a three-month period during the summer.

Results of the Field Assessment

Nearly 300 fourth and fifth grade students at two elementary schools in Mebane, North Carolina participated in the field assessment of The Basics of Bicycling program. The curriculum was taught during regularly scheduled physical education periods by the schools' physical education instructors, with assistance from HSRC and N.C. DOT Bicycle Program staff. To prepare for the course, instructors and HSRC staff participated in a one-day training session led by the developers of the curriculum, Linda Tracy and John Williams.

The results of the field assessment clearly show that The Basics of Bicycling can be successfully implemented in an elementary school setting. Given the fact that bicycling is one of this country's most popular recreational activities and is an excellent source of health and fitness, it is certainly not difficult to justify a place for it in the physical education curriculum. Given, too, that bicycling is a leading cause of injury to elementary school-age children, one could justify its inclusion as a unit in health and safety as well. Although we feel that physical education teachers are a "natural" for teaching The Basics of Bicycling, we see no reason to exclude regular classroom teachers from offering the program to their students. Indeed, there could be some advantages to this, such as greater flexibility in scheduling.

Two of the greatest obstacles we feel to widespread adoption of the curriculum into elementary curricula are the need for bikes and helmets. For this field evaluation, HSRC was able, through no small amount of effort, to secure a serviceable fleet of bicycles by fixing up unclaimed bicycles made available by local police departments. Also, money was available in the project to purchase helmets. Although clearly too large a task for teachers to assume, it is possible that a school's parent-teacher organization, health and safety committee, etc. might be willing to take on the task of securing bicycles and helmets. Local civic groups, boy scout troops, etc. might also be a source of help. If the repaired bikes could be kept by the school from one year to the next, with new bikes being added to the fleet each year, then over the period of a few years a very serviceable fleet of bicycles could evolve.

An alternative and in many ways preferable approach to securing bicycles is to purchase a fleet of new bicycles specifically for use in teaching the curriculum. If the curriculum is taught at 4-5 elementary schools within a school system, then the central office could purchase the bikes and rotate them among the schools. The bike shop we worked with in Burlington was willing to order bikes and sell them to the program essentially at cost. In Florida, used school busses are turned into traveling bike vans; seats are removed and 30+ bikes are placed along the length of the bus, with storage for helmets and tools as well. The primary advantage of this approach is that the bikes would be in good mechanical condition from the start, and one could assume that repair and maintenance should be minimal for some initial period of time. Also, by equipping at least some of the bicycles with "quick release" seat posts, a single BMX frame bike could easily be adjusted to fit all but the very tallest and shortest fourth graders. Finally, although we experienced no problems in using a wide assortment of different size and style bikes, some quite new and expensive and others old and of little value, there would nevertheless seem to be some advantage to having the children all riding essentially the same bike.

As a final note regarding bicycles, the curriculum guide recommends one bike per child (plus one or two extra and a bike for the teacher). While this would obviously be desirable, we only had 16-18 bikes for classes of up to 28 students and did

not feel that the program suffered because of it. Each child was assigned a "partner" of the same height (or leg length), and bikes were rotated back and forth among partners giving each child opportunity to ride. When not riding, children would watch, help with repair, hold a traffic sign to keep it from blowing over in the wind, remind passing bicyclists to signal before turning, etc. An advantage to this sharing of bicycles is that not as many bicycles need to stored and locked up each night!

The Basics of Bicycling also requires a fair number of "props" (car fronts, road signs, traffic lights, etc.) that would be time consuming for any single individual to construct. Again, for this field assessment HSRC with the help of the Bicycle Program was able to make the props available. One recommendation of this project is that when a teacher or school system purchases the curriculum, they also receive a set of props more or less ready for use. Our goal here is to remove any obstacles that might keep a teacher from implementing the curriculum.

In addition to these obvious equipment and material needs, there is a need to educate teachers, parents, and school administrators about the importance of bicycle safety education. And finally, there is the need for a mechanism for training those teachers who want to teach the curriculum. Although The Basics of Bicycling will include an instructor's module for the teacher, we feel that a 1-2 day training session led by knowledgeable bike persons who have themselves taught the curriculum is a key to its successful implementation on a more widespread basis. Teachers who are not experienced bicyclists themselves need to experience first-hand how to check out the mechanical condition of a bike, make minor repairs, size and fit a helmet, etc. They also need to be reassured that they can, indeed, maintain control in a class with 20+ children on-bike!

