MODULE 1: CRASH PREVENTION
LESSON 3: ROAD WEATHER INFORMATION SYSTEMS
GRADE LEVEL: 9 - 12

Weather conditions can have a major impact on transportation. In this lesson, students will learn how to use internet-based databases and identify how weather relates to traffic incidents. They will also be able to identify several ITS technologies that help to reduce weather-related incidents.

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Lesson 3 – Road Weather Information Systems

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Grade Level: 9-12	**Lesson in this Module:** 3 of 4
Time Required: 60 minutes	**Lesson Dependency:** None
Keywords: transportation engineering; intelligent transportation systems; road weather information systems; variable message sign; variable speed limit	

Related Curriculum

Subject Areas	Science; technology; engineering; mathematics
Curricular Units	Intelligent transportation systems
Activities	Crash analysis of weather-related crashes; research existing road weather information systems; optional prototype programming activity

Educational Standards

This lesson plan and its associated activities are correlated to the national standards in the each of the core discipline areas of STEM: Next Generation Science Standards, American Association for the Advancement of Science Standards, Standards for Technological Literacy, International Society for Technology in Education Standards, Common Core Mathematics Standards, and the National Council of Teachers of Mathematics Standards.

Pre-Requisite Knowledge

Lesson 1 and 2 of this Module.

Learning Objectives

- Students will be able to identify how weather relates to traffic crashes.
- Students will learn how to use internet-based databases.
- Students will be able to identify several ITS technologies that help to reduce weather-related crashes.

Introduction/Motivation

Weather conditions can have a major impact on transportation. It can affect the speed of traffic, a vehicle's performance (traction, stability, and maneuverability), how far a driver can see ahead, pavement friction and even cause damage to infrastructure, such as pavement, signs, signals, and bridges.

Lesson Background & Concepts for Teachers

An example of weather events that have significantly affected the safety and mobility of the roadway includes a snowstorm event in Georgia that made national news in 2014 when less than 3 inches of snow fell and created havoc on their main highways (Figure 1). More than 1,200 traffic accidents were reported in the state during the weather event and some travelers were stuck for up to thirty hours. (http://www.cbsnews.com/news/atlanta-other-parts-of-south-paralyzed-by-ice-snowstorm/)

Figure 1. Georgia snowstorm 2014. (Image courtesy of http://cbsnews1.cbsistatic.com/hub/i/r/2014/01/30/b2a3684a-dc2f-41ad-be04-50c0ea2bd7b3/thumbnail/620x350/4b8c1f32495701dd9a188b41a19fad8a/atlantatraffic02.jpg)

On average, there are over 5.8 million vehicle crashes each year and about 23% (nearly 1.3 million) of these crashes are weather-related. Clearly, weather has some large impacts on the safety of the roadways. (http://www.ops.fhwa.dot.gov/weather/q1_roadimpact.htm)

The National Highway Traffic Safety Administration (NHTSA), under the US Department of Transportation, was established by the Highway Safety Act of 1970. NHTSA has many responsibilities, which can be summed up simply as "helping with traffic safety" as its name implies. One system NHTSA maintains is the Fatality Analysis Reporting System (FARS). FARS is a nationwide census or database that contains information on all vehicle crashes in the United States that occur on a public roadway and involve a fatality (death).

In Activity 1, students will learn more about FARS by building a query which will help them understand the correlation between weather and crashes. In order to begin building a query, start with this FARS website link: http://www-fars.nhtsa.dot.gov//QueryTool/QuerySection/SelectYear.aspx.

1. Select a year to query and click the 'Submit' button.
2. For the student's activity, click on 'Option 1' and click the 'Submit' button. This will allow the students the opportunity to explore data specific to the crash such as date, time, location, first harmful event, light and atmospheric conditions.
3. Choose the data fields that are of interest, especially Atmospheric Condition. Other suggested fields are: Crash Related Factors; Number of Fatalities in Crash; Crash Hour; Light Condition; First Harmful Event; and Injury Severity.

