LET'S GO!

INTRODUCTION

As the birthplace of the automobile, the United States has historically prioritized cars as the primary mode of transit. Americans use cars for 85 percent of their daily trips, and 30 percent of those trips are less than one mile in length.[1] While other high-income countries have reduced their reliance on cars, the United States remains an outlier. Some of this discrepancy can be explained by unique features of the U.S. as a developed country, such as the relatively high proportion of rural residents.

Places with dense populations, like cities, are natural conduits for transportation systems like bus and rail. But transit systems in cities across the United States are often underdeveloped and inefficient, especially in comparison to the network of roads and highways. In many areas, underdeveloped transit has become a self-fulfilling prophecy, where the barriers to create a functioning transit system are so large that they become deprioritized.

Transportation is the largest source of CO_2 emissions in the United States, and travel in light density vehicles (cars) creates more emissions than any other type of transit.[2] As the world seeks to keep global temperature increase limited to 1.5 degrees Celsius, the United States will have to critically reassess its urban transit strategies.

MATERIALS

- Student Worksheets 1 – 4
- Personal computers/tablets

PROCEDURE

1. Read or display the following excerpt from an EPA press release to your students:

   The U.S. Department of Transportation's Federal Highway Administration (FHWA) released new data today showing total U.S. driving in 2018 surged to a record-setting 3.225 trillion vehicle-miles traveled (VMT)... The 3.225 trillion miles driven in 2018 represents an increase of 12.2 billion miles over the previous year.[3]

2. Ask students to consider some reasons why this total has increased. *(Answers may include population growth (resulting in more drivers on the road), a decrease in gas prices, and greater availability of inexpensive cars.)*

330 MILLION IN THE USA

CONCEPT
Transportation infrastructure in many U.S. metropolitan areas does not match the needs of its residents or best environmental practices, especially in areas where the population is steadily growing.

OBJECTIVES
Students will be able to:

- Use an online mapping tool to calculate transit times between various locations.
- Interpret small-scale data and extrapolate meaning for large populations.
- Compare and contrast the benefits and drawbacks of different types of transit for both people and the environment.

SUBJECTS
Social Studies, Geography (General and AP), Mathematics, Science, Environmental Science (General and AP)

SKILLS
Analyzing data, critical thinking, researching, interpreting and analyzing maps, decision making, comparing and evaluating

METHOD
Students use interactive mapping to strategize urban transit and determine the most convenient ways for people to get around a city, and then use emissions data to extrapolate the impact of thousands of individual travel choices.

3. Distribute one of the four Student Worksheets to each student so that there is an even mix of Worksheets in the class. Students will need access to the Internet. Give students time to individually complete their Worksheet.

    a. Students are assigned one of four cities (Detroit, Austin, Washington, D.C., or Portland) and a starting location.
    b. Students use Google Maps to find the time and distance for traveling to four attractions in their city by car and public transit.
    c. They will then decide which mode of transportation they would prefer for each destination.

4. Instruct students to form groups of four so that each group has all Student Worksheets represented. Allow them time to compare sizes and densities of each city and their transit options. What similarities and differences do they notice?

5. Display this map from the New York Times (might require you to register a free account).

    Find each metropolitan area covered on the Worksheets. Ask students the following questions:

    a. Have total emissions gone up and down?
    b. What about per capita emissions?
    c. What's the difference between the two?
    d. Why might those two metrics be different?

