Dear Teachers:

This guide offers four modules that support the teaching of concepts found in the Clean School Bus USA Idle-Reduction Campaign literature. The modules include Health, Science, Social Studies, and Math and are intended to be teaching tools and suggestions that you can choose from, based on your needs. It is recommended that you review the Teacher's Prep for each module so that you understand the overall concepts and the importance of reducing emissions from diesel engines.

Each module contains the following sections with an Appendix at the end of the entire Guide:

- Overview
- Teacher's Prep
- Classroom Questions & Answers
- Classroom Activities [Note: Activities with an asterisk (*) have been provided by Minnesota North Star Chapter of the Sierra Club and whose Web site is: www.northstar.sierraclub.org]
- Research Activities

Appendix: Bonus Word Search Games (NOTE: Three word search games of varying degrees of difficulty are included on the CD that accompanies the Idle-Reduction Kit, as well as in the Appendix of this Guide. Select an appropriate one to be used by your students to review terms used when discussing the need for idle-reduction programs.)

The United States Environmental Protection Agency's (EPA) Clean School Bus USA Team would appreciate your comments on the appropriateness of the material for students from grades three through eight. A feedback form is provided with your Idle-Reduction Kit. If you use the Teacher's Guide materials, please give us your comments on their effectiveness and how they could be improved by simply attaching extra pages to the feedback form we ask you to FAX back to us. Thank you for your interest in educating your students about the importance of idling reduction and the benefits to their health and the environment. If you have any questions, please either call the Clean School Bus phone line at 734-214-4780 or email us at CleanSchoolBusUSA@epa.gov.

The Clean School Bus Team

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CLEAN SCHOOL BUS USA

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Subject Area: Health

Overview

This module is used to discuss functions of the lung and heart and how air pollution may affect healthy children and adults that have existing health concerns. It also provides students with an understanding of how the air pollution from idling buses might impact the occupants in the school and how people affected with asthma may feel when they are having difficulty breathing.

Teacher's Prep

How healthy lungs work
Lungs draw air into (inhale) and out of the body (exhale) through either the nose or mouth. The lungs transfer oxygen into the bloodstream to help the body use food and its nutrients and remove carbon dioxide (CO_2), a waste product, from the bloodstream. The nose helps you detect odors and filters some of the large particles in the air you breathe so they won't enter your lungs.

How a healthy heart works
The heart is like a pump that delivers blood throughout your body. By contracting like a pump, the heart forces the blood to move throughout your body's blood vessels. The blood delivers oxygen to the cells that, along with nutrients from the food that you eat, give your body energy. Your blood also helps remove carbon dioxide and other waste products from the cells, so that waste is removed from the body.

Children vs. Adults
Unlike adults, children's organs (e.g., like their lungs and heart), are still developing. Their organs may be more sensitive to things that they encounter. Children breathe at a faster rate than adults, and they can be exposed to different elements than adults because of different daily activities. Children are usually not as tall as adults, and they may be outdoors playing and near areas that contain diesel fuel exhaust.

Environmental Pollutants Found in the Air
The Earth's atmosphere is primarily made up of invisible gaseous substances. Most of the major air pollutants are gaseous substances that can't be seen but can adversely affect human health, as well as damage the environment. Among the major ambient air pollutants that may reasonably be anticipated to endanger public health are carbon monoxide, lead, nitrogen oxides, sulfur dioxide, ozone, and particulate matter. (See Table # 1 to understand more about these pollutants, their sources, and effects.) To protect public health and welfare, the United States Environmental Protection Agency (EPA) has set national emission standards for these pollutants. These are known as National Ambient Air Quality Standards (NAAQS). Additional pollutants, known as hazardous air pollutants or air toxics, can affect people's health, whether it is something that is an immediate (acute) health affect, or something long term, like cancer. In order to prevent those and other potentially dangerous air pollutants from reaching harmful levels, we need to monitor the environment. By monitoring the environment, we are able to identify emission sources.

Subject Area: Health (cont.)

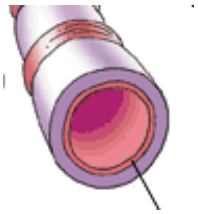
Teacher's Prep (cont.)

