ALTERNATIVE FORMS OF TRANSPORTATION: THE BICYCLE

INTRODUCTION

This lesson explores the role bicycles play in students' lives. Students will compare and contrast their personal experiences with bicycles with those of typical Americans and Europeans. This lesson plan will give students experience working in groups as they assess the positive and negative aspects of a bicycle-centered infrastructure. Students will use the knowledge they gain to propose ways for bicycles to be incorporated into their communities. By the end of the lesson, students will understand and be able to explain why support for bicycles and the bicycle economy vary throughout the world.

LESSON OVERVIEW

Grade Level & Subject: Grades 5 – 8 Social Studies, Economics

Length: 1 – 2 Class Periods

Objectives:
After completing this lesson, students will be able to:
- Conceptualize the role of the major forms of transportation in their own town
- Examine the pros and cons of the different types of transportation available in cities
- Understand the positives and negatives of building the bicycle infrastructure.
- Comprehend the health, environmental and other effects of incorporating biking into their personal lifestyles

National Standards Addressed: [1]

This lesson addresses the following **National Standards for Civics and Government** from the **Center for Civic Education**.
- **Content Standard: NSS-C.5-8.5 ROLES OF THE CITIZEN**
  What are the Roles of the Citizen in American Democracy?
    - What are the responsibilities of citizens?
    - How can citizens take part in civic life?
- **Content Standard: NSS-C.5-8.3 PRINCIPLES OF DEMOCRACY**
  How Does the Government Established by the Constitution Embody the Purposes, Values, and Principles of American Democracy?

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[1] http://www.education-world.com/standards/

- How does the American political system provide for choice and opportunities for participation?

This lesson addresses the following **Index of Standards** from **The National Council on Economic Education**.

- **Content Standard: NSS-EC.5-8.4 ROLE OF INCENTIVES**

  At the completion of Grade 8, students will know the Grade 4 benchmark for this standard, and also understand:
  - Responses to incentives are predictable because people usually pursue their self-interest
  - Changes in incentives cause people to change their behavior in predictable ways.
  - Incentives can be monetary or non-monetary.

This lesson addresses the following Math Standards and Expectations from The National Council of Teachers of Mathematics:[2]

- **Content Standard: CONNECTIONS**

  Instructional programs from prekindergarten through grade 12 should enable all students to:
  - Recognize and apply mathematics in contexts outside of mathematics.

Materials Needed:
- **Reproducible#1 – How Do You Travel?**
- **Reproducible #2 – Sample Transportation Sheet**
- Internet to access articles
- Printer to print Reproducibles
- Chalkboard/whiteboard

Assessment:

Students will be assessed through the following activities:
- Classroom participation
- 400 – 500 word response that includes the pros and cons of initiating a bike sharing program in students' town and the pros and cons of initiating a traffic calming program in the town
- Group work contribution when thinking about the potential infrastructure of their town
- Class participation in responding to Warm-Up and Wrap-Up questions
- Correct completion of extension experiment and analysis comparing each student's present transportation methods to transportation purely by bicycle

LESSON BACKGROUND

Relevant Vocabulary:
- **Alternative Transportation:** modes of travel other than private cars, such as walking, bicycling, rollerblading, carpooling and transit.[3]

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[2] National Council of Teachers of Mathematics, http://www.nctm.org/

[3] "NRDC: Glossary of Environmental Terms." *NRDC: Natural Resources Defense Council - The Earth's Best Defense.* Retrieved 15 March 2011 from http://www.nrdc.org/reference/glossary/a.asp.

- **Calorie:** A unit of energy- producing potential supplied by food and released upon oxidation by the body, equal to the amount of energy required to raise the temperature of 1 kilogram of water by 1 degree C at one atmosphere pressure[4]
- **Fossil Fuels:** A hydrocarbon deposit, such as petroleum, coal, or natural gas, derived from the accumulated remains of ancient plants and animals and used as fuel. Carbon dioxide and other greenhouse gases generated by burning fossil fuels are considered to be one of the principal causes of global warming[5]
- **Public Transportation:** Any form of transportation that charge set fares, run fixed routes, and are available to the public such as buses, subways, ferries, and trains[6]

Background Information:

Karl Drais invented bicycles in 1817, calling them the "laufmaschine" or "running machine" in German. According to an article published in the *Washington Post* entitled *The History of the Bicycle*, because most people of this era traveled on foot or by horse, the bicycle was a revolutionary invention. The transition to bicycle use was not an easy one; most people were not accustomed to balancing in the manner required by this new technology. However, this form of transport caught on quickly and in 1819 the first bicycle shop opened in the United States. Bikes became extremely popular by 1900.[7] However, after Karl Benz's invention of the automobile in 1885/86[8], the bicycle began to be overshadowed by a machine that could go faster and hold more people.

