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16. Abstract

The U.S. system of traffic signs, signals, and pavement markings provides a means of communicating important information to drivers that may not be available to them through any other means. This system of traffic control devices is basic in its concept of providing specific information based on colors, shapes, symbols, and/or message content. The application of traffic control devices, however, has become more complex as numerous devices are developed or modified over the years and as transportation agencies take different, yet subtle, approaches to utilizing devices for similar traffic situations. Previous driver comprehension research on traffic control devices has determined that a number of devices have a high potential of being misunderstood by a significant percentage of the adult driving population. A review of education-related materials and survey assessments of teenage driver education instructors, law enforcement personnel, and teenage drivers entering driver education has been conducted to identify specific problematic devices that should be focused upon during the education process. On the basis of previous driver comprehension studies and the results of this study, researchers have made recommendations to improve driver education with respect to traffic control devices.

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RECOMMENDATION TO IMPROVE DRIVER EDUCATION ON TRAFFIC CONTROL DEVICES

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DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the opinions, findings, and conclusions presented herein. This project was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration or the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation and is not intended for construction, bidding, or permit purposes. The engineer in charge of the project was Angelia H. Parham (TN-100,307).

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CHAPTER 1
INTRODUCTION

The current system of traffic control devices in the United States provides a means of communicating important information to all roadway users. The most basic type of traffic control devices are signs, signals, and pavement markings, and they provide information about laws and regulations, potential roadway hazards, and safe guidance information to desired destinations. These devices would serve little purpose if they were misunderstood by a significant percentage of the driving population. The misunderstanding of traffic control devices can result in drivers not complying with the intended message, becoming lost, confused, and frustrated, and being involved in a crash.

Ideally, drivers are taught at a young (adolescent) age the basic meaning of some traffic control devices, particularly the colors of some signs and basic traffic signal displays. Teenage drivers should be formally taught the meaning of all colors and shapes of traffic control devices, as well as the meaning of numerous signs, signal displays, and pavement marking schemes during their driver education training. During this training, driver education instructors will: address the meaning of some traffic control devices through a limited number of lectures; administer "sign" tests for students to demonstrate their knowledge and deficiencies of numerous devices; and assign reading lessons from a "driver handbook" or other self-taught study material in order to teach the intended meaning of numerous traffic control devices.

However, the meaning of many devices on the roadway are either never learned or forgotten. Also, drivers may never have had exposure to a new device prior to seeing it on the roadway. Misunderstanding may also be attributed to the complexity of the driving environment, changes in or inconsistency in use of traffic control devices from one state to another, and the minimal amount of cooperation that presently exists between transportation professionals and driver education instructors.

PROJECT BACKGROUND

The Texas Department of Transportation (TxDOT) is one of numerous state and federal agencies/organizations that have sponsored research in the past 20 years to investigate driver comprehension of traffic control devices. Much has been learned about what transportation officials know about how drivers understand and react to certain traffic control devices. The results of the research have been used in numerous ways, particularly to recommend engineering changes in design and application of traffic control devices so that devices are more legible, more conspicuous, and

easier to understand. However, further engineering improvements are not possible for many devices and therefore require a greater emphasis in driver and traffic safety education courses.

Project 1794 was initiated by TxDOT to build upon a previously funded educational effort that was completed by the Texas Transportation Institute (TTI) in fiscal years 1996 and 1997. This educational effort, entitled "Know Your Vital Signs" (*1*), was a preliminary effort to educate drivers on basic traffic control device colors, shapes, and meanings, and was based on the research results of a TxDOT/TTI research study entitled "Project 1261 - Assessment and Improvement of Motorist Understanding of Traffic Control Devices" (*2, 3*). In this five-year study, researchers evaluated over 50 different traffic control devices in the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD) (*4*) and numerous alternative designs. Through surveys of Texas motorists, the study identified several devices that have a high potential of being misunderstood by the public and recommended several devices to be included in future educational efforts, including an education campaign effort ("Know Your Vital Signs") and the incorporation of research results into the teenage driver education curriculum and the *Texas Drivers Handbook* (*5*).

Project 1794 was initiated to build upon the recommendations of Project 1261 by identifying the needs of the teenage driver and adult traffic safety education instructors so that further specific and targeted educational products and programs could be developed. This includes specific information on traffic control devices that should be included in the driver education curriculum and in the *Texas Drivers Handbook* in addition to cost-effective outreach products and programs that would involve the development of videos, brochures, newsletter articles, and/or information through the Internet.

Project 1794 Goals and Objectives

The Texas Department of Transportation sponsored Project 1794 to develop a driver education program for traffic control devices. The original objectives of this project were:

- to identify which traffic control devices have the potential of being misunderstood,
- to identify the driver audience(s) that should be emphasized in the educational effort,
- to identify target media efforts to educate drivers on traffic control devices, and
- to develop and implement these products.

A secondary focus was added to this project to identify driver behavior issues that are considered critical to reducing traffic crashes and improving traffic safety. These driver behavior issues, once identified, would be emphasized in the teenage driver education and adult safety education curriculum materials.

This project is to be completed over a 36-month period with the following goals:

- Phase I (Year 1) - Focus on identifying the critical traffic control devices to be targeted in educational efforts.
- Phase II (Year 2) - Focus on identifying critical driver behavior issues to be emphasized in educational efforts.
- Phase III (Year 3) - Focus on the development and implementation of educational products and/or programs.

RESEARCH METHODOLOGY

To accomplish the objectives of this study, the researchers developed several tasks for the 36-month period. These tasks are listed in three phases.

Phase I

1) Develop and administer a survey of law enforcement personnel to identify general perceptions and problems associated with adult driver comprehension of traffic control devices.
2) Develop and administer a survey of teenage driver education instructors to identify general perceptions and problems associated with teenage driver comprehension of traffic control devices.
3) Develop and administer a survey of teenage drivers to identify comprehension deficiencies prior to their obtaining a driver's license.
4) Establish a technical working group comprised of representatives from the Texas Department of Transportation, Texas Education Agency, the Texas Department of Public Safety (DPS), and organization(s) that represent teenage driver and traffic safety education instructors.
5) Document the research results in the first-year report.

Phase II

1) Identify critical driver behavior issues that should be emphasized in teenage driver and traffic safety education courses.
2) Develop preliminary ideas for incorporating this information into curriculum materials.
3) Document the research results in a second-year report.

Phase III

1) Develop and implement a driver education program that targets the most problematic traffic control devices and driver behavior issues with the goal to reduce the likelihood of motorists being involved in a fatal crash and improving the overall safety of the transportation system.
2) Document the research implementation in a third-year report and project summary report.

FINDINGS AND RECOMMENDATIONS

During Phase I of this study, the researchers used the results of the project evaluations to develop recommendations for improving teenage driver understanding of traffic control devices. These recommendations provide for implementation of results into education curriculums for teenage drivers and revisions to the *Texas Drivers Handbook* (*5*) as well as ideas for outreach materials that can be developed during Phase III of this study. Chapter 6 summarizes these recommendations.

CHAPTER 2
DRIVER EDUCATION RESEARCH AND PUBLIC OUTREACH

Extensive research and public outreach efforts have been conducted over the past 20 years to address educating the public on traffic control devices. The primary goals of these efforts have been to reduce the likelihood of at-risk drivers being involved in a fatal automobile crash. These at-risk drivers include teenagers (ages 15 to 19) and older drivers (over age 55).

RESEARCH ON DRIVER COMPREHENSION

Previous research efforts have been conducted to assess motorist comprehension of traffic control devices and/or their characteristics. Very few, if any, of these previous studies have specifically addressed teenage driver comprehension difficulties; rather, they have addressed the general driving public's knowledge of traffic control devices and the driving actions required for these devices when seen on the road. The following studies addressed a number of traffic control devices and determined how well these devices were understood by motorists.

FHWA-Sponsored Study

The purpose of this FHWA-sponsored study (*6*) was to identify deficiencies in signing, to develop and test alternative sign designs, and to make recommendations for needed changes to the National *MUTCD* (*7*). Weaknesses in regulatory, warning, and symbol signs were identified from the results of previous research. The researchers used a multi-phase laboratory procedure to identify the effectiveness of specific sign alternatives and select the best design for each sign. The first phase consisted of a test booklet of pictures of signs to determine the least effective, redesigned sign alternatives. This process allowed the least effective signs to be eliminated from the study. The second phase also utilized a test booklet to test various alternative signs to determine which were most effective. Finally, the most effective alternatives were tested in a driving simulator. Recommendations for changes to the *MUTCD* were based on the simulator results (*6*).

Texas Transportation Institute Studies

The Texas Transportation Institute has published four different studies on the comprehension of traffic control devices (*2*, *3*, *8*, *9*). The studies evaluated driver understanding of selected traffic control devices in Texas.

Researchers in the first study in 1978 tested 27 different traffic control devices and involved 408 subjects (*8*). Thirteen devices used in the booklet survey were identified as "seriously misunderstood" and potentially hazardous if misconceived. Table 1 lists these 13 devices.

Table 1. Traffic Control Devices That Were Considered "Seriously Misunderstood"(*8*).

Type of Device	Traffic Control Device	Sign Label
Signs	School Advance symbol sign	S1-1
	School Crossing symbol sign	S2-1
	Slow Down on Wet Road sign	W8-5
	Curve symbol sign	W1-1L or R
	Turn symbol sign	W1-2L or R
	Pavement Width Transition symbol sign	W4-2R
	Double Turn symbol sign	R3-8L
	Climbing Lane Ahead[a] sign	R4-6A
	Yield to Traffic in Center Lane[a] sign	R4-6B
Signal Displays	Protected Turn Traffic Signals (green and amber arrows)	-
	Flashing Intersection Control Beacon	-
Pavement Markings	Double Yellow Line (nature of prohibition)	-
	Solid White Line (not discriminated from dashed)	-

[a]Traffic Control Device no longer in current Texas MUTCD.

This study investigated five different demographic characteristics of the sample, one of which was age. Age of the driver had a significant relationship to the level of understanding. Persons aged 55 and over had lower scores on the overall comprehension scale. The researchers noted that these individuals had not been exposed to driver education and had not received formal driving training. The youngest driving ages (14 to 24) also had lower scores than the remainder of the field. Age appears to be a dominant segmental element for describing level of understanding of traffic control devices (*8*). Other population segments with low understanding scores include those with low driving exposure and ethnic minorities with language and cultural barriers.

Researchers in a 1981 study of Texas drivers (*9*) administered a test booklet survey evaluating 63 different traffic control devices. The researchers reported the existence of confusion, misunderstanding, and lack of familiarity with certain traffic control devices. The researchers also identified 19 devices needing improvements and posing hazards if misunderstood by the driving public. Table 2 presents the list of devices. The findings clearly showed that there is a lack of understanding of the meaning of shapes and colors of signs. Furthermore, ethnic minorities, older drivers, and those with lower levels of education were more likely to misinterpret the intended meaning of traffic sign symbols. Those drivers with the highest level of understanding of pavement

markings were those who had taken a driver education course. Also, many drivers were confused by the complexity exhibited in signal displays.

Table 2. Traffic Control Devices Identified as Needing Improvements (*9*).

Type of Device	Traffic Control Device	Sign Label
Signs	Do Not Enter symbol sign (no verbal message)	R5-1
	Stop sign (no verbal message)	R1-1
	Yield sign (no verbal message)	R2-1
	One-Way Traffic sign (no verbal message)	R6-1
	Prohibited Right Turn sign	R3-1
	Keep Right sign	R4-7
	Yield to Traffic in Center Lane sign[a]	R4-6B
	Double Turn sign	R3-8L
	Large Arrow sign	W1-6
	No Passing Zone sign	W14-3
	Turn sign	W1-1
	School Crossing sign	S2-1
	Chevron sign	W1-8
	Detour Arrow sign (no verbal message)	M4-10
Signal Displays	Flashing Red beacon	-
	Flashing "DON'T WALK" pedestrian signal	-
Pavement Markings	Double Solid Yellow Center marking	-
	Broken Yellow Center marking	-
	Two-Way Left-turn lane marking	-

[a]Traffic Control Device no longer in current Texas *MUTCD*.

In 1990, TTI began a research study evaluating motorist understanding of traffic control devices which is documented in two separate studies (*2*, *3*). Researchers measured driver comprehension of 52 traffic control devices through five different evaluation procedures. Four of the procedures utilized a survey format, and the other procedure used focus groups. A total of 2,414 Texas drivers participated in the evaluations. The researchers described the findings, recommendations, and implementation efforts associated with each of the 52 traffic control devices studied in these reports. The recommendations included engineering changes in the *TMUTCD* (*4*), editorial revisions to the *Texas Drivers Handbook* (*5*), and suggestions for changes to driver and safety education curriculums. Researchers identified several devices where increased emphasis in driver and safety education courses would be the most effective means of improving driver comprehension. Table 3 presents these traffic control devices, as well as the devices suggested for revision in the *Texas Drivers Handbook* (*5*).

Table 3. Traffic Control Devices to be Emphasized in Education Efforts (*2, 3*).

Type of Device	Traffic Control Device	Sign Label
Signs	Sign Shape and Color	-
	Two-Way Left-turn Lane sign	R3-9b
	HOV Restriction sign and Preferential lane markings	R3-14
	Slower Traffic Keep Right sign	R4-3
	Keep Right sign	R4-7
	Left Turn Yield on Green Ball sign	R10-12
	Slow Down on Wet Road	W8-5
	Watch for Ice on Bridge sign	W19-2
	Ramp Metered When Flashing sign	W19-3
Signal Displays	Yellow Traffic signal indications	-
	Flashing Red Intersection beacon	-
	Lane-Use Control sign	-
Pavement Markings	Type 3 Object marker	-
	Center Line and Lane markings	-
	Edge Line marking	-

PUBLIC OUTREACH EFFORTS

Several public outreach efforts have focused on improving driver education of traffic control devices. These efforts have primarily involved videos, brochures, software, and the Internet as a medium for educating drivers. The following is a listing of recently developed outreach programs and a description of their focus.

AAA Foundation for Traffic Safety

The AAA Foundation for Traffic Safety is a not-for-profit, publicly-supported research organization dedicated to the development of educational material to improve traffic safety. The Foundation receives its funding support from numerous sources but primarily from contributions from motor vehicle clubs associated with the American Automobile Association in the United States and Canada.

In the past, the Foundation has produced numerous driver education materials, often based upon research conducted as part of a Foundation grant. The Foundation has numerous products related to improving driver and traffic safety; the following is a list of some of these products that are specific to traffic control devices.

Road Signs, Signals, and Markings This 16-page brochure (*10*) addresses the basic colors of traffic signs and the meaning of some regulatory, warning, and guides signs, traffic signals, and pavement markings. The information is targeted towards all drivers.

How to Drive This book (*11*), in its ninth edition, is geared towards new and experienced drivers. It is intended to supplement driver and safety education materials by providing a concise and easy-to-read book on risk-management in driving, traffic rules and regulations, traffic control devices, and other traffic safety issues that can improve drivers' skills on the road. The book is divided into several chapters, with one chapter completely dedicated to the explanation of numerous traffic signs, signals, and pavement markings.

Signs, Signals, and Markings: Understanding the Language of the Road This 16-minute video (*12*) is geared towards adult drivers and explains the "underlying rules and logic" behind the colors, shapes, and meanings of traffic signs, signals, and markings.

Know Your Vital Signs Education Campaign

This media campaign effort (*1*) was developed by the Texas Transportation Institute as a result of a research project that identified several devices to be emphasized in driver education. In the products that were developed, the theme outlines a central message: "Traffic Signs are Vital to Driver Safety – Learn Them, Understand Them, and Follow Them. Know Your Vital Signs" (*1*).

The campaign effort included the following tasks:

- a "kick-off" press conference and press releases to newspapers in Texas;
- two combination brochures/posters that featured the "Know Your Vital Signs" theme;
- a 30-second public service announcement (PSA) for television (in English and Spanish) based on the "Know Your Vital Signs" theme;
- a 12-minute instructional video for teenage driver education instructors to use as part of their classroom teaching aids;
- a slide presentation to be used by safety personnel at public meetings;
- a teenage driver education curriculum supplement; and
- a "Know Your Vital Signs" interactive CD-ROM software package, geared towards teaching teenage drivers the colors, shapes, and basic meanings of some traffic control devices.

The success of this media campaign was largely due to the cooperation of several state agencies in developing and testing the products prior to public release.

Read Your Road Campaign Effort

Sponsored by the U.S. Department of Transportation (US DOT) and the Federal Highway Administration (FHWA), this spiral-bound, map-size book (*13*) is an easy-to-read guide that covers basic information geared towards travelers. This includes general information on traffic signs, signals, pavement markings, work zones, driving hazards, travel safety tips, and information on courteous driving or sharing the road.

Road Sign Games

Developed for elementary-aged children, these games (*14*) involve the recognition and learning of several different regulatory, warning, guide, and recreation signs that one might see during extended travels, such as vacations. The goal of the games are to locate the signs, identify their purpose, and to "score" based upon locating and recognizing the most signs. The games are excellent exposure tools for children to learn the importance of traffic safety.

Driver's Education '98

This software package (*15*) is an extensive interactive software "game" that delivers high quality graphics and multimedia capabilities to teach teenage or novice drivers the basic information that is required as they are learning to drive. The software, installed and run with a CD-ROM, also incorporates a driving simulator on-screen and allows the connection of auxiliary input devices, such as a ThrustMaster®-compatible driving wheel, pedals, and joysticks.

The program includes traffic laws from all 50 states; self-paced lesson plans on various topics such as general safety information, traffic control devices, and operating/maneuvering a vehicle in different driving environments; self evaluation tests; and the driving simulator. The program prepares a student for their actual driving (if required) and for written tests that they are required to satisfactorily pass prior to obtaining their driver's license. The program was developed by traffic safety and driver education professionals.