Finally, we want to again stress that The Basics of Bicycling was an enjoyable experience for teachers and students alike. Teachers liked it because bicycling is an activity in which virtually all children participate and enjoy. They also recognized the need for a curriculum of this sort, having observed first-hand the unsafe riding behaviors of children and knowing of children who had been injured in a bicycle crash. The children, too, enjoyed the lessons, and were appreciative of the fact that

they were learning behaviors that would make them safer and more responsible traffic participants.

Impact Evaluation Results

The effectiveness of The Basics of Bicycling curriculum was evaluated at several levels using a variety of data sources. At one level we assessed children's knowledge concerning traffic signs and signals; left, right and stopping hand signals; how to tell if a bike is the correct size; how to correctly adjust and wear a helmet; and how to check the safety of a bike before riding. We also evaluated the children's riding skills at the conclusion of the seven lessons to determine whether they rode on the right side of the roadway; scanned behind for traffic before merging left; stopped and searched before entering the traffic stream; signalled turns and waited until there was a gap in traffic before entering; obeyed traffic signs; etc. For all of these assessments we compared the children's performance at the two "test" schools in Mebane with the performance of children at our two comparison schools in Graham. The results detailed in Chapter 3 clearly show that the Mebane children outperformed the Graham children, particularly in their performance on the simulated road environment course.

Effectiveness in terms of increased ownership and use of helmets is less clear cut. The data used to address this question was based on a survey sent home with the children in the spring before the start of the course and a similar survey sent out the following fall. At baseline, 12.7 percent of the children reported owning or having use of a helmet, but less than half reported wearing them on even half the occasions they rode. There were no significant differences between the schools. For the fall follow-up survey, the percentage of respondents reporting owning a helmet declined to 9.4. Although the same number of Mebane and Graham children reported owning a helmet in the follow-up survey, more of the Mebane children reported purchasing their helmet over the summer, since the educational program – 10 of the 15 Mebane helmet owners compared to 2 of the 15 Graham helmet owners. The Mebane helmet owners were also more likely to report that they wore their

helmet every time they rode.

Concerning the effectiveness of the curriculum in reducing the number of crashes and injuries, data from the surveys suggest that during the summer following their exposure to the curriculum the Mebane children were less likely to be involved in a bike crash and less likely to be injured than the Graham children. The problem here is again one of sample size, in that 400 children followed for a period of three months simply would not be expected to yield more that a few injuries serious enough to require a doctor's attention. (One recent estimate cited in an unpublished National Institute of Child Health and Human Development document was that 12,000 children would need to be followed for a period of five years to collect prospective information on 100 children with injuries severe enough to result in hospitalization.) Thus, to carry out a valid assessment of the injury reducing effectiveness of The Basics of Bicycling curriculum, it would need to be implemented in a larger number of schools and/or the children followed for a longer period of time.

Finally, it must be noted that a major weakness of our evaluation is that it did not include any observation of children's riding behaviors outside of the school setting. The planned rodeo event was an attempt in this direction but did not draw many participants. The issue here is whether children's riding behavior (including helmet usage) in a classroom setting extends to their riding behavior in their neighborhoods and with their friends. If it does not, then certainly there would be no reason to expect any changes in crash or injury occurrence. Again, this is an area that needs to be addressed in future research.

Concluding Comments

Clearly there is a need for bicycle safety education. Bicycle-related injuries are a leading cause of hospitalization and emergency room visits for elementary school-age children. Bike crashes are also a leading source of head injury and the serious sequelae this can imply. The Basics of Bicycling program is designed to reduce the injury toll to young bicyclists by teaching them to ride safely and responsibly, and by

encouraging them to use appropriate bicycle equipment, especially an approved bicycle helmet. Although the curriculum can be taught to groups of children in any setting (Scouts, 4-H, local parks and recreation department programs, YMCA's, church groups, etc.), it is especially designed for use in the elementary school setting. The reason for this is simple: by institutionalizing the curriculum in the school environment, it will reach more children more consistently.

The curriculum was developed with the idea that bicycle safety education should be presented as part of a continuum of traffic safety education that begins in the very earliest school years with school bus safety education, progresses to pedestrian safety education, then moves on to bicycle safety education and, finally, drivers' education. An implication here is that the traffic skills and attitudes that a young bicyclist learns participating in a program such as The Basics of Bicycling will have positive carry over to the time when he/she becomes old enough to operate a car, motorcycle, or other motor vehicle. If so, then the impact of the curriculum could have far more lasting ramifications.

Clearly much remains to be accomplished before bicycle safety education becomes a reality for North Carolina school children. The curriculum is available. The challenge now is to market the curriculum and to develop the resources and materials needed to teach it. This is a challenge that the North Carolina DOT Bicycle Program has already begun to address.