Respiratory & Cardiac Problems & Environmental Air Pollutants
When the heart or lungs are damaged, diseased, or are more sensitive (like being very young or old, or having specific allergies, etc.), things like air pollutants may affect how these organs work. Many students have asthma or know of someone with this respiratory problem. Asthma is a long-term (chronic) respiratory disease, but it is treatable if managed properly. Proper asthma management includes avoiding certain "triggers." When a person with unmanaged asthma encounters something that triggers a reaction in their lungs that is non-typical, they can have an "asthma attack." During an asthma attack, airways become inflamed and narrow. Sometimes extra mucous is produced, resulting in asthma symptoms *(see Figures 1 and 2)*. Asthma attacks can range in severity, so people with asthma should understand their triggers and avoid certain environmental pollutants that may irritate their lungs. Other lung problems that are caused by or impacted by environmental pollutants include bronchitis (or inflammation of the bronchiole tubes in the lungs), coughing or other respiratory irritations, and difficulty breathing.

There are a variety of heart problems that can be affected by air pollution, specifically "particle pollution." Problems can include irregular heart beats and non-fatal heart attacks. People that are more sensitive to air pollution or have respiratory and/or heart diseases should be aware of the air pollution in their community. EPA has information about air quality available through brochures ("Smog: Who does it Hurt?" at: http://www.airnow.gov/index.cfm?action=health2.index, and "AQI – Air Quality Index" at: http://airnow.gov/index.cfm?action=aqibroch.index) as well as its air quality website (www.airnow.gov)

EPA, along with state and local agencies, monitors air quality by measuring how clean or dirty the air is. You can find out about the pollution levels in your community by visiting the AirNow website at http://www.airnow.gov/ to get an idea of what pollution levels are projected for next few days.

Some areas of the country even have a service that will email or page you with a notification of the local air quality forecast. This program, EnviroFlash, allows people concerned about their health or their family's, the ability to adjust their plans for unhealthy air quality days.



Firgure #1:
Healthy bronchial tube in lung

Figure #2:
Bronchial tube inflamed and showing signs of excess mucus during an asthma attack

Subject Area: Health (cont.)

Teacher's Prep (cont.)

Table 1: Sources of Air Pollution and Their Health Effects - Major Man-Made Air Pollution

POLLUTANT	DESCRIPTION	SOURCES	SIGNS/EFFECTS
Carbon Monoxide (CO)	• Colorless, odorless gas	• Vehicles (e.g., lawn mowers, motorcycles) burning gasoline • Indoor sources including kerosene, wood-burning, natural gas, or coal-burning stoves and heaters	• Headaches, reduced mental alertness, death • Heart damage
Lead (Pb)	• Metallic element	• Vehicles burning leaded gasoline • Metal refineries	• Brain and kidney damage • Contaminated crops and livestock
Nitrogen oxides (NOx)	• Gaseous compounds made up of nitrogen and oxygen	• Vehicle exhaust • Power plants burning fossil fuels • Coal-burning stoves	• Lung damage • Reacts in atmosphere to form acid rain • Deteriorates buildings and statues • Damages forests • Forms ozone & other pollutants (smog)
Ozone (0_3)	• Gaseous pollutant • Smog	• Vehicle exhaust and certain other fumes • Formed from other air pollutants in the presence of sunlight	• Lung damage • Eye irritation • Respiratory tract problems • Damages vegetation and crops
Particulate matter (PM)	• Very small particles of soot, dust, or other matter, including tiny droplets of liquids	• Diesel engines and vehicle exhaust • Power plants • Industries • Wood stoves	• Heart and lung damage • Eye irritation • Reduces visibility • Discolors buildings and statues
Sulfur dioxide (SO_2)	• Gaseous compound made up of sulfur and oxygen	• Coal-burning power plants and industries • Coal-burning stoves • Refineries	• Eye irritation • Lung damage • Kills aquatic life • Reacts in atmosphere to form acid rain • Damages forests • Deteriorates buildings and statues

Subject Area: Health (cont.)

Classroom Questions & Answers

Q: What is "air pollution?"
A: Air pollution makes the air dirty. It can affect our health and can come from a variety of sources. Sometimes, air pollution comes from nature, like from erupting volcanoes. However, the majority of the air pollution is manmade and comes from factories or power plants, cars, trucks, buses, and even your family's activities like smoking cigarettes or mowing the lawn with a gasoline powered engine.

Q: What is diesel exhaust?
A: Diesel exhaust is the smoke that you see and other elements that are too small to see, that are discharged into the air when diesel fuel is burned, thus contributing to air pollution.

Q: Why are kids more harmed by air pollutants, including diesel exhaust, than adults?
A: Kids' respiratory systems are still developing, and kids have a faster breathing rate.