Internet Web Sites

Several world wide web (WWW) Internet sites are devoted to driver education materials on traffic control devices. The following list includes some of the more comprehensive sites and a short description of each.

WWW.DRIVERS.COM This web site, known as the Traffic Safety Information Village, contains information and hypertext links on driver licensing, driver services, driver training, and road safety. The site also contains a link to the "Village Community," which is a collection of transportation-related links to driver education and training information and various safety-related Internet sites. Many of the linked sites are subscription sites that require a paid subscription.

WWW.AAAFTS.ORG This is the "home page" of the AAA Foundation for Traffic Safety, the previously described organization that sponsors research and published information on improving driver education and training. This web site contains information on various traffic and transportation issues, such as educational and research materials, a traffic safety discussion "forum," and information on submitting proposals. Visitors to this web site have the ability to order education materials such as videos, books, and brochures related to traffic safety, including the traffic control device materials previously described.

WWW.AAA.COM This site of the American Automobile Association (AAA) is a travelers web site for information on traveling needs and services that are available through the Internet. Some of the information on this site is geared towards young and/or novice drivers, such as traffic safety information and driver licensing. Little information, however, is available on traffic control devices.

144.80.48.8/ADTSEA/DEFAULT.HTM This is the site for the American Driver and Traffic Safety Education Association (ADTSEA), the professional association which represents traffic safety educators throughout the United States and abroad. The organization is a national advocate for quality traffic safety education and publishes policies and guidelines for the driver education discipline. ADTSEA conducts conferences, workshops, and seminars, provides consulting services, and develops traffic safety education materials for its members and for the public.

WWW.DRIVERS.COM/DSAA This is the site for the Driving School Association of America (DSAA), a national organization that represents over 350 commercial driving schools throughout the U.S. and Canada. The association works to support a more effective

training and education program for drivers and works to improve the educational products that are utilized by its members for teaching driver education and traffic safety.

NEED FOR FURTHER EDUCATION EFFORTS

Although the above-mentioned research and public outreach efforts have been successful and thorough, the general driving public has had limited access to the products, and drivers are often required to purchase the products when they are available. Ideally, educational products should be developed based upon sound engineering research and incorporated into existing materials that are used to teach drivers during driver and/or traffic safety education. Education materials should also be readily available and easy to access, preferably for free or at a nominal cost, to all drivers. These materials should be easily accessible to teenage and older drivers who have the highest risk of being involved in a fatal crash.

CHAPTER 3
SURVEY OF DRIVER EDUCATION INSTRUCTORS

The researchers developed and administered a survey instrument to over 1,200 driver education instructors in Texas with the objective to identify the instructors' perceptions of teenage driver comprehension difficulties with traffic control devices. Secondary objectives of the survey were to identify the types of teaching aids and materials that instructors utilize in the classroom to educate teenagers on traffic control devices and to identify instructors who were willing to assist the researchers with a follow-up survey of their students.

SURVEY SAMPLE

The researchers obtained a mailing list from the Texas Education Agency. The list included over 1,300 public high school and commercial (private) school driver education instructors in Texas. Surveys were sent to 904 different public school instructors and to 389 different commercial school instructors for a total of 1,293 instructors. (Duplicate names were eliminated; owners of more than one commercial school were included only once.) A total of 256 public school instructors returned a survey (a 28 percent response rate), while only 52 commercial school instructors returned a survey (a 13 percent response rate).

SURVEY INSTRUMENT

The researchers developed an eight-page booklet survey that addressed basic information about the instructors, their classrooms, their teaching aids and materials, their perceptions of teenage driver comprehension deficiencies with traffic control devices, and their willingness to participate in follow-up surveys in their classroom. A copy of this survey is provided in Appendix A. The survey was carefully designed to be simple to complete yet comprehensive enough to obtain adequate information about teenage drivers and traffic control devices. Driver instructors were offered an incentive to complete and return the survey — a copy of the 12-minute "Know Your Vital Signs" video that was developed by TTI. The survey also emphasized the importance of the research study and the results of the survey, which could ultimately aid the instructors in their jobs of educating young drivers on the importance of safety.

SURVEY ADMINISTRATION

The survey was mailed to the 1,293 instructors, and a postage-paid seal was placed on the back of the survey to encourage the instructors to complete it and to save them the cost of return postage. When instructors completed and returned the survey, the researchers forwarded a one-page copy of the preliminary results of the survey and a copy of the "Know Your Vital Signs" video to those instructors.

SURVEY RESULTS

After administering the survey, the researchers developed a database for the survey results, providing a simple means of analyzing and reporting the results of the evaluation. The following sections summarize the results of this survey.

Section 1 - General Questions

In Section 1 of the survey, instructors were asked to provide general background information on their classroom, their involvement in teaching driver education, and the types of and preferred teaching materials and aids used in the classroom. Tables 4 and 5 summarize these results.

Section 2 - Curriculum-Related Questions

In Section 2 of the survey, instructors were asked about their use of the state-adopted driver education curriculum, including how closely they followed the curriculum and the time spent teaching about certain groups of traffic control devices. Table 6 summarizes these results.

Section 3 - Driver Comprehension-Related Questions

In Section 3 of the survey, instructors were asked for their perceptions of the difficulties that teenage drivers have in the comprehension of traffic control devices. The questions included information on the importance of traffic control devices in the curriculum, specific devices that present difficulty for teenage drivers, and general levels of knowledge of traffic control devices before and after teenager drivers participate in driver education. Tables 7 and 8 summarize these results.

Table 4. General Classroom Information.

Section 1 Questions	Public		Commercial		Total	
	Number	%	Number	%	Number	%
Your Position:						
Driver Education Teacher	211	82%	42	81%	253	82%
Classroom	53	21%	12	23%	65	21%
In-Car	29	11%	13	25%	42	14%
Both	211	82%	42	81%	253	82%
Safety Education Teacher	8	3%	21	40%	29	9%
Driver/Safety Ed. Coordinator	57	22%	15	29%	72	23%
School Principal/Vice-Principal	24	9%	3	6%	27	9%
Teacher	115	45%	9	17%	124	40%
Superintendent	8	3%	0	0%	8	3%
Counselor	2	1%	0	0%	2	1%
Athletic Director/Coach/Health Instructor	83	32%	3	6%	86	28%
Other	7	3%	13	25%	20	6%
I Teach the Classroom Portion of DE:						
Never	5	2%	6	12%	11	4%
Part-time	67	26%	12	23%	79	26%
Full-time	63	25%	28	54%	91	30%
After School	116	45%	31	60%	147	48%
Before School	99	39%	1	2%	100	32%
Less Than 3 Times Per Year	72	28%	1	2%	73	24%
More Than 3 Timer Per Year	27	11%	18	35%	45	15%
Summer Only	25	10%	2	4%	27	9%
Other	29	11%	9	17%	38	12%
Average Class Size:						
5 - 10	8	3%	3	6%	11	4%
10 - 15	25	10%	8	15%	33	11%
15 - 20	45	18%	14	27%	59	19%
20 - 25	84	33%	8	15%	92	30%
> 25	96	38%	19	37%	115	37%

Table 5. General Teaching Information.

Section 1 Questions	Public		Commercial		Total	
	Number	%	Number	%	Number	%
Teaching Content From:						
State-Adopted Curriculum	141	55%	37	71%	178	58%
Textbook	198	77%	36	69%	234	76%
Drive Right	149	59%	45	87%	194	63%
Responsible Driving	101	39%	11	21%	112	36%
Other	12	5%	3	6%	15	5%
Teaching Material:						
Video Tapes	245	96%	51	98%	296	96%
35mm Slides	8	3%	3	6%	11	4%
Transparencies	134	52%	20	38%	154	50%
Handouts	236	92%	46	88%	282	92%
Chalk/Dry Erase Boards	212	83%	48	92%	260	84%
Texas Drivers Handbook	251	98%	52	100%	303	98%
Computer	21	8%	0	0%	21	75%
Guest Speaker	136	53%	34	65%	170	55%
Newspaper/Magazines/Other	194	76%	44	84%	238	76%
Preferred Teaching Materials:						
Video Tapes	1		1		1	
Texas Drivers Handbook	2		4		2	
Textbooks	3		2		3	
Handouts	4		3		4	
Transparencies	5		5 (Tie)		5	
Guest Speaker	6		5 (Tie)		6	
Newspaper/Magazines	7		7		7	

Table 6. Curriculum-Related Information.

Section 2 Questions	Public		Commercial		Total	
	Number	%	Number	%	Number	%
What Approved Unit of Curriculum is Primarily Used:						
Unit II - Motor Vehicle Traffic Laws	214	84%	45	87%	259	84%
Unit IV - Highway Characteristics	61	24%	13	25%	74	24%
Other	21	85%	8	15%	29	9%
Answer Yes or No to the Following	**Yes**	**%**	**Yes**	**%**	**Yes**	**%**
When Teaching the Meaning/ Importance of TCDs, I:						
Develop Own Lesson Plan	204	80%	41	79%	245	80%
Lesson Plan Based on TDH	220	86%	42	81%	262	85%
Lesson Plan Based on Textbook	224	88%	38	73%	262	85%
Commercial Handouts	187	73%	34	65%	221	72%
Engage Discussions in Classroom	239	93%	50	96%	289	94%
Old Copies of DPS Sign Tests	189	74%	40	77%	229	74%
Give Pre-Test on TCDs	182	71%	38	73%	220	71%
Give Post-Test on TCDs	200	78%	35	67%	235	76%
Use Computer Program for TCDs	5	2%	1	2%	6	2%
Student Completes Worksheet During In-Car Phase	55	21%	11	21%	66	21%
Engage Discussions During Observation Phase	226	88%	42	81%	268	87%
Approx. No. of Minutes Teaching:						
Basic Sign and Signal Shapes	68		48			
Basic Device Colors	59		45			
Traffic Signs	67		49			
Traffic Signals	53		44			
Pavement Markings	37		36			
Construction/Work Zone Devices	32		26			
RR/Highway Grade Crossings	39		29			
Traffic Control in School Zones	32		22			
Sign Vandalism	14		12			
Other	32		15			
Total Average Minutes	444		319			

Table 7. Driver Comprehension-Related Information.

Section 3 Questions		Public		Commercial		Total	
		Number	%	Number	%	Number	%
Difficulties with Comprehension:							
In the Classroom?	Yes	43	17%	10	19%	53	17%
	No	186	73%	37	71%	223	73%
	Not Sure	19	7%	2	4%	21	7%
On the Road?	Yes	78	31%	20	38%	98	32%
	No	145	57%	23	44%	168	55%
	Not Sure	20	8%	5	10%	25	8%
If "YES," What Difficulties/Devices:							
Basic Shapes		32	13%	7	13%	39	13%
Basic Colors		22	9%	4	8%	26	8%
Signs		30	12%	5	10%	35	11%
Regulatory Signs		26	10%	9	17%	35	11%
Warning Signs		23	9%	12	23%	35	11%
Guide Signs		7	3%	4	8%	11	4%
Traffic Signals		44	17%	14	27%	58	19%
Basic Traffic Signal Indications		17	7%	6	12%	23	8%
Left-Turn Displays (Signs/Signals)		59	23%	18	35%	77	25%
Flashing Intersection Beacons		32	13%	8	15%	40	13%
Freeway Lane Control Signals		45	18%	7	13%	52	17%
Pavement Markings		35	14%	12	23%	47	15%
Passing/No Passing Zone Markings		21	8%	6	12%	27	9%
White Edge/Centerline Markings		32	13%	7	13%	39	13%
Double Solid White Markings		30	12%	12	23%	42	14%
Center Two-Way Left-Turn Lane Markings		45	18%	14	27%	59	19%
Construction/Work Zone Devices		28	11%	6	12%	34	11%
RR/Highway Grade Crossing Devices		15	6%	7	13%	22	7%
Traffic Control in School Zones		19	7%	9	17%	28	9%
Other		14	6%	6	12%	20	7%

Table 8. Hazard Emphasis- and Student Knowledge-Related Information.

Section 3 Questions	Public		Commercial		Total	
	Number	%	Number	%	Number	%
Hazard Emphasis in Disobeying TCDs:						
Speeding	85	33%	18	35%	103	34%
Citations	52	20%	12	23%	64	21%
Accidents	189	74%	34	65%	223	73%
Fatalities	107	42%	23	44%	130	42%
General Unsafe Driving Behavior	136	54%	26	50%	162	53%
Other	13	5%	7	13%	20	7%
Student Knowledge of TCDs:						
Before Unit Begins	66%		58%		65%	
After Unit Ends	91%		89%		91%	

DISCUSSION OF RESULTS

Eighty-two percent of the responding instructors were driver education teachers who taught both classroom and in-car training. Forty percent were teachers, and 28 percent were athletic directors, coaches, or health instructors. Thirty percent of the respondents were full-time instructors. Sixty-seven percent of the classrooms had 20 or more students. Seventy-six percent of the respondents used a textbook, and 58 percent used the state-adopted curriculum. Preferred teaching materials included the *Texas Drivers Handbook* (*5*), video tapes, handouts, chalk/dry erase boards, newspapers/magazines/etc., computers, guest speakers, and transparencies.

Eighty-four percent of the instructors used Unit II—Motor Vehicle Traffic Laws—in their curriculum; 24 percent used Unit IV—Highway Characteristics. Instructors used the following to teach the meaning/importance of traffic control devices (ranging from 71 to 94 percent of respondents): their own lesson plans; lesson plans based on the *Texas Drivers Handbook* (*5*), lesson plans based on a textbook; commercial handouts; engaging in classroom discussions; old copies of Texas Department of Public Safety (DPS) sign tests; pre-tests on traffic control devices; post-tests on traffic control devices; and engaging in discussions while driving. Public school driver education instructors spent an average of 444 total minutes teaching traffic control related materials, while commercial instructors spent an average of 319 minutes.

Seventeen percent of instructors believed that students had difficulties with comprehending traffic control device materials in the classroom. Thirty-two percent believed that students had difficulties with comprehension of traffic control devices while on the road. Instructors listed the following five devices as most misunderstood: left-turn displays, traffic signals, two-way left-turn

lanes, freeway lane control signals, and pavement markings. Instructors responded that students know approximately 65 percent of the meaning of traffic control devices before the unit begins and approximately 91 percent of the meaning of traffic control devices after the unit ends. Instructors primarily emphasized the following as potential hazards of misunderstanding and disobeying traffic control devices (in descending order of responses): accidents, general unsafe driving behavior, fatalities, speeding, and citations.

CHAPTER 4
SURVEY OF LAW ENFORCEMENT PERSONNEL

Researchers surveyed law enforcement personnel within the state of Texas. The objective was to obtain law enforcement officials' opinions on driver understanding of traffic control devices and to determine areas where law enforcement officials believe that driver education and training can be improved.

SURVEY SAMPLE

The researchers obtained a mailing list from the Texas Police Chiefs' Association which included 352 listings of law enforcement agencies within the state. The membership spans the entire state of Texas, including both small towns and large cities.

SURVEY INSTRUMENT

The researchers developed a four-page survey booklet containing nine questions. These questions addressed traffic control devices that are misunderstood by drivers, particular problem areas by age group, problems due to misunderstanding the English language, areas for improvement in driver education and training, opinions on driver retraining or recertification, emphasis of continuing education, current training or public education for drivers provided by the agency, driver education materials provided by the agency, and other comments or suggestions regarding driver education or training. A copy of the survey questions is included in Appendix B.

SURVEY ADMINISTRATION

The survey was mailed to 257 local, county, and state law enforcement agencies that are members of the Texas Police Chiefs' Association (listings of retired and deceased members were excluded from the survey). Recipients were encouraged to distribute the survey to fellow officers who had an interest in improving driver education and training.

The survey booklet was designed so that it could be folded and returned with a postage-paid seal included on the survey form. A total of 233 surveys were returned, representing 137 different agencies. These agencies represent 71 Texas agencies in 74 Texas cities. The agencies included 66 police departments and law enforcement officials at five college campuses and at one airport.

SURVEY RESULTS

The survey questions are summarized as follows.

Question 1: What traffic control devices are most misunderstood by drivers?

The top six responses to this question were:

Traffic Control Device	Number of Responses
• **Center Lane Left Turn Only**	30
• **Yield** signs	25
• Traffic signals (protected phases - green and red arrows)	21
• Solid white pavement lines	14
• Pavement markings	12
• **Stop** signs: stop at sign, white line, or intersection?	12

All of the responses to Question 1 are shown in Table 9.

Table 9. Responses to Question 1.

TRAFFIC CONTROL DEVICE	# OF RESPONSES
Barricades and traffic cones (going around)	2
Broken yellow lines	1
Center Lane Left Turn Only	30
Chicken tracks for turn lanes	1
Crosswalks	5
Directional arrows on multiple lanes	5
Directional arrows on off-ramp	1
Directional sign showing multi-turn lanes when all lanes are not shown on sign	1
Do Not signs	1
Do Not Cross Double White Line	1
Do Not Stop on Tracks	1
Double left-turn lanes	2
Double left-turn lines and signs	2
Exit Only signs on exit ramp	1
Exit Only sign	1
Faded signs	1
Failure to yield to ramp traffic	2
Four-way stop	2
Flashing lights (red and yellow)	7
Highway signs with #s and direction - most drivers don't know direction	1
International signs	1
Lack of signage in advance of exits or lane changes	1
Left-turn lanes	5
Left-turn lanes are not merge lanes (lack of understanding)	1
Long detours	1
Mandatory lane direction signals	1
Mandatory left turn marked by arrows or signs	1
Merge signs	4
No Left Turn (and at specified times)	2

Table 9. Responses to Survey Question 1 (continued).