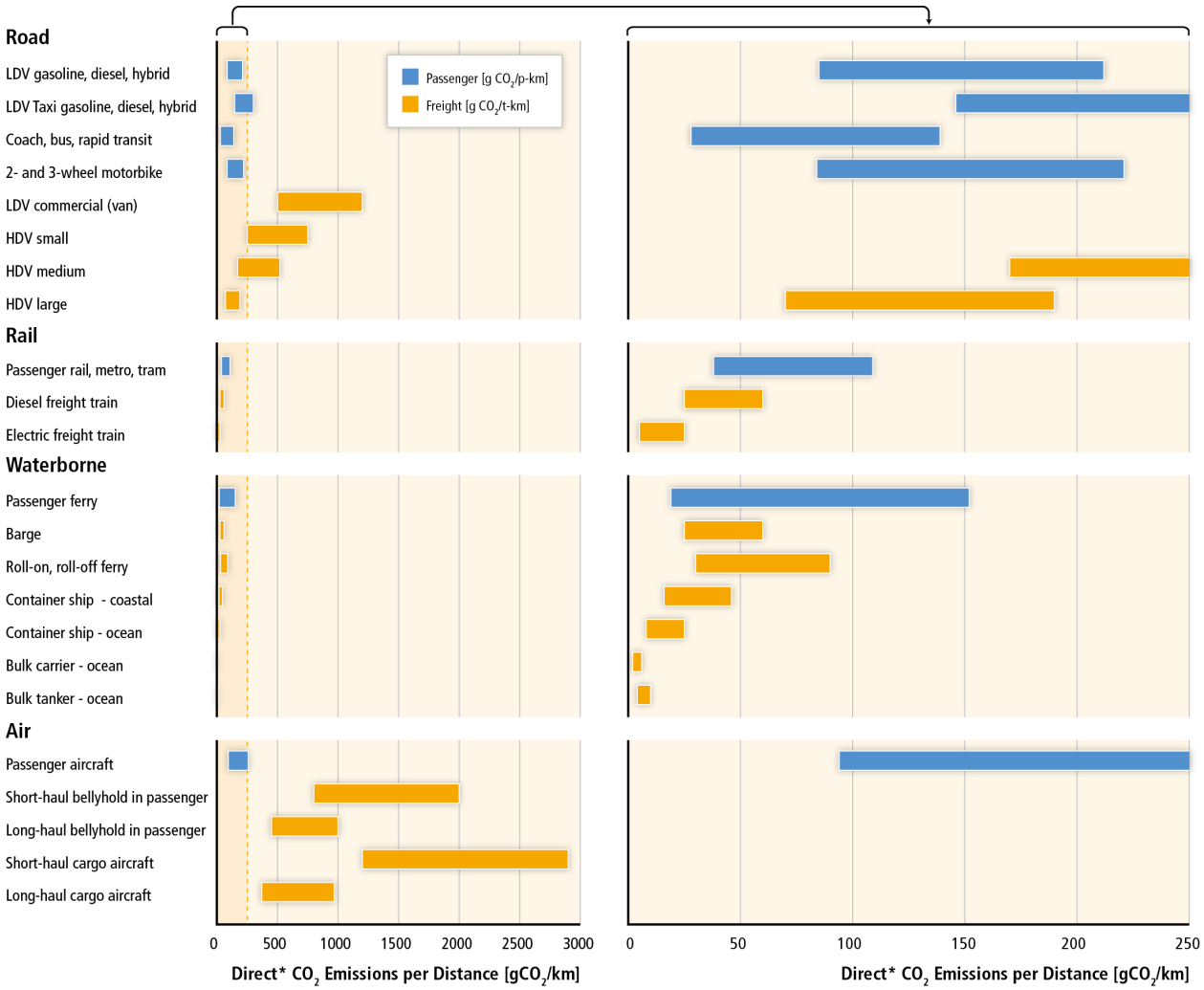
6. Display the IPCC graph on the next page showing the emissions ranges for different types of transportation. Point out the rows for "Non-taxi LDVs" (light duty vehicle – most personal cars), "Coach, bus, rapid transport," and "Passenger rail, metro, tram."

7. Have students calculate the amount of CO_2 that would be emitted by both transportation options (car and public transit) for their four locations. The amount of emissions should be recorded in the "Graph Calculations" column of their Student Worksheet.

    - Because Google Maps doesn't include mileage for public transit, students should use the driving distance (from the second column of their chart, currently in miles) to calculate both the car emissions and public transit emissions.
    - Students will need to convert miles to kilometers in order to do the calculations and should calculate both ends of the range.
    - Example: If the distance to a student's destination is 5.3 miles, students would find the emissions for car travel by doing the following:

        - Convert to kilometers: 5.3 mi x 1.61 mi/km = 8.53 km
        - Use the LDV row to find the low end of emissions: 8.53 km x 80 gCO_2/km = 682 gCO_2
        - Use the LDV row to find the high end of emissions: 8.53 km x 210 gCO_2/km = 1,791 gCO_2

    NOTE: Typically, the distance from one place to another is different depending on how you get there. For example, a bus route may be less direct than driving in your own car or a metro route may be much more direct. Even so, by using the car distance to calculate CO_2 emissions for both transport modes, students will see the difference in emissions between various modes of transportation.



