

Development of a Work Zone Training Program



Final Report
August 2009

About the SWZDI

The goal of the Smart Work Zone Deployment Initiative is to improve the safety and efficiency of traffic operations and highway work by investigating better ways of controlling traffic through work zones. The SWZDI is part of the Transportation Pooled Fund Program, Study Number TPF-5(081). The project is administered by Iowa State University's Institute for Transportation. The lead agency is the Iowa Department of Transportation.

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16. Abstract Safety in highway work zones has been a major concern for many decades. Over the years, government agencies and highway industry have developed work zone safety training programs to educate general public, professionals, and government employers. Existing training programs are conducted in the old fashion classroom setting which has some disadvantages such as high travel costs and locations far away from jobs. The objective of this research project was to develop a web-based training program for highway work zone safety. The developed program was built on advanced computer science technologies and delivered via Internet so that a trainee can access the training materials at any time and at any location as long as there is an Internet service. Training topics cover sign, marking, highway traffic signal, and temporary traffic control. At the end of training, a trainee will have an opportunity to take an on-line quiz with 50 questions. A certificate will be sent to the trainee via e-mail if that person's test score is higher than the passing grade. The developed web-based training program has several advantages. First, using the developed program will eliminate the travel costs for the instructors and trainees. Second, both the instructors and trainees will spend less time away from their jobs. Third, the developed program can be easily modified and updated with any new information. Finally, trainees can learn the training materials at their own pace. The self pace format can be easily fitted in a busy working schedule.			
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CHAPTER 1 – INTRODUCTION

1.1 Problem Statement

The aging highway system in the United States has led to an increasing funding allocation on existing highway preserving, rehabilitating, expanding, and enhancing. As a result, the traveling public has to encounter more and more work zones on the highways. Work zones create an inevitable disruption on regular traffic flows and result in vehicle crashes. Safety in highway work zones has been a major concern for many decades. Since the 1960s, a variety of research projects in the area of work zone safety have been conducted (Mohan and Gautam 2002; Bai and Li 2006; Bai and Li 2007; Bai and Li 2009). The Federal Highway Administration (FHWA) and the American Association of State Highway and Transportation Officials (AASHTO) have played leading roles on this subject and have developed practical highway work zone safety guides and programs. Many State Departments of Transportation (DOTs) have been initiating research projects to improve work zone safety in their states. Other concerned organizations and research individuals have also participated in this campaign by conducting meaningful research on various work zone safety issues.

Despite the effort, work zone safety remains unsatisfactory nationwide. In 2007, there were 835 work zone fatalities and over 40,000 injuries in work zones (FHWA 2008). The direct cost of highway work zone crashes, estimated based on the crash data from 1995 to 1997, was as high as \$6.2 billion per year: an average cost of \$3,687 per crash (Mohan and Gautam 2002). Due to the current conditions of work zone safety, the need to educate people concerning work zone safety is a must. Traditional education and training programs need to be updated to increase

its efficiency in serving the public. A web-based work zone safety training program is a solution of the future to provide efficient, effective, and high quality training to the general public, highway professionals, and government employees.

1.2 Report Organization

This report includes the following chapters:

1. Introduction. The report starts with this introduction chapter which presents a general problem statement of this research and brief description of the report organization.
2. Literature review. This chapter synthesizes the findings from a comprehensive review of the literature that is relevant to this study. The topics included in the review are work zone safety and existing training programs. The content studied in this chapter provides a background for the research project.
3. Research objective, scope, and methodology. The primary objective, the scope, and the methodology of this research project are defined in this chapter.
4. Program and procedures. This chapter describes the construction and organization of the web based training program. In addition, the description of the procedures and an explanation of the uses of each section within the web-based training program are provided.

5. Conclusions and recommendations. Based on this research project, conclusions and recommendations on the effectiveness of the web-based training program, the feasibility of utilizing this system and the implementation of this system, are provided in this chapter.

CHAPTER 2 – LITERATURE REVIEW

2.1 Introduction

According to the Transit Cooperative Research Program, Internet technologies and applications are evolving rapidly to provide the tools needed to develop and supply training for an abundance of topics via the World Wide Web (FHWA 2003b). It is obvious that the advanced technologies enhance our way of life in delivering information. The amount of people owning and using computers is exponentially increasing. There are about 77 million people who use the computer at work, according to Bureau of Labor Statistic (BLS 2005). This gives DOTs around the United States the ability to reach out to the public and highway industry professionals through the Internet via web-based training (WBT).

Currently DOTs' work zone safety training is conducted in an old fashioned classroom setting. This traditional classroom setting has some disadvantages. The first disadvantage is the high cost. Using the WBT will eliminate the travel cost for the instructors and trainees. In addition, both the instructors and trainees spend less time away from their jobs. Second, a WBT program can be easily modified and updated with new information. Trainees can access the most updated WBT program anywhere and anytime using a computer with Internet access. Finally, the users of a WBT program can learn the materials at their pace. The self pace format can easily fit in a busy schedule.

Temporary traffic control (TTC) devices are utilized in the highway work zones to provide drivers and construction workers with a reasonably safe environment. As indicated in the MUTCD, TTC devices that are commonly used in work zones include flaggers, traffic signs, arrow panels, portable changeable message signs, channelizing devices, pavement markings, lighting devices, temporary traffic control signals, and rumble strips (FHWA 2003a). Reviews of the effectiveness of TTC devices have been conducted in detail by other researchers. The focus of the literature review for this research project was on the previous development of WBT programs in safety.

2.2 Development of WBT Program in Safety

This section presents an overview of existing WBT programs in safety. These programs are reviewed to give an insight in helping researchers to develop the WBT program in work zone safety. Table 2.1 presents a list of existing WBT programs.

Table 2.1: List of Existing WBT Programs in Safety

No.	Website	Brief Description
1	http://www.free-training.com/osha/forklift/forkmenu.htm	Forklift Operation & Safety Course Menu
2	http://www.free-training.com/osha/hazcom/hazmenu.htm	Hazard Communication Course Menu
3	http://www.free-training.com/osha/ppe/Ppemenu.htm	Personal Protection Equipment Course Menu
4	http://www.free-training.com/osha/back/backmenu.htm	Back Safety Course Menu
5	http://www.motorcarriertraining.com/catalog.asp	DOT Transportation Safety Institute Online Training Center
6	http://www.dot.state.mn.us/const/wzs/flaggertrainrequireal08_filef/v3_document.html	Flagger Trainer Re-Qualification Minnesota Department of Transportation
7	http://www.onlineflagger.com/	Online flagger training

The Forklift Operation and Safety Course Menu (FOSCM 2008), Hazard Communication Course Menu (HCCM 2008), Personal Protection Equipment Course Menu (PPECM 2008), and Back Safety Course Menu (BSCM 2008) are forms of WBT programs. The developments of these training programs were sponsored by several companies and Clemson University. The developer of these WBT programs is Instructional Design Inc and programs are provided to the general public free of charge. All safety training contents used in these programs are based upon the OSHA standards. These programs are usually used by manufacturer companies to train

employees, contractors, and anyone who will perform the specific task such as operating the fork lift. The design of these programs is simple and the programs are easy to use. The downfall of these training programs is the quizzes. The scope of the quizzes is limited and the ability of the WBT to test a user if he or she read the material is not sufficient. For example, for each section there are only one or two questions. If the trainee answered the questions wrong, the program will return to the first part of the section. The trainee will re-read the materials and at the end he or she will see the same question(s). For some cases, the questions are a true or false question. If the trainee answered the question wrong the first time, then correct answer is obvious.

The fifth WBT program in Table 2.1 is from the U.S. DOT Transportation Safety Institute Online Training Center. The Transportation Safety Institute is the first to offer self-paced training for motor carriers over the Internet (TSIOTC 2009). Through this program, administrators, drivers, safety managers, mechanics, owner/operators, auditors, and inspectors have access to training on Title 49 of the Federal Motor Carrier Safety Regulations (FMCSRs) any time and any place via Internet. The goals of the MotorCarrierTraining.com program are to:

- Provide an easily accessible and cost-affordable means of FMCSRs training
- Enhance awareness of the FMCSRs and specific requirements
- Enable users to identify/reference specific sections within the FMCSRs
- Enable users to acquire knowledge/skills that are necessary to comply with the FMCSRs
- Provide appropriate procedures for maintaining the records required by the FMCSRs
- Identify and explain the acute and critical regulations in the FMCSRs
- Help motor carriers achieve a “satisfactory” safety rating.

This WBT program provides the same official training currently offered through the Transportation Safety Institute's instructor-led courses at its Oklahoma City training facility and at various locations throughout the country. The developer of this website is AdvanceOnline Solution, Inc.

The sixth example of WBT is the flagger training program developed by the Minnesota Department of Transportation (MnDOT 2008). This program is used as a train-the-trainer program to educate contractor's personnel to train employees to act as flaggers on MnDOT construction projects. By successfully completing the program, trainees meet requirements of the new MnDOT flagger training specifications contained in the traffic control special provisions. The course includes review of flagger requirements and related layouts in the Field Manual, discussion of safe practices, flagger attire, and flagger responsibilities. Quizzes are imbedded within the program; users have to answer the questions correctly before going on to the next sections. The drawback of this program is the limited amount of quiz questions.

The last example of a WBT program is the online flagger training developed by Profession Traffic Graphic Inc (OFT 2009). The program follows the American Traffic Safety Service Association (ATSSA) basic curriculum and guidelines, and provides a learning experience for the trainees by using a large amount of graphics, illustrations, and interactive content. Since the computer can compare and provide feedback in a non-intimidating environment, the trainees can experiment with online scenarios and receive feedback whereas they may not ask a question in a normal classroom setting. Everyone taking this class must pass section reviews that evaluate his or her knowledge for each section before moving on. This is something that is not currently done in a classroom setting. Managing an account is very easy

using this WBT program. After paying for the training, a trainee is allowed to take a class, manage a profile, view a list of registered students and check their status.

Based on the results of literature review, there is no WBT program for work zone safety. Thus, there is a need to develop such an online training program for government agencies, industries and the general public.

CHAPTER 3 – RESEARCH OBJECTIVE AND METHODOLOGY

3.1 Objective

The primary objective of this research was to develop a web-based training program for highway work zone safety. The training program was to cover the following topics:

- Signs
- Markings
- Highway Traffic Signals
- Temporary Traffic Control.

The developed program was to be built based on advanced computer science technologies and delivered via Internet. It was intended to have three unique characteristics: (1) user friendly and easy to use, (2) easy to maintain and update, and (3) cost effective. The information used in designing the WBT for work zones is limited to the MUTCD and information provided by the Kansas Department of Transportation (KDOT).

3.2 Methodology

The objective of this research project was achieved through the following four steps:

Step 1: Literature Review. The research team first conducted a comprehensive literature review to gather examples of existing WBT transportation safety programs.

Step 2: Technical Information Organization. The effectiveness of delivering the information is dependent on the order of the information organized. Researchers present information from a basic level to a more sophisticated level.

Step 3: Website design and program. The design of the WBT includes storing technical information data into a server and programming the logic behind the WBT. The WBT must be secure in keeping personal information of trainees. The order of web pages must flow logically to help trainees to learn the materials.

Step 4: Conclusions and Recommendations. Based on the literature review, website design, and program, conclusions on the WBT for work zone safety were presented. Recommendations for the enhancement of the user interface of the WBT and future research needs were also outlined.

CHAPTER 4 – WORK ZONE SAFETY TRAINING PROGRAM DEVELOPMENT

4.1 Introduction

Due to the rising needs in highway maintenance and construction, the number of work zones is increasing throughout the United States. Highway work zones disrupt normal traffic flow and create safety problems. With more than one thousand fatalities and 40,000 injuries nationwide each year, improvements in safety are urgently needed. To help address safety issues in work zones, a WBT program for work zone safety has been developed. Its website address is http://www.ittc.ku.edu/~xwang85/old_kdot/home.html. The developed program can be used to train appropriate project personnel relating to work zone maintenance and construction as well as general public at any time and at any location as long as there is Internet access.

In this chapter, the explanations of the program development are introduced in detail. The development of the WBT program is divided into two tasks, the gathering of technical information and the design of training program framework. The initial process of the technical information gathering was to organize the technical information. The goal of organizing the technical information was to inform users from the basic knowledge to the more sophisticated level of technical information. There are two primary sources for the technical information, one is from the MUTCD and another is from KDOT. The technical information was organized into

four different sections. Subjects of these sections are signs, markings, highway traffic signals, and temporary traffic control.