TRAFFIC CONTROL DEVICE	# OF RESPONSES
No Parking	3
No Passing Zone	1
No Thru Trucks	1
No U-Turn	2
One-way traffic going into two-way traffic	2
Pavement markings	12
Railroad crossing signs	3
Raised traffic islands replaced by striping (cars drive across to get to turn lane)	1
Reversible lane signs	1
Right Turn Only or **Right Lane Must Turn Right**	5
Right turn on red	7
School zones	1
School zone beginning and ending lines	2
School Zones: No parking/loading	1
Signs	1
Single white line (edge line)	1
Solid white lines	14
Solid white lines at entrance/exit ramp areas	3
Solid yellow lines	9
Speed Limit signs (1 comment - too small: make bigger and fluorescent green)	6
Speed Limit signs in construction zones	1
Speed Limit Radar Enforced	1
Stop bars	4
Stop signs set back more than 5 feet behind a stop line or crosswalk	1
Stop signs: stop at sign, white line, or intersection?	12
Traffic signals (particularly yellow phase)	9
Traffic signals (protected phases - green and red arrows)	21
Turnlane signals and markings	1
Uncommon intersections (such as Y-intersections)	1
U-turns at interchanges	1
Warning signs on off ramps (1 on off ramps)	2
Yellow buttons on the roadway	2
Yield signs	25
Yield signs for on and off ramps	9

Question 2. Have you noticed any particular problem area(s) for these specific age groups?

	Yes	No
Ages 16-25	172	33
Ages 26-55	85	92
Ages 56-up	149	50

The most common responses to this question are listed in Table 10.

Table 10. Most Frequent Responses to Question 2.

Responses		
Ages 16-25	Ages 26-55	Ages 56-up
Speeding Inexperience Not paying attention Inadequate driver training	Always in a hurry and running late Driver inattention DWI (or DUI) offenses common Inattentive; ignore traffic control devices Common use of cell phones Road rage Speeding	Driving too slowly and impeding traffic Vision and hearing problems Slowed reaction times (increased perception/ reaction times)

Question 3. What problems involve not understanding the English language?

The most common responses were:

- Communication with police officers after an offense
- Stop and yield signs
- Word signs rather than international symbols

Question 4. Can you suggest any areas for improvement in driver education/training?

The most common responses were:

- More (longer) driver training with emphasis on traffic control devices, construction areas, laws, courtesy, and accidents
- More driving time during driver training
- More defensive driving classes
- More awareness of the dangers of driving (instilled by riding with police officers, EMS, etc., or by current slides or movies of accidents and fatalities)

Question 5. Should drivers be periodically retrained or recertified? **Yes:** 182 **No:** 32
If yes, how often? (See Table 11.)

Table 11. Responses on Frequency of Driver Retraining or Recertification.

Number of Years	1	2	3	4	5	6	7	8	10	12	15	18	20
Number of Responses	2	13	7	22	43	5	1	14	40	1	2	1	4

Comments included the following:

1. Every renewal
2. Every 2 years
3. Drivers with numerous citations
4. Older drivers
5. Various combinations of these responses

Question 6. If continuing education is required for all drivers, what should be emphasized?

Most common responses:

6. New laws or requirements
7. Basic skills
8. Defensive driving
9. Patience and courtesy
10. Safety

Question 7. Does your agency provide any type of public education or safety training for drivers?

11. Education: 50
12. Education and Training: 11
13. Training: 14
14. Neither: 132

Descriptions of education and/or training included:

15. Defensive driving
16. Driver's education
17. DWI/Drinking and driving
18. Red light violation hazards
19. Citizen police academy
20. Public service announcements
21. Seatbelt safety

8. Does your agency provide any driver education materials for the public?

YES: 50 **NO**: 154

If yes, can you provide a copy (or copies) of the material?

YES: 14 **NO**: 24

9. Do you have any other comments or suggestions regarding driver education or training?

22. Make driver education tests more stringent
23. Require public schools to teach courses
24. Require regular testing of all drivers
25. Emphasize importance of driving and the possible consequences

DISCUSSION OF RESULTS

The law enforcement survey results indicate that several traffic control devices are misunderstood by drivers; the most misunderstood devices include the **Center Lane Left Turn Only** sign, **Yield** signs, and traffic signals. The results also indicate that a large percentage of respondents have noticed particular problem areas for younger drivers (ages 16 to 25) and for older drivers (ages 56 and up); about half of the respondents indicated problem areas for drivers ages 29 to 55. Suggested areas for improvement in driver education and training include: more training with emphasis on traffic control devices, construction areas, laws, courtesy, and accidents; more in-vehicle driving time; more defensive driving classes; and more awareness of the dangers of driving. A large percentage of respondents indicated that retraining or recertification is a good idea; the most suggested for the frequencies of retraining or recertification were four, five, and ten years.

CHAPTER 5
SURVEY OF TEENAGE DRIVERS

The primary objective of this survey was to evaluate teenage drivers' understanding of traffic control devices and then to identify which devices are most misunderstood by teenagers. The objectives were achieved by conducting a survey of 260 teenagers before their participation in a driver education course. This chapter documents the major tasks involved in the development and administration of the survey instrument.

SURVEY SAMPLE

This survey targeted teenage drivers in Texas before their participation in a formal driver education course and prior to any formal education on traffic control devices. Due to the difficulties of research involving persons under the age of 18, the scope of this research was limited to teenager drivers enrolled in a driver education program. To administer the survey to the teenagers, authorization by each of the driver education programs was obtained along with parental consent and student assent. The survey was conducted at five public high schools and at one commercial driver education program in Texas which had indicated an interest in the evaluation of students' knowledge of traffic control devices in a previous survey of driver education instructors. These programs were extremely cooperative with the research efforts and showed interest in the study results. A total of 260 students participated in the study.

SURVEY INSTRUMENT

A selection procedure was developed to determine which devices were most appropriate to include in this survey. The traffic control devices included in the survey were based on:

- findings from previous TTI comprehension studies;
- findings from previous driver education instructor and law enforcement surveys;
- inclusion in the *Texas Drivers Handbook* (*5*);
- traffic control devices included in Texas Department of Public Safety (DPS) driver licensing sign tests; and
- the Texas Education Agency (TEA) curriculum guide.

Basic knowledge of traffic control devices is required to obtain an instruction permit and/or a driver's license in the State of Texas. The "basic knowledge" traffic control devices were obtained from the TEA curriculum guide, the current *Texas Drivers Handbook* (*5*), and previous driver

licensing tests. Other traffic control devices that were selected to be included in the survey are those that have been considered important or commonly misunderstood by previous studies and surveys.

Based on inputs from the TTI comprehension studies, driver education instructors, law enforcement personnel, the *Texas Drivers Handbook* (*5*), and DPS sign tests, researchers developed a list of 64 different traffic control devices to include in the survey. A total of 71 traffic control devices, including basic sign colors and 12 different left-turn signal/sign displays, were selected to be pilot tested. The pilot test included five-section horizontal and five-section cluster left-turn signal displays. Due to time and space limitations of the final survey, 10 devices and six cluster left-turn signal displays were eliminated based on the results of the pilot test. The final survey addressed a total of 53 traffic control devices, including basic sign shapes and colors and seven left-turn signal displays. A copy of the survey instrument is provided in Appendix C. The following sections summarize the traffic control devices included in the pilot and final survey.

Basic Shapes and Colors

Basic shapes and colors of traffic control devices were identified as problematic to drivers in the 1981 and 1990 TTI studies (*8*, *9*) and from the results of the driver education instructor survey described in Chapter 3 of this report. Eight basic colors for signs were included in the pilot survey. The pilot survey only asked the meanings of the color associated with traffic signs, and the color was depicted in a vertical rectangle. The basic colors include red, green, blue, yellow, black, white, orange, and brown. Since the pilot survey did not include any questions related to the shape of a sign, the final survey added different shapes to the color questions. Also, the pilot survey indicated that the colors red and green were understood by the majority of teenagers. The shapes and colors included in the final survey are presented in Table 12.

Table 12. Basic Shapes and Colors Included in the Final Survey.

Device	Shape	Color
	Horizontal Rectangle	Blue
	Pentagon	Yellow
	Vertical Rectangle	Black
	Vertical Rectangle	White
	Diamond	Orange
	Horizontal Rectangle	Brown

Regulatory Signs

The selection procedure identified 13 regulatory signs that were misunderstood and/or identified as problematic to teenage drivers by driver education instructors. All 13 devices were included in the pilot survey with the exception of the **Center Lane Two-Way Left Turn Only (R3-9a)** and the **HOV Restriction (R3-14)** signs. Two types of center lane two-way left-turn signs were identified by the selection procedure: the **Center Lane Two-Way Left Turn (R3-9b)** sign is post mounted, and the **R3-9a** sign is overhead mounted (*7*). The **R3-9b** sign is most common in Texas and was, therefore, included in the pilot and final surveys. The **HOV Restriction (R3-14)** sign was not available in graphic format; therefore, it was replaced with a similar sign, the **Restricted Lane Ahead (R13-12)** sign. The **Left Lane for Passing Only (R4-2a)** sign was included in the survey since it is a relatively new device in Texas, and there are no comprehension data on this sign. Regulatory signs were also included in left-turn signal displays and are discussed in the subsequent section. Nine regulatory signs were selected for the final survey. Table 13 presents the regulatory signs included in the pilot and final surveys.

Warning Signs

Eighteen warning signs were identified for inclusion in the pilot survey. These devices included those that were identified by the selection procedure with the exception of the **Reverse Turn (W1-3)**, **Rough Road (W8-8)**, **Right Lane Ends (W9-1)**, and **Lane Ends Merge Right (W9-2)** signs. The **Added Lane (W4-3)** sign was added to the pilot and final surveys. The pilot survey indicated three warning signs which were clearly understood by teenagers, and they were subsequently dropped from further survey evaluation; therefore, the final teenage driver survey addressed a total of 14 warning signs. The signs included in the pilot and final surveys are listed in Table 14.

Table 13. Regulatory Signs Included in the Pilot and Final Surveys.

Device	Device Name	Sign Label	Pilot	Final
	Stop with Cross Traffic Does Not Stop supplemental sign	R1-1 R1-5B	✓	✓
	Yield sign	R1-2	✓	✓
	Speed Limit sign	R2-1	✓	✓
	Turn Prohibition sign	R3-2	✓	
	U-Turn Prohibition sign	R3-4	✓	
	Double Turn sign	R3-8L	✓	
	Center Lane Two-Way Left Turn Only sign	R3-9b	✓	✓
	Left Lane for Passing Only sign	R4-2a	✓	✓
	Slower Traffic Keep Right sign	R4-3	✓	✓
	Do Not Cross Double White Line sign	R4-3b	✓	✓
	Keep Right sign	R4-7	✓	✓
	Do Not Enter sign	R5-1	✓	✓
	Restricted Lane Ahead sign	R13-12	✓	

Table 14. Warning Signs Included in the Pilot and Final Surveys.

Device	Device Name	Sign Label	Pilot	Final
	Turn sign	W1-1R	✓	✓
	Curve sign	W1-2R	✓	✓
	Chevron Alignment sign	W1-8	✓	✓
	Stop Ahead sign	W3-1	✓	
	Lane Reduction Transition sign	W4-2	✓	✓
	Added Lane sign	W4-3	✓	✓
	Narrow Bridge sign	W5-2a	✓	✓
	Divided Highway Begins sign	W6-1	✓	✓
	Divided Highway Ends sign	W6-2	✓	✓
	Two-Way Traffic sign	W6-3	✓	✓
	Pavement Ends sign	W8-3a	✓	
	Slow Down on Wet Road sign	W8-5	✓	✓
	Low Shoulder sign	W8-9a	✓	✓
	Pedestrian Crossing sign	W11A-2	✓	✓
	Truck Crossing sign	W11-10	✓	✓

Table 14. Warning Signs Included in the Pilot and Final Surveys (continued).

Device	Device Name	Sign Label	Pilot	Final
	No Passing Zone sign	W14-3	✓	
	Watch for Ice on Bridge sign	W19-2	✓	✓
	Ramp Metered When Flashing sign	W19-3	✓	✓

School Zone, Railroad, and Construction Signs

Table 15 presents the school zone and railroad signs included in the pilot and final surveys. Previous research has indicated that the **School Crossing (S2-1)** and **School Advance (S1-1)** signs are misunderstood by most motorists (*2*, *3*). A question was also included regarding school zone speed and when drivers can resume their normal speed. Three highway-railroad grade crossing signs and two construction signs were included in the pilot and final surveys. Table 16 presents the construction signs included in the pilot and final surveys. If these types of traffic control devices are misconceived or acted on inappropriately, a hazardous or fatal crash could result. Additionally, there are little data on these devices, especially with respect to teenager drivers.

Pavement Markings

Pavement markings were included in the pilot and final surveys. Figure 1 is an example of a pavement marking used in the surveys. Pavement markings were of concern to both driver education instructors and law enforcement personnel as described in Chapters 3 and 4 of this report. Previous TTI studies also concluded that pavement markings were not well understood by motorists (*2*, *3*). Seven types of pavement marking indications were included in the pilot survey and six in the final survey. The pilot survey results indicated that the broken yellow center line marking was well understood by teenage drivers; therefore, it was not included in the final survey. Table 17 presents the pavement markings evaluated in the pilot and final surveys.

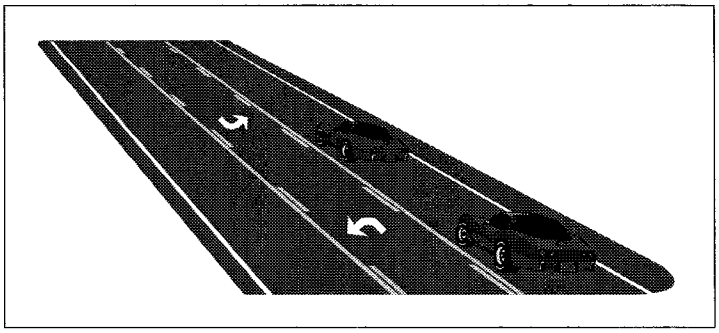


Figure 1. Example of Pavement Marking Figure Included in the Pilot and Final Surveys.

Table 15. School Zone and Railroad Signs Included in the Pilot and Final Surveys.

Device	Device Name	Sign Label	Pilot	Final
	School Crossing sign	S2-1	✓	✓
	School Advance sign	S1-1	✓	✓
	School Speed Limit sign	S5-1	✓	✓
	Railroad Advance sign	W10-1	✓	✓
	Parallel Railroad Advance Warning sign	W10-3	✓	✓
	Railroad Crossing sign	R15-1	✓	✓

Table 16. Construction Signs Included in the Pilot and Final Surveys.

Device	Device Name	Sign Label	Pilot	Final
	Flag Man Ahead symbol sign	CW20-7	✓	✓
	Detour sign	M4-10R	✓	

Table 17. Pavement Markings Included in the Pilot and Final Surveys.

Marking Type	Pilot Survey	Final Survey
Broken White Center Markings	✓	✓
Combination of Broken and Solid Yellow Center Markings	✓	✓
Broken Yellow Center Line Markings	✓	
Two-Way Left-Turn Channelization Striping	✓	✓
Two-Way Left-Turn Channelization Marking	✓	✓
Double Solid Yellow Markings	✓	✓
Double Solid White Markings	✓	✓

Traffic Signals

Three types of traffic signals were included in the pilot and final surveys. The first type of signal that was included in both surveys was the freeway lane control signal. The 1995 TTI study (*3*) found that this type of signal was not well understood by drivers, and lane control signals are becoming more common due to increased attention to traffic management in urban areas. Two freeway lane control signal indications were included in both surveys: the green "arrow" and the yellow "X." Figure 2 is an example of the freeway lane control signal image used in the pilot and final surveys.

The second type of signals identified for the survey were flashing red and flashing yellow intersection beacons. The 1995 TTI study (*3*), the survey of driver education instructors, the law enforcement survey, and the teenage driver survey all indicated that these devices were misunderstood by drivers; potential hazardous situations could occur if the devices are misunderstood.

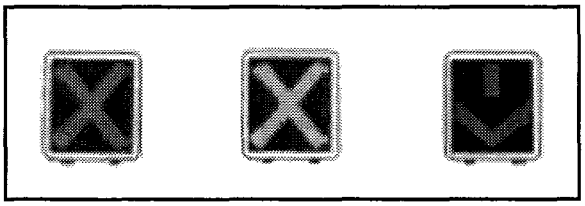


Figure 2. Example of Freeway Lane Control Signal Figure Included in the Pilot and Final Surveys.

Figure 3 depicts the image used for the flashing red and flashing yellow intersection beacons that were included in pilot and final surveys. Red and yellow signal indications were used in each respective flashing intersection beacon. Table 18 presents the freeway lane control signals and intersection beacons included in the pilot and final surveys.