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Appendix A - Survey Forms

A.1. Baseline Student Bicycle Survey

A.2. Bicycle Injury Report Form

A.3. Follow-up Student Bicycle Survey

South Mebane
Student Bicycle Survey

Instructions

Answer all questions, sign your name, have a parent look over and sign, and return to your teacher tomorrow. Ask a parent if you need help answering a question.

Put a check beside your answer.

1. Do you own a bicycle, or have use of a bicycle?

   __ Yes
   __ No *If you answered "no" you do not need to complete the rest of the survey. Just sign your name, have a parent sign, and return to your teacher.*

2. What kind of bicycle is it? (If you have more than one bicycle, answer for the bicycle you ride most often.)

   __ One speed, regular or BMX frame
   __ More than one speed, hand brakes
   __ More than one speed, foot pedal brakes or hand and foot pedal brakes
   __ Other (please describe) _____

3. How often do you ride a bicycle? *(Check one)*

   __ Every day or almost every day
   __ 3 or 4 times a week
   __ Once or twice a week
   __ Several times a month
   __ Never, or hardly ever

4. How far from your home do you usually ride? *(Check one)*
   (You might need to ask for help with how far you ride.)

   __ One block or less
   __ 2-3 blocks
   __ 1/2 mile - 1 mile
   __ 1 to 2 miles
   __ More than 2 miles

5. Where do you usually ride? *(Check as many as apply)*

   __ Yard, driveway, sidewalk, or parking lot
   __ Neighborhood street - low to medium traffic
   __ Other two lane road - low to medium traffic
   __ Other two lane road - medium to heavy traffic
   __ Other (please describe) _____

(Continued)

A.1. Baseline student bicycle survey (spring 1990).

6. Do you own a bicycle helmet, or have one that you can use?

__ Yes
__ No *If you answered no, skip to Question 7.*

If yes, how often do you wear the helmet? *(Check one)*

__ Every time I ride
__ Almost every time I ride
__ About half the time
__ Less than half the time
__ Never

Thinking back to the last time you rode your bike, did you wear a helmet then?

__ Yes
__ No
__ Don't remember

7. Have you ever needed to see a doctor or go to a hospital because of a bicycle injury?

__ Yes *(If more than one time, please answer on a separate sheet of paper and attach.)*
__ No

If yes, how old were you at the time? _____

Were you wearing a bicycle helmet? _____

Please describe your injury _____

_____

What caused the accident? _____

_____

Did you have to stay overnight at a hospital? _____

8. Have you ever fallen from your bike and hit your head?

__ Yes
__ No

If yes, how many times? _____

Were you wearing a helmet any of these times? _____

Print your name here: _____ **Grade:** _____

Have your parent sign here: _____ **Teacher:** _____

A.1 (Cont.). Baseline student bicycle survey (spring 1990).

Bicycle Injury Report

Instructions for completing:

Please complete for any child treated for a bicycle-related injury. If you have questions about the form, call Jane Stutts at the Highway Safety Research Center (1-800-672-4527). Completed forms should be kept in the attached envelope and mailed in at the end of each month. Thank you for participating.

Name of child: _____ ☐ Male ☐ Female

Age: _____ School attending: _____ Grade: _____

Date of injury: _____ Time: _____ ☐ a.m. ☐ p.m.

Location: _____ ☐ On-road ☐ Off-road

If on-road give street name or intersection and city or town.
If off-road note if driveway, parking lot, playground, vacant field, etc.

Description of accident: _____

_____

_____

_____

Injury description: *Please describe up to 3, beginning with most severe.*

Location	Nature of Injury	Severity (minor, moderate, serious, severe)

	Yes	No	Don't Know
Was a motor vehicle involved?	___	___	___
Was a report filed with police or Highway Patrol?	___	___	___
Was bicyclist wearing a helmet?	___	___	___
Was bicyclist riding against traffic?	___	___	___
Did a bicycle mechanical defect contribute to the accident?	___	___	___
Was more than 1 person riding on the bike?	___	___	___

Please use back of form for any additional comments.

Name of person completing form: _____ Date: _____

A.2. Bicycle injury report form (summer, 1990).

Follow-up Student Bicycle Survey

1. Name: _____
   First Last

2. During the summer, how often did you ride a bike?

   __ Every day or almost every day
   __ 3 or 4 times a week
   __ Once or twice a week
   __ Several times a month
   __ Never, or hardly ever

3. Did you have any falls or injuries while riding this summer?

   __ No falls or injuries
   __ One or more falls, but no serious injuries } *Go on to Question 4*
   __ Injuries that could be treated at home
   __ Injuries that required seeing a doctor or visiting a hospital emergency room
   __ Injuries that required staying overnight in a hospital

   Please describe any injuries *(for example, "broken arm" or "badly cut leg")*

   _____

   _____

   Where were you riding at the time? *(for example, "in the street in front of my house," "in my driveway" or "on a dirt road")*

   _____

4. Do you have a bicycle helmet?

   __ No *(Skip to Question 5)*
   __ Yes *(Please answer questions below)*

   Did you get the helmet after taking the bicycle safety course last spring or before?