Many believe that bicycles are one of the most efficient machines ever created. The average speed of a person speed walking is 3 miles per hour[9], while the average speed of riding a bicycle on urban streets is 10-15 miles per hour, which is three to five times faster. A car goes an average of 20 miles per hour in urban areas while a bus goes 13 miles per hour. Driving uses 1,860 **calories** to travel one mile while walking burns 100. Biking only uses 35 calories. 80% of the calories burned by a car are absorbed by the car's engine and by road friction, only 20% of the calories that the car uses are actually used to propel the car forward, and a mere 2.5% of the calories used in a car are used to move the driver. 14 bikes fit into one car parking space, and eight bikes fit into one road space that a car fits into. 20% of the world's citizens have the money to buy a car while 85% of the world's population has the money to buy a bicycle. Motor transportation contributes more to air pollution in

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[4] "Calorie Entry." *The American Heritage® Stedman's Medical Dictionary.* Retrieved April 05, 2011 from http://dictionary.reference.com/browse/calorie.

[5] "Fossil Fuels Entry." *The American Heritage® Science Dictionary.* Retrieved April 05, 2011 from http://dictionary.reference.com/browse/fossil fuels.

[6] "Public Transportation Entry." *Dictionary.com's 21st Century Lexicon.* Retrieved April 05, 2011 from http://dictionary.reference.com/browse/public transportation.

[7] "The History of the Bicycle Entry." *The Washington Post: National, World & D.C. Area News and Headlines - Washingtonpost.com.* Retrieved March 29, 2011 from http://www.washingtonpost.com/wp-dyn/content/article/2010/09/14/AR2010091406212.html.

[8] "Who Invented the Automobile? (Everyday Mysteries: Fun Science Facts from the Library of Congress)." *Library of Congress Home.* Retrieved March 29, 2011 from http://www.loc.gov/rr/scitech/mysteries/auto.html.

[9] "Can a Modest Amount of Mild Exercise - Just Walking - Reduce the Risk of Heart Attack?" *The Healthful Life Project.* Retrieved April 5, 2011 from http://njms2.umdnj.edu/hwmedweb/archives/exercise2_archive.htm.

the United States than any other contributor.[10]

Riding a bike is about five times as efficient as walking in terms of energy use. Three miles on a bike requires 100 calories; this same amount of energy would only take a car 280 feet. Bicycles don't require **fossil fuels** to power them like most forms of transportation do. Many people consider bikes as a useful tool for exercising and for recreational activities, but it is important to consider bicycling as an **alternative form of transportation** to work, school, or other locations travelled to on a daily basis.[11] On a world scale, there are 1.4 billion bikes compared to 400 million cars.[12]

Resources:

"The National Bicycling and Walking Study: 15–Year Status Report." Pedestrian and Bicycle Information Center, May 2010. Retrieved 29 March 2011 from http://katana.hsrc.unc.edu/cms/downloads/15-year_report.pdf.

"The Bicycle Revolution - Highway History - FHWA." *Home | Federal Highway Administration*. N.p., n.d. Retrieved 29 March 2011 from http://www.fhwa.dot.gov/infrastructure/bicycle.cfm.

"Parisians Show Their Va Va Voom as City Rolls out 'freedom' Bike Scheme - Times Online." *The Times | UK News, World News and Opinion*. N.p., n.d. Retrieved 29 March 2011 from http://www.timesonline.co.uk/tol/news/world/europe/article2224917.ece.