Q: How can we find out about how clean or dirty the air is?
A: Visit the AirNow website at http://www.airnow.gov/. Talk to state or local air pollution agencies, or talk with the local chapter of the American Lung Association for more information.

Related questions/discussion points

Name a lung disease.
What is heart disease?
What is asthma?
How many cases of asthma in school kids were reported for our school district last year?
What kinds of health conditions can young students develop because of breathing air pollution?

Classroom Activities

Activity #1: Team Audit*

Create school campus questions related to possible pollutants that impact the health of the students and staff. Teams can investigate, analyze, and problem solve. Examples:
Where do the buses park?

- Where are the school's air-intake vents?
- In addition to school buses, what other trucks or cars come to school? (e.g., food or supply delivery trucks, mail trucks, UPS trucks, cars dropping off / picking up students)
- Do any of these cars, trucks, or buses leave their engines running (idling) while at school?
- Does air pollution from idling vehicles entering the school? Why?
- Are there any other sources of outdoor air pollution around the school that might impact the health of students and staff? Are there sources of indoor air pollution in the school as well?
- What is the Air Quality like today in your area? What does "Air Quality" mean?

Subject Area: Health (cont.)

Classroom Activities (cont.)

Additional Resources for Performing Assessment

EPA's Healthy School Environments Assessment Tool (SEAT) (www.epa.gov/schools)
EPA's Indoor Air Quality Tools for Schools (www.epa.gov/iaq/schools) and refer to "Walkthrough Checklist"

Activity #2: Understanding the Importance of Good Respiratory Health

Materials Needed:
Have enough small diameter straws for participating students to use.

NOTE: Students participating in the session should not have any physical limitations. If anyone has breathing problems or problems with physical exertion, make sure they understand that they don't have to participate.

Activity:
Try to answer the questions: What does it mean to have healthy lungs and heart? What does it feel like when someone has an asthma attack?

Have the students measure their breathing rate and pulse at rest. Record those measurements down.

Have those students who don't have any physical health issues jog in place for 45 seconds. Measure their pulse rate and breathing rate after 45 seconds. Have students count their heart beats for six (6) seconds and multiply by 10 to yield beats per minute.

Wait five minutes while the students' breathing and pulse rates return to normal. To find out what an asthma attack may feel like, have students jog in place again for 45 seconds.

After the 45 seconds, immediately have the students pinch their noses and breathe only through the straw. Tell them if they need to, they can breathe without the straw. Ask them how it felt.

Try to measure pulse rate and breathing rate after the straw exercise. Do they notice any difference?

Activity # 3 Where's that Odor?**

*****From Project A.I.R.E: Air Information Resources Education (K-12). For online access to this and other exercises, go to: http://www.epa.gov/region1/students/teacher/aire.html***
This exercise lets students use their noses as monitoring devices to determine the source of odors introduced into the classroom and demonstrates how air pollution (from sources like idling school buses) can distribute in an environment. It helps students recognize the role citizens play in environmental cleanup.

Subject Area: Health (cont.)

Classroom Activities (cont.)

Activity # 3 Where's that Odor?** (cont.)

Students will use their sense of smell to detect and recognize odors using their noses as air monitoring devices. Odor is the subjective perception of the sense of smell (olfaction). They will learn that not everyone has the same ability to smell objects at the same levels (or concentrations). The minimum concentration (threshold) of an odor that can be detected and identified through the sense of smell depends on how the odor is presented (such as flow rate and purity) and the sensitivity of the olfactory cells in the nose, which vary from person to person. Odors usually are identified at higher levels than what the nose can actually detect as being an odor. These levels are known as "thresholds." Odor thresholds are the concentrations (or amounts) of the odor that are detected or identified. For example, the detection threshold of ammonia is about 17 parts-per-million (ppm) [NOTE – this unit of measure ("ppm") is common for concentrations measured on a volume basis), and the recognition threshold is 37 ppm.]

Materials Needed:
Blue, red and yellow food coloring, sandwich size containers, chalkboard or flipchart, colored chalk or markers, and vanilla extract, vinegar, and/or minty mouthwash (or other odorous liquids that do not irritate the respiratory systems of students or staff).

Instructions:
Before class begins, mix the blue, red, and yellow food coloring to make a color that is similar to the color of vanilla extract. You may also use other substances to make a solution that is similar in appearance to vanilla extract, but they should create as little odor as possible. Using the tops of the sandwich containers, put a small amount (just enough to cover the lid surface) of vanilla extract in one of the container lids. Put a small amount of the other liquids that have odor in other container lids. Then put equal amounts of a look-alike liquid in the remaining container lids. Place the lids around the room and cover them with the inverted container. On the chalk board, draw two maps of the classroom: one for charting time and the other for charting odor intensity. Students should have a worksheet for tracking both measures.