The framework of the WBT program for work zone safety is represented by a flow chart shown in Figure 4.1. The overall layout is divided into three segments, which are (1) Registration, (2) Training, and (3) Quiz.

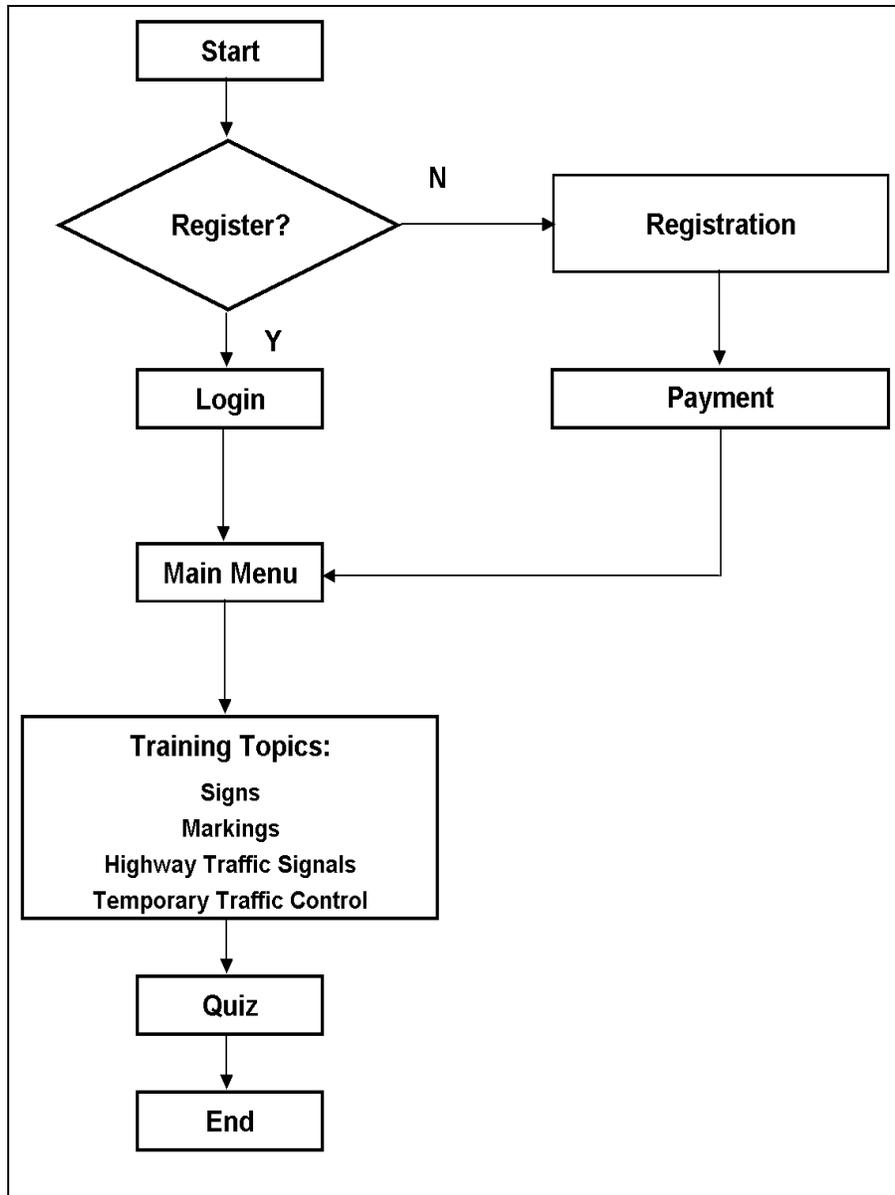


Figure 4.1: Framework of the WBT Program for Work Zone Safety

The registration segment includes four parts. They are: the front page, the introduction page, the login page, and the registration page. The front page shows a picture of a work zone with the title of the WBT program and the click button (Enter here) as indicated in Figure 4.2. After a user clicks the button “Enter here”, the user will proceed into the second part of the registration segment as shown in Figure 4.3. The second part shows a brief introduction from the

webmaster to the user. The introduction of the webmaster contains the purpose of constructing the work zone safety training program. This segment also contains the instruction concerning new user registration, the required fee, and the certificate. A new user of the training program must register first and then pay the one-time course fee of \$30. After that, the registered user can return to the training program as many times as the user likes. If the user takes the quiz and passes it at the end of training, a certificate will be sent to that person via e-mail. The passing score for the quiz is 70 points out of 100 points.



Figure 4.2: Front cover layout of the WBT

Work Zone Safety Training Program

Due to the rising needs in highway maintenance and construction, the number of work zones is increasing throughout the United States. Highway work zones disrupt normal traffic flow and create safety problems. With more than one thousand fatalities and 40,000 injuries nationwide each year, improvements in safety are urgently needed. To address the safety issue in the work zones, a web-based training program for work zone safety has been developed. The developed program can be used to train appropriate project personnel relating to work zone maintenance and construction as well as general public at any time and at any location as long as there is an Internet access.

A new user of the training program must register first, then, pay the one-time course fee of \$30. After that, the registered user can return to the training program as many times as the person likes. If the user takes the quiz and passes it at the end of training, a certificate will be sent to that person via e-mail. The passing score for the quiz is 70 points out of 100 points. If a user has any comments and/or suggestions about this training program, please send the comments and/or suggestions to Dr. Yong Bai (ybai@ku.edu) at the University of Kansas.

Next

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Figure 4.3: Introduction of the WBT program

The third part of the start segment is the login page for the new user, the return user, and the administrator as shown in Figure 4.4. In this section, a return user could input his or her user name and password to proceed into the main menu of the training program. If the return user forgot the password or the username, the WBT program has an option tool to look up the information in a secure fashion and sends the information to the user via e-mail. For a first time user, the person will proceed into the registration page after clicking on the “Register” button. In this page, a user has to input the personal information such as first name, last name, gender, address, city, state, zip code, phone, email, employer, a username and password as shown in Figure 4.5. After the user has input the information, the user will have an opportunity to review

and confirm his or her information before proceeding to the payment page as shown in the Figure 4.6. After confirming the input information, the user has the options to pay the one-time training fee using either a coupon or a credit card as shown in Figure 4.7. Companies can purchase coupons ahead of time and distribute them to their employee if companies are willing to pay for the training fee. After paying the fee, the user will enter the main menu of the training program.

Work Zone Safety Training Program

New User

If you are a new user, you must register and pay the course fee of \$30.

Return User

If you are a return user, please log in the training program using Username and Password.

Username

Password

[Forgot the Username?](#) [Forgot the Password?](#)

Administrator

If you are an administrator, please log in using Username and Password.

Username

Password

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Figure 4.4: Login page of the WBT program

Work Zone Safety Training Program

Step 1. Tell us about yourself

*First Name:

*Last Name:

Gender:

*Address:

*City:

*State:

*Zip/Postal Code:

* Phone:
e.g. xxx-xxx-xxxx

Fax Number:
e.g. xxx-xxx-xxxx

*E-mail:

*Employer:

Job Title:

Step 2. Select a login name and password

*Username:

*Password:
Minimum of 8 characters in length.

*Re-type password:

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Figure 4.5: Registration information

E-Training Program for Work Zone Safety and Mobility

Please check your information

First Name: test

Last Name: test

Gender: 0

Address: 123 test

City: test

State: KS

Zip/Postal Code: 66044

Phone: 785-222-2222

Fax Number:

E-mail: test@test.test

Employer: KU

Job Title: student

Username: test

[Back](#) [Next](#)

Figure 4.6: Confirmation of registration information

Work Zone Safety Training Program

The course fee for the E-training program is \$30 per person. You may pay the fee using either a credit card or a coupon that is pre-purchased by your employer.

<p style="text-align: center;">Pay Using Coupon</p> <p>Coupon Code: <input style="width: 80%;" type="text"/></p> <p style="text-align: right;"><input type="button" value="Submit"/></p>	<p style="text-align: center;">Pay Using Credit Card</p> <p>Credit Card Type: <input style="width: 80%;" type="text" value="-Select One-"/></p> <p>Credit Card Number: <input style="width: 80%;" type="text"/></p> <p>Verification Code: <input style="width: 80%;" type="text"/></p> <p>Expiration Date: <input style="width: 20%;" type="text" value="Jan - 1"/> <input style="width: 20%;" type="text" value="2008"/></p> <p>Card Holder First Name: <input style="width: 80%;" type="text"/></p> <p>Card Holder Last Name: <input style="width: 80%;" type="text"/></p> <p>Card Holder Address: <input style="width: 80%;" type="text"/></p> <p style="margin-left: 20px;"><input style="width: 80%;" type="text"/></p> <p>City: <input style="width: 80%;" type="text"/></p> <p>State: <input style="width: 80%;" type="text" value="-- please select a state"/></p> <p>Zip/Postal Code: <input style="width: 80%;" type="text"/></p> <p style="text-align: right;"><input type="button" value="Submit"/></p>
---	--

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Figure 4.7: Payment page layout

4.2 Layout of the Training Program Main Menu

The second segment of the developed WBT program consists of the training modules. As described in Section 4.1 there are five different modules including the sign module, the marking module, the highway traffic signal module, the temporary traffic control module, and the quiz module. Return users or the new users that proceed from the payment page will go to the main menu of the training modules as shown in Figure 4.8. Users will have the flexibility to choose

any module on the menu including the quiz module if they already have the required knowledge. Details of each module are described in the following sub-sections.

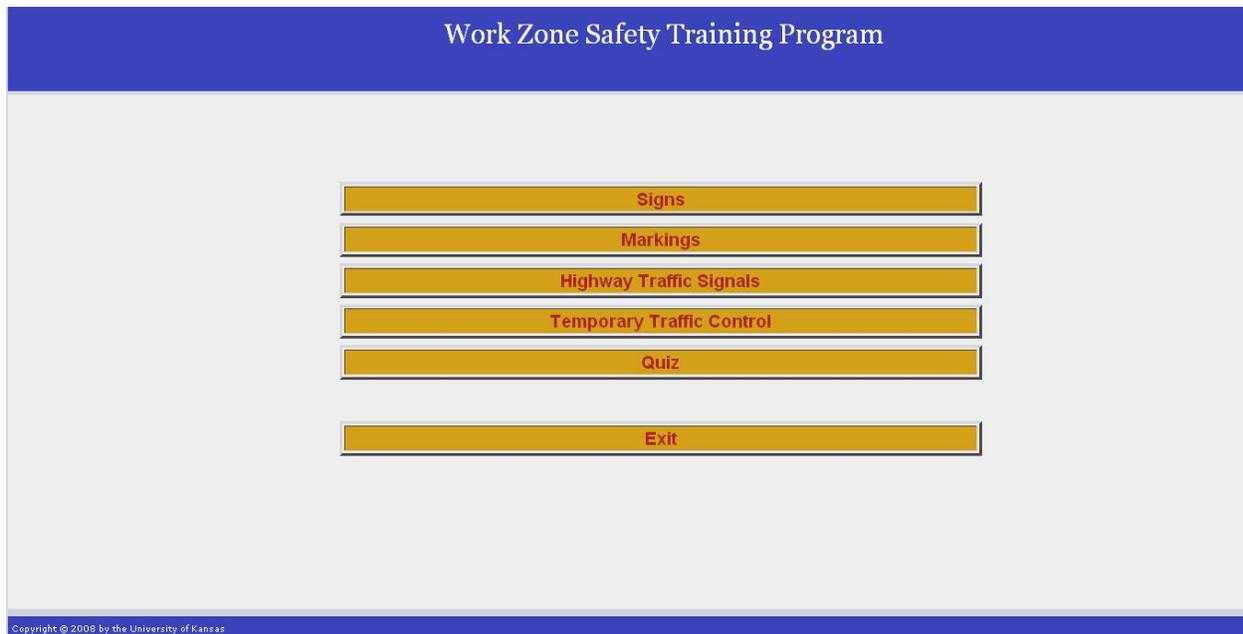


Figure 4.8: Layout of the training modules on the main menu

4.2.1 Sign Module

The first training module is the sign module. The main purpose of this module is to educate users on the different types of signs used in traffic control, including for temporary traffic control in work zones. There are three types of signs stressed in this module including regulatory signs, warning signs, and guide signs. Users will get to know the physical characteristics and functions of different types of signs during the training. A list of the main titles and subtitles of the training topics covered in the sign section is shown in Table 4.1. The table of contents of the sign module is presented in Figure 4.9. The ultimate goal is to enhance the users' knowledge about the signs and their implementations in temporary traffic controls.