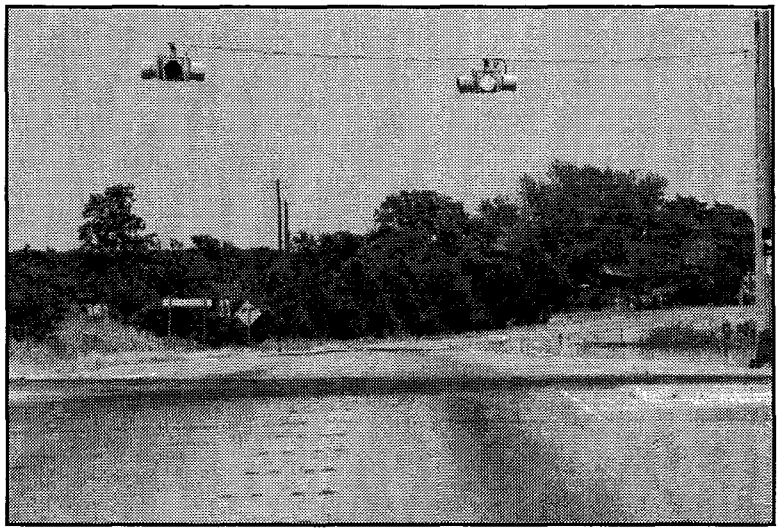
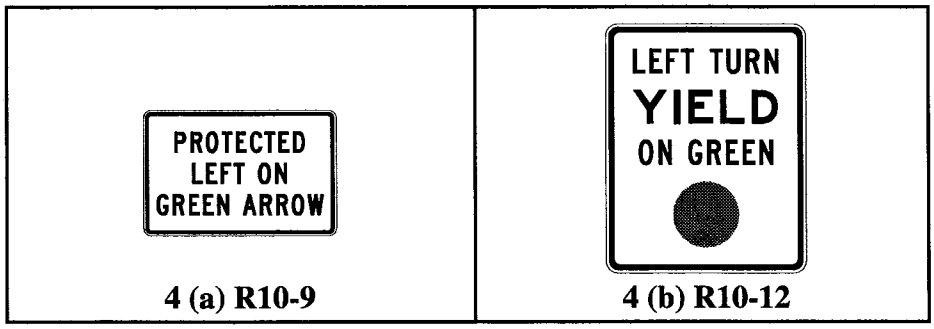


Figure 3. Flashing Intersection Beacon Figure Included in the Pilot and Final Surveys.

The 1995 TTI study (*3*), the survey of driver education instructors, the law enforcement survey, and the teenage driver survey all indicated that left turn indications were misunderstood by drivers. Twelve different indications were pilot tested using the five-section horizontal and five-section cluster signal head displays, with and without supplemental signs. The supplemental signs used in addition to the signal displays are the **Protected Left On Green Arrow (R10-9)** and the **Left Turn Yield On Green Ball (R10-12)** signs. These signs are presented in Figure 4. The use of supplemental signs varies from city to city and from state to state; therefore, different configurations were included in the survey.

Table 18. Freeway Lane Control Signals and Flashing Intersection Beacons Included in the Pilot and Final Surveys.

Signal Type	Pilot Survey	Final Survey
Flashing Red Intersection Beacon	✓	✓
Flashing Yellow Intersection Beacon	✓	✓
Lane Control Green "Arrow"	✓	✓
Lane Control Yellow "X"	✓	✓



4 (a) R10-9 4 (b) R10-12

Figure 4. Supplemental Signs for Left-Turn Signal Displays.

Pilot survey results indicated that there was no significant difference between the displays. Additionally, an ongoing study of left-turn signal displays (*16*) found that the five-section horizontal display is the most common display used in Texas. Therefore, the horizontal left-turn signal head display was selected for use, and the cluster signal head display was eliminated from the final survey. Figure 5 depicts a typical cluster signal head display image used for six displays in the pilot survey. Figure 6 depicts a typical horizontal signal head display image used for six displays in the pilot survey and seven signal head displays used in the final survey. A left-turn display which included a circular red and green arrow indication and the **R10-12** sign were added. Table 19 presents the left-turn signal displays used in the pilot and final survey.

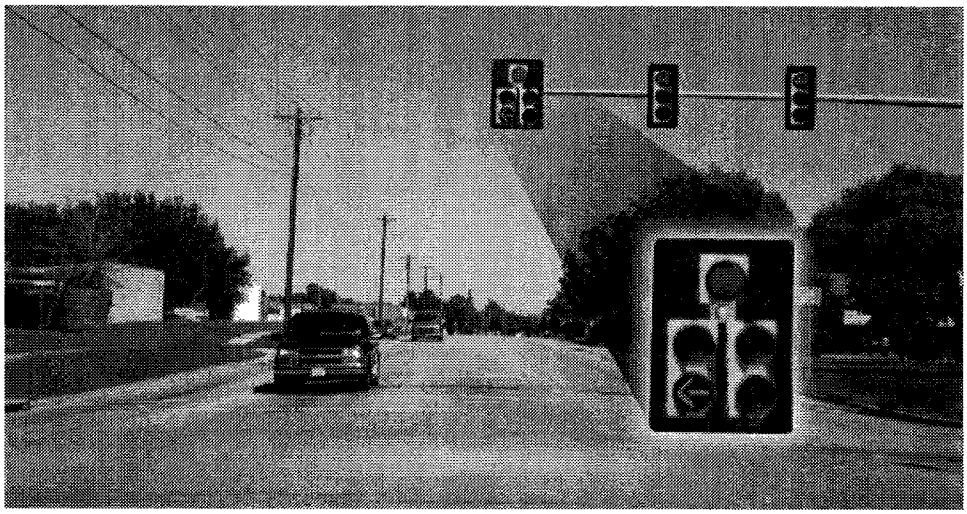


Figure 5. Cluster Display Included in the Pilot Surveys.

Figure 6. Horizontal Display Included in the Pilot and Final Surveys.

Table 19. Left-Turn Signal Displays Included in the Pilot and Final Surveys.

Signal Face	Signal Indication	Supplemental Sign	Sign Label	Pilot Survey	Final Survey
Cluster	Circular Green	None	-	✓	
Cluster	Circular Green and Green Arrow	None	-	✓	
Cluster	Circular Red and Green Arrow	None	-	✓	
Cluster	Circular Green and Green Arrow	Protected Left on Green Arrow	R10-9	✓	
Cluster	Circular Green	Left Turn Yield on Green Ball	R10-12	✓	
Cluster	Circular Red and Green Arrow	Protected Left on Green Arrow	R10-9	✓	
Horizontal	Circular Green	None	-	✓	✓
Horizontal	Circular Green and Green Arrow	None	-	✓	✓
Horizontal	Circular Red and Green Arrow	None	-	✓	✓
Horizontal	Circular Green	Left Turn Yield on Green Ball	R10-12	✓	✓
Horizontal	Circular Green and Green Arrow	Protected Left on Green Arrow	R10-9	✓	✓
Horizontal	Circular Red and Green Arrow	Protected Left on Green Arrow	R10-9	✓	✓
Horizontal	Circular Red and Green Arrow	Left Turn Yield on Green Ball	R10-12		✓

Survey Instrument Development

The survey instrument, closely resembling similar tests taken by teenage driver education students, was designed to assess students' understanding of the selected traffic control devices before a driver education course. As described in the previous section, a thorough critique was made of previous literature, driver education instructors, and law enforcement opinions to compile a list of traffic control devices to be included in the survey. A multiple-choice question booklet was developed, guided by the following criteria:

1. Ease in developing and reproducing the survey instrument
2. Time for participants to complete the survey
3. Ease of administration
4. Cost of reproducing and administering the survey instrument
5. Ease of data reduction

The majority of the answers to the multiple-choice questions were obtained from two TTI studies (*2,3*) which evaluated the understanding of specific traffic control devices. The remaining answers came from an ongoing study (*16*) on left-turn signal displays and previous DPS sign tests. The survey was pilot tested to obtain general format comments by the survey respondents and to refine the questions and response choices. Some response choices in the test booklet were modified as a result of the pilot test results. Afterwards, the refined survey was administered, and the results were analyzed. The test format evaluated 53 different traffic control devices.

SURVEY ADMINISTRATION

The survey was administered at driver education programs located in four cities (Waco, San Antonio, Houston, and Georgetown) in Texas. The driver education programs were chosen by information gathered from the previous survey of driver education instructors which indicated that instructors often give a pre-test to their students when entering a class to determine their deficiencies. Therefore, the researchers obtained a list of instructors who had indicated interest in further participation in the evaluation of students' knowledge of traffic control devices and rules of the road. Researchers contacted the instructors to obtain information on the class size, the beginning and ending dates of their respective driver education classes, and any special provisions or accommodations that must be met. Based on this information and time constraints of the research, nine driver education programs were selected.

The teenage drivers who were surveyed represented one commercial school program and six public school programs. The commercial school consisted of two classes which followed a two-phase (classroom and in-car) curriculum. A total of 38 teenage drivers were tested from the commercial school; the public school programs tested 222 teenage drivers, which included six classes that followed a three-phase (classroom, simulation, and in-car) curriculum.

Survey booklets and answer sheets were hand delivered to each of the driver education programs and included specific instructions for the instructor to follow when administering the survey. The answer sheets were returned by mail or picked up by the researchers.

SURVEY RESULTS

The final survey evaluated 53 traffic control devices to identify which devices pose comprehension problems to teenagers. Due to errors in the data collection process, the **Slower Traffic Keep Right (R4-3)** and **Chevron Alignment (W1-8)** signs were not evaluated. The following sections summarize the results.

Basic Shape and Colors

The understanding of specific sign shapes and colors varied. The **yellow pentagon** and **orange diamond** signs were well understood by the teenage participants, with over 85 percent selecting the correct response. Problems did exist, however, in the comprehension of **blue** and **brown horizontal** signs. Approximately 50 percent of the participants correctly identified the signs; however, about 20 percent could not differentiate between the two. Approximately half of the participants correctly identified the **white** and **black vertical rectangle** signs. The results also indicated that there was some confusion between day and night operations of these signs.

Regulatory Signs

A total of eight regulatory signs were evaluated to determine whether teenage drivers understood the regulations communicated by these signs and how the drivers would respond to the signs.

The regulatory signs that were shown to have the highest comprehension level were the **Yield (R1-2)** and the **Left Lane for Passing Only (R4-2a)** signs. The findings indicated that a large majority of teenagers recognized the proper driving response to these signs. Furthermore, approximately 80 percent of the participants selected the correct response for the **Yield** sign and one of the two correct responses for the **Left Lane for Passing Only** sign. The **Left Lane for Passing Only** sign is intended to reduce unnecessary weaving on multiple-lane roadways and to discourage the use of the left-most lanes when traveling below the normal speed of traffic. The most common correct response to the sign was to use the left lane for passing another car. Only 30 percent selected the other correct response, which stated that slower traffic should use the right lane.

Four regulatory signs had a correct response percentage greater than 60 percent. These signs included the **Stop** sign with the **Cross Traffic Does Not Stop** supplemental sign **(R1-1/R1-5B)**, the **Speed Limit (R2-1)** sign, the **Do Not Cross Double White Line (R4-3b)** sign, and the **Do Not Enter (R5-1)** sign. The results indicate that there was some trouble in the comprehension of these signs and that emphasis in the education of these signs is needed.

The results of the study indicated that the **Center Lane Two-Way Left Turn Only (R3-9b)** and the **Keep Right (R4-7)** signs are not fully understood by teenagers. The focus of the **Center Lane Two Way Left Turn Only** sign questions was to determine how drivers used the center lane, and two responses to the question were considered correct. The majority of teenagers taking the survey selected one of the two correct responses, one of which indicated that the center lane can be used for making left turns in either direction. However, only 25 percent stated that drivers in the center lane should be "aware of head-on traffic." Approximately 43 percent of teenagers selected the incorrect response for the **Center Lane Two-Way Left-Turn Only** sign which was that the "center lane can be used as a waiting area." Vehicles shall not be driven in the center lane except when preparing for or making a left turn from or into the roadway; therefore, waiting to make a right turn onto or crossing the road would be incorrect.

The **Keep Right** sign is intended for use at the beginning of divisional islands, divided roadways, bridge piers, and other locations where traffic is required to stay to the right of an obstruction. Thirty-two percent of teenagers selected the correct response: "drive to the right,"and another 32 percent of the teenagers selected the "stay right of the bridge pier in the middle of the road" response. The latter response is only partially correct; however, the response indicated that teenagers do not fully understand the **Keep Right** sign.

Warning Signs

A total of 14 warning signs were evaluated in this survey. Some warning signs are included in the "other" category, including highway-railroad grade crossing warning signs and school zone warning signs. One-half of the 14 warning signs evaluated in the study were not adequately understood by teenagers. These signs are discussed in the next section.

The results indicated that the **Watch for Ice on Bridge (W19-2)** sign is well understood by teenagers, with 95 percent choosing the correct response. The **Turn (W1-1R)**, **Curve (W1-2R)**, and **Pedestrian Crossing (W11A-2)** signs were also understood by the majority of the students, with over 70 percent of the respondents correctly identifying the meaning of these signs. A large majority of teenagers recognized the horizontal alignment difference between the **Turn** and **Curve** sign; however, confusion may still exist on the recommended speed difference between the two signs.

The **Narrow Bridge (W5-2a)** sign was included to evaluate teenagers' understanding of the detailed message of the sign. The **Narrow Bridge** sign had two correct responses which stated that the "lane. . . may get narrower" and the "shoulder may get narrower or end." Based on the survey results, over 65 percent of the respondents selected the "lane. . . may get narrower" response. Only about 38 percent of the respondents associated the sign with the "shoulder may get narrower or end" response. About half of the respondents selected the response that indicated that there was a bridge ahead. This response is not completely correct, as the sign is used to indicate that the roadway

pavement is narrower than the bridge and is not used simply to indicate the presence of a bridge. Drivers who selected this response may not grasp the intended meaning of the sign.

The results indicate that the **Two-Way Traffic (W6-3)** and the **Slow Down on Wet Road (W8-5)** signs are not fully understood by teenagers; the correct response to these signs was less than 65 percent. A common response to the **Slow Down on Wet Road** sign was "be prepared for several curves in the road ahead." This area of misunderstanding was associated in previous studies (*3,9*).

The **Divided Highway Begins (W6-1)** and **Divided Highway Ends (W6-2)** signs were evaluated and are used where there are changes between a two-way road and a divided highway. About half of the respondents correctly identified the **Divided Highway Begins**. Thirteen percent indicated that they did not know the meaning of the sign. Furthermore, about one-quarter of the respondents selected responses that included physical barriers, such as an island or bridge pier, to keep to the right of while driving. There were also problems with the comprehension to the **Divided Highway Ends** sign as well. Only 39 percent of the respondents selected the correct response. Twenty-seven percent of the respondents selected the response that indicated that a divided highway begins, and 13 percent were not sure as to what the sign meant.

About half of those who took the survey selected the correct response to the question on the **Lane Reduction Transition (W4-2)** sign. This sign is used to indicate a reduction in the number of lanes in the direction of travel. Other popular responses to this sign included "the median between opposing traffic will end" and "the lane will become narrower." The **Added Lane (W4-3)** sign is intended for use in advance of a point where two roadways converge and merging movements are not required. About 40 percent of the respondents selected the correct answer; half of the respondents selected the responses that indicated a need to "yield" or "merge" with other traffic.

The signs with the lowest correct response percentages were the **Low Shoulder (W8-9a)**, **Truck Crossing (W11-10)**, and **Ramp Metered When Flashing (W19-3)** signs. The results showed that only 35 percent correctly selected the proper response for the **Low Shoulder** sign. Only a quarter of the respondents selected the correct response for the **Truck Crossing** sign, which is intended to warn drivers that trucks may be entering or crossing the roadway ahead. Teenagers most often selected the response that indicated the sign was used to warn drivers that the roadway is "heavily used by trucks." Another sign that was not understood by teenagers is the **Ramp Metered When Flashing** sign. This sign is intended for use when a traffic signal is used to control the traffic entering the main lanes of a freeway. Only 22 percent of the teenagers selected the correct response to the sign, and a third of the respondents were not sure what the sign meant.

School Zone, Railroad, and Construction Signs

Seven signs were evaluated that are classified in other categories or special applications by the *TMUTCD*. These include school signs, highway-railroad grade crossing warning signs, and construction signs.

The traffic control devices related to school areas included the **School Advance (S1-1)**, **School Crossing (S2-1)**, and **School Speed Limit (S5-1)** signs. The questions on the **School Advance** and **School Crossing** signs had more than one response that was correct, and the question on the **School Speed Limit** sign only had one correct response. Results for the **School Advance** sign indicate that 50 percent of students associated the sign with a school area, and 59 percent associated it with an advance warning of a school crosswalk. A large percentage of respondents selected responses relating to pedestrians, suggesting that teenagers have difficulty in distinguishing between school signs and pedestrian signs.

The results of the **School Crossing** sign question also suggest that there is difficulty in distinguishing between school and pedestrian signs; the majority of the teenagers who took the survey selected the response that associated the sign with pedestrians. Additionally, they associated the sign with warning of a school area ahead. The **School Crossing** sign is intended for use at established school crosswalks, and a driver must stop when children are crossing the road. Sixty percent correctly selected the response that a driver must stop if children are crossing the road. About half of the respondents correctly selected the response which indicated that there is a crosswalk next to this sign. The results for the **School Advance** and **School Crossing** signs indicated that teenagers do not fully understand the intended message of the signs.

The purpose of the **School Speed Limit** sign question was to determine when teenagers would resume their normal speed after driving through a school zone. Results indicate that 64 percent correctly selected the "speed limit sign" response.

Two highway-railroad grade crossing signs were evaluated to determine where teenagers would expect to see the signs in relation to the railroad tracks and the roadway. About 80 percent indicated the correct position of the **Railroad Advance (W10-1)** warning sign, indicating that most teenagers understand the sign and its use in advance of the railroad tracks. The position of the **Railroad Crossing (R15-1)** sign was also evaluated in the same way, and 70 percent selected the correct response that it is located "at the grade crossing." The **Parallel Railroad Advance (W10-3)** warning sign was also evaluated in the study; about 95 percent selected the correct response that associated the sign with a railroad track at the next intersection.