When class begins, explain how determining what and where air pollutants come from (monitoring) is an important part of protecting people and the environment. Detection (what is there) of pollutants can be accomplished by different kinds of monitoring devices (tools). A simple example of visual detection is the dirt on the classroom window where pollutants have stuck to (or have been deposited on) the glass. When you breathe, the hairs in your nose act like a monitoring tool by filtering dust, and special cells (olfactory) in the back of the nose allow you to identify some chemicals in the air. Explain that because monitoring tools are expensive and take longer to use, than you have in class, the students will use their noses to detect and identify air chemicals. Instruct them to use their noses like scientists would use a monitoring device to detect and estimate the strength (volume or intensity) of an odor and to determine the source of the odor.

Subject Area: Health (cont.)

Classroom Activities (cont.)

Activity # 3 Where's that Odor?**(cont.)

Explain to the students that they will need to map the classroom to chart the results of the experiment. You can take the chart below, or go to the Web link provided at the beginning of this exercise, to provide students with their own worksheets. As students map the room on their own chart, you do the same on the chalk board. Fill in the maps to show the location of each student.

Make sure each student understands where they are on the map. When the maps are complete, briefly describe the experiment. Tell students the idea is to record when they first smell an odor and to measure how strong it is at various times. Go over the time and intensity (strength) measurements and make sure everyone understands how to fill out the worksheet. (Plan on taking extra time for this when doing the experiment in lower grade levels.)

WHERE'S THAT ODOR?

Classroom Map

			Front of	**classroom**			
			Back of	**classroom**			

TIME
A= _____
B= _____
C= _____
D= _____

INTENSITY
1 -- No odor detected at all
2 -- Begin to smell the odor
3 -- Odor is strong
4 -- Odor is very strong

Subject Area: Health (cont.)

Classroom Activities (cont.)

Activity # 3 Where's that Odor?**(cont.)
When ready, remove covers from the sources containing liquids throughout the room. Leave the lids uncovered for two minutes. Announce the time every 30 seconds. (For example, "A" on the worksheet would be T+30 seconds; "B" would be T+60 seconds, and so on). Remind students to find their place on their worksheet map and fill in the letter (time) and number (intensity) the FIRST TIME they smell an odor. If they detect more than one odor, they should fill in the letter (time) and the number (intensity) the first time they smell EACH odor.

At the end of two minutes, cover all the sources again. Call on a number of students in different parts of the room. (If time permits, let all students participate.) Have each, in turn, come forward and mark their location (in colored chalk/marker) on each of the maps on the board with the time and intensity information they have recorded on their worksheet.

Lead a student discussion about the results of the experiment. Ask why some students recorded stronger odors sooner than others. Did the odor move in one direction more than another? If so, what does that suggest about the way pollutants move in the air? Did anyone detect more than one odor. Where did the odor(s) come from? The students' answer should point you to the real sources. (If not, be prepared to point out the real sources and explain how real scientists might use additional trials or put out more monitors to be sure the results are accurate.)

Describe why it is necessary to determine where contaminants, particularly invisible ones, are coming from (health effects, environmental and ecological effects). Give some examples. Explain that if the contaminants in the experiment had been harmful, finding out where they were coming from would make it possible for their local officials and EPA to take steps to remove them.

Research Activities for Students

Activity #1: Have students research more about lung and heart diseases. Find out more about other respiratory or heart diseases that are affected by air pollution.

Activity #2: Have students research more about why their health as young people is impacted by certain environmental conditions more so than healthy adults.

Activity #3: Have students research more about asthma and what can either "trigger" an asthma attack or exacerbate (make existing asthma worse) asthma symptoms.

Activity #4: If the students know someone with asthma who doesn't mind sharing this information, have them interview the person about their asthma triggers, and ask whether they notice certain environmental triggers that worsen their asthma. Ask about what it feels like when they have an asthma attack and how they manage their asthma.

Subject Area: Health (cont.)

Research Activities for Students (cont.)

Activity #5: If there isn't anyone to share information with about how they cope with asthma, have students contact the local chapter of the American Lung Association and see if they can work with the school to invite a representative to the school to train students about asthma.

Activity #6: Research other sources of "particulate matter," like secondhand smoke, coal plants, and wood stoves.