Table 4.1: Main Content in Sign Module

Modules	Topics	Sub-topics
Signs	Functions of signs	N/A
	Types of signs	N/A
	Sign shape	N/A
	Sign colors	N/A
	Regulatory signs	N/A
	Examples of regulatory signs	N/A
	Regulatory signs used in temporary traffic control	<ul style="list-style-type: none"> * ROAD (STREET) CLOSED Sign * Local Traffic Only Sign * STOP Sign * Speed Limit Sign * DO NOT PASS Sign * WEIGHT LIMIT Sign * STAY IN LANE Sign * PEDESTRIAN CROSSWALK Sign * SIDEWALK CLOSED Sign * Special Regulatory Sign
	Warning signs	N/A
	Examples of Warning Signs	N/A
	Warning signs used in temporary traffic control	<ul style="list-style-type: none"> * ROAD (STREET) WORK Sign * DETOUR Sign * ROAD (STREET) CLOSED Sign * ONE LANE ROAD Sign * Lane(s) Closed Signs * CENTER LANE CLOSED AHEAD Signs * THRU TRAFFIC MERGE LEFT (RIGHT) Sign * Lane Ends Signs * SLOW TRAFFIC AHEAD Sign * EXIT OPEN, EXIT CLOSED, EXIT ONLY Signs * Flagger Sign * Two-Way Traffic Sign * Workers Sign * ROAD MACHINERY AHEAD Sign * Motorized Traffic Sign * Shoulder Work Sign * UTILITY WORK Sign * SOFT SHOULDER Sign * UNEVEN LANES Sign * NO CENTER STRIPE Sign
	Guide signs	N/A
	Examples of guide signs	N/A
	Guide signs used in temporary traffic control	<ul style="list-style-type: none"> * Road Work Next XX km (miles) sign * END ROAD WORK Sign * Detour Signs * PILOT CAR FOLLOW ME Sign

Signs

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- [Warning Signs](#)
- [Examples of Warning Signs](#)
- [Warning Signs Used in Temporary Traffic Control](#)
- [Guide Signs](#)
- [Examples of Guide Signs](#)
- [Guide Signs Used in Temporary Traffic Control](#)

Quit

Work Zone Safety Training Program©

Figure 4.9: Table of contents of Sign module

4.2.2 Marking Module

The subject of the second training module is pavement marking. Marking on highways has an important role in providing guidance and information for the drivers. In some cases, markings are used to supplement other traffic control devices such as signs and signals. In other instances, markings are used alone to effectively convey regulations, guidance, or warnings in ways not obtainable by the use of other devices. The main purpose of this module is to train users on the major types of markings and their implementations. The major types of markings

include pavement and curb markings, object markers, arrow panels, and channeling devices. A list of the main titles and subtitles of the training topics covered in the markings section is shown in Table 4.2. A table of contents of marking module is shown in Figure 4.10.

Table 4.2: Main Content in Markings Module

Modules	Topics	Sub-topics
Markings	Introduction to markings	N/A
	Pavement and curb markings	<ul style="list-style-type: none"> * Yellow Centerline Pavement Markings and Warrants * No-Passing Zone Pavement Markings and Warrants * Other Yellow Longitudinal Pavement Markings * White Lane Line Pavement Markings and Warrants * Other White Longitudinal Pavement Markings * Edge Line Pavement Markings * Warrants for Use of Edge Lines * Extensions Through Intersections or Interchanges * Lane Reduction Transition Markings * Approach Markings for Obstructions * Raised Pavement Markers * Raised Pavement Markers Substituting for Pavement Markings * Transverse Markings * Stop and Yield Lines
	Object markers	<ul style="list-style-type: none"> * Design and Placement * Markings for objects in the roadway * End-of-roadway markers
	Arrow panels	N/A
	Channeling devices	<ul style="list-style-type: none"> * Introduction to Channeling Devices * Cones * Tubular Markers * Vertical Panels * Drums * Barricades

Markings

Table of Contents

- [Introduction to Markings](#)
- [Pavement and Curb Markings](#)
- [Object Markers](#)
- [Arrow Panels](#)
- [Channeling Devices](#)

Quit

Work Zone Safety Training Program©

Figure 4.10: Table of contents of marking module

4.2.3 Highway Traffic Signal Module

The main purpose of this training module was to educate users on highway traffic signals. This module also introduces the importance of traffic control signals. The following types of highway traffic signals are discussed in this module: traffic control signals, pedestrian signals, emergency-vehicle traffic control signals, traffic control signals for one-lane, two-way facilities, traffic control signals for freeway entrance ramps, traffic control signals for movable bridges, lane-use control signals, flashing beacons, and in-roadway lights. A list of the main titles and subtitles of the topics covered in the highway traffic signal module is shown in Table 4.3. Figure 4.11 shows the table of contents of highway traffic signals.

Table 4.3: Main Content in Highway Traffic Signals Module

Modules	Topics	Sub-topics
Highway Traffic Signals	Traffic control signal	N/A
	Traffic control signal features	N/A
	Pedestrian control features	N/A
	Traffic control signals for emergency vehicle access	N/A
	Traffic control signal for one-lane, two-way facilities	N/A
	Traffic control signal for freeway entrance ramps	N/A
	Traffic control for movable bridges	N/A
	Lane-use control signals	N/A
	Flashing beacons	N/A
	In-roadway lights	N/A

Highway Traffic Signals

Table of Contents

- [Traffic control signal](#)
- [Traffic control signal features](#)
- [Pedestrian control features](#)
- [Traffic control signals for emergency vehicle access](#)
- [Traffic control signal for one-lane, two-way facilities](#)
- [Traffic control signal for freeway entrance ramps](#)
- [Traffic control for movable bridges](#)
- [Lane-use control signals](#)
- [Flashing beacons](#)
- [In-roadway lights](#)

Quit

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Figure 4.11: Table of contents of highway traffic signals

4.2.4 Temporary Traffic Control Module

The fourth training module is the temporary traffic control module. TTC devices are used in highway work zones to provide continuous, reasonably safe and efficient traffic flow during road work. As indicated in the MUTCD, TTC devices commonly used in work zones include flaggers, traffic signs, arrow panels, portable changeable message signs, channeling devices, pavement markings, lighting devices, TTC signals, and rumble strips (FHWA 2003). All of these devices are presented in this training module. Examples of typical applications are explained in drawings shown in the module. The main purpose of this module is to educate users on the TTC devices and their implementations in the work zones. Table 4.4 presents the main contents in this training module and Figure 4.12 shows the table of contents of the temporary traffic control module in the developed WBT program.

Table 4.4: Main Content in Temporary Traffic Control Module

Modules	Topics	Sub-topics
Temporary Traffic Control	Introduction to temporary traffic control	N/A
	Temporary traffic control element	<ul style="list-style-type: none"> * Temporary Traffic Control Plan * Temporary Traffic Control Zones * Components of Temporary Traffic Control Zones * Tapers * Detours and Diversions * One-Lane, Two-Way Traffic Control * Flagger Method of One-Lane, Two-Way Traffic Control * Flag Transfer Method of One-Lane, Two-Way Traffic Control * Pilot Car Method of One-Lane, Two-Way Traffic Control * Stop or Yield Control Method of One-Lane, Two-Way Traffic Control
	Flagger control	<ul style="list-style-type: none"> * Introduction * Functions and Responsibilities * Safety * Clothing * Hand-Signaling Devices * Flagger Station * Remember * Hand-signaling procedures with stop/slow paddles * Emergency Flagging
	Type of temporary traffic control zone activities	<ul style="list-style-type: none"> * Work Duration * Location of Work * Work Outside of Shoulder * Work on the Shoulder with No Encroachment * Work on the Shoulder with Minor Encroachment * Work Within the Median * Work Within the Traveled Way of Two-Lane Highways * Work Within the Traveled Way of Urban Streets * Work Within the Traveled Way of Multi-lane, Non-access Controlled Highways * Work Within the Traveled Way at an Intersection * Two-Lane, Two-Way Traffic on One Roadway of a Normally Divided Highway * Crossovers * Interchanges * Work in the Vicinity of Highway-Rail Grade Crossings * Temporary Traffic Control During Nighttime Hours

Table 4.4: Main Content in Temporary Traffic Control Module (continued)

Modules	Topics	Sub-topics
Temporary Traffic Control	Typical application	<ul style="list-style-type: none"> * Work Beyond the Shoulder * Work on Shoulders * Short-Duration or Mobile Operation on Shoulder * Shoulder Closure on Freeway * Shoulder Work with Minor Encroachment * Road Closure with Diversion * Road Closure with Off-Site Detour * Overlapping Routes with Detour * Lane Closure on Two-Lane Road Using Flaggers * Lane Closure on Two-Lane Road with Low Traffic Volumes * Lane Closure on Two-Lane Road Using Traffic Control Signals * Haul Road Crossing * Work in Center of Road with Low Traffic Volumes * Mobile Operations on Two-Lane Road * Detour for One Travel Direction * Detour for Closed Street * Lane Closure on Near Side of Intersection * Right Lane Closure on Far Side of Intersection * Left Lane Closure on Far Side of Intersection * Half Road Closure on Far Side of Intersection * Multiple Lane Closures at Intersection * Closure in Center of Intersection * Closure at Side of Intersection * Sidewalk Detour or Diversion * Crosswalk Closures and Pedestrian Detours * Interior Lane Closure on Multi-lane Street * Lane Closures on Street with Uneven Directional Volumes * Half Road Closure on Multi-lane, High-Speed Highway * Stationary Lane Closure on Divided Highway * Lane Closure with Temporary Traffic Barrier * Mobile Operation on Multi-lane Road * Lane Shift on Freeway * Double Lane Closure on Freeway * Interior Lane Closure on Freeway * Median Crossover on Freeway * Median Crossover for Entrance Ramp * Median Crossover for Exit Ramp * Work in Vicinity of Exit Ramp * Work in Vicinity of Entrance Ramp * Work in Vicinity of Highway-Rail Grade Crossing



Figure 4.12: Table of contents of Temporary Traffic Control module

4.2.5 Quiz Module

The final module in the training program is the quiz module. The quiz module is divided into five sections including (1) quiz on signs, (2) quiz on markings, (3) quiz on highway traffic signals, (4) quiz on temporary traffic control, and (5) final score as shown in Figure 4.13. Sections 1 thru 4 are designed to test users' comprehensive knowledge of the training materials. Users have the flexibility to choose which section they take first. All the quizzes are time oriented, meaning a user has a limited time to answer the questions in each quiz section. Each

question is worth two points. The quiz on the signs section consists of 10 questions with a total score of 20 points. A user is allowed 15 minutes to answer all questions on the sign section. Quiz information on other section is shown in Table 4.5. After completing a quiz section, a user will be prompted to his or her report card for each section as shown in Figure 4.14. The user can proceed to the next quiz section when he or she is ready. Users will not be shown which specific questions they missed due to the fact that there are limited questions available and showing the correct answers could compromise the results of the quiz.. However, users have the chance to take the quizzes many times. The passing score is 70 points out of 100 points. This WBT program will record how many times each user takes the quiz as indicated in Figure 4.14. Finally, users will be able to view the overall scores by clicking the “Final Score” button shown in Figure 4.13. An example of Final Score table is shown in Figure 4.15.