The **Flag Man Ahead (CW20-7)** symbol sign was the only construction sign evaluated; driver comprehension of this sign is an important factor in the safety of the flag person. The majority of teenagers tested selected the two correct responses which associated the sign with a warning of "construction ahead" and a "person controlling traffic ahead." Approximately 35 percent of the

respondents selected incorrect responses which associated the sign with "detours" and "having to stop." The results indicated that the intended message of the **Flag Man Ahead** sign is not fully understood by teenagers.

Pavement Markings

The first pavement marking evaluated involved the two-way left-turn lane. The two-way left-turn lane is indicated with pavement markings (Figures 7 and 8) and is usually accompanied with the **Center Lane Two-Way Left Turn Only (R3-9b)** sign. The study evaluated two different pavement marking applications for a two-way left-turn lane: one application depicted only the yellow channelization markings and the other included the left-turn directional symbols. The question and responses were similar to the **Center Lane Two-Way Left Turn Only** sign.

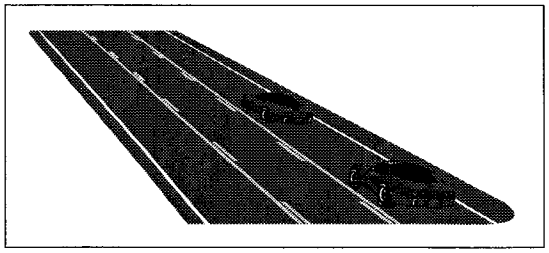


Figure 7. Two-Way Left-Turn Channelization Markings.

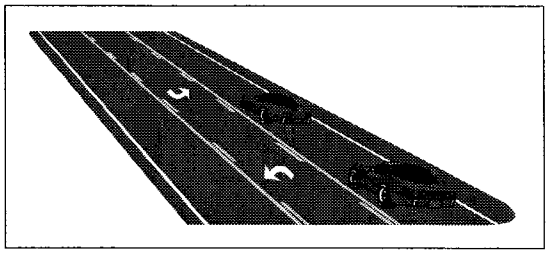


Figure 8. Two-Way Left-Turn Channelization Markings and Symbols.

The results indicate that most teenage drivers chose the correct response and were aware that the center lane is used for making left turns in either direction. Furthermore, the percentage of correct responses was approximately 15 percent higher with the use of the left-turn arrow symbols. The other response that was most commonly selected was that the "lane could be used as a waiting area when turning onto or crossing the road." As mentioned before, a vehicle shall not be driven in the lane except when preparing for or making a left turn from or into the roadway. The other correct response emphasized that drivers should be "aware of head-on traffic." The majority of teenagers did not choose this response; however, the symbols did emphasize that opposing traffic can use the lane for left turns, resulting in a higher correct response rate.

The correct response for the **single broken lane marking** was selected by only 55 percent of the respondents. The results of the survey indicated that the **double solid white marking** was not fully understood by teenagers; less than 65 percent of the respondents selected the correct response, and 11 percent were not sure what the marking meant.

Teenage driver understanding of three yellow pavement markings was also evaluated in the research study. The first marking evaluated was the **combination of broken and solid yellow markings**. Seventy-three percent of the respondents selected the proper response for this marking, and the remaining 25 percent indicated some degree of uncertainty. The correct response for the **double solid yellow marking** was chosen by 77 percent of the respondents. However, approximately 10 percent of the participants indicated that they were allowed to pass on the roadway.

The **broken yellow center marking** is used to separate traffic traveling in opposite directions where passing is permitted if it is safe to do so. The correct response was chosen by 64 percent of the respondents. However, over 20 percent indicated that the road was a one-way road where changing lanes is allowed. The results suggested that teenagers do not fully understand the meaning of pavement markings and that greater emphasis is needed on defining the direction of travel associated with different pavement markings.

Signals

Traffic control signals are used to assign right-of-way to the various traffic movements, therefore providing safe and efficient traffic operations. Three types of signal operations—freeway lane control signals, flashing intersection beacons, and left-turn signal displays—were evaluated in the research study.

Freeway Lane Control Signals

Two freeway lane control signal indications were evaluated in this research study. The first was the steady downward green "arrow," and the survey results indicated that teenage drivers understand the signal indication—81 percent selected the correct response. The second indication evaluated was the steady yellow "X." The results suggest that teenager drivers do not understand the indication; only 33 percent choosing the correct response and 28 percent choosing "not sure."

Flashing Intersection Beacons

Flashing intersection beacons were identified as misunderstood by the 1994 TTI comprehension study (2) and by the driver education instructor survey. When a driver approaches an intersection with a flashing yellow or red beacon, some confusion or uncertainty may exist as to what indication the intersecting traffic observes or what actions the intersecting traffic will take. Both the flashing red and yellow beacons were evaluated in the survey without any other traffic control devices present in the question, so that other devices, such as pavement markings or signs, did not affect the responses to any questions relating to flashing intersection beacons.

When a driver is approaching a flashing red intersection beacon, the intersecting traffic may see either a flashing red or yellow indication. The results of the survey indicated that teenagers do not fully understand the relationship between the indication they see on the approach and the indication displayed to intersecting traffic. Only 32 percent of those evaluated chose the correct response.

A driver approaching a flashing yellow indication would expect the intersecting traffic to see a flashing red indication. Like the flashing red indication, teenagers do not fully understand what the intersecting traffic would see. From the results of the survey, only 22 percent chose the correct response. The results of the survey indicated that the teenagers' comprehension level of flashing intersection beacons is well below 65 percent and, therefore, deemed unacceptable.

Left-Turn Signal Displays

There are several different combinations of phasing and control for left turns at signalized intersections, and several combinations of signal faces and supplemental regulatory signs are used in Texas to inform drivers of the type of left-turn signal operation. Three types of left-turn signal indications, with and without supplemental signs, were evaluated. These questions involved the five-section horizontal signal face and the **Protected Left with Green Arrow (R10-9)** and **Left Turn Yield on Green Ball (R10-12)** supplemental signs. The questions asked the respondents what their appropriate maneuver would be if they wanted to turn left at the intersection.

Respondents were shown left-turn signal displays with the circular green indication. Two left-turn signal displays were evaluated with the circular green indication—a left-turn signal display without a supplemental sign and a left-turn signal display with the **Left Turn Yield on Green Ball** supplemental sign. The survey results indicate that only 36 percent of the respondents correctly selected the appropriate action to the indication without the supplemental sign. Sixty-nine percent correctly selected the appropriate response with the **Left Turn Yield on Green Ball** supplemental sign. This sign has the word "yield" and the circular green indication on it, therefore giving the respondents an inference to the correct response. The results indicate that approximately 35 percent of the respondents would "go" and 24 percent would "stop." The results suggest that teenagers do not have an understanding of the left-turn signal display and what appropriate action should be taken without a supplemental sign. However, using the **Left Turn Yield on Green Ball** supplemental sign with this indication increased the correct responses by 30 percent.

Two left-turn signal displays were evaluated with the circular green and green arrow indication—left-turn signal display without a supplemental sign and with the **Protected Left with Green Arrow** supplemental sign. The survey results indicated that 80 percent of the respondents chose the correct response with and without the supplemental sign. Overall, the majority of teenagers taking the test understood the circular green and green arrow indications.

The final questions relating to left-turn signal displays are associated with the circular red and green arrow indication. This indication has been found to be confusing to motorists in which the green arrow indication seemingly contradicts the red circular indication (*9*). There are several different combinations of signs that are used with left-turn signal displays; therefore, three displays with the circular red and green arrow indication were evaluated with and without signs: left-turn signal display without a supplemental sign, left-turn indication with the **Protected Left with Green Arrow**, and left-turn indication with **Left Turn Yield on Green Ball** supplemental signs.

The focus of each question was on whether the respondent understood that the left turn was protected or permitted. The correct response rate for the circular red and green arrow indication without a supplemental sign was low; only 25 percent selected the correct response, and the majority of the respondents selected the "stop, then wait for a gap" response for this indication. Another 20 percent would "yield and wait for a gap." This indicates that the circular red indication presents confusion and affects the respondent's decision to turn left.

The indication with the **Protected Left with Green Arrow** had a correct response rate of 45 percent. Like the indication without the supplemental sign, a high percentage selected the "stop, then wait for gap" response. The results for the circular red and green arrow indication with the **Left Turn Yield on Green Ball** indicated that this sign was one of the least effective at informing drivers of the protected/permissive nature of the left turn. The correct response rate was identical to that of the indication without the supplemental sign, with only 24 percent selecting the correct response. The majority of the respondents indicated that they would "yield and then wait for a gap." This would suggests that the word "yield" on the supplemental sign affected their decision, similar to the circular green indication with the same sign. About 23 percent of those who took the survey selected the "stop, then wait for gap" response.

Overall, the results indicate that teenagers may not have a full understanding of the circular red and green arrow indication. The indication with the **Protected Left with Green Arrow** sign had the highest correct response rate; however, only 45 percent of the respondents selected the correct response.

DISCUSSION OF RESULTS

The traffic control devices evaluated in this survey were limited to those which had the greatest potential for misunderstanding as identified by previous research studies and by surveys of driver education instructors and law enforcement personnel. In general, the traffic control devices evaluated in this study were found to have less than an 85 percent correct response rate. Furthermore, the survey results indicate that 31 out of the 53 traffic control devices evaluated were understood by less than 65 percent of the teenagers who participated in the survey. These devices are presented in Table 20.

The results indicate that countermeasures are needed for the improvement in teenager driver understanding of traffic control devices. Such countermeasures could include increased public awareness and increased emphasis in the driver education curriculum. It was found that the *Texas Drivers Handbook (5)* is the primary tool used by driver education instructors to teach the meaning of traffic control devices. Therefore, there may be a need to revise the descriptions of the devices included in the handbook or to add devices which are not currently in the handbook.

Table 20. Traffic Control Devices with Correct Response Rates Less Than 65 Percent.

Type of Device	Traffic Control Device	Sign Label
Sign Shapes and Colors	Blue Horizontal Rectangle	-
	Black Vertical Rectangle	-
	White Vertical Rectangle	-
	Brown Horizontal Rectangle	-
Regulatory Signs	Do Not Cross Double White Line	R4-3b
	Keep Right	R4-7
	Do Not Enter	R5-1
Warning Signs	Lane Reduction Transition	W4-2
	Added Lane	W4-3
	Divided Highway Begins	W6-1
	Divided Highway Ends	W6-2
	Two-Way Traffic	W6-3
	Slow Down on Wet Road	W8-5
	Low Shoulder	W8-9a
	Truck Crossing	W11-10
	Ramp Metered When Flashing	W19-3
Other Signs	School Advance	S1-1
	School Crossing	S2-1
	Flag Man Ahead	CW20-7
Markings	Two-Way Left-Turn Channelization Striping (without Symbols)	-
	Broken White Center Marking	-
	Double Solid White Center Marking	-
	Broken Yellow Center Marking	-
Signals	Yellow "X" Freeway Lane Control Signal	-
	Flashing Red Intersection Beacon	-
	Flashing Yellow Intersection Beacon	-
	Left-Turn Signal Display with Circular Green Indication and No Supplemental Sign	-
	All Left-Turn Signal Display with Circular Red and Green Arrow Indications	-

CHAPTER 6
SUMMARY OF FINDINGS AND RECOMMENDATIONS

Recent research studies (*2,3*) have identified various traffic control devices which are misunderstood by most drivers. The studies also indicated that teenage and older drivers have the most difficulty in understanding traffic control devices. The studies recommended that increased educational efforts are needed, particularly in teenage driver education. Limited educational materials focusing on improving driver education of traffic control devices are available; these materials include videos, brochures, software, and Internet sites.

Research efforts have assessed motorist comprehension of traffic control devices and/or their characteristics. Very few, if any, of these studies have specifically addressed teenage driver comprehension difficulties. The first phase of this project primarily identified the needs of teenage drivers related to traffic control devices through surveys of traffic safety education instructors and teenage drivers. Additionally, a survey of law enforcement officials addressed traffic control devices that are misunderstood by drivers, particular problem areas by age group, and areas for improvement in driver education and training.

The following summaries and recommendations are based on the results of these surveys, and recommendations are given for further research efforts.

SUMMARY OF SURVEY RESULTS

Driver Education Instructor Surveys

The driver education instructor survey identified instructors' perceptions of teenage driver comprehension difficulties with traffic control devices. The survey also identified the types of teaching aids and materials that instructors utilize in the classroom to educate teenagers on traffic control devices. Thirty-two percent of driver education instructors believed that students had difficulties with comprehension of traffic control devices while on the road. Instructors listed the following five devices as most misunderstood:

- left-turn displays,
- traffic signals,
- two-way left-turn lanes,
- freeway lane control signals, and
- pavement markings.

Instructors primarily emphasize the following as potential hazards of misunderstanding and disobeying traffic control devices (in descending order of responses): accidents, general unsafe

driving behavior, fatalities, speeding, and citations. Instructors responded that students know approximately 65 percent of the meaning of traffic control devices before the unit begins and approximately 91 percent of the meaning of traffic control devices after the unit ends.

Driver education instructors use the following methods to teach the meaning and importance of traffic control devices:

- their own lesson plans,
- lesson plans based on The *Texas Drivers Handbook* (*5*),
- lesson plans based on a textbook,
- commercial handouts,
- engaging in classroom discussions,
- previous copies of Texas Department of Public Safety (DPS) sign tests,
- pre-tests on traffic control devices,
- post-tests on traffic control devices, and
- engaging in discussions while driving.

Public school driver education instructors spent an average of 444 total minutes teaching traffic control related materials, while commercial instructors spent an average of 319 minutes.

Law Enforcement Official Surveys

The law enforcement survey results indicate that several traffic control devices are misunderstood by drivers of various ages; the most misunderstood devices include the Center Lane Left Turn Only sign, Yield signs, and traffic signals. A large percentage of respondents noted that they have noticed particular problem areas for younger drivers (ages 16-25) and for older drivers (ages 56 and up); about half of the respondents indicated problem areas for drivers ages 29-55. Suggested areas for improvement in driver education and training include: more training with emphasis on traffic control devices, construction areas, laws, courtesy, and accidents; more in-vehicle driving time; more defensive driving classes; and more awareness of the dangers of driving. A large percentage of respondents indicated that retraining or recertification is a good idea; the most suggested for the frequencies of retraining or recertification were four, five, and 10 years.

Teenage Driver Surveys

The traffic control devices evaluated in the teenage driver survey were limited to those which had the greatest potential for misunderstanding as identified by previous research studies and from the surveys of driver education instructors and law enforcement personnel. The goal of the survey was to obtain information to assess the understanding of traffic control devices by teenage drivers

between the ages of 15 and 17. A total of 53 traffic control devices were evaluated, including various shapes and colors, signs, markings, and signals.

The study results indicated that only four traffic control devices had a correct response rate of 85 percent or better and require no changes to the explanation in the education of the devices. Twenty-two of the traffic control devices evaluated were understood, in terms of correct response rates, by more than 65 percent of the respondents. However, these devices were found to have a correct response rate of less than 85 percent, indicating a possible need to emphasize these devices in driver education and/or The *Texas Drivers Handbook* (*5*). The remainder of the traffic control devices were understood by less than 65 percent of the teenagers who participated in the survey. Traffic control devices that proved most difficult to teenage drivers were flashing beacons, left-turn signal displays, and symbol signs. The comprehension levels of those devices were relatively low and determined to be unacceptable. Furthermore, countermeasures are needed for the improvement in teenager driver understanding, as detailed in Chapter 5.

RECOMMENDATIONS

The first phase of this research project identifies traffic control devices which teenage drivers do not fully understand. Furthermore, the results indicate that an increased emphasis in the driver education curriculum is needed. It was found that the *Texas Drivers Handbook* (*5*) is the primary tool used by driver education instructors to teach the meaning of traffic control devices. Therefore, there is a need to revise the descriptions of the devices included in the handbook or to add devices which are not currently included in the handbook. There should be a continual effort to improve teenage drivers' understanding of traffic control devices through improvements in the driver education curriculum and the *Texas Drivers Handbook* (*5*). Based on the survey results of instructors, law enforcement officials, and teenage drivers, the following recommendations are made regarding the need to increase teenage driver understanding of traffic control devices. These recommendations should be included in the driver education curriculum and the *Texas Drivers Handbook* (*5*).

Sign Shapes and Colors

Colors and shapes, in general, should remain an important part of the driver education curriculum according to the survey results of driver education instructors, teenage drivers, and law enforcement officials.

The survey results also indicate a need for an emphasis on black and white vertical rectangle signs in addition to blue and brown horizontal rectangle signs. These recommendations are included in Table 21.

Table 21. Recommendations for Sign Shapes and Colors.

Explain the use of the eight **basic sign colors** (red, black, white, orange, yellow, brown, green, and blue) as discussed in the *Texas Manual on Uniform Traffic Control Devices* (*4*) and the *Texas Drivers Handbook*			
Explain the use of the **standard sign shapes** (octagon, equilateral triangle, round, pennant, diamond, rectangle with longer dimension vertical, rectangle with longer dimension horizontal, trapezoid, pentagon, and other shapes reserved for special purposes) as discussed in the *Texas Manual on Uniform Traffic Control Devices* (*4*) and the *Texas Drivers Handbook* (*5*).			
Device	**Shape**	**Color**	**Recommendation**
	Horizontal Rectangle	Blue	Emphasize that blue rectangles are used for motorist service information signs (including police services and rest areas).
	Vertical Rectangle	Black	Emphasize that black vertical rectangles are used as a *background* for **Night Speed** signs **(R2-3)**. (Black is used as a *message* on white, yellow, and orange signs.)
	Vertical Rectangle	White	Emphasize that white vertical rectangles are used as a *background* for regulatory signs (except **Stop** signs). (White is used as a *message* on brown, green, blue, black, and red signs.)
	Horizontal Rectangle	Brown	Explain that brown rectangles are used for guide and information signs to points of recreational or cultural interests.

