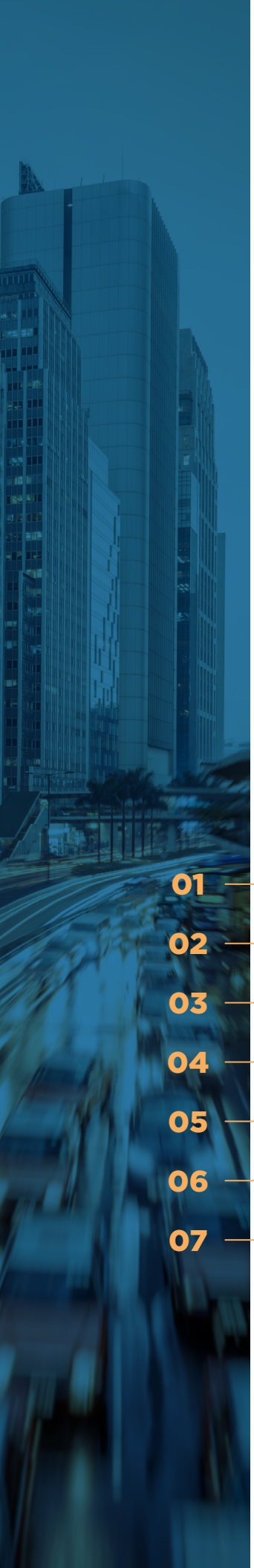


Hummingbird

Connecting North Texas Communities with Emerging Transportation Technologies

# AV2.1 EMERGING TRANSPORTATION TECHNOLOGIES

## K-12 Lesson Plans*



www.connectNTxFutures.org

*These lesson plans are primarily designed for high school students but can be easily adapted for younger age groups.

**February 2022**

01

# Preparing for Emerging Transportation Technologies

## OVERVIEW

Students will learn about emerging transportation technologies and brainstorm what the North Central Texas region needs to do to prepare for the technologies.

## ENGAGE

Start with a word cloud activity (on Mentimeter, Kahoot, Slido, etc.) in which students answer the following question: "When you hear the phrase 'today' s transportation' what comes to mind?" . Some additional probing questions should be asked to keep students on track:

- What modes of transportation do we currently use?
- What are some features of these modes?
- What are some good things associated with today' s transportation?
- What are some challenges associated with today' s transportation?

Segue: "Both transportation challenges AND opportunities have arrived in North Texas. And that' s what we will be focusing on today."

Show the project mission video **(Emerging Transportation Technologies are Heading to North Texas)**

## EXPLORE

Segue: "You are being tasked with helping our region prepare for emerging transportation technologies. What are your initial thoughts?" <allow students to respond> "Our first step is to learn more about these technologies. In the video, it was mentioned that some of these technologies are already in the region. Do you know of any?" <allow students to respond> "Let' s take a look at some."

Show examples of emerging transportation technologies (see the **Examples of Emerging Transportation Technologies in North Texas** video).

Facilitate a gallery walk for students to explore the technologies in more detail.

- If in-person: print **infographics** and place them around the room
- If virtual: share **infographics** virtually, as a link to a PDF or slideshow

## EXPLAIN

Present the slides which zone in on automated, connected, electric, and shared (ACES) vehicle technologies **(Presentation slides)**.

Explain the mission **(presentation slides)**.

**Areas of preparation**

**Research and brainstorming**

**Team formation**

**Presentation of guidance to the Transportation Commission**
(teacher, classmates, and other guests)

### Areas of preparation

Present slides to share example categories/areas of preparation (use the collaborative space in the **presentation slides** to jot down notes when students share their ideas of other areas).

- Infrastructure
- Policies
- Behavior
- Insurance
- Workforce preparation
- Other

## ELABORATE

### Team Formation

Organize students into teams **(presentation slides)**

### Research and Brainstorming

Team members work together to determine what needs to be done to prepare for the technologies, organized into the areas above

- Allow students to use the Internet to research, but also encourage them to be creative.

## EVALUATE

### Presentation of Guidance

Have teams present their guidance to the Transportation Commission (teacher, classmates, and other guests).

- Allow students to choose the format that they will use to present. Encourage them to choose the format early on in their planning time.

## EXTEND

Have students imagine what the future will look like with emerging transportation technologies.

Share examples (images, art, renderings, prototypes, etc.).

Provide options for students to "show" what they think the future of transportation will look like (example options: skit with a script, writing prompt, drawing - by hand or computer-aided, poem or song)

## RESOURCES

- **Mission video**
- **Emerging technology examples video**
- **Infographics**
- **Presentation slides**

02

# English - Same Message, Different Audience

## ENGAGE

Give all students the same message: e.g., "Connected and Automated Vehicle, or C/AV, technologies allow self-driving cars to communicate with each other and their environment." Randomly assign the students an audience (see example list below). Have the students share how they would communicate the message to their audiences.

- Your friend
- Your grandparents
- Your teacher
- Grocery store cashier
- Your parents
- Bus driver

## EXPLORE

Have students view different forms of communication from the **NCTCOG Transportation Department.**

- **Press Release**
- **Reports**
- **Social Media Posts**

- How do the forms of communication differ? Who is the audience for each form of communication?