Quiz

Table of Contents

- [Quiz for Signs](#)
- [Quiz for Markings](#)
- [Quiz for Highway Traffic Signals](#)
- [Quiz for Temporary traffic Control](#)
- [Final Score](#)

Quit

Work Zone Safety Training Program©

Figure 4.13: Table of contents of Quiz module

Table 4.5: Quizzes Information

Quiz Module	Number of Questions	Total Score	Allowed Time (min)
Sign	10	20	15
Markings	16	32	24
Highway Traffic Signal	7	14	10
Temporary Traffic Control	17	34	24
Total	50	100	73

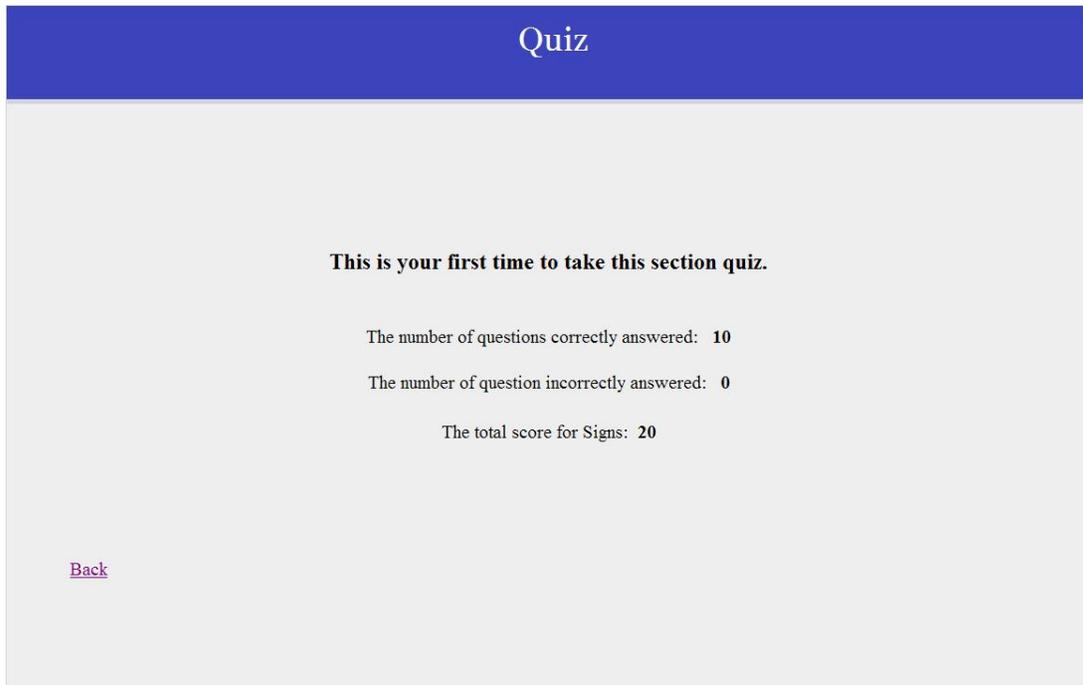


Figure 4.14: Report card for section quiz

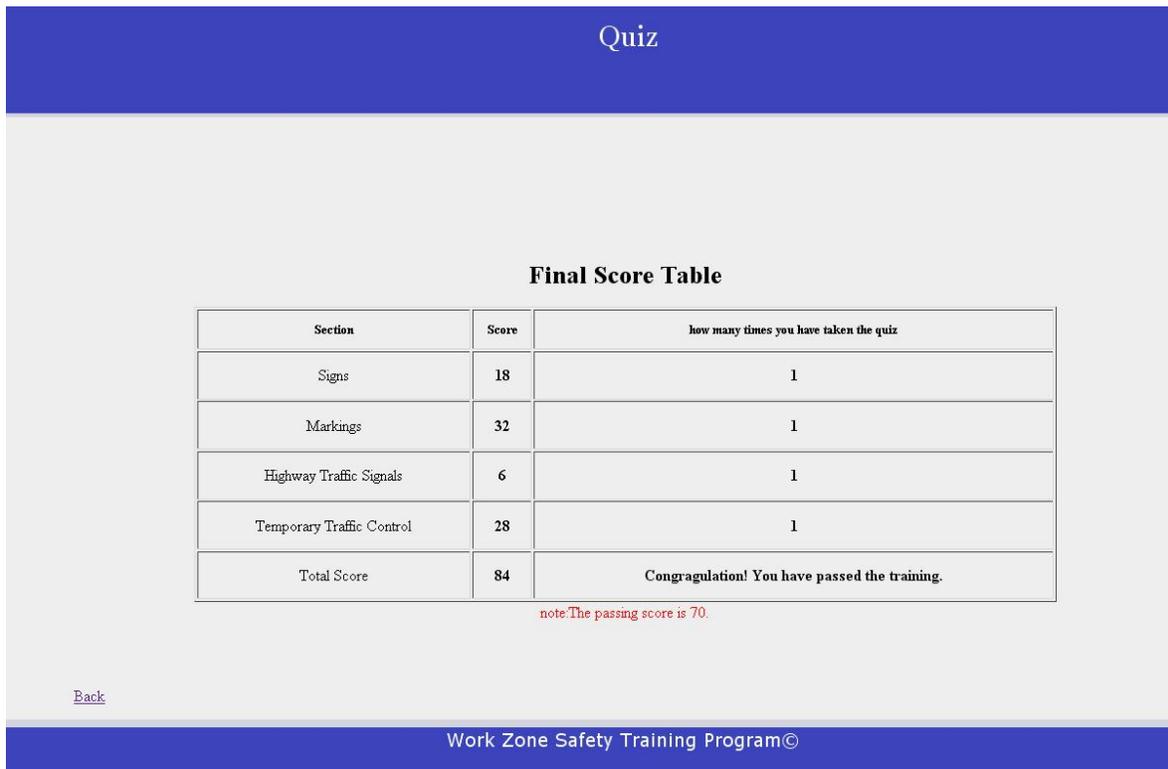


Figure 4.15: Overall quiz scores

4.3 Programming Design

The task of the programmer in designing the WBT program was to take organized technical information and upload it to the World Wide Web. The programmer developed an n-tier client-server architecture for the training program. A model of a three-tier client-server is shown in Figure 4.16.

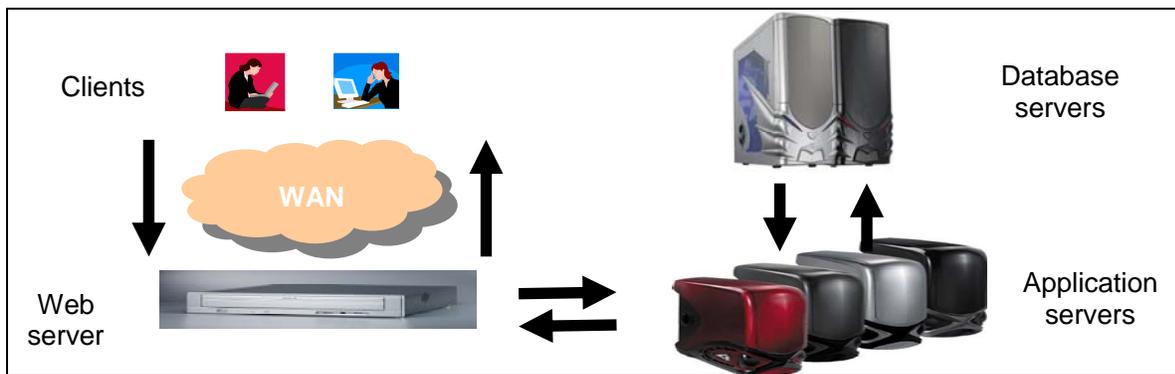


Figure 4.16: Three-tier client-server model for the WBT program

The three tiers are:

- 1) Web server: handle user inputs, such as username and password, and display results to user, such as training contents and quiz score;
- 2) Application servers: enforce business logic including generating training content and providing feedback in a training program; and
- 3) Database servers: store all information, including training program and registered user information in an integrated way.

The training program developments are divided into two separate but related steps: (1) database development and (2) interface development.

1) Database Development

The descriptions of design information are briefly introduced here. First, each user has personal information such as username, password, first name, last name, gender, address, city, state, zip, phone, fax number, e-mail, employer, and job title. Second, there are coupon codes. Third, in the quiz section, there are four test subjects: quiz on signs, quiz on markings, quiz on highway traffic control and quiz on temporary traffic control. Fourth, each question has the following information including question number (section#_question#), answer and score. Fifth, users can take the quizzes as many times as they want and the program will record the number of tests taken. Finally, the following information should be shown to users:

- The score for each section after the quiz for that section is done
- The final score after all quizzes are done and whether the user passes the quiz or not.

Entity-Relationship E/R Model development:

The entities will be the knowledge of the training program and the relationships will be the connection of the knowledge in the training program. Entities also include registered user information and question information. The E/R diagram is shown in Figure 4.17.

In the E/R diagram, the rectangles represent entities which are specific objects in the mini-world that is represented in the database; the circles represent attributes which are properties used to describe the entity or relationship; the diamond represents the relationship between two entities.

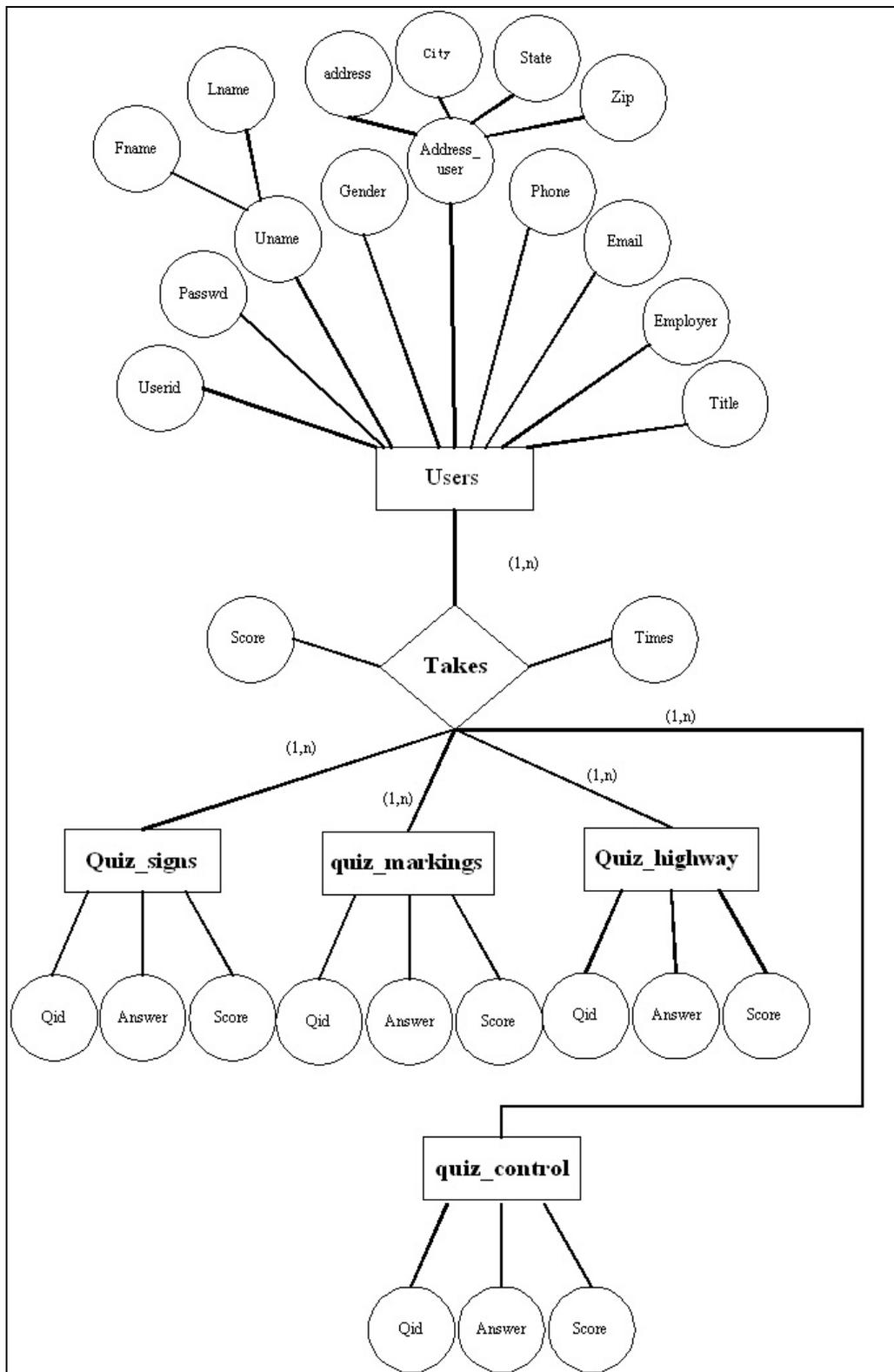


Figure 4.17: The E/R diagram for the WBT program

Relational Schema Development:

Several tables can be developed based on the results of translating the E/R diagram. First, the table of Users is utilized to store all information of users. The schema of the table, including the name of the table, the name of attributes and the type of attributes, is used to describe the format of the table. The attributes denote username, password, first name, last name, gender, address, city, state, zip, phone number, fax number, email address, employer name and job title, respectively. Among them, the attribute of userid is used to index the table and it must be unique.

Users(userid: string, passwd: string, fname: string, lname:string, Gender: string, Address: string, City: string, State:string, Zip:string, Phone:string, fax: string, email: string, employer:string, title:string).