Regulatory Signs

The majority of regulatory signs were adequately understood by teenagers, and only minor changes are needed in the driver education curriculum. The driver education instructor and law enforcement survey results identify several regulatory devices that need an increased emphasis during driver training. Table 22 lists these signs and the recommendations for each sign.

Table 22. Recommendations for Regulatory Signs.

Device	Device Name	Sign Label	Recommendation
	Stop sign	R1-1	Explain that vehicles are to stop at the stop sign OR at the stop bar if one is present.
	Stop with Cross Traffic Does Not Stop supplemental sign	R1-1 R1-5B	Emphasize that this direction of traffic always stops but that the intersecting street does not.
	Yield sign	R1-2	Explain that the intersecting traffic has the right-of-way. Emphasize that it is necessary to slow down to look for a conflict with oncoming traffic, but it is not necessary to stop unless there is a conflict.
	Speed Limit sign	R2-1	Explain that this is the legal speed limit and that exceeding the limit may result in citations or accidents due to exceeding the safe speed of the roadway.
	Center Lane Two-Way Left Turn Only sign	R3-9b	Emphasize the awareness of possible head-on collisions. Also explain that the center lane should be used for left turns only and not as a waiting area to turn onto the roadway.
	Do Not Cross Double White Line sign	R4-3b	Emphasize the prohibitory nature of the sign.
	Keep Right sign	R4-7	Explain the necessity of staying to the right.

Warning Signs

Seven of the 14 warning signs evaluated in the teenage driver survey were not adequately understood by the sample of teenage drivers. The majority of these signs were symbol signs, and the meaning of these symbols needs to be emphasized in the driver education curriculum. Several warning signs were also identified as being misunderstood by both the driver education instructor survey and the law enforcement survey. Table 23 lists the devices noted as misunderstood by the survey respondents and suggested recommendations.

Table 23. Recommendations for Warning Signs.

Device	Device Name	Sign Label	Recommendation
	Turn sign	W1-1	Explain that the turn sign is used where the recommended speed on a curve is 30 MPH or less.
	Lane Reduction Transition sign	W4-2	Explain that this sign indicates that there will be a reduction in the number of traffic lanes in the direction of travel on a multilane highway.
	Added Lane sign	W4-3	Explain that this sign is used where two roadways converge, and that merging movements are *not* required.
	Narrow Bridge sign	W5-2a	Explain that this sign applies to very narrow bridges and that the bridges may be narrower than the pavement approaching the bridges.
	Divided Highway Begins sign	W6-1	Explain that this sign indicates that opposing lanes of traffic will be separated by a physical barrier on a section of highway
	Divided Highway Ends sign	W6-2	Explain that this sign indicates that the opposing lanes of traffic will no longer be separated by a physical barrier—this section of highway is ending. It warns of the two-way traffic ahead.
	Slow Down on Wet Road sign	W8-5	Emphasize that this sign is used only where the pavement surface is extraordinarily slippery when it is wet.

Table 23. Recommendations for Warning Signs (continued).

Device	Device Name	Sign Label	Recommendation
	Low Shoulder sign	W8-9a	Explain that the sign applies to a sharp drop from the pavement edge to the shoulder and not to an uneven road surface.
	Pedestrian Crossing sign	W11A-2	Emphasize that this sign is to be used in areas where pedestrians are unexpected. Explain the difference between this sign and the **School Crossing** sign **(S2-1)**, which is used in school zones and has a different shape.
	Truck Crossing sign	W11-10	Explain that trucks may be entering or crossing the road at one or several locations.
	No Passing Zone sign	W14-3	Explain that this sign may be used on two-lane roads to identify the beginning of no passing zones that are indicated by pavement markings, **Do Not Pass** signs **(R4-1)**, or both.
	Ramp Metered When Flashing sign	W19-3	Describe the ramp metering operation, the traffic controls which are used with the sign, and the possible locations of the sign.

School, Railroad, and Construction Signs

Railroad-highway grade crossing, school zone, and construction signs were evaluated due to the potential hazards if these signs are misunderstood. The devices noted as most misunderstood in the surveys of teenage drivers, driver education instructors, and law enforcement personnel are listed in Table 24. Recommendations for training are also included for each device.

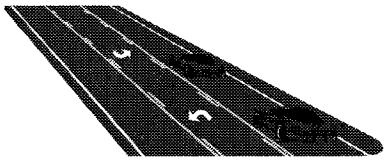
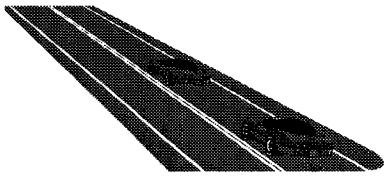
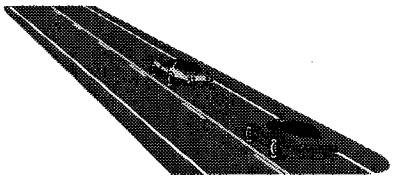
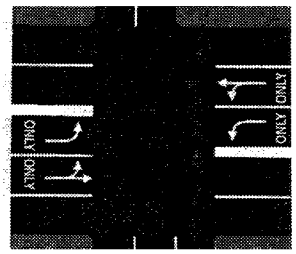
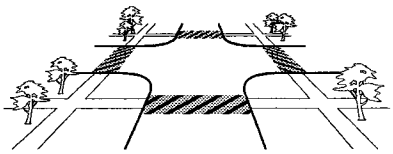
Table 24. Recommendations for School, Railroad, and Construction Signs.

Device	Device Name	Sign Label	Recommendation
	School Crossing sign	S2-1	Confusion exists between the "advance" and "crossing" meaning of the sign; emphasize the difference between the signs. The School Advance sign is used *in advance of* locations where school buildings or grounds are adjacent to the highway and may also be used where established school crossings are not adjacent to a school ground. The School Crossing sign is used *at established crossings*. A School Advance sign is to be used in advance of every School Crossing sign.
	School Advance sign	S1-1	
	School Speed Limit sign	S5-1	Explain that school speed limit signs are used for school zones where the speed limit is lower than on the rest of the roadway. The times the reduced speed limit is in effect are posted on the School Speed Limit sign, or they may be in effect only when a flashing beacon is activated (also posted on the School Speed Limit sign). The end of the reduced speed is marked by a regular **Speed Limit Sign (R2-1)** or by an **End of School Zone sign (S5-2)**.
	Railroad Advance sign	W10-1	Explain that a Railroad Advance Warning sign is used *in advance of* a railroad-highway grade crossing to warn of an upcoming railroad crossing.
	Railroad Crossing sign	R15-1	Explain that the Railroad Crossing (R15-1) sign is used *on each roadway approach* to the crossing.
	Flag Man Ahead Symbol sign	CW20-7	Explain that the Flag Man Ahead sign is used to warn that there is a flag man ahead and that drivers should slow down for the work area and prepare to stop.

Pavement Markings

The results of the teenage driver survey, the driver education instructor survey, and law enforcement survey indicate that greater emphasis on pavement markings is needed, including the direction of travel associated with yellow and white markings. Table 25 lists recommendations for the most problematic pavement markings identified by the surveys.

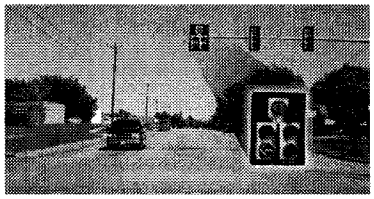
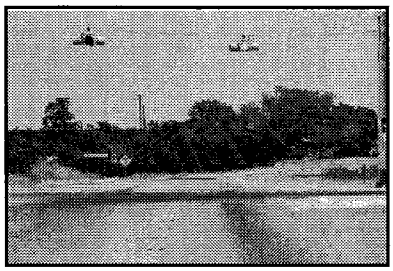
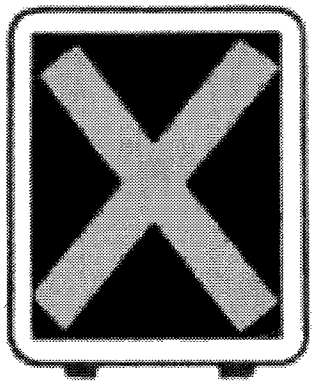
Table 25. Recommendations for Pavement Markings.

Device	Device Name	Recommendation
	Two-Way Left-Turn Channelization Striping and Combinations of Striping and Symbols Markings	Explain that the center lane is to be used only to make left turns; emphasize the danger of head-on collisions because left turns can be made from both directions.
	Double Solid White Lane Marking	Emphasize that this marking prohibits crossing the white line even though traffic is only one direction in these lanes.
	Solid Yellow Line	Explain that the solid yellow line prohibits passing from the lane closest to the pavement marking. Explain that there is no passing in that area due to sight distance restrictions or other special conditions.
	Directional Arrows on Multiple Lanes	Explain that the arrows indicate the movements that are permitted in each lane (either straight, turns, or a combination). The same turning movements should also be shown on a regulatory sign.
	Crosswalks	Explain that presence of a crosswalk indicates the presence of pedestrians in the area. Crosswalks are used at signalized intersections and across approaches to intersections on which traffic stops, and they are used to guide pedestrians in the proper paths.

Traffic Signals

The signal indications evaluated in the teenage driver survey were not well understood by teenagers. Signal indications represent a major problem for many teenagers, especially flashing intersection beacons and the left-turn signal displays with circular red and green arrow indications. The instructor and law enforcement surveys also indicated that various traffic signals are often misunderstood. Based on these results, Table 26 lists recommendations to improve driver understanding of the signals evaluated.

Table 26. Recommendations for Traffic Signals.

Type of Traffic Signal	Recommendation
Traffic Control Signals 	Explain the correct driver actions for basic signal indications, including the protected and permitted turn phases, turn arrows, and supplemental signs. Emphasize the correct driver actions for different combinations of indications and supplemental signs for left-turn signal displays. Illustrate the various combinations of indications and supplemental signing, and emphasize that use varies from one location to another.
Flashing Beacons 	Explain that flashing intersection beacons are used where traffic signals aren't justified but where high accident rates indicate a special hazard. The beacons may be 1) yellow on one route (normally the major roadway) and red for the other approaches or 2) red for all approaches. A stop sign is used with a red beacon. Emphasize that these intersections should be approached with caution and to consider the beacons seen by drivers on other approaches. (Flashing intersection beacons appeared to be the most misunderstood traffic control devices in the teenage driver survey.)
Lane Use Control Signals 	Explain that a lane control signal is used to permit or prohibit the use of a specific lane and that the signal is placed over the lane of traffic. A steady yellow "X" means that a driver should prepare to vacate that lane of traffic because a lane control change is being made and to avoid occupying that lane when a steady red "X" is displayed. A flashing yellow "X" means that a driver is permitted to use that lane for a left turn but is cautioned that he may be sharing that lane with opposite flow left-turning vehicles. (It should be noted that changes in the yellow indication are being proposed and implemented by the Texas Department of Transportation. The yellow "X" indication will be changed to a diagonal, downward yellow arrow indication.)

Recommendations for Further Research

The teenage driver survey used driver education classes and students to evaluate teenage driver understanding of traffic control devices in Texas. It was found that driver education programs were ideal locations to evaluate young drivers due to their controlled classroom setting and the ability to evaluate persons under 18 years of age. Furthermore, it was found that the majority of the driver education instructors contacted were interested in participating in research related to traffic safety. Surveys of driver education instructors provided valuable input regarding difficulties in understanding various traffic control devices. Surveys of law enforcement personnel provided additional input regarding traffic control devices and verification of traffic control devices that are commonly misinterpreted or misunderstood.

The research showed that important and viable information could be collected with the cooperation of traffic engineers, driver education officials, and law enforcement agencies. The recommendations included in the report can be included in revised driver education and training materials to clarify the areas of misunderstanding identified in the surveys.

A continual effort should be made to research traffic safety issues, to revise teaching methods and instructional/media materials, and to assess student performance to improve the quality and success of driver education and training.

CHAPTER 7
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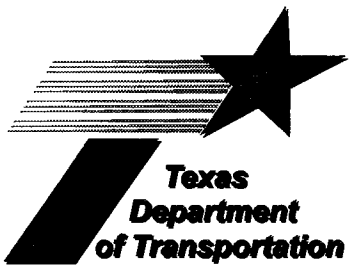
APPENDIX A
SURVEY OF TEENAGE DRIVER EDUCATION INSTRUCTORS

This appendix contains a copy of the survey instrument that was administered to over 1,200 public and commercial teenage driver education instructors. The mailing list of instructors was obtained courtesy of the Texas Education Agency who maintains an active list of all instructors and programs in the State of Texas. A total of 256 public high school instructors and 52 commercial school instructors (total of 308) participated in the survey.

DRIVER EDUCATION SURVEY



The **Texas Transportation Institute** (TTI) is conducting a research study for the **Texas Department of Transportation** (TxDOT) to develop educational materials to improve driver comprehension of traffic control devices. Previous engineering research has identified many signs, signal displays, and pavement markings that drivers of all ages and backgrounds have difficulty in comprehending. Traffic control devices that are misunderstood can lead to serious safety concerns. Therefore, the objectives of this study are as follows:

- ➜ Obtain input from driver and safety education instructors on information that is taught in the classrooms related to traffic control devices, as well as identify problem areas for students;

- ➜ Obtain input from law enforcement personnel on compliance and comprehension problem areas related to traffic control devices; and

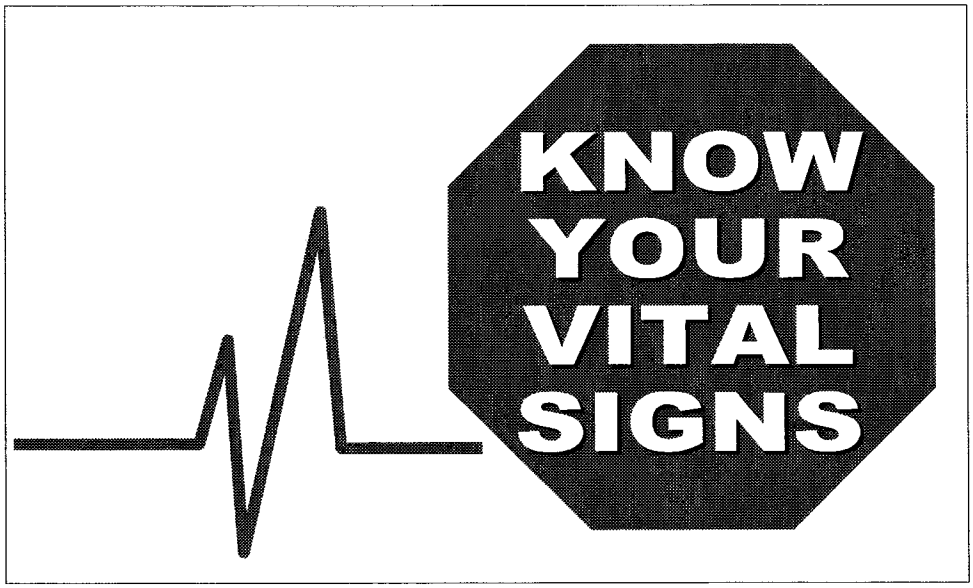
- ➜ Based on this input and on previous engineering research, develop educational materials targeting specific audiences and specific traffic control devices.

Please take a few minutes to fill out this survey. Your input is extremely important for the success of this project. The input from driver education and safety instructors such as yourself will greatly assist in the development of improved educational and curriculum materials for the classroom.

If you have any questions or comments, please feel free to contact Dale Picha at the address or phone number below. Thank you in advance for your time and assistance.

Dale L. Picha, Assistant Research Scientist
Texas Transportation Institute, CE/TTI Room 601
College Station, Texas 77843-3135
Phone: (409) 845-6004 FAX: (409) 845-9761

FREE "Know Your Vital Signs" Video



Note to all Driver Instructors:

Upon completing and returning this survey, the staff at the Texas Transportation Institute will send you a recently published, 12-minute video titled "**KNOW YOUR VITAL SIGNS**." The content of the video was based on previous research results on traffic control devices and includes information on "vital" signs that drivers should know, understand, and obey. The package includes a poster and a recommended curriculum lesson plan. The information is *vital* for all drivers to know, especially our young drivers.

❑ Yes, please send me the video when I return the completed survey.

TRAFFIC SIGNS ARE VITAL TO DRIVER SAFETY.

LEARN THEM.

UNDERSTAND THEM.

FOLLOW THEM.

Take a defensive driving course. Study the Texas Driver's Handbook. Watch out for the other guy, drive safely and. . .

"Know Your Vital Signs" video sponsored by **PARTNERS FOR SAFER DRIVING:**
The Texas Department of Transportation, The Department of Public Safety,
The Texas Education Agency, The Texas Department of Health,
The Texas Transportation Institute, 3M Corporation

SECTION 1 - GENERAL QUESTIONS

This section contains questions related to your classroom, students, and teaching materials.