   __ After
   __ Before

   How often do you wear the helmet when riding?

   __ Every time I ride
   __ Almost every time I ride
   __ About half the time
   __ Less than half the time
   __ Never

5. Do you think it is a good idea for schools to teach bicycle safety courses like the one you had last spring? Why or why not?

   _____

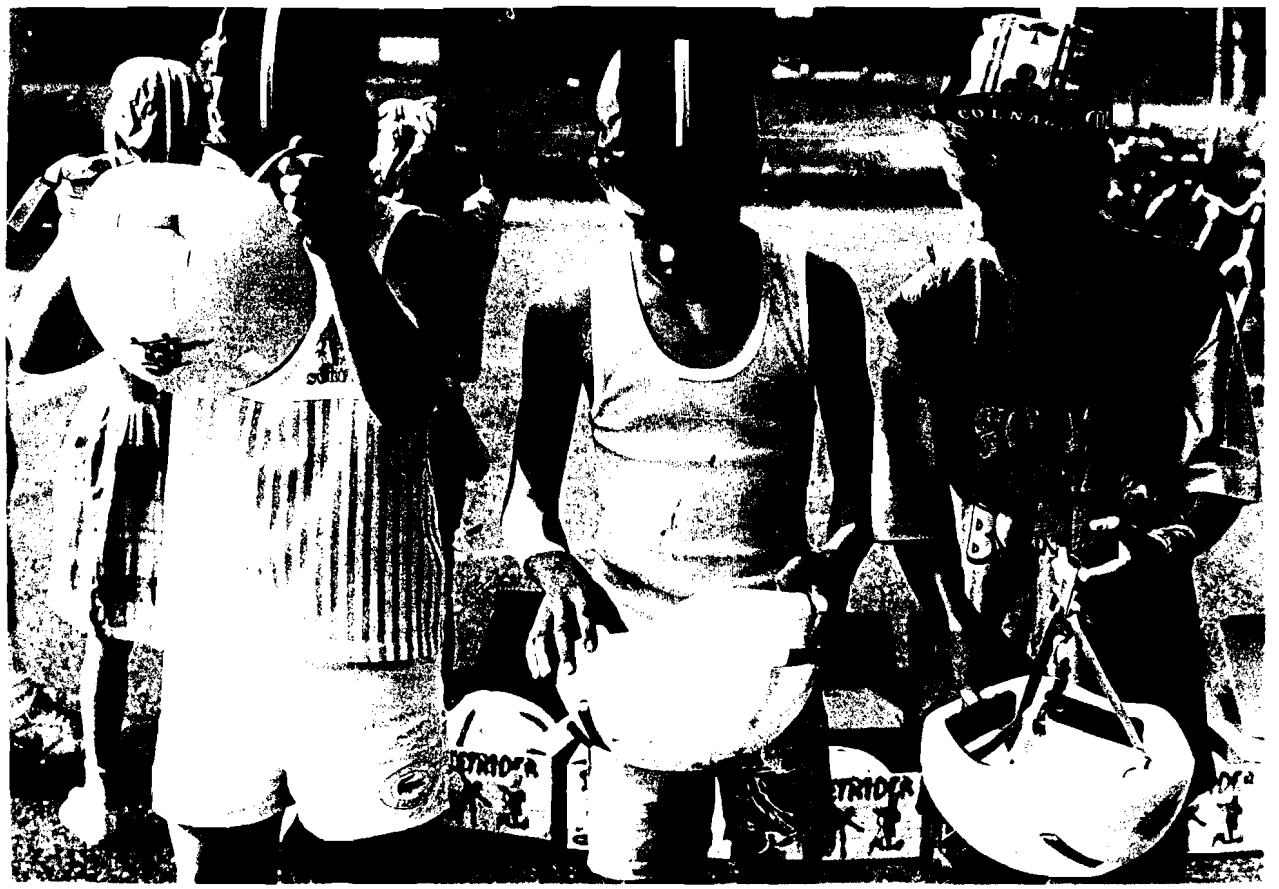
   _____

   _____

Thanks for your help! Please mail back to me at UNC using the enclosed envelope.

A.3. Follow-up student bicycle survey (fall, 1990).

Appendix B - Photographs



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