Userid is also the primary key. The fields of fname, lname, address, city, state, zip, phone, email, userid and passwd cannot be empty; zip must be five digits; phone must be the format of xxx-xxx-xxxx; mail should be the format of *@*.*. All these constraints are validated by Javascript and PHP.

Second, the table of User_score is used to store all information related to users' test scores. The schema of Users_score is as follows. The attributes denote username, score of Sign quiz, score of Markings quiz, score of Highway Control Signals quiz, score of Temporary Traffic Control quiz, times the user taken the Sign quiz, times the user taken the Making quiz, times the user taken Highway Control Signals quiz, times the user taken Temporary Traffic Control quiz and whether the user passes the quiz or not, respectively. Among them, the attribute of userid is

the primary key and is used to index the table. When one record is deleted from the relation of Users, the corresponding record in the relation User_score will also be deleted.

User_score(userid: string, score_sign: int, score_marking: int, score_highway: int, score_control: int, quiz_status: char, times_sign, times_marking, times_highway, times_control, quiz_status: string).

Coupon(codes: string);

In addition to the table of user and the table of user_score, the following four tables are used to save information related to questions. The attributes denote question number, correct answer, and score of each question, respectively. Among them, the attribute of qid is used to index the table and it must be unique.

Quiz_sign(qid: string, answer: string, score: int), qid is the primary key.

Quiz_marking(qid: string, answer: string, score: int), qid is the primary key.

Quiz_highway(qid: string, answer: string, score: int), qid is the primary key.

Quiz_control(qid: string, answer: string, score: int), qid is the primary key.

The PostgreSQL server was used as the database management system (DBMS) to implement the relational schema.

2) *Interface Development*

After formalizing the interface requirement, HTML forms were designed and developed. These forms include user registration, user training, user information, and quiz information. Hypertext Preprocessor (PHP) has gained popularity in developing on-line database applications since it accesses the database easily and can be embedded into HTML directly. PHP was designed from the ground up to be used for scripting web pages. As a result, it has lots of built-in facilities. The program developer may have to write or use some pre-written modules if Perl, Java or another language was used. PHP was used to implement all the forms to support the interaction of users and database servers. To check valid input and show messages in boxes or in new windows, Javascript was also utilized. Cascading Style Sheets (CSS) were used in the interface development since it was easier to make site-wide changes and less coding was needed on the web pages.

4.4 **Implementation details**

Once a user logs in and pays the fee, the username is recorded using PHP. This will keep track of each user's global variables on each page. In this way, unregistered users will not be able to access to the training contents. This also provides the knowledge of who is taking the quiz through tracking the variable of *username*. Implementation details are as follows

home.html:homepage.

Descriptions of implementation programming are included in the *home.html:homepage* and key items are briefly explained in the following sub-chapters.

4.4.1. Codes in the Folder of Register

login.html: Show the web page for information about the training system

admin_login.php: Show the web page for login (new user, return users and administrator)

build_table.php: Included in *admin_login.php* to build all needed tables

For new users:

register.php: Show the web page for registration

adduser.php: (access database) Support *register.php*, check and save all information into the database and print all the information in a new page

header.php: Included in *adduser.php* and contain the codes of header part for the page showing the information users entered.

payment.php: Show the web page for payment

check_coupon.php and *check_credit.php*: (access database) Support payment by checking information that is entered by users. If the information does not match with the corresponding record in the database, show the warning message on current page. Otherwise, go to the main menu page of training system.

payment_part.php and *payment_header.php*: Included in *check_coupon.php* to support the function of showing the warning message on current page.

For return users:

check_login.php: (access database) Support login of return users by checking the username and password. If the username and password match the information in the database, go to main menu page. Otherwise, the warning message is shown on current page.

admin_login_header.php and admin_login_part.php: Included in *check_login.php* to support the function of showing the warning information on current page.

get_pd.php: (access database) Support the function of finding password and require users to enter username and return the password through e-mail

get_userid.php: (access database) Support the function of finding username and require users to enter e-mail and return the username through e-mail

For the administrator:

check_admin.php: (access database) Support login of the administrator by checking the username and password. If the username and password match the information in the database, go to the main menu page. Otherwise, the warning message is shown on current page.

admin_login_admin_header.php and admin_login_admin_part.php: Included in *check_admin.php* to support the function of showing the warning message on current page.

Other codes:

Menu.php: Show the web page of the main menu for training contents. The training contents of each subject were presented in several web pages.

style.css and style1.css: Specify the style of web pages

logout.php: Logout and close the registered session

4.4.2. Codes in the Folder of Signs, Marking, Highway and Traffic Control

The folder of sign, marking, highway, and traffic control was designed to show corresponding training contents in the subjects of sign, marking, highway traffic signal, and temporary traffic control. The page number and links to previous page and next page were shown on each page when needed. When finishing one subject or quitting from it, users just click the "Quit" button to close the current window. All pictures of subjects were stored in the subfolder. Some of the program items are explained below.

head.php: Common beginning codes of almost all *.php (exception in head*.php)

footer.php: Common end codes of almost all *.php

sign.php: Show the web page of the content of the section of Signs.

markings.php: Show the web page of the content of the section of Markings

HighwaySignal.php: Show the web page of the content of the section of Highway Control Signals.

TrafficControl.php: Show the web page of the content of the section of Temporary Traffic Control.

i.php: Show the web page containing the training contents that is the same as the *i*th page of the slides.

4.4.3. Codes in the Folder of Quiz

Add_tuple_quiz.php: Add all tuples including the question number, answer and score to the table Quiz_sign, Quiz_marking, Quiz_highway and Quiz_control.

quiz_signs.php, *quiz_markings.php*, *quiz_highways.php*, *quiz_controls.php*: For each section quiz, a time limit (1.5 minutes/each question) was indicated on the screen. A timer is placed on screen to show the remaining time. Once the remaining time is 00:00, the results are automatically submitted. If the users finish all questions and there is still some time left, they need to submit the results manually. The “copy” of questions or “save as” of question pages are disabled.

save_signs.php, *save_markings.php*, *save_highways.php*, *save_controls.php*: Check each answer and show the results for each section.

Quiz_result.php: Show the final score for all quizzes.

If a user does not take any section quiz, a warning sign of “Sorry no quiz has been taken” will display on the screen. If a user has not completed all sections of quizzes a warning sign of “Additional quizzes need to be taken” will display. Otherwise, the results of the quizzes,

including the score of each section and number of times the user has taken each section quiz. If the user passes the quiz, a message of “Congratulations! You have passed the training” will be displayed on the screen. Otherwise, a message of “Sorry, Try again” will show up.

4.5 Test

A series of tests on the developed training program is conducted to check whether all functions work properly or not. The details of the tests are described as follows.

Test 1: Registration page

- a) Empty the field marked with “*”;

Result: Alert box with corresponding warning is shown.

- b) Wrong format of zip code, phone number and email;

Result: Alert box with corresponding warning is shown.

- c) After submitting the user information, go back to correct some wrong information;

Result: Original information is still kept for modifications. Revised information will be saved and printed on a new page for confirmation.

Test 2: Payment page

- a) Enter wrong coupon code;

Result: warning message is shown on current page.

- b) Correct the wrong coupon code;

Result: Go to the main menu page.

Test 3: Login page

a) Enter wrong username or password of return users;

Result: Warning message is shown on current page.

b) Enter wrong username and password of administrator;

Result: Warning message is shown on current page.

c) Enter correct username and password of return users;

Result: Go to main menu page.

d) Enter correct username and password of administrator;

Result: Go to main menu page.

e) Click “forgot the username?” button;

Result: New small window pops up and the user is required to enter the email address.

f) Wrong email address is entered;

Result: Warning message is shown in current window.

g) Correct email address is entered;

Result: The username is sent to the user via e-mail and a message is shown in the current small window indicating the successful operation.

h) Click “forgot the password?” button;

Result: New small window pops up and the user is required to enter the username.

i) Wrong username is entered;

Result: Warning message is shown in current window

j) Correct username is entered;

Result: The password is sent to the user via e-mail matched with the username and a message is shown in the current small window indicating the successful operation.

Test 4: Quiz

a. Take quiz more than one time;

Result: The number of times is shown correctly on the screen.

b. Over time limitation during the quiz;

Result: Closes the quiz page and submit the results automatically

c. Multi-users take quiz at the same time;

Result: The record in the database for each user is correct.

d. Users have not taken all quizzes;

Result: Show the warning message.

e. Answer every question correctly;

Result: Total score is 100 and show the message of "Congratulation! You pass it."

f. Answer all questions incorrectly;

Result: Total score is 0 and show the message of "Sorry. Try again."

CHAPTER 5 – CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Highway work zone safety has been a public concern for years and considerable research effort has been devoted to mitigate work zone traffic risks. In September 2004, the FHWA published updates to the work zone regulations at 23 CFR 630 Subpart J, which is referred to as the Work Zone Safety and Mobility Rule (Rule). The Rule applies to all State and local governments that receive Federal-aid highway funding. The State DOTs and local transportation agencies were required to comply with the provisions of the Rule by October 12, 2007. As a requirement, State DOTs and local agencies need to develop (1) an agency-level work zone safety and mobility policy, (2) agency-level procedures for work zone impacts assessment, training, the use of data, and process reviews, and (3) project-level procedures to address the work zone impacts of individual projects.

To respond to the requirements of FHWA, a research project sponsored by the Smart Work Zone Deployment Initiative was conducted to develop the WBT program for appropriate project personnel relating to work zones. The project personnel include states DOTs personnel, design consultants, and construction personnel. Training topics cover signs, markings, highway traffic signals, and temporary traffic control.

Because the work zone safety training covers diversified topics and trainees are located in different organizations, using the traditional training approach (gathering people in a central

location and training them) would be time consuming and not cost effective. The developed WBT program was built based on advanced computer science technologies and would be delivered via Internet. The use of the developed program provides several significant advantages. First, trainees are able to select a convenient time to receive required training via Internet at their offices or at home. Thus, it saves travel time and cost. Second, the developed program has quiz sections on each major training subject. As a result, the program constantly evaluates and records the training effectiveness and determines if additional training is needed or not. Third, the developed program can be easily updated when new knowledge is available. Thus, it can provide up-to-date training.

5.2 Recommendation

The developed WBT program can be improved in several ways for future research. First, the amount of quiz questions currently uploaded into the WBT program is limited. Hence, it is recommended to increase the number of questions and build a question bank. Questions in this bank could be randomly selected and distributed to each corresponding quiz section.

Implementing the random questioning will prevent future educational misconduct. The second recommendation is to enhance the graphical design within the developed WBT program.

Highlighting important terminologies and emphasizing important topics could potentially increase the readability and quality of the WBT program. Third, there is a need to develop interactive functions in the WBT program such as adding videos, music, and animation to magnify the interaction between the users and the program. Finally, an electronic signature system should be developed to prevent the identity fault and automatically identify those who have received training and those who have not.