LESSON STEPS

Warm-up: *How do people travel in your town?*

1. Either draw the graph from **Reproducible #1 – How Do You Travel?** on the board, or show it as a transparency on the overhead.
2. Survey the class and record the appropriate number of tallies on the table.
3. Ask the students if they believe that this survey is representative of all students in their town. Why or why not? *Answers will vary but for example: the class might have a large population of kids who ride bicycles while, in fact, most people in town drive cars, etc.*
4. Ask students if their class's figures can be representative of how the typical American town uses transportation to get to school. Why or why not? *Ex: Is their town urban which makes walking/biking/public transit more popular? Is their town rural or suburban, which often leaves driving as the only feasible transportation option?*
5. Ask students if they could easily switch from using one form of transportation to another? What would be the easiest switch? What would be the impacts of this switch? *Example: Switching from a parent driving to school to taking the bus. It would give their parents more free time, would*

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[10] "BikeFacts." *Michigan State University*. Retrieved April 5, 2011 from https://www.msu.edu/~corcora5/velo/bikefacts.html.
[11] "Science of Cycling: Human Power." *Exploratorium: the Museum of Science, Art and Human Perception*. Retrieved March 29, 2011 from http://www.exploratorium.edu/cycling/humanpower1.html.
[12] "Bikes for the World ." *America - Engaging the World.*. Retrieved March 29, 2011 from http://www.america.gov/bikes.html.

be a longer commute to school for them, would be more gas efficient and reduce fossil fuel emissions.

Activity One: *Bike Sharing and Traffic Calming*

1. Access, print out and pass out copies to students of The New York Times-"European Support for Bicycles Promotes Sharing of the Wheels"[13] and Bicyclinginfo.org-"Traffic Calming"[14]

2. Instruct the students to read the articles. Then, ask them to write a 250 – 500 word response on the pros and cons of initiating a bike sharing program in their town and the pros and cons of initiating a traffic calming program in their town. If the town already has either of these, have the students write about the benefits and problems of the programs. Encourage students to use the information from the articles as a resource.

3. Assign the students to groups of four, and have them work together, using the articles and their responses, to propose an idea for their town's infrastructure to provide for bicycles as a more feasible form of transportation. Instruct them to address the following questions:

    - Do you think it's possible to shift your town to a more bicycle-friendly place? If it already is bicycle friendly, what aspects of your town make it a good place for bicycle transportation?

    - What, specifically, would you do to alter the infrastructure of your town? Would you cut car lanes and replace them with bicycle lanes? Would you reduce the number of car lanes and increase the number of bike lanes? Would you add bike lanes in addition to the present quantity of car lanes? Would you keep everything as it is?

    - Would you put a tax on the use of certain forms of transportation in order to achieve your goals? How would this work? How would your town react to this tax? What would be the outcome of this type of tax?

    - How do you think different groups of people within your town would react to your proposed changes? How would this affect car dealerships and gas stations? How would it affect families? How would it impact bike shops? How would impact the police force? How would it influence commuters? How would it affect those concerned about car accidents?

    - How would you advertise your campaign? What would flyers say to support your arguments? How would you convince those who are against what your advocating to support your proposals?

4. Ask the students if they think their ideas would be better for the town or if the present transportation methods the town uses work better.

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[13] Rosenthal, Elisabeth. "European Support for Bicycles Promotes Sharing of the Wheels." *The New York Times.* 9 November 2008. Retrieved March 29, 2011 from
http://www.nytimes.com/2008/11/10/world/europe/10bike.html?_r=1&oref=slogin
[14] "Traffic Calming." *Bicyclinginfo.org.* Retrieved March 29, 2011 from
http://www.bicyclinginfo.org/engineering/calming.cfm

Wrap Up: *The Cons: Why are Bicycles Not More Popular in the United States?*

1. Access, print out and hand out copies of [America.gov-"Portland, Oregon, Embraces Bike-Friendly Urban Infrastructure"](#) [15] and ["Bicycle Commuting Statistics: Cascade Bicycle Club Education Foundation"](#)[16]
2. Give the students time to read the articles.
3. Engage the students in a discussion. Pose the following questions:
   - With all of these positive aspects of biking, why is it not as widespread of a form of transportation in the United States? *Travelling a further distance, families travelling together, transporting a lot of materials, among other possible arguments.*
   - What types of locations would be ideal for biking initiatives to be passed, such as those in Oregon? *Among many possible answers, communities that cover small areas and suffer a lot of traffic congestion and slow, underfunded or non-existent public transportation options. Another important aspect is a mild climate that doesn't experience many severe weather conditions that would disable the option of biking.*
   - For what populations would switching to biking have the greatest positive impact? *Among other possible responses, populations composed of younger people who have the physical ability to bike to work, and populations suffering from obesity that can be drastically reduced through biking as a main form of transportation. Environmentally focused individuals would also benefit from this.*
   - What about the greatest negative impact? *Among several possible responses, elderly or physically impaired individuals who are unable to ride bicycles, individuals who rely on the use of other forms of transportation for their livelihoods, people with young children who cannot ride bicycles or with large families who it would be difficult to keep track of using bikes as the primary form of transportation*