*The ranges only give an indication of direct vehicle fuel emissions. They exclude indirect emissions arising from vehicle manufacture, infrastructure, etc. included in life-cycle analyses except from electricity used for rail.

8. Have students refer to their original transportation choice, circled on their Worksheet. Use the populations listed on each Worksheet and find the ranges of CO_2 equivalents if every person living in each of the four cities made these same choices.

DISCUSSION QUESTIONS

1. Are there any forms of transportation that don't create any emissions?

   Answers may include: walking, cycling, or scootering which create no additional greenhouse gas emissions in the process of transit.

2. What types of emissions are not accounted for when we estimate the emissions from transit?

   Statistics about emissions from transit don't include any of the emissions from the manufacture of various forms of transit – digging the subway tunnels, building the buses, etc. While greenhouse gas emissions from manufacturing are significant, they are dwarfed by the amount of emissions from transportation itself.

3. What factors affected your choices in transportation in the first part of the activity?

   Answers may include: the total time taken, amount of walking, transfers, or need to find parking.

4. After calculating the carbon footprint for both car and public transit routes, did you change your mind about what was a preferable route? Why or why not?

   Answers will vary. Some students will change their minds to use public transit because of the lower average CO_2 emissions, but other students will still prefer to travel by car. Students may want to switch some routes where the disparity in travel time between car and transit is not too large, and still travel by car in other routes.

5. What choices do you think the residents of each metropolitan area should use for their transportation?

   Answers will vary. Students may say that people should try to use public transit when they can and only use cars when absolutely necessary. Others will say that people should be aware of the carbon footprint of their choices but still make the choices that are most convenient for them. Students' opinions may also differ depending on which city they covered on their Worksheet and how versatile the transit options are in that city.

6. Will the time or distance traveled for each type of transportation always be exactly the same?

   Most transportation routes are unlikely to always be exactly the same. Depending on the time of the day, streets may be more congested, adding extra transit time for buses and cars. Trains may have modified schedules at night or on the weekend, or may be unavailable entirely. Weather events like rain and snow can significantly slow traffic as well.

7. Students used the miles found from the car route to calculate emissions for both types of transportation, as Google does not provide mileage estimates for public transit. What are some reasons why the actual mileage might differ?

   Buses often take more circuitous routes than a person driving in a car, as buses serve a larger population of people who have multiple stops. Trains and subways may have either longer or shorter distances than a car route might. These transit stops may not directly go to a student's final location, but they can also circumvent streets and buildings more easily to take a direct route.

ASSESSMENT

Students write a letter home to a friend or family member explaining their experience traveling around their new city, including pros and cons of the different transportation options.

FOLLOW-UP ACTIVITY

Have students pick one of the metropolitan areas explored during the class activity and research transit issues affecting the city. Instruct them to write a short assessment of these issues and the steps that the city is taking to address them. Do you agree with what the city is choosing to do, or would you address it in a different way? If the city is not addressing the issues, what could they do to alleviate the problem?

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[1] Buehler, Ralph (February 4, 2014). 9 Reasons the U.S. Ended Up So Much More Car-Dependent Than Europe. Bloomberg News. Retrieved from https://www.citylab.com/transportation/2014/02/9-reasons-us-ended-so-much-more-car-dependent-europe/8226/

[2] U.S. Environmental Protection Agency. Sources of Greenhouse Gas Emissions. Retrieved from https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

[3] U.S. Department of Transportation, Federal Highway Administration. (March 21, 2019). Strong Economy Has Americans Driving More Than Ever Before. Retrieved from https://www.fhwa.dot.gov/pressroom/fhwa1905.cfm

LET'S GO!