1. Type of School

- ☐ Public School / Education Service Center
- ☐ Private / Commercial Driving School
- ☐ College / University

2. Your Position *(Check all that apply)*

- ☐ Driver Education Teacher
  - ☐ Classroom
  - ☐ In-Car
  - ☐ Both
- ☐ Safety Education Teacher
- ☐ Driver / Safety Education Coordinator
- ☐ School Principal / Vice Principal
- ☐ Teacher (Other than Driver Education)
  Grade Level _____
  Primary Subject Area _____
- ☐ Superintendent
- ☐ Counselor
- ☐ Athletic Director / Coach / Health Instructor
- ☐ Other _____

3. I teach the classroom phase of Driver Education *(Check all that apply)*

- ☐ Never
- ☐ Part-time
- ☐ Full-time
- ☐ After school
- ☐ Before school
- ☐ Less than 3 times a year
- ☐ More than 3 times a year
- ☐ Summer only
- ☐ Other _____

4. I teach the in-car phase of Driver Education *(Check all that apply)*

- ☐ Never
- ☐ Part-time
- ☐ Full-time
- ☐ After school
- ☐ Before school
- ☐ Less than 3 times a year
- ☐ More than 3 times a year
- ☐ Summer only
- ☐ Other _____

(Proceed to next column)

5. Average Class Size *(Driver Education Only)*

☐ < 5	☐ 15 - 20
☐ 5 - 10	☐ 20 - 25
☐ 10 - 15	☐ > 25

6. Teaching Content From: *(Check all that apply)*

- ☐ State-Adopted Curriculum
- ☐ Text Book
  - ☐ Drive Right
  - ☐ Responsible Driving
  - ☐ Other _____

7. Teaching Material *(Check all that apply)*

- ☐ Video Tapes
- ☐ 35mm Slides
- ☐ Transparencies (B&W or Color)
- ☐ Handouts (Printed Material)
- ☐ Chalk / Dry Erase Board
- ☐ Texas Driver Handbook
- ☐ Computer:
  - ☐ Software (e.g. Power Point)
  - ☐ CD-ROM
  - ☐ Internet
- ☐ Guest Speakers
- ☐ Newspapers / Magazines
- ☐ Other _____

8. What are your preferred teaching material(s)?

Please rank

1. _____
2. _____
3. _____

9. Do You Have Internet Access

In Your Office/School?	☐ Yes	☐ No	☐ Soon
In Your Classroom?	☐ Yes	☐ No	☐ Soon
In Your Home?	☐ Yes	☐ No	☐ Soon

10. Do you have any specific comments?

_____

_____

_____

SECTION 2 - CURRICULUM-RELATED QUESTIONS

This section contains curriculum-related questions about traffic control devices.

1. What Approved Unit of the Curriculum Guide Do You Primarily Use When You Teach Students About Traffic Control Devices?

☐ Unit II - Motor Vehicle Traffic Laws
☐ Unit VII - Highway Characteristics
☐ Other _____

2. Answer Yes or No to the Statements Below that Most Apply to You when Teaching About the Meaning and Importance of Traffic Control Devices. *(Check All That Apply)*

___Yes	___ No	I develop my own lesson plans based on the approved TEA curriculum.
___Yes	___ No	I develop my own lesson plans based on the Texas Driver Handbook.
___Yes	___ No	I develop my own lesson plans based on chapters in the textbook.
___Yes	___ No	I use one or more commercial handouts (printed material).
___Yes	___ No	I engage students in discussions about the meaning and importance of traffic control devices during classroom and simulation instruction.
___Yes	___ No	I use copies of old Department of Public Safety sign tests.
___Yes	___ No	I give students a pre-test on traffic control devices.
___Yes	___ No	I give students a post-test on traffic control devices.
___Yes	___ No	I use a computer program to teach traffic control devices: Name of computer program _____
___Yes	___ No	I require students to complete worksheets on traffic control devices while participating in the observation phase of in-car training.
___Yes	___ No	I engage students in discussions about the meaning and importance of traffic control devices during the observation phase of in-car training.

3. Approximately how much time do you spend and what teaching aids do you use teaching the following:

	Amount of Time Used (Est. Minutes)	Teaching Aids Used **(See Box)**
Basic Sign and Signal Shapes	_____ .	_____
Basic Sign, Signal, and Marking Colors	_____ .	_____
Traffic Signs	_____ .	_____
Traffic Signals	_____ .	_____
Pavement Markings	_____ .	_____
Construction & Maintenance Work Zone Devices	_____ .	_____
Railroad Highway Grade Crossings	_____ .	_____
Traffic Control in School Zones	_____ .	_____
Sign Vandalism	_____ .	_____
Other _____	_____	_____
Total Estimated Minutes	_____	

Teaching Aids Used

1. Videos
2. Handouts
3. Textbook
4. 35mm Slides
5. Transparencies
6. Guest Speaker
7. Software
8. Chalk/Dry Erase Board
9. Other _____
10. Other _____

SECTION 3 - DRIVER COMPREHENSION QUESTIONS

This section contains questions related to your experiences and perceptions of students' comprehension of traffic control devices.

1. **Do You Feel Traffic Control Devices are Important in the Curriculum?**

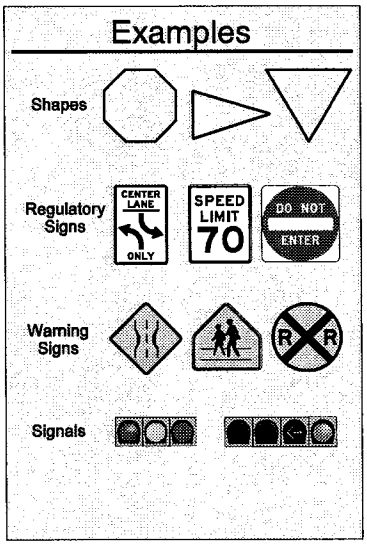
☐ Yes
☐ No

2. **Based on Experience, are Students Having Difficulties With the Comprehension of Traffic Control Devices:**

☐ **In the Classroom?** ☐ Yes ☐ No ☐ Not Sure
☐ **On the Road?** ☐ Yes ☐ No ☐ Not Sure

3. **If You Answered "YES" above, What Difficulties or Devices? (PLEASE BE SPECIFIC)**

☐ Basic Shapes
☐ Basic Colors
☐ Signs (please list *specific* signs)
  ☐ Regulatory Signs _____
  ☐ Warning Signs _____
  ☐ Guide Signs _____
☐ Signals
  ☐ Basic Traffic Signal Indications
  ☐ Left-Turn Displays (signs and signals)
  ☐ Flashing Intersection Beacons (flashing all-red or red/yellow)
  ☐ Freeway Lane Control Signals
☐ Pavement Markings
  ☐ Passing / No Passing Zone Markings
  ☐ White Edge / Centerline Markings
  ☐ Double Solid White Markings
  ☐ Center Two-Way Left-Turn Lane Markings
☐ Construction & Maintenance Work Zone Devices
☐ Traffic Control at Railroad Highway Grade Crossings
☐ Traffic Control in School Zones
☐ Other _____
☐ Other _____



4. **What Do You Primarily Emphasize in Your Classroom as the Potential Hazards of Misunderstanding and Disobeying Traffic Control Devices?**

☐ Speeding ☐ Accidents ☐ General Unsafe Driving Behavior
☐ Citations ☐ Fatalities ☐ Other _____

5. **Do You Administer an Examination to Test a Student's Knowledge of Traffic Control Devices and Rules of the Road?**

☐ Yes ☐ No If Yes, do you provide a grade? ☐ Yes ☐ No
If Yes, are results of this test available? ☐ Yes ☐ No

6. **Generally Students Know Approx. __?__ % of the Meaning of Traffic Control Devices BEFORE the Unit Begins:**

☐ 100% ☐ 90% ☐ 80% ☐ 70% ☐ other _____ %

7. **Generally Students Know Approx. __?__ % of the Meaning of Traffic Control Devices AFTER the Unit Ends:**

☐ 100% ☐ 90% ☐ 80% ☐ 70% ☐ other _____ %

SECTION 4 - GENERAL INFORMATION

The following information is optional; if provided, your input will remain <u>confidential</u> with the research staff at the Texas Transportation Institute.

Name: _____

Position: _____

School / District: _____

Address: _____

_____

Telephone: ( ) _____

FAX: ( ) _____

E-Mail: _____

School Internet Address: _____

"Know Your Vital Signs" Video

☐ As indicated before, Yes, please send me the free video. I included my **name** and **address** above.

☐ I would be interested in receiving the results of this survey.

☐ I would be interested in receiving other information related to this project as it becomes available.

☐ I would be interested in further participation with this study. A follow-up study to this survey will be an evaluation of students' knowledge of traffic control devices and rules of the road.

A postage-paid return has been provided for your response.
Please **fold** and **tape** the survey and return it by **April 24, 1998**.

If you have any questions or comments, please contact Dale Picha at (409) 845-6004.

THANK YOU IN ADVANCE FOR YOUR ASSISTANCE

APPENDIX B
SURVEY OF LAW ENFORCEMENT PERSONNEL

This appendix contains a copy of the survey instrument that was administered to law enforcement personnel in Texas. The survey was mailed to 257 different local, county, and state law enforcement agencies that are members of the Texas Police Chiefs Association. A total of 214 surveys were returned, representing 137 different agencies.

LAW ENFORCEMENT QUESTIONNAIRE

Ideally, drivers are taught the meaning of most traffic control devices through the driver education process. However, the meanings of many devices are never learned, forgotten, or misunderstood. Additionally, when new devices are implemented, no opportunity is provided for novice or experienced drivers to learn the meaning of the device prior to seeing it on the roadway.

To promote and increase safety and to address these issues, the Texas Department of Transportation is sponsoring a project to improve driver education and training within the state of Texas. The goal of the project is to develop detailed education materials targeted to specific messages and driver groups. As law enforcement officers, your input is critical to this process. We would like to know what messages drivers need to know or understand better to make them safer drivers.

We would like specific ideas on items that need to be addressed and ideas on how to implement these items.

Please Proceed
To Next Page

LAW ENFORCEMENT QUESTIONNAIRE

1. **In your opinion, what traffic control devices are <u>most misunderstood</u> by drivers?**
   This may include signs, signals, and/or pavement markings.

For example, some drivers have difficulty understanding the **Two-Way Left-Turn Lane Sign**. Do you know of others?

2. **Have you noticed any particular problem area(s) for these specific age groups?**
   If yes, please explain.

Ages 16-25 ❑ *Yes* ❑ *No*

Ages 26-55 ❑ *Yes* ❑ *No*

Ages 56-up ❑ *Yes* ❑ *No*

3. **What problems involve not understanding the English language?**

For example, some drivers may not be able to read or speak English and understand basic word signs. Do you know of signs or markings like this?

4. **Can you suggest any areas for improvement in driver education/training?**

5. **Should drivers be periodically retrained or recertified?** ❑ *Yes* ❑ *No*

If yes, how often? Every _____ *years*

Comments

6. If continuing education is required for all drivers, what should be emphasized?

_____

_____

_____

7. Does your agency provide any type of public education or safety training for drivers?
❑ *Education* ❑ *Training* ❑ *Neither* If so, please describe what is provided.

_____

_____

8. Does your agency provide any driver education materials for the public?
(Examples: brochures, newsletters, videos, public service announcements, seminars, etc.)
❑ *Yes* ❑ *No*
If yes, can you provide a copy (or copies) of this material? ❑ *Yes* ❑ *No*

9. Do you have any other comments or suggestions regarding driver education or training?

_____

_____

_____

(This information is optional.)

Name _____ Agency _____

Address _____ *City* _____

State _____ *Zip Code* _____ *Work Phone* _____

Thank you for completing the survey. Please fold and return or fax to:

Angelia Parham, P.E.
Texas Transportation Institute
CE/TTI Bldg., Suite 301
College Station, TX 77843-3135

Phone: (409) 845-9878
FAX: (409) 845-6481

Thank you for your input.

APPENDIX C
SURVEY OF TEENAGE DRIVERS

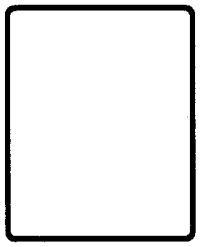
This appendix contains a copy of the survey instrument that was administered to 260 teenage drivers prior to their obtaining a driver's license. The survey addressed 53 different traffic control devices found in the *Texas Manual on Uniform Traffic Control Devices* (*4*). Many of the survey questions were similar, if not the same, as the questions that teenage drivers would normally see on the Texas Department of Public Safety-issued tests that are administered by their instructors.

Texas Transportation Institute

Signs, Signals, and Markings Test

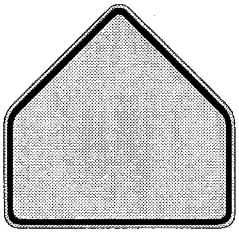
PLEASE <u>DO NOT</u> WRITE YOUR NAME OR MARK ON THE QUESTION BOOKLET!!

1. **What does a sign this color and shape mean?**
Circle only ONE answer.



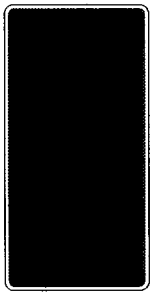
A. Indicates daytime driving conditions.
B. Indicates traffic laws or regulations.
C. Motorist services, such as gas stations, restaurants, and hotels.
D. Not sure.

2. **What does a sign this color and shape mean?**
Circle only ONE answer.



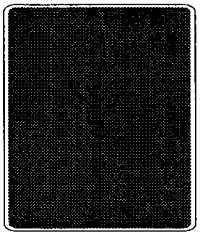
A. Route for hazardous material trucks.
B. Advisory or warning for construction work.
C. General warning for a school and school crossing.
D. Not sure.

3. **What does a sign this color and shape mean?**
Circle only ONE answer.



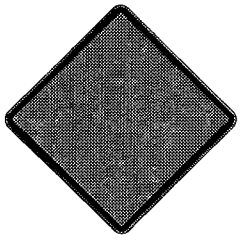
A. Indicates traffic laws or regulations.
B. Stop or prohibition.
C. Indicates guidance for public recreation and scenic places.
D. Not sure.

4. **What does a sign this color and shape mean?**
Circle only ONE answer.



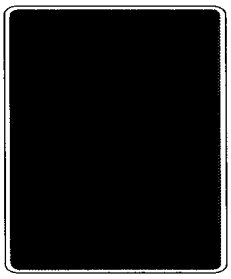
A. Guidance for public recreation and scenic routes.
B. Motorist services, such as gas stations, restaurants, and hotels.
C. Regulation and warning.
D. Not sure.

5. **What does a sign this color and shape mean?**
Circle only ONE answer.



A General warning or advisory.
B. Warning for construction work.
C. Warning for school zone.
D. Not sure.

6. **What does a sign this color and shape mean?**
Circle only ONE answer.

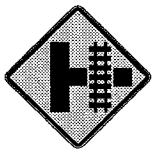


A. Indicates guidance for public recreation and scenic places.
B. Indicates a nature trail for bikes and pedestrians.
C. Indicates a warning for wildlife in the area (such as a deer crossing).
D. Not sure.

7. **What does this sign mean?**
Circle only ONE answer.

A. Slow down for a side road to the right.
B. Slow down for a curve to the right.
C. Slow down for a turn to the right.
D. I am not sure what this sign means.

8. **What is the meaning of this sign?**
Circle only ONE answer.

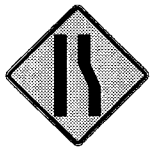


A. You will go through a tunnel if you turn right.
B. You will cross a railroad track if you turn right at the intersection.
C. You are driving next to an unpaved road.
D. There is a fence along the right side of the road.
E. You will be on a Ranch Road if you turn right at the next intersection.
F. You will be required to turn right at the intersection ahead.
G. I am not sure what this sign means.

9. **If you want to turn left, and you see the traffic signals shown, you would...**
Circle only ONE answer.

A. Go.
B. Yield, wait for gap.
C. Stop, then wait for gap.
D. Stop.
E. I am not sure what I would do.

10. **What is the most correct meaning of this sign?**
Circle only ONE answer.

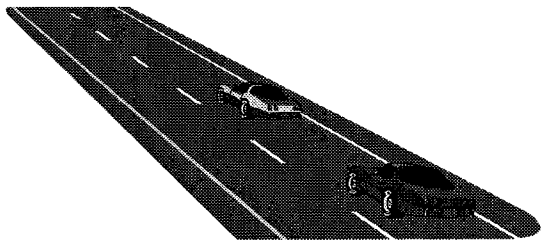


A. The lane ends and traffic in the right lane should move into the left lane.
B. The lane ends and traffic in the left lane should move into the right lane.
C. The median between opposing traffic will end.
D. There is only a single lane ahead for both directions of traffic.
E. The lane you are in will become narrower.
F. I am not sure what this sign means.

11. **What does the green "arrow" signal mean?**
Circle only ONE answer.

A. Stop here.
B. Do not drive in this lane.
C. This is a signal for buses.
D. Move out of this lane.
E. This lane is okay to drive in.
F. I am not sure what this signal means.

12. **Which one of the following statements is true about the dashed white line?**
Circle only ONE answer.



A. This is a one-way road where you are allowed to change lanes.
B. This is a one-way road where you are not allowed to change lanes.
C. This is a two-way road where you are allowed to pass.
D. I am not sure what the lane line means.

13. What is this sign telling you?
Circle only ONE answer.

A. You do not have to stop because you are crossing the intersection.
B. Traffic from all directions must stop at the intersection.
C. Traffic from the right or left may not slow down or stop at the intersection.
D. I am not sure what this sign means.

14. If you want to turn left, and you see the traffic signals shown, you would...
Circle only ONE answer.

A. Go.
B. Yield, wait for gap.
C. Stop, then wait for gap.
D. Stop.
E. I am not sure what I would do.

15. What does this sign mean?
Circle only ONE answer.

A. Be prepared to yield to other vehicles entering your lane.
B. Be prepared to merge with traffic from the right or left.
C. There is an intersection of two roadways ahead.
D. Stop and yield to traffic to your right or left.
E. Two roadways come together ahead-stay in your own lane.
F. I am not sure what this sign means.

16. What does this sign mean?
Circle only ONE response.

A. Drive at least 55 miles per hour.
B. Drive 55 miles per hour in the daytime only.
C. Drive no faster than 55 miles per hour day or night.
D. I am not sure what this sign means.