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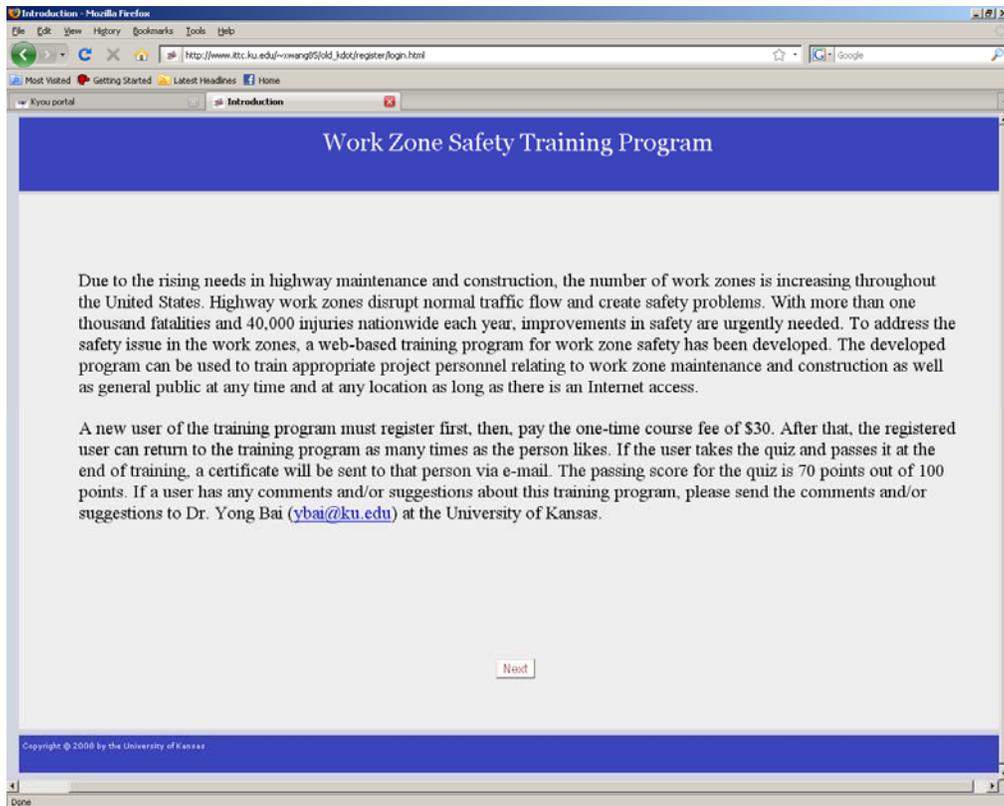
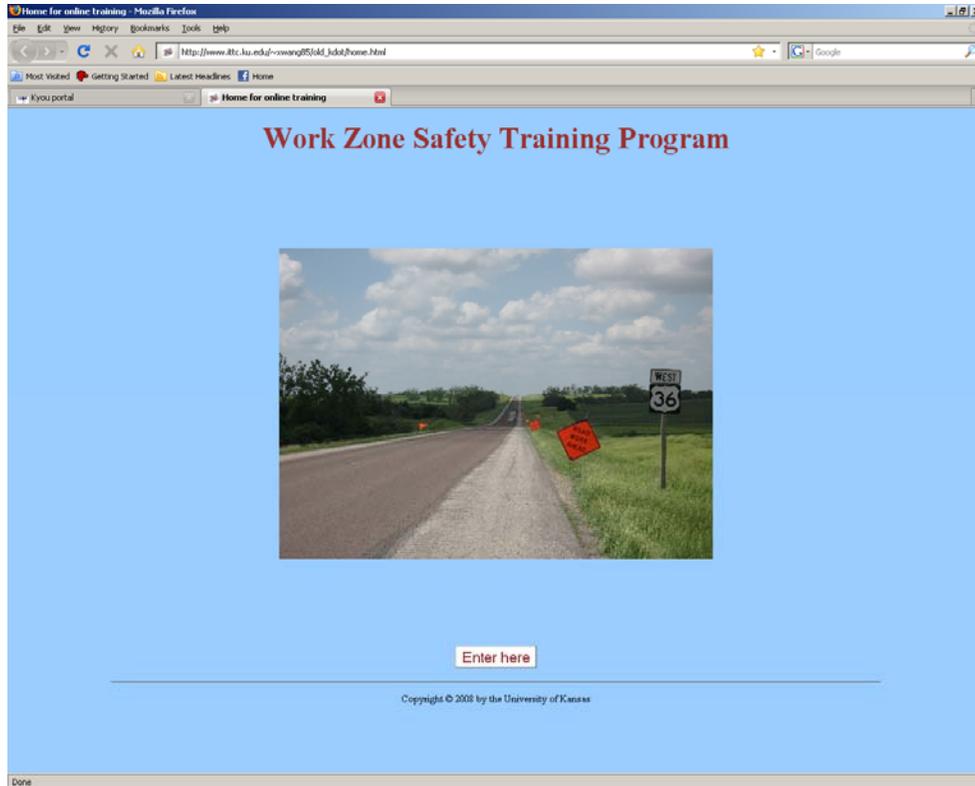
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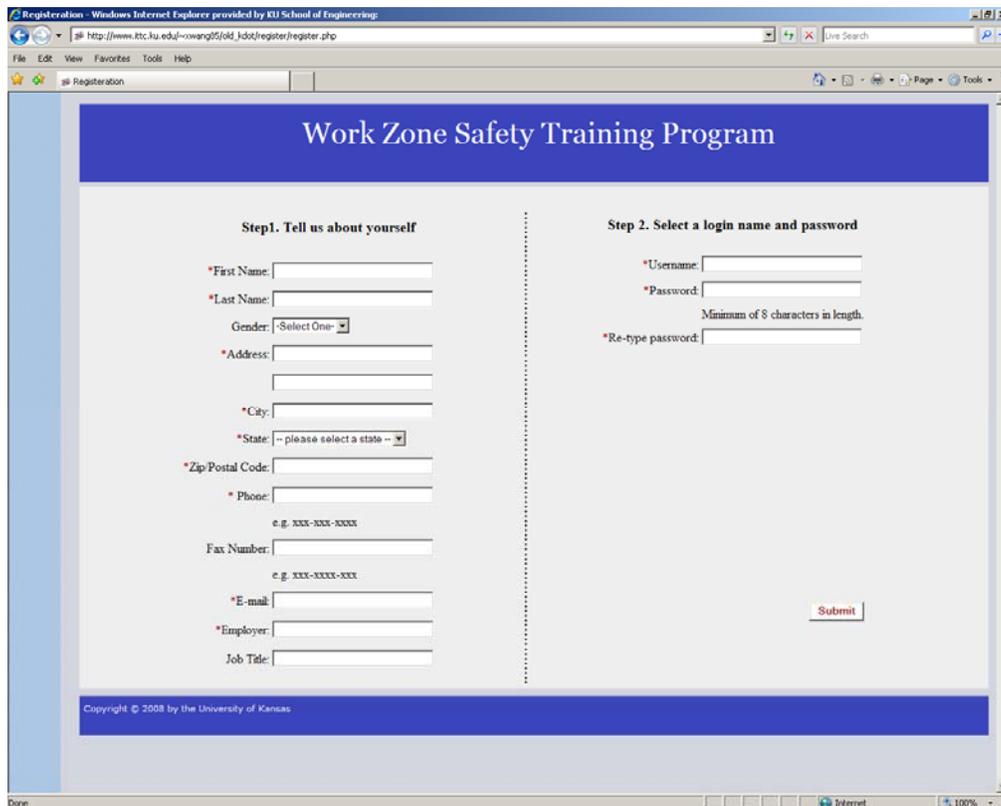
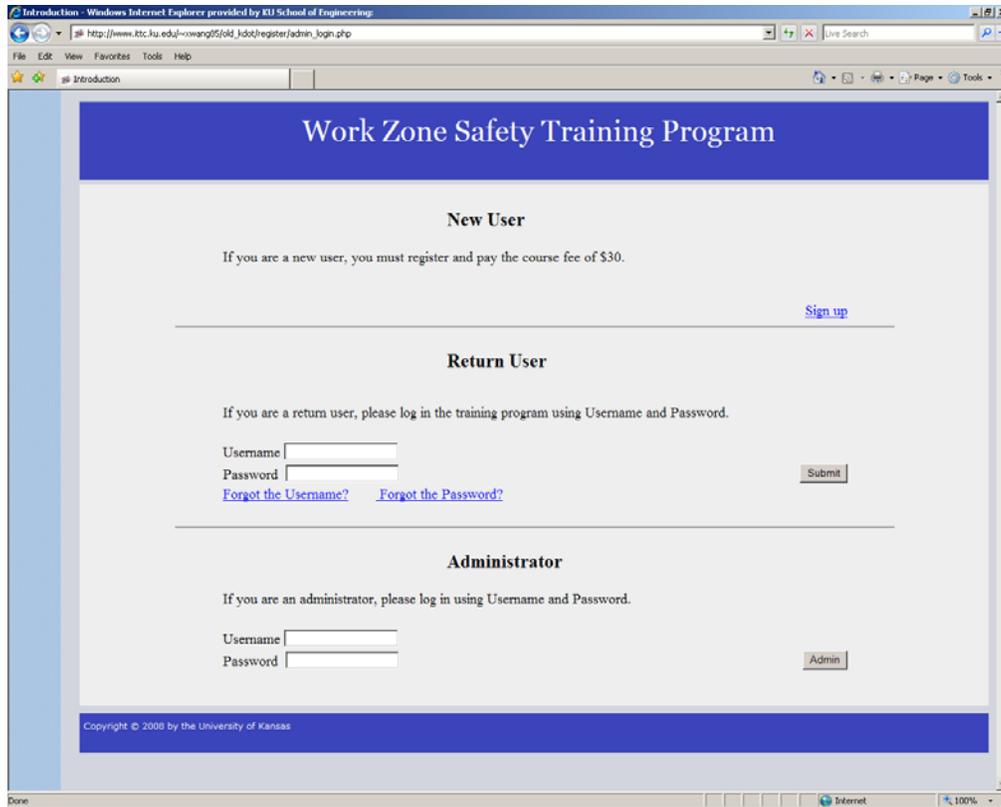
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Appendix A:

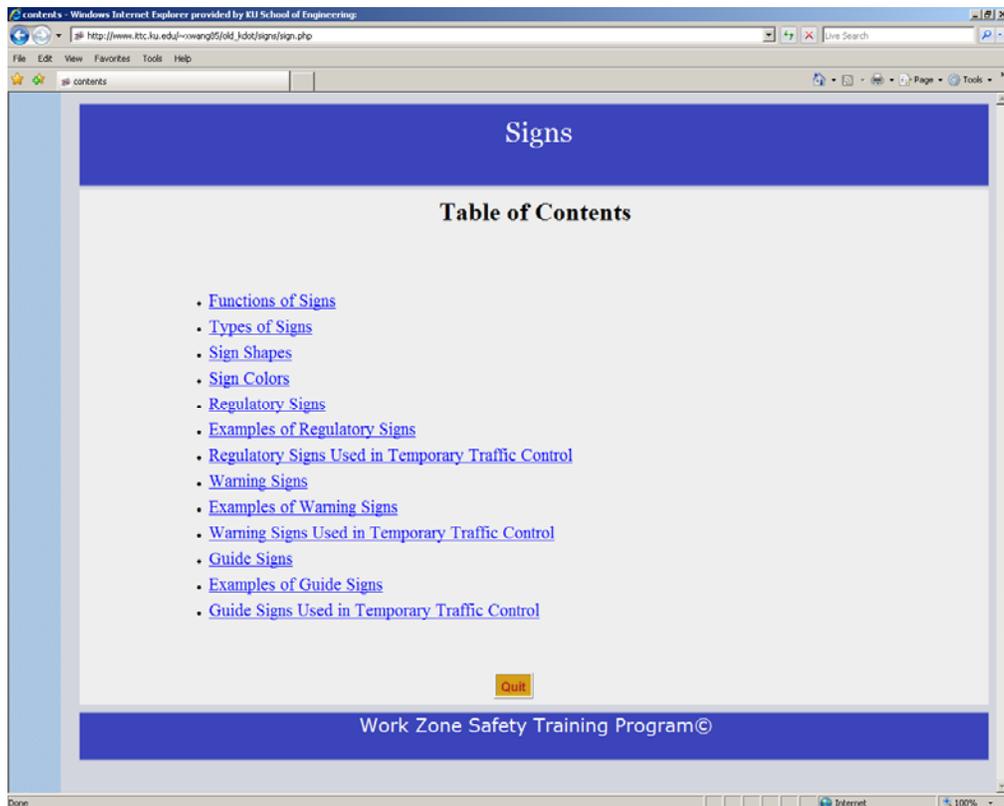
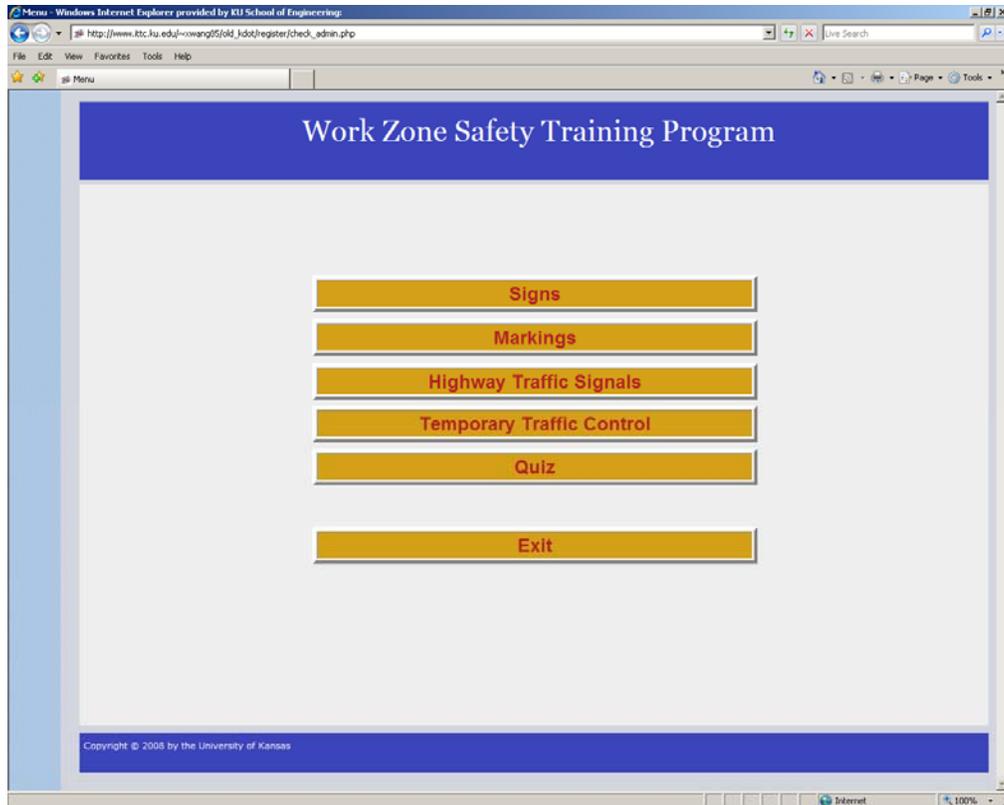
Web Site Layout of Registration segment