STUDENT WORKSHEET 1: DETROIT

Name: _____ Date: _____

Congratulations! You're starting your freshman year at **Wayne State University in Detroit, Michigan**, where **672,662** people live in the city and **4,317,179** people live in the metropolitan area. You'll be living with a roommate in Leon H. Atchison Hall. After taking some time to settle in, you've decided it's time to get out and see some of the sights that Detroit has to offer. You've found four places you'd like to visit around the city, and plan on taking separate trips from your residence hall to visit each one.

Since you're still learning the layout of the city, you've decided to use Google Maps (www.google.com/maps) to help plan your itinerary. Use the address for your residence hall and the addresses of locations around the city to decide whether or not you're going to use **public transit** or **a car** to get to each of your destinations. Mark the time taken and the total distance traveled, along with any other notes that you'd like to make about the planned route. Once you've compared each option, **circle** your preference for transit or car.

Notes about Detroit
As the home of the automobile, Detroit offers abundant parking throughout its downtown area. However, almost all of this parking is commercially run, with rates averaging $5 an hour or $20 a day. Most parking is in low density surface parking lots. Public transportation in Detroit is operated by the Detroit Department of Transportation (DDOT) and consists of 40 core bus routes, a few of which run 24 hours a day. Costs range from $2 for a 4-hour bus pass to $70 for a month pass.

Starting Location: Leon H. Atchison Hall, 5110 Anthony Wayne Drive, Detroit, MI 48202

Locations	Best car route	Best transit route	Graph Calculations
Belle Isle Park *A large park on an island in the Detroit River, known for its aquarium and hiking trails.* 99 Pleasure Dr Detroit, MI 48207	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	
Motown Historical Museum *The original recording studio of Motown Records and now a museum dedicated to its history.* 2648 W Grand Blvd Detroit, MI 48208	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	
Guardian Building *A landmark Detroit skyscraper and a famous example of the "Art Deco" style of architecture.* 500 Griswold St Detroit, MI 48226	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	
Comerica Park *Sports arena home to the NFL's Detroit Lions and hosts many concerts and events.* 2000 Brush St Detroit, MI 48226	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	

LET'S GO!

STUDENT WORKSHEET 2: AUSTIN

Name: _____ Date: _____

Congratulations! You're starting your freshman year at the **University of Texas, Austin** in **Austin, Texas**, where **964,254** people live in the city and **2,168,000** people live in the metropolitan area. You'll be living with a roommate in **Jester East Residence Hall**. After taking some time to settle in, you've decided it's time to get out and see some of the sights that Austin has to offer. You've found four places you'd like to visit around the city, and plan on taking separate trips from your residence hall to visit each one.

Since you're still learning the layout of the city, you've decided to use Google Maps (www.google.com/maps) to help plan your itinerary. Use the address for your residence hall and the addresses of locations around the city to decide whether or not you're going to use **public transit** or **a car** to get to each of your destinations. Mark the time taken and the total distance traveled, along with any other notes that you'd like to make about the planned route. Once you've compared each option, **circle** your preference for transit or car.

Notes about Austin
Austin is known for its sprawling, spacious footprint. Most of downtown Austin's streets include metered street parking, which costs $2 an hour. Parking in private garages can be reserved all day or night for between $10 to $15 Public transportation in Austin is in the middle of a rapid expansion. Capital Metro operates 14 frequent bus routes throughout the city, with single passes starting at $1.25 and day passes from $2.50.

Starting Location: Jester East Residence Hall (JSM), 201 East 21st Street, Austin, TX 78705

Locations	Best car route	Best transit route	Graph Calculations
Umlauf Sculpture Garden & Museum *A museum and outdoor sculpture garden featuring the works of American sculptor Charles Umlauf.* 605 Azie Morton Rd Austin, TX 78704	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	
Congress Avenue Bridge *A bridge spanning the Colorado river where over a million bats can be seen flying at dusk.* Congress Ave Austin, TX 78704	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	
Texas Capitol *The home of the Texas state legislature and Governor's offices.* 1100 Congress Ave Austin, TX 78701	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	
Franklin Barbecue *A famous lunch spot for Austin barbecue.* 900 E 11th St Austin, TX 78702	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	

LET'S GO!

STUDENT WORKSHEET 3: WASHINGTON, D.C.