## EXPLAIN

As a class, watch a video and/or read an article on writing for your audience.

- Video: **"Writing with your audience in mind"**
- Article: **"Stop sending the right message to the wrong person"** (Filip Sardi)

## ELABORATE

Have students choose three different audiences (including format) to summarize a part of their "guidance" from the earlier activity.
*Students can research different types of audiences or choose from their personal network.

## EVALUATE

Have students exchange work with a classmate and read each other's writings. Students will "guess" the intended audience for each writing and provide feedback to their classmates.

# 03 Social Studies - A Review of Transportation Policy

## ENGAGE

Watch a video on the history of transportation.

- Video: **An Aminated History of Transportation** (The Atlantic)

## EXPLORE

Discuss the need for laws and policies to maintain a safe and organized transportation system (i.e., Why do we need transportation policy and laws?).

## EXPLAIN

Explain what policy is.

» **Definition (Merriam-Webster)**

- **1a:** prudence or wisdom in the management of affairs
- **1b:** management or procedure based primarily on material interest
- **2a:** a definite course or method of action selected from among alternatives and in light of given conditions to guide and determine present and future decisions
- **2b:** a high-level overall plan embracing the general goals and acceptable procedures, especially of a governmental body

» Video: **"What is policy?" (Carleton University)**

## ELABORATE

Walk through an example of transportation-related policy as a class.

## EVALUATE

Break students into groups to review and summarize **Texas S.B. No. 2205** (relating to automated motor vehicles).

# 04 Math - Avoid the Crash!

## ENGAGE

Show a car coming braking in the path of a stopped car (e.g., show a part of a video such as this **gif**; do not show the car crashing).

Pose the question: Will the driver stop in time?

» Allow students to share their thoughts, guesses, etc.

## EXPLORE

Students may say that "it depends" or that they "need more information."

- Ask probing questions
  - "In the absence of other video footage, what information do we need to answer this question?"
  - "What factors impact how quickly a person can bring a car to a stop so that they do not hit an object in front of them?"

- Have students answer the questions. Here are some example answers: speed, distance, deceleration reaction time, roadway condition (dry, wet, icy, etc.), visibility, attention/distraction (e.g., texting while driving, eating)

## EXPLAIN

Build on the students' answers. Explain that stopping distance can be influenced by many factors:

| | |
|---|---|
| **Perception time** | Time that goes by from when your eyes see a hazard to when your brain recognizes it |
| **Reaction time** | Time from when a driver recognizes a hazard to when the driver takes actions to avoid the hazard |
| **Speed** | Distance traveled per unit of time |
| **Braking distance** | The distance that a car travels before coming to a complete stop when the brakes are applied in a vehicle moving at a specified speed |
| **Roadway conditions** | Characteristics of the roadway which can influence friction, the resistance that one object experiences when moving over another object |
| **Other factors** | Weather, driver condition, car condition |

The stopping distance formula includes:

Perception-Reaction Distance + Braking Distance

The distance that the car travels while the driver is perceiving and reacting to the hazard

Braking distance (defined above) can be calculated as

$$\frac{v^2_0 - v^2_f}{2\mu g}$$

$v^2_0$ = initial speed, prior to braking

$v^2_f$ = final speed (when coming to a complete stop, this is equal to zero)

$\mu$ = coefficient of friction

$g$ = gravitational acceleration

The driver was initially traveling at 75 feet per second. When the driver recognized the stopped car in front of them, they were 300 ft away from it. Will the driver safely stop in time to avoid hitting the stopped car?

- Assume a perception-reaction time of 1.5 seconds
- Assume a coefficient of friction of 0.8 (common for dry asphalt)
- Assume a gravitational acceleration rate of 15 ft/s$^2$ (average rate for which a driver can safely decelerate a car on a dry street surface, without anticipated probability of losing control of the vehicle)

SEE SOLUTION

To make this problem more challenging, have students:

- Convert from miles per hour to feet per seconds (i.e., provide the time in mph)
- Derive the formula for braking distance
- Research different roadway conditions (e.g., different coefficients of friction)
- Model different roadway users (e.g., average perception and reaction times will differ for groups of people depending on several factors)

## ELABORATE

Do a think-pair-share.