Road Weather Information System (RWIS) is a term used to describe systems that monitor and collect data relating to weather information in order to help drivers and transportation managers make better decisions. There are many technologies available to help with the weather impacts on roads and safety. They can assist the general public in making good driving choices, as well as being useful to transportation managers in order to make decisions that help keep everyone safer, such as closing flooded roads, displaying advisory messages on signs, sending out more snow plows to clear snow-covered roads, or even adjusting the amount of de-icing chemicals according to the pavement temperature. Activity 2 will allow the students to explore the internet to see the variety of weather-related technologies that are available. The different types of technologies are discussed below.

Variable message sign
(Image courtesy of: en.wikipedia.org)

The first type of technology is "Surveillance, Monitoring, and Prediction" which is basically devices or systems that watch and try to predict the weather. An example is a sensor station that measures atmospheric, pavement, and/or water level conditions. Information that can be reported are things such as air temperature, humidity, wind speed/direction, rain or snow rates, pavement temperature, pavement freeze point, and road condition (such as wet, icy, flooded). These sensor stations can be fixed in one location or there are some that are able to be mobile and attached almost anywhere including a vehicle.

The second type is "Information Dissemination" technology, which involves how the weather-related information that is collected is broadcasted or spread to travelers. There are a number of different technologies that have been created to do this. One example that most State DOT's have is their statewide road condition web site. Through a site like this, travelers can see if a road is flooded, snow covered, or closed, for instance. Some states even have created an app for smartphones that display this information. Another is a 511 phone system, where people can call an automated system to hear weather or traffic alerts for roads in their area. Variable message signs along the roadway, as well as in-vehicle devices capable of displaying traveler information, are great examples of "Information Dissemination" technologies that can help keep drivers aware of weather-related impacts. If drivers are given accurate and timely information relating to weather and traffic alerts, they can make decisions such as slowing down or taking an alternate route, which helps in safety and crash prevention.

Variable Speed Limit Sign (image courtesy of: safety.fhwa.dot.gov)

The last type of weather-related technology is "Decision Support, Control and Treatment" which focuses on helping transportation managers make decisions to help keep the roadways operating safely. This can be systems that combine information such as traffic flow and topographic data with weather-related data and radar. This information can then be used to assist in decision-making in regards to traffic control and motorist warnings. For example, if there is dense fog in an area, there may be automated signs that display a dense fog advisory message, but managers can also choose to reduce speed limits with Variable Speed Limit signs. In a snow or ice event, signal timing can even be adjusted remotely to make the yellow phase on a traffic signal a bit longer to accommodate slower moving vehicles and the possibility they may not be able to stop as quickly.

In Activity 3, students will have the opportunity to program a simulated weather information device that can sense the temperature and lighting conditions in its environment. This activity helps highlight for students the importance of programming for automated RWIS. Further, the activity provides an opportunity for students to learn and feel confident about programming.

Vocabulary/Definitions

Vocabulary Word	Definition
Fatality Analysis Reporting System	A nationwide census or database that contains information on all vehicle crashes in the United States that occur on a public roadway and involve a fatality (death).
Query	To ask a question about something. In this lesson plan, we query a database by asking it to give us the number of fatal crashes that happened during certain weather conditions.
Road Weather Information System (RWIS)	Systems that monitor and collect data relating to weather information in order to help drivers and transportation managers make better decisions.
Surveillance, Monitoring, and Prediction System	Devices or systems that watch and try to predict the weather.
Information Dissemination System	Devices or systems that broadcast or send weather-related information to travelers.
Decision Support, Control and Treatment System	Devices or systems that help transportation managers make decisions to help keep the roadways operating safely.
Reverse-engineering	The scientific method of taking something apart in order to figure out how it works.
Variable message sign	Traffic control device whose message can be changed to provide motorists with information about traffic congestion, traffic crashes, maintenance operations, adverse weather conditions, roadway conditions, or other highway features; also referred to as changeable message sign (CMS) or dynamic message sign (DMS).
Variable speed limit	Variable speed limits are speed limits that change based on road, traffic, and weather conditions. Electronic signs slow down traffic ahead of congestion or bad weather to smooth out flow, diminish stop and go conditions and reduce crashes.