Extension: *Track your transportation*

1. Refer to **Reproducible #2 – Sample Transportation Sheet** as an example throughout the activity!
2. Assign students to track their transportation use for three days. Each time they travel more than a quarter mile, they must track their mode of transportation (if a car is used, MPG of the vehicle must be recorded), the distance they travel using it, the quantity of money they spent (if public transit) and the amount of time it takes for them to make the trip. Have them calculate how much fuel was used (assuming 0 gallons for walking, biking, public

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[15] Zwanieck, Andrzeji. "Portland, Oregon, Embraces Bike-Friendly Urban Infrastructure."*America - Engaging the World.*. December 9, 2008. Retrieved March 29, 2011 from http://www.america.gov/st/econ-english/2008/December/20081209152637saikceinawz0.4403955.html.

[16] "Bicycle Commuting Statistics: Cascade Bicycle Club Education Foundation." *Cascade Bicycle Club Education Foundation, Seattle, Washington*. Retrieved March 29, 2011 from http://www.cbcef.org/bike-commuting-statistics.html.

transportation and for driving use the MPG of the vehicle/the number of miles travelled). The amount of money spent if travelling by car, use price per gallon of gas times the number of gallons used.

3. After the three days, have them calculate the average speed they travelled at (total travel time/total distance in miles), and the amount of money they spent per mile (The total amount of money spent divided by the total distance travelled using all modes of transportation)

4. Have them assume that the average bike goes about 15 miles per hour. Have them think: would they be travelling faster on average or slower if they switched to biking everywhere? They would not be using any fuel. Assuming they had to buy a new inexpensive bike for $80 in order to do this, how many of their average days (judging from their three day sample) would it take them of switching to biking for it to pay for itself? For instance, if in their 3 days they spent $10 on fuel and public transit, it would take 24 days for the bike to pay for itself ($10/3 gives you the cost per day, then divide 80 by this number to find the number of days).

CONCLUSION

During this lesson, students examined the many factors involved in transportation infrastructure and acknowledged the varying opinions of different community members when it comes to transportation laws and regulations. They comprehended the economic, environmental, and social pros and cons of different forms of transportation. Students also became aware of the fact that there are pros and cons with every initiative and that it is impossible to completely satisfy everyone's needs with transportation infrastructure. Furthermore, students formed their own opinions about the future of transportation based on models from the present and recent past.

LESSON PLAN CREDITS

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How Do You Travel?

	Get driven alone	Carpool	Bus	Public transit	Bike	Walk
How do you get to school?						
How do you regularly travel for daily activities such as extracurricular activities, visiting friends, and working?						

Sample Transportation Sheet

*Assuming gas is at $5/gallon

Mode of Transport	Distance travelled	Money spent	Time for trip	Quantity of Fuel Used
Car (25 mpg)	5 miles	$1	12 minutes	.2 gallons
School bus	7 miles	$0	30 minutes	--
Car (25 mpg)	10 miles	$2	25 minutes	.4 gallons
Public transit	4 miles	$2.50	30 minutes	--
walk	2 miles	$0	30 minutes	--
bike	4 miles	$0	16 minutes	--
Car (25 mpg)	5 miles	$1	12 minutes	.2 gallons
Public transit	4 miles	$2.50	30 minutes	--
Car (25 mpg)	5 miles	$1	12 minutes	.2 gallons
Totals:	**46 miles**	**$10**	**197 minutes**	**1 gallon**

Calculations:

Average speed:
Minutes to hours→197/60= 3.28333 hours
Miles per hour→46/3.28333=14.01 mph

This person would be going about 1 mph faster if he/she biked everywhere since bikes go about 15 mph

Average expenditure per mile:
$10/46=$0.2174/mile

How long would it take for an $80 bike to pay for itself?
This person spends: $10/3=$3.333333 per day
To get $80 it would take 24 days of riding a bike or walking ($80/$3.333333=24)
instead of regular habits in order to reach the point where the $80 spent on the bike would have been spent using other forms of transportation.