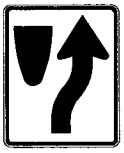
17. Please circle ANY of the following responses that apply when you see this sign.
You may circle MORE THAN ONE answer

A. There is a school area ahead.
B. Pedestrians may be walking on the shoulder or sidewalk.
C. There is a pedestrian crossing ahead.
D. There is a school crosswalk ahead.
E. I am not sure what this sign means.

18. What does this sign mean?
Circle only ONE answer.

A. Slow down-a hazardous condition may exist on the bridge.
B. Speed up and hurry across the bridge.
C. Continue as you are-the sign is displayed regardless of conditions.
D. I am not sure what this sign means.

19. What is the meaning of this sign?
Circle only ONE answer.



A. Watch for side road traffic to the right.
B. Drive to the right.
C. Slow down for a right turn.
D. Stay to the right as you enter the traffic circle.
E. Stay to the right of the bridge pier in the middle of the road.
F. I am not sure what this sign means.

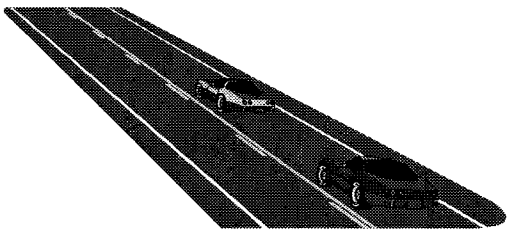
20. If you want to turn left, and you see the traffic signals shown, you would...
Circle only ONE answer.

A. Go.
B. Yield, wait for gap.
C. Stop, then wait for gap.
D. Stop.
E. I am not sure what I would do.

21. What is the meaning of this sign?
Circle only ONE answer.

A. Do not cross the double white line, unless you need to pass and overtake another vehicle.
B. Do not cross the double white line unless you have an emergency.
C. Do not cross the double white line if other cars are in the other lane.
D. I can cross the double white line if no other cars are near me.
E. I am not sure what this sign means.

22. If you are traveling in the right lane, which of the following statements is true about the center line?
Circle only ONE answer.



A. This is a two-way road where you are allowed to pass.
B. This is a two-way road where you are not allowed to pass.
C. This is a one-way road where you are allowed to change lanes.
D. I am not sure what the center line means.

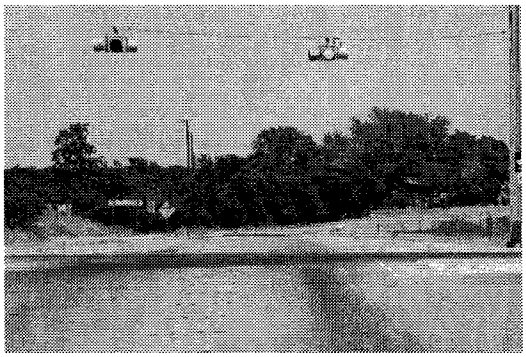
23. What does this sign mean?
Circle only ONE answer.

A. Slow down for a right turn.
B. Look for a detour to the right.
C. Slow down for a left curve.
D. Slow down for a right curve.
E. I am not sure what this sign means.

24. Which of the following responses apply when you see this sign. You may circle MORE THAN ONE answer.

A. You will go under an overpass ahead.
B. The shoulder may get narrower or end.
C. You will have to share your lane with traffic from the other direction.
D. You are about to enter a tunnel.
E. The lane you are in may get narrower.
F. There is a bridge ahead.
G. I am not sure what this sign means.

25. If your direction of travel faces the blinking yellow light, what color would the intersecting traffic see?
Circle only ONE answer.



A. Blinking red.
B. Blinking yellow.
C. Either red or yellow, depending on the intersection.
D. I am not sure.

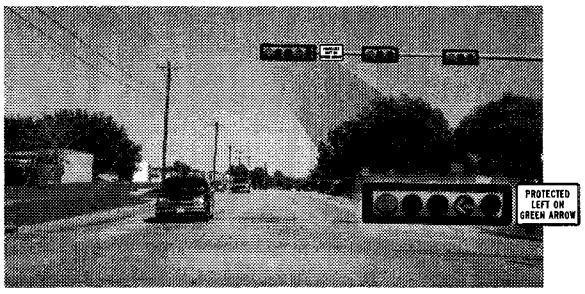
26. What does this sign mean?
Circle only ONE answer.

A. There is a divided highway ahead-keep right.
B. The divided highway ends ahead-keep right.
C. Slow down for the end of the pavement.
D. Two-way traffic ends.
E. The road narrows ahead to only one lane of traffic.
F. I am not sure what this sign means.

27. What is the meaning of this sign?
You may circle MORE THAN ONE answer.

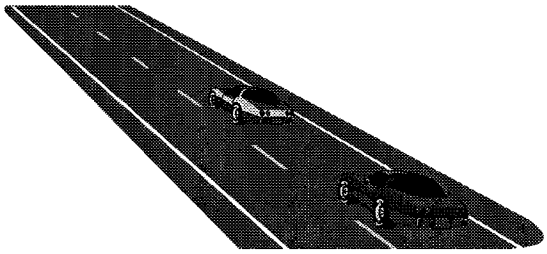
A. Slower traffic should use the right lane.
B. When driving slow, use the left lane.
C. Do not drive in the left lane.
D. Use the left lane for passing another car.
E. When driving slow, use the shoulder.
F. I am not sure what this sign means.

28. If you want to turn left, and you see the traffic signals shown, you would...
Circle only ONE answer.



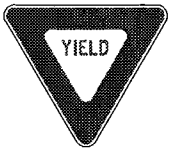
A. Go.
B. Yield, wait for gap.
C. Stop, then wait for gap.
D. Stop.
E. I am not sure what I would do.

29. Which one of the following statements is true about the dashed yellow center line in the image?
Circle only ONE answer.



A. This is a two-way road where you are allowed to passed.
B. This is a two-way road where you are not allowed to pass.
C. This is a one-way road where you are allowed to change lanes.
D. I am not sure what the yellow center line means.

30. What is this sign telling you?
Circle only ONE answer.



A. You are not required to slow down or stop.
B. You must stop at the intersection.
C. Vehicles on the other road will be slowing down and stopping.
D. You must slow down and check for traffic.
E. I am not sure what this sign means.

31. What is the most correct meaning of this sign?
Circle only ONE answer.

A. This is a warning that this roadway is heavily used by trucks.
B. Trucks may be entering or crossing the road at one or several locations on the following section of the roadway.
C. Be prepared for slow moving trucks using the roadway.
D. Trucks may be entering or crossing the road at a single location a short distance ahead.
E. No cars are allowed on this section of the road, only large trucks.
F. I am not sure what this sign means.

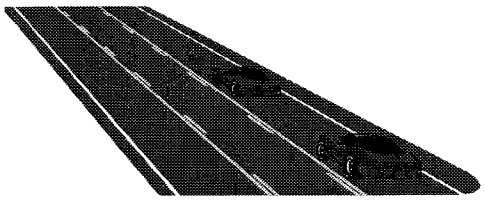
32. What does this sign mean? Circle only ONE answer.

A. Get ready to cross a two-way roadway.
B. Get ready to enter a two-way roadway.
C. The No Passing Zone begins on this two-way roadway.
D. Passing is allowed, but do so carefully.
E. This is a reminder that the road you are traveling will become a one-lane roadway.
F. I am not sure what this sign means.

33. Which of the following responses apply when you see this sign. You may circle MORE THAN ONE answer.

A. Be prepared for several curves in the road ahead.
B. Watch out for cars that are out-of-control.
C. Slow down to keep from losing control.
D. Be prepared for potholes in the road that might cause you to lose control.
E. Slow down when the road is wet to keep from losing control.
F. Watch out for large puddles of water on the road when it is raining.
G. I am not sure what this sign means.

34. Which one of the following statements is true about the yellow lines? You may circle MORE THAN ONE answer.



A. You cannot drive in the center lane for any reason.
B. Drivers in the center lane should be aware of head-on traffic.
C. The center lane can be used for passing and overtaking other vehicles.
D. The center lane can be used for making left turns in either direction.
E The center lane can be used as a parking area for businesses along the road.
F. The center lane can be used as a waiting area when turning onto or crossing the road.
G. I am not sure what this sign means.

35. If you want to turn left, and you see the traffic signals shown, you would...
Circle only ONE answer.

A. Go.
B. Yield, wait for gap.
C. Stop, then wait for gap.
D. Stop.
E. I am not sure what I would do.

36. What does this sign mean?
Circle only ONE answer.

A. Watch for a sharp drop from the pavement edge to the shoulder.
B. Get ready to detour.
C. Slow down for loose gravel.
D. You are approaching an uneven road surface.
E. I am not sure what this sign means.

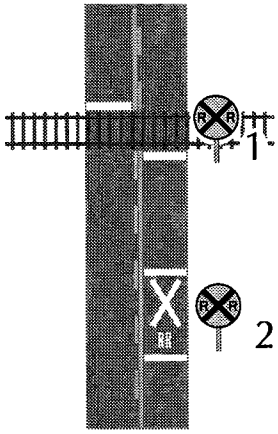
37. At what point can you speed up again after passing this sign? Circle only ONE answer.

A. After you cross the school crosswalk.
B. After you go past the block of the school building.
C. When you see a speed limit sign.
D. I am not sure.

38. What does this sign mean?
Circle only ONE response.

A. Slow down and watch for people crossing the street on foot.
B. Slow down because you are near a school crossing and children may be crossing the street on foot.
C. Pedestrians are not permitted to cross this area.
D. Slow down because you are near an intersection.
E. Pedestrians may be walking on the shoulder or sidewalk.
F. I am not sure what this sign means.

39. What position would you expect to see this sign?
Check only ONE position.



_____ Position 1
Near the track

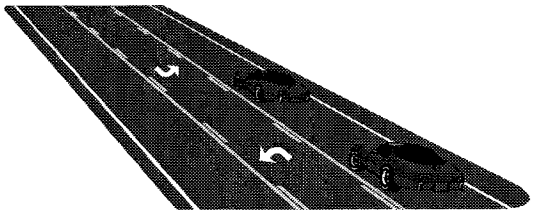
OR

_____ Position 2
Several hundred feet from the track

40. What does the yellow "X" signal mean?
Circle only ONE answer.

A. Stop here.
B. Do not drive in this lane.
C. This is a signal for buses.
D. Move out of this lane.
E. This lane is okay to drive in.
F. I am not sure what this signal means.

41. Which one of the following statements is true about the yellow lines? You may circle MORE THAN ONE answer.

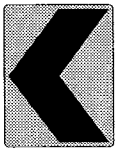


A. The center lane can be used for passing and overtaking other vehicles.
B. Drivers in the center lane should be aware of head-on traffic.
C. You cannot drive in the center lane for any reason.
D. The center lane can be used for making left turns in either direction.
E. The center lane can be used as a waiting area when turning onto or crossing the road.
F. The center lane can be used as a parking area for businesses along the road.
G. I am not sure what this sign means.

42. What is the meaning of this sign?
You may circle MORE THAN ONE answer.

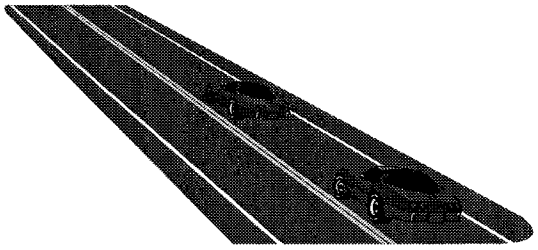
A. When driving slow, use the left lane.
B. Use the left lane for passing another car.
C. Slower traffic should use the right lane.
D. When driving slow, use the shoulder.
E. Do not drive in the left lane.
F. I am not sure what this sign means.

43. This is called the "Chevron" sign–What does it mean?
You may circle MORE THAN ONE answer.



A. There is a detour in the road ahead–follow the direction of the arrow.
B. There is a curve in the road ahead.
C. Keep left and slow down.
D. There is a gas station ahead
E. Keep right and slow down.
F. I am not sure what this sign means.

44. Which one of the following statements is true about the solid yellow lines? Circle only ONE answer.

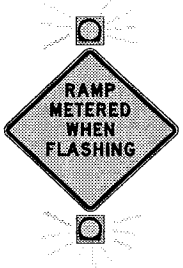


A. This is a two-way road where you are allowed to pass.
B. This is a two-way road where you are not allowed to pass.
C. This is a one-way road where you are allowed to change lanes.
D. I am not sure what the yellow center line means.

45. If you want to turn left, you see the traffic signals shown, you would... Circle only ONE answer.

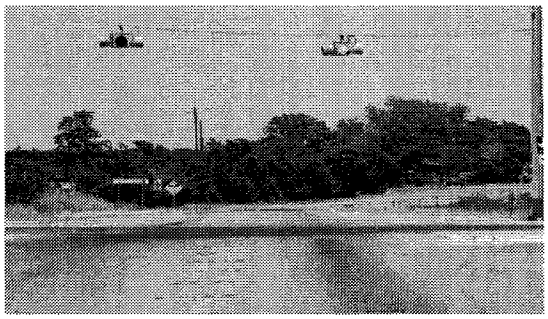
A. Go.
B. Yield, wait for gap.
C. Stop, then wait for gap.
D. Stop.
E. I am not sure what I would do.

46. What does this sign mean? Circle only ONE response.



A. When the yellow lights are flashing, a traffic signal at the entrance to the freeway is in use.
B. Only a certain number of cars are allowed on the ramp when the yellow lights are flashing.
C. You must pay a toll to use the freeway entrance ramp.
D. I am not sure what this sign means.

47. If your direction of travel faces the blinking red light, what color would the intersecting traffic see? Circle only ONE answer.



A. Blinking red.
B. Blinking yellow.
C. Either red or yellow, depending on the intersection.
D. I am not sure.

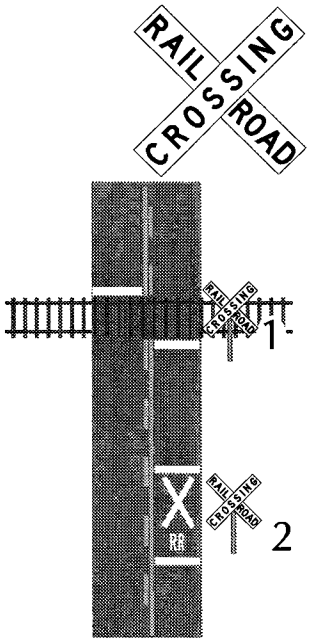
48. What does this sign mean? Circle only ONE answer.

A. There is a divided highway ahead-keep right.
B. The divided highway ends ahead-keep right.
C. There is a bridge pier in the middle of the road-keep right.
D. There is a curbed island in the road ahead-keep right.
E. You are entering a traffic circle.
F. I am not sure what this sign means.

49. Which of the following responses apply when you see this sign. You may circle MORE THAN ONE answer.

A. The center lane can be used as a parking area for businesses along the road.
B. The center lane can be used as a waiting area when turning onto or crossing the road.
C. You cannot drive in this area for any reason.
D. The center lane can be used for making left turns in either direction.
E. Drivers in the center lane should be aware of head-on traffic.
F. The center lane can be used for passing and overtaking other vehicles.
G. I am not sure what this sign means.

50. What position would you expect to see this sign?
Check only ONE position.



____ Position 1
Near the track

OR

____ Position 2
Several hundred feet from the track

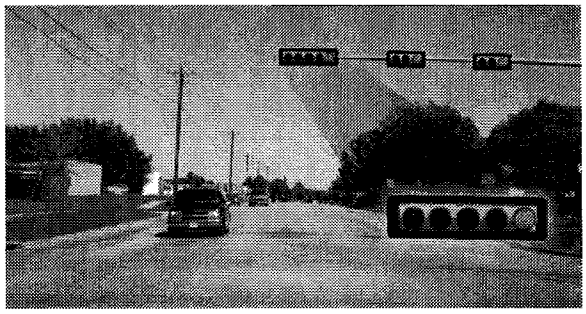
51. What does this sign mean?
Circle only ONE answer.

A. Enter the street ahead slowly.
B. Wrong direction - get ready to turn right or left.
C. Stop before entering the street ahead.
D. Yield to other traffic before entering the street ahead
E. Hazardous pavement conditions ahead - do not enter.
F. I am not sure what this sign means.

52. Please circle ANY of the following responses that apply when you see this sign.
You may circle MORE THAN ONE answer.

A. There is a school area ahead.
B. Stop because children may be crossing the road.
C. There is a pedestrian crossing ahead.
D. There is a school crosswalk next to this sign.
E. I am not sure what this sign means.

53. If you want to turn left, and you see the traffic signals shown, you would . . .
Circle only ONE answer.

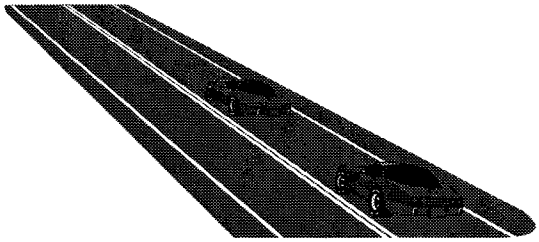


A. Go.
B. Yield, wait for gap.
C. Stop, then wait for gap.
D. Stop.
E. I am not sure what I would do.

54. What is the meaning of this sign?
You may circle MORE THAN ONE answer.

A. Detour ahead.
B. Watch for a construction or maintenance project ahead.
C. Stop until you are waved on.
D. Someone is controlling traffic ahead.
E. I am not sure what this sign means.

55. Which one of the following statements is true about the solid white lines?
Circle only ONE answer.



A. This is a one-way road where you are allowed to change lanes.
B. This is a one-way road where you are not allowed to change lanes.
C. This is a two-way road where you are allowed to pass.
D. I am not sure what the lane lines mean.