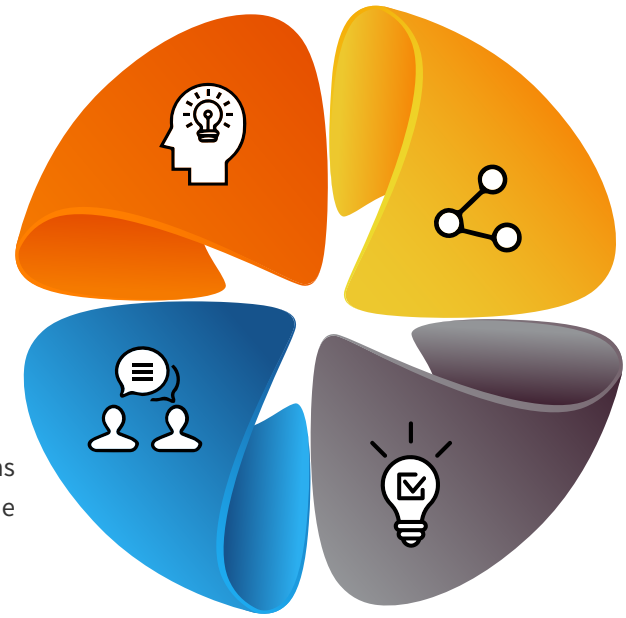
**"Consider the same problem but for an automated vehicle. What factors change? Would the fully automated car be able to come to a complete stop before hitting the stopped car?"**

### Think

Have students individually think about the assumptions regarding which factors and values may change.

### Pair

Have pairs of students discuss their assumptions with each other and come up with an answer to the question.



### Share

Once students have a chance to determine their answers (with proof/written explanation), have them share their answers with the class.

### Synthesize and go over the answer as a class

The main factors that will change are the perception and reaction times. If we assume a perception-reaction time of 0.5 seconds and keep all other values the same, then the automated car WILL stop before hitting the stopped car. You can consider playing a video of a similar situation with an automated vehicle (see **video** of Tesla via DailyMail).

## EVALUATE

Exit Ticket: A driver reacts to a big tree branch laying across the road when they are about 270 feet away from the branch. What speed was the driver traveling if they came to a complete stop just before hitting the branch? Assume a coefficient of friction of 0.8 and a deceleration rate of 15 ft/s$^2$.

**Hint 1: Find the missing value for the initial speed.**

**Hint 2: Perception-reaction time does not pertain to this problem.**

SEE SOLUTION

05

# Science - Pavement Markings and the Science of Retroreflectivity

**An extension of TTI's lesson plan**

## ENGAGE

Place a piece of duct tape and a piece of retroreflective tape, parallel to each other, on black posterboard. Show students the two different types of tape. Ask them what they notice about the two different types of tape.

## EXPLORE

Shine a light on each piece of tape (do this with the lights on as well as with the lights off) and ask students to share their observations.

## EXPLAIN

Explain what retroreflectivity is. "The term retroreflective refers to a surface, material, or device (retroreflector) that reflects radiation, such as light, back to its source."

» Watch video on retroreflectors **"Retroreflectors..." (Technology Connections).**

## ELABORATE

Have students learn about 3M's Retroreflective Technology (see the **webpage** and **report**). Afterward, provide students with duct tape, glass beads, glue, and a glue applicator (popsicle stick, paintbrush, etc.). Their task is to transform their duct tape into retroreflective tape using the materials provided.

## EVALUATE

Exit ticket - Have students write a paragraph in which they explain "retroreflectivity" and why it may be useful for the safe application of automated vehicle technology on roadways.

| | |
|---|---|
| ***Materials needed for this activity:** | **black backboard, duct tape, retroreflective tape (preferably the same color as the duct tape), glue, glass beads, flashlight** |

06

# First Lego League (WeDo 2.0 Software) - Blind Spot Monitoring

## ENGAGE

Have one student stand with a mirror slightly to their right side. Have another student stand behind them on their right and then get into a spot where the person in front cannot see them. "_____ is in ____' s blind spot."

## EXPLORE

How can we use motion sensing to detect people in our blind spots? On the WeDo 2.0 software, go to Classroom Projects >> Model Library >> 14. Motion. Select a motion detection activity for the students to complete.

## EXPLAIN

In driving, a blind spot is "any area immediately surrounding your vehicle that cannot directly be observed by you, the driver, within your normal field of vision" **(source)**. Newer cars are becoming safer by using "blind spot detection." This is one of the building blocks of automated vehicles. There are three primary types of sensors in automated vehicles: radar sensors, Lidar (Light Detection and Ranging) sensors, and camera sensors.

## ELABORATE

Show a video on blind-spot monitoring **(Toyota How-To: Blind Spot Monitor with Rear Cross Traffic Alert).** On the WeDo 2.0 software, go to Classroom Projects >> Model Library >> 2. Drive. Select a "2. Drive" activity for the students to complete.

## EVALUATE

Have students create their own WeDo 2.0 Lego models that combine driving and motion detection to replicate blind-spot monitoring for cars.

07

# Other Transportation-Related Lesson Plans

### Let's Move: Identifying Modes of Transportation

Education.com

**Age/Grade:** Preschool

**https://www.education.com/lesson-plan/lets-move/**

### K-12 Teacher Resources

Texas A&M Transportation Institute

**Age/Grade:** Grades 4-6

**https://safed.tti.tamu.edu/k-12-teacher-resources/**

### Lesson Plans

Northeast Transportation Workforce Center

**Age/Grade:** Grades 6-12

**http://netwc.net/lesson-plans/**

### Science Technology Engineering and Math (STEM) Resources

Institute of Transportation Engineers

**Age/Grade:** All

**https://www.ite.org/technical-resources/councils/transportation-education-council/science-technology-engineering-and-math-stem-resources/**