Associated Activities

- **Activity 1 – Evaluating Crash Data using the Fatality Analysis Reporting System (FARS)**
  http://www-fars.nhtsa.dot.gov/QueryTool/QuerySection/selectyear.aspx

    - Discussion: How does weather affect crashes? Predict whether there are more crashes when the weather is clear, rainy, sleet/hail, snow, fog/smog/smoke, severe crosswinds, blowing sand/soil/dirt, cloudy, or blowing snow. Rank your choices.

    - Include this in the background section and as a hand out (describe step-by-step for middle school students). Include suggestions to help students understand and interpret the data.

- **Activity 2 – Research Weather-related Driver Information**

    - Students will use the internet to search current weather-related intelligent transportation systems. The following list of searches should yield reasonable results:

        - Weather driver information systems

        - Wet-weather variable speed limits

        - Weather intelligent transportation system

        - Road conditions weather

        - Road weather information system

        - Clarus weather system

        - Maintenance Decision Support System (MDSS)

    - Summarize your findings and post the results to Edmodo. Include a list of weather-related transportation technologies in your geographic region. Read posts from other geographic areas, how are the technologies similar or different from your geographic area?

- **Optional Activity 3 – Program a mock weather information system**

    - Using the provided Arduino system, follow the lab instructions to program the LCD screen to display weather-specific information based on the input from the system's temperature sensor.

Lesson Closure

- The weather is a variable we cannot change; however, how we respond to the weather when driving can enhance our safety and efficiency. What are variables that we *can* change to be safer and more efficient drivers in response to adverse weather?
    - Which weather events had the largest influence on crashes?
    - Were there any risky weather scenarios that you surprised to learn about?

- Intelligent transportation systems are one way that transportation engineers are working to make travel safer and more efficient. What other weather-related technologies do you anticipate we will need in the future to travel safely?

Attachments

- PowerPoint Slides for a demonstration on how to use the FARS Database
- Word document to record predictions and findings during the FARS activity
- PowerPoint Slides to introduce programming an Arduino
- Lab instructions for how to program a prototype weather information system
- Word document with a teacher's resource for the programming lab

Extensions/Multimedia

- NHTSA - http://www.nhtsa.gov/About+NHTSA/Who+We+Are+and+What+We+Do
- Utilize Edmodo (www.edmodo.com) to provide further questioning and discussion between students and teacher. Edmodo is safe social learning website made specifically for teachers and students. It is a way to collaborate on assignments, homework, projects, and after-school STEM programs and is used as a communication tool to provide additional questioning and feedback from teachers and students.
- TripCheck - https://tripcheck.com/Pages/RCMap.asp?curRegion=0 TripCheck is a one-stop shop for information on travelling in Oregon, with the latest conditions via road cameras, continuous winter travel updates, year-round highway construction details, and other valuable tips.
- Contact your local traffic management center and arrange a field trip.
- Connected Vehicles and Weather – The Vehicle Data Translator http://www.its.dot.gov/presentations/roadweather/pdf/Chapman%20-%20VDT.pdf
- SparkFun Introduction to Arduino & Programming: http://create.coloradovirtuallibrary.org/sites/default/files/Curriculum/SparkFun/Beginner/IntrotoArduino.ppt
- Comic Introduction to Arduino: http://playground.arduino.cc/uploads/Main/arduino_comic_v0004.pdf
- Arduino programming notebook: http://playground.arduino.cc/uploads/Main/arduino_notebook_v1-1.pdf
- Teachers can go to the following website to learn how to implement the "hour of code" into your curriculum: http://hourofcode.com/us/resources/how-to
- Students can go to the following website for examples coding activities geared toward a middle and high school level: http://code.org/learn