Name: _____ Date: _____

Congratulations! You're starting your freshman year at **Howard University** in **Washington, D.C.**, where **705,749** people live in the city and **6,240,000** people live in the metropolitan area. You'll be living with a roommate in George W. Cook Hall. After taking some time to settle in, you've decided it's time to get out and see some of the sights that D.C. has to offer. You've found four places you'd like to visit around the city, and plan on taking separate trips from your residence hall out to visit each one.

Since you're still learning the layout of the city, you've decided to use Google Maps (www.google.com/maps) to help plan your itinerary. Use the address for your residence hall and the addresses of locations around the city to decide whether or not you're going to use **public transit** or **a car** to get to each of your destinations. Mark the time taken and the total distance traveled, along with any other notes that you'd like to make about the planned route. Once you've compared each option, **circle** your preference for transit or car.

Notes about Washington, D.C.
Washington's downtown area is densely constructed, and parking can be hard to come by. Most lots cost between $15 and $20 for an all-day pass. Street parking is quite rare. Public transportation is operated by the Washington Metropolitan Transit Authority (WMATA), whose Metrorail consists of six lines and 91 stations through the Washington metro area. WMATA also operates 269 bus routes. Costs start at $2 for a single rail or bus trip.

Starting Location: George W. Cook Hall, 601 Fairmont Street NW, Washington, DC 20001

Locations	Best car route	Best transit route	Graph Calculations
Eastern Market *A public market hosted in a historic building with vendors selling food and crafts.* 225 7th St SE Washington, DC 20003	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	
United States Capitol *The home of the U.S. Congress.* First St SE Washington, DC 20004	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	
Smithsonian National Zoological Park *One of the oldest zoos in the U.S., focused on education and conservation.* 3001 Connecticut Ave NW Washington, DC 20008	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	
Nationals Park *Sports arena home to the World Series-winning Washington Nationals.* 1500 S Capitol St SE Washington, DC 20003	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	

LET'S GO!

STUDENT WORKSHEET 4: PORTLAND

Name: _____ Date: _____

Congratulations! You're starting your freshman year at **Portland State University** in **Portland, Oregon** where **653,115** people live in the city and **4,236,400** people live in the metropolitan area. You'll be living with a roommate in **Broadway Residence Hall**. After taking some time to settle in, you've decided it's time to get out and see some of the sights that Portland has to offer. You've found four places you'd like to visit around the city, and plan on taking separate trips from your residence hall out to visit each one.

Since you're still learning the layout of the city, you've decided to use Google Maps (www.google.com/maps) to help plan your itinerary. Use the address for your residence hall and the addresses of locations around the city to decide whether or not you're going to use **public transit** or **a car** to get to each of your destinations. Mark the time taken and the total distance traveled, along with any other notes that you'd like to make about the planned route. Once you've compared each option, **circle** your preference for transit or car.

Notes about Portland
The city of Portland operates five different parking districts, which together contain over 14,000 metered parking spaces. Parking is free on Sundays until 1pm, and otherwise costs between $1.60 and $3.50 an hour or a $5 flat rate on weekends. Private parking structures offer additional spots for higher costs. TriMet operates Portland's public transit, with 85 bus routes and 145 light rail cars on five lines. Public transportation costs $2.50 for a 4-hour bus and rail pass, with rides free after spending $5 in a single day.

Starting Location: Broadway Residence Hall, 625 SW Jackson Street, Portland, OR 97201

Locations	Best car route	Best transit route	Graph Calculations
Portland Saturday Market *An outdoor arts and crafts market operated year-round.* 2 SW Naito Pkwy Portland, OR 97204	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	
International Rose Test Garden *A rose garden with over ten thousand flowers and 650 species.* 400 SW Kingston Ave Portland, OR 97205	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	
Voodoo Doughnut - Old Town *A famous donut shop known for its inventive pastries.* 22 SW 3rd Ave Portland, OR 97204	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	
Powell's City of Books *The world's largest bookstore, occupying an entire city block.* 1005 W Burnside St Portland, OR 97209	**Time:** **Distance (in miles):** **Notes:**	**Time:** **Notes:**	