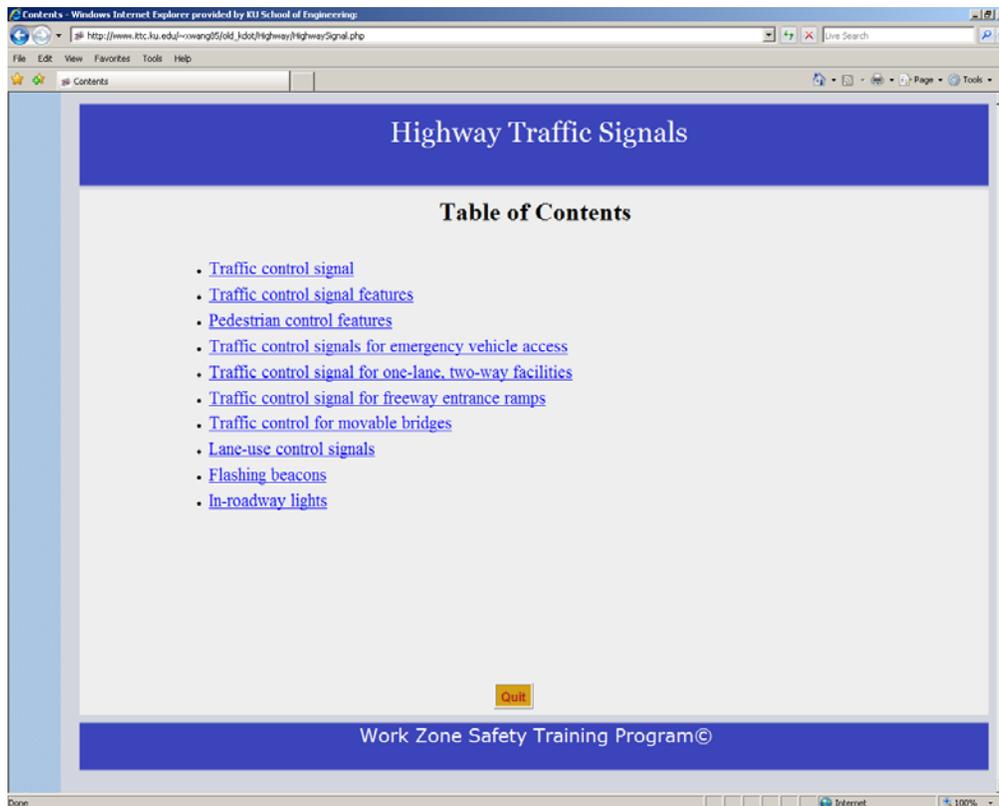
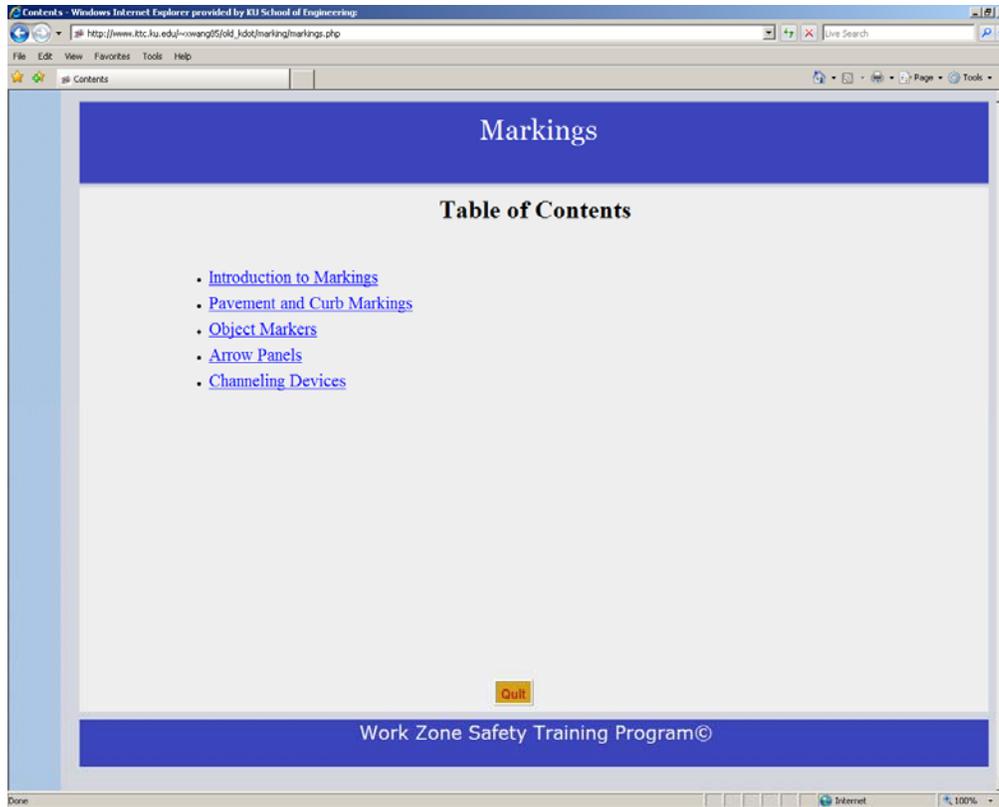


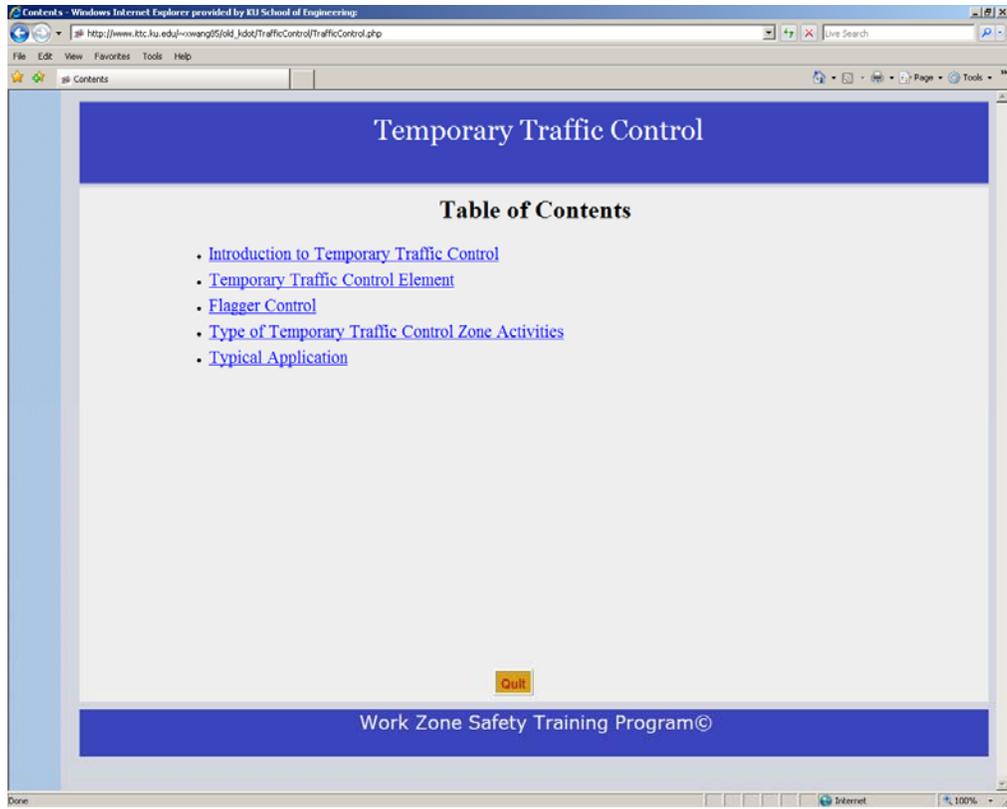


Appendix B:

Web Site Layout of Training modules







Appendix C:

Web Site Layout of Quiz module and Questions

Contents - Windows Internet Explorer provided by KU School of Engineering: Live Search

http://www.ittc.ku.edu/~xwang65/old_dot/Quiz/quiz.php

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Quiz

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- [Quiz for Markings](#)
- [Quiz for Highway Traffic Signals](#)
- [Quiz for Temporary traffic Control](#)
- [Final Score](#)

Work Zone Safety Training Program©

Done Internet 100%

Quiz #1 Signs

1) There are different types of Signs, but three types of signs that are discussed in this training program are?

- A) Regulatory Signs, Specific Service Signs, and Warning Signs
- B) Warning Signs, Guide Signs, and Specific Service Signs
- C) Guide Signs, Emergency Management Signs and Regulatory Signs
- D) Regulatory Signs, Warning Signs, and Guide Signs

2) What is the function of Regulatory signs?

- A) The function of regulatory signs is to give notice of traffic laws or regulations.
- B) The function of regulatory signs is to show route designations, directions, distances, services, points of interest, and other geographical, recreational, or cultural information.
- C) The function of Regulatory signs is to give notice of a situation that might not be readily apparent.
- D) None of these answers are right

3) Which is an example of Guide signs?

A)



C)



B)



D)



E) None of the above

4) Which is an example of Regulatory signs?

A)



C)



B)



D)



E) None of the above

5) Match the background colors with the corresponding type of sign.

___ Regulatory Signs

A) Black, Red, White

B) White, Yellow, Green

C) Yellow, Florescent yellow-green

___ Warning Signs

D) Black, Yellow

E) Green, Blue, Red, white, Brown

___ Guide Signs

- 6) Which warning signs are used in Temporary Traffic Control?
- A) Slow Traffic Ahead Signs, Flagger Signs, Road Work Signs
 - B) Road Work Signs, Stop Signs, center lane closed ahead Signs
 - C) Road work next XX km signs, End road Work signs, Pilot car Signs
 - D) Flagger signs, stop signs, one lane road signs
 - E) None of the above
- 7) Which Guide signs are used in Temporary Traffic Control?
- A) Slow Traffic Ahead Signs, Flagger Signs, Road Work Signs
 - B) Road Work Signs, Stop Signs, center lane closed ahead Signs
 - C) Road work next XX km signs, End road Work signs, Pilot car Signs
 - D) Flagger signs, stop signs, one lane road signs
 - E) None of the above
- 8) Which Regulatory signs are used in Temporary Traffic Control?
- A) Slow Traffic Ahead Signs, Flagger Signs, Road Work Signs
 - B) Road Work Signs, Stop Signs, center lane closed ahead Signs
 - C) Road work next XX km signs, End road Work signs, Pilot car Signs
 - D) Flagger signs, stop signs, one lane road signs
 - E) None of the above
- 9) Which are these are guide sign used in TTC?
- A) ROAD WORK NEXT XX km (MILES)
 - B) END ROAD WORK
 - C) Detour signs
 - D) All of the above
 - E) None of the above

10) What sign shall be mounted in a conspicuous position on the rear of a vehicle used for guiding one-way vehicular traffic through or around a TTC zone?

- A) Pilot car sign
- B) Yield sign
- C) Stop Sign
- D) Detour Sign
- E) None of the above

Quiz #2 Markings

- 1) What is the function of Markings?
 - A) To provide guidance and information for the road user
 - B) To provide protection for motor vehicles
 - C) To provide guidance and information for only pedestrian
 - D) None of above

- 2) What are the major types of markings?
 - A) Pavement and curb markings
 - B) Object markers and delineators
 - C) Colored pavements and barricades
 - D) Channelizing devices and islands
 - E) All the above

- 3) A double line indicates?
 - A) Maximum and special restriction
 - B) Minimum and special restriction
 - C) Minimum and maximum restriction
 - D) Special restriction and hazard restriction
 - E) None of the above

- 4) A solid line indicates?
 - A) Guidance
 - B) Warning
 - C) Discourage or prohibit crossing
 - D) Regulatory
 - E) None of the above

- 5) A broken line indicates?
- A) Guidance
 - B) Warning
 - C) Permissive Condition
 - D) Hazardous and toxic substances
 - E) None of the above
- 6) A dotted line provides?
- A) Regulatory
 - B) Guidance
 - C) Warning
 - D) Hazard
 - E) None of the above
- 7) Pavement and curb markings are commonly placed by using paints or thermoplastics; however, other suitable marking materials, including raised pavement markers and colored pavements, are also used. The materials used for markings should provide?
- A) The specified color throughout their useful life
 - B) Minimize tripping or loss of traction for pedestrians and bicyclists
 - C) Both A and B
 - D) None of the above
 - E) Maximize tripping or loss of traction
- 8) What is the function of channeling devices?
- A) To guide road user of condition created by work activities in or near the roadway.
 - B) To warn road users of conditions created by work activities in or near the roadway and to guide road users.
 - C) To regulate road users of conditions created by work activities in or near the roadway and to guide road users
 - D) None of the above
 - E) All of the above

9) Channeling devices includes?

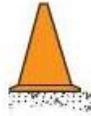
- A) Regulatory Signs, warning Signs, guide signs
- B) Stop signs, yield signs
- C) Cones, tubular markers, vertical panels, drums, barricades, and temporary raised islands
- D) A and C
- E) None of the above

10) Which of these figures is a cone that is used during day time and 35 mph speed road way?

A)



C)



B)



D)



E) None of the above

11) Which of these figures is a vertical plane?

A)



C)



B)



D)



E) None of the above

12) Which of these figures is a Drum?

A)



C)



B)



D)



E) None of the above

- 13) What are barricades?
- A) A portable or fixed device having from one to three rails with appropriate markings and is used to control road users by closing, restricting, or delineating all or a portion of the right-of-way.
 - B) A fixed device having four to six rails with appropriate markings and is used to regulate road users by flowing, restricting, or delineating all or a portion of the right-of-way.
 - C) A portable device having from three to ten rails with appropriate markings and is used to divert road users by flowing, restricting, or delineating all or a portion of the right-of-way.
 - D) None of the above
- 14) Which one represents an example of a barricades type?
- A) Type I
 - B) Type II
 - C) Type III
 - D) All of the above
 - E) None of the above
- 15) Edge line markings shall be placed on paved streets or highways with the following characteristics except:
- A) Freeways
 - B) Expressways
 - C) Rural arterials with a traveled way of 6.1 m (20 ft) or more in width and an ADT of 6,000 vehicles per day or greater.
 - D) Sidewalk
 - E) None of the above
- 16) Pavement markings shall be used to guide traffic away from fixed obstructions within a paved roadway.
- A) True
 - B) False

Quiz #3 Highway Traffic Signals

- 1) A special traffic control signal that assigns the right-of-way to an authorized emergency vehicle is called?
 - A) Flashing Beacon
 - B) Lane-use control signals
 - C) Vehicle traffic control signal
 - D) emergency-vehicle traffic control signal
 - E) None of the above

- 2) What are some examples of highway traffic signals except?
 - A) Warning signs
 - B) Ramp control signal
 - C) Lane use signal
 - D) Flashing beacons
 - E) None of the above

- 3) A special types of highway traffic signals installed in the roadway surface to warn road users that they are approaching a condition on or adjacent to the roadway that might not be readily apparent and might require the road users to slow down and/or come to a stop.
 - A) Warning signs
 - B) Flashing Beacon
 - C) In-Roadway Lights
 - D) Emergency-vehicle traffic control signal
 - E) None of the above

- 4) A highway traffic signal with one or more signal sections that operates in a flashing mode is called?
 - A) Warning signs
 - B) Flashing Beacon
 - C) In-Roadway Lights
 - D) Emergency-vehicle traffic control signal
 - E) None of the above

5) Traffic control signals, even when justified by traffic and roadway conditions, can be ill-designed, ineffectively placed, improperly operated, or poorly maintained. Improper or unjustified traffic control signals can result in one or more of the following disadvantages:

- A) Excessive delay
- B) Excessive disobedience of the signal indications
- C) Increased use of less adequate routes as road users attempt to avoid the traffic control signals
- D) Significant increases in the frequency of collisions (especially rear-end collisions)
- E) All of the above

6) Pavement markings that clearly communicate the operational plan of an intersection to road users do not play an important role in the effective operation of traffic control signals.

- A) True
- B) False

7) When a traffic control signal is not in operation, such as before it is placed in service, during seasonal shutdowns, or when it is not desirable to operate the traffic control signal, the signal faces shall be covered, turned, or taken down to clearly indicate that the traffic control signal is not in operation.

- A) True
- B) False

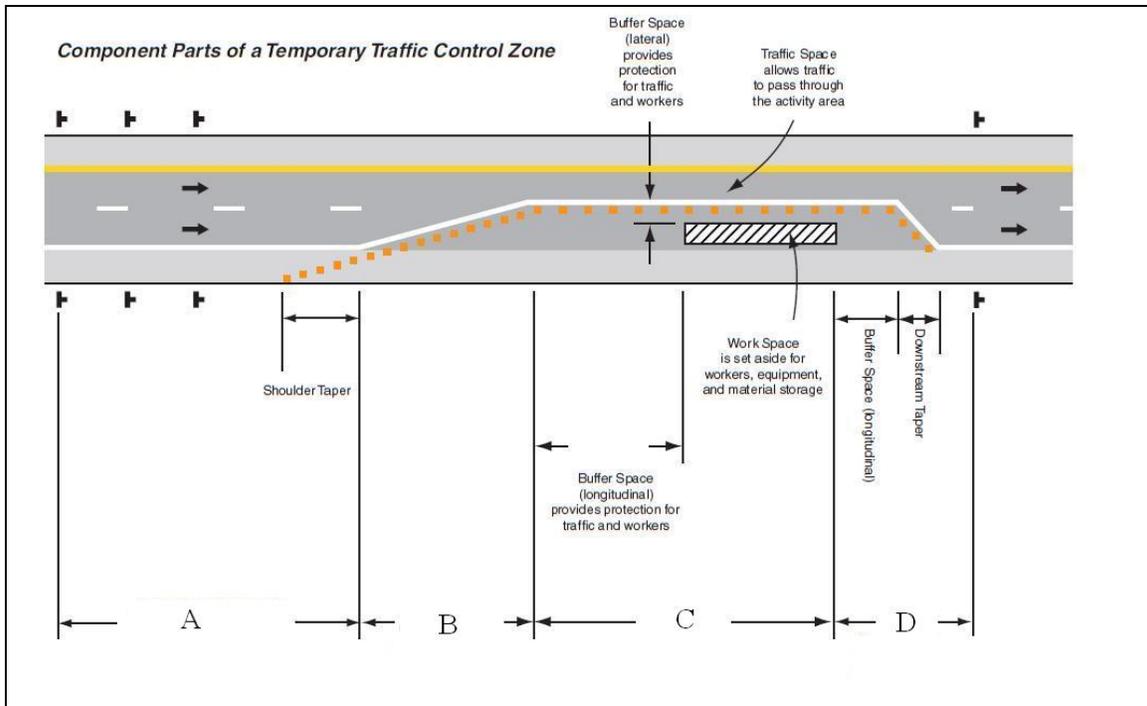
Quiz #4 Temporary Traffic Control

- 1) What is the primary function of TTC?
 - A) To provide income to the state
 - B) To provide the reasonably a fast movement in a work zone
 - C) To allow workers to finish their work
 - D) To provide efficient place to work
 - E) To provide for the reasonably safe and efficient movement of road users through or around TTC zones while reasonably protecting workers, responders to traffic incidents, and equipment.

- 2) What is a Work Zone?
 - A) It extends from the first warning sign or high-intensity rotating, flashing, oscillating, or strobe lights on a vehicle to the END ROAD WORK sign or the last TTC device
 - B) It a truck check point
 - C) An area of a building with no construction
 - D) An area of a highway with construction, maintenance, or utility work activities
 - E) A and D

- 3) What is an incident area?
 - A) An area of a highway where temporary traffic controls are imposed by authorized officials in response to a traffic incident, natural disaster, or special event
 - B) It extends from the first warning device (such as a sign, light, or cone) to the last TTC device or to a point where road users return to the original lane alignment and are clear of the incident
 - C) Beside an area of a highway with construction, maintenance, or utility work activities
 - D) A and B
 - E) None of the above

- 4) Match the component to its respected place?



- ___ The Activity Area
- ___ Advance Warning Area
- ___ The Termination Area
- ___ Transition Area

5) What is Detour and diversion?

- A) A detour is a temporary road onto an highway in order to slow down the work zone and A diversion is a temporary rerouting of road users onto a temporary highway or alignment placed around the work area.
- B) A detour is a temporary rerouting of road users onto an existing highway in order to avoid a TTC zone and A diversion is a temporary rerouting of road users onto a temporary highway or alignment placed around the work area.
- C) A detour is a highway in a TTC zone and A diversion is a temporary rerouting on a highway.
- D) None of the above

- 6) If traffic on the affected one-lane roadway is not visible from one end to the other, then _____, a _____ used or a traffic control signal should be used to control opposing traffic flows.
- A) Flagging procedure, pilot car with a flagger
 - B) Diversion, regulatory sign
 - C) Warning signs, guide sign
 - D) B & C
 - E) None of the above
- 7) The operation of the pilot vehicle should be coordinated with flagging operations or other controls at each end of the one-lane section. The pilot car should have the name of the contractor or contracting authority prominently displayed.
- A) True
 - B) False
- 8) The Stop sign shall be mounted at a conspicuous location on the rear of the vehicle.
- A) True
 - B) False
- 9) If the STOP or YIELD sign is installed for only one direction, then the STOP or YIELD sign should face road users who are driving on the opposite side of the roadway that is closed for the work activity area.
- A) True
 - B) False
- 10) A flaggers Job is not an important one.
- A) True
 - B) False

- 11) The performance of a flagger affects the safety of workers and those of the traveling public.
- A) True
 - B) False
- 12) If any driver refuses to follow the flagger's instructions what should the flagger do?
- A) Ignore the driver
 - B) Vehicle license number and description should be recorded and the circumstances reported to your supervisor.
 - C) Call 911
 - D) Argue with the driver
 - E) Convince the driver to follow instructions by approaching the driver's car in a nicely manner
 - F) None of the above
- 13) What is the function and responsibility of a flagger?
- A) Flaggers job is to talk to driver and inform the driver the condition of the road and weather.
 - B) Flaggers reduces the speed of incoming construction vehicle
 - C) Flaggers guide traffic vehicle through the highway
 - D) Flaggers job is to count traffic vehicles
 - E) Flaggers intermittently stop, reduce the speed of, and/ or guide traffic safely through a work area.
- 14) A flagger should constantly bear in mind that dealing with thousands of vehicles and drivers, there always exists the chance that an errant, unpredictable, inattentive or careless driver will appear and become a hazard. In those cases a flagger should give verbal warning of danger to fellow workers and the public when necessary and reasonable.
- A) True
 - B) False

- 15) Work on multi-lane (two or more lanes of moving motor vehicle traffic in one direction) highways is divide into?
- A) Right-lane closures
 - B) Left-lane closures
 - C) Interior-lane closures
 - D) Multiple-lane closures
 - E) Closures on five-lane roadways
 - F) All the above
- 16) The maximum length of activity area for one-way operation under TTC signal control is determined by the capacity required to handle the peak demand.
- A) True
 - B) False
- 17) Things to a flagger should do except?
- A) Be alert at all time. An alert flagger will more likely command the respect of motorists and will be more able to respond to emergency situations.
 - B) Remove, fold over, or turn away the flagger sign and other inappropriate signs, when flagging is no longer being performed.
 - C) Leave your station until properly replace except to avoid imminent danger.
 - D) Stand alone where you can be identified by the motorists.