Activity #7: The earth's ozone layer occurs naturally in the stratosphere and provides a protective layer shielding the Earth from harmful ultraviolet radiation. In the troposphere, it is a chemical oxidant, a greenhouse gas, and a major component of smog. What are some of the sources for tropospheric ozone? Have the students identify some of the common sources found in their community.

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Subject Area: Science

Overview

This module should focus on fuel and define energy needs of the transportation industry. It should cover how a diesel engine works and how it is different from a gasoline engine. Discussion should focus on air pollutants that typically come from diesel engines and why they are exhausted into the air. Finally, technologies that reduce pollutants in exhaust, as well as other technologies that are used to save fuel by reducing idling times should be discussed. For your convenience, Web sites have been suggested for further research and study during your preparation; however, using Internet search engines for the areas you seek further information on will reveal numerous other optional sites.

Teacher's Prep

Gather information on the following:

- Energy and why it is needed. (HINT: Go to the following online resource to learn more about energy and fuels: http://www.fossil.energy.gov/education/index.html)
- Different fuels used in transportation and how they relate to energy. (HINT: Go to the following Web site to learn more about the history of energy and transportation: http://www.rqriley.com/energy.htm)
- How a diesel engine works (compression ignition) and on how a gasoline engine works (spark ignition) so you can identify the differences. (HINT: Go to the following Web site for an explanation of how a diesel engine works: http://auto.howstuffworks.com/diesel.htm and go to the following Web site for an explanation of how a gasoline engine works: http://auto.howstuffworks.com/engine.htm). Use this information to discuss the air pollutants being exhausted by diesel engines during combustion of fuels while an engine operates.

Classroom Question & Answers

Q: A bus uses fuel to operate. What is fuel?
A: Just as food is fuel for humans to operate, engines need fuel to run.

Q: What is diesel fuel and what is diesel exhaust?
A: Fuel is an input and exhaust is an output of combustion in an engine. Diesel is a type of energy burned by the engine to run a school bus or other diesel vehicles and equipment. Diesel fuel burns as oil that is injected into hot compressed air. Diesel exhaust, on the other hand, is composed of waste gases or fumes that escape from an engine that is burning diesel fuel.

Q: What is idling?
A: Idling is when the engine runs, but the bus is not moving. Sometimes, idling is necessary, like when a vehicle is stopped at a traffic light or stuck in a traffic jam. Some idling is not necessary, like when the driver is waiting for students at a field trip or has the engine running for more than the recommended time of five to 15 minutes, especially when in standard operating conditions.

Subject Area: Science (cont.)

Classroom Question & Answers (cont.)

Q: What positive things can result when drivers reduce the amount of time they allow the bus engine to idle?
A: Drivers can save fuel, save money, reduce pollution, and protect children and the community from breathing harmful pollutants when they reduce idling time.

Q: How much time do most bus manufacturers recommend an engine needs to warm up?
A: Five to 15 minutes.

Q: What should a bus driver do if s/he is driving behind a vehicle that shows visible exhaust or has noticeable odor?
A: Drive farther behind it. The rule-of-thumb is to try to stay three to five bus lengths away from vehicles with visible exhaust.

Related questions/discussion points

Are some diesel fuels cleaner than others?
What clean fuels can be used with buses? (e.g., ultra-low sulfur diesel, biodiesel, compressed natural gas)
Why do people idle their car or bus engines?
What are some other types of fuels used in vehicles? What makes them different from diesel fuel?

Classroom Activities

Activity # 1: Comparative Sock Experiment*

Materials Needed:
Two new, white tube socks, heavy rubber band, oven mitt, diesel bus.

Time: 20 minutes.

Activity:
Before presentation, have one adult place one sock over the end of the tailpipe from a diesel vehicle. If needed, secure the sock with a heavy rubber band. Start the engine and idle it for at least five minutes. Remove the sock with an oven mitt, as the tailpipe will be hot. Turn the sock inside out to compare it with the clean sock and visibly see the accumulated particulate matter.

Subject Area: Science

Classroom Activities (cont.)

Activity # 2: Three Paper Experiment*

Materials Needed:
Three pieces of heavy paper or index cards (with location and date marked on each piece), Vaseline, string or duct tape, and magnifying glasses.

Time: 20 -30 minutes

Activity:
Collecting particulate matter from various areas around school campus will allow students to visibly analyze where and why accumulation is greatest.

Coat each paper with Vaseline. Hang one near the bus parking area, place the second in the school, and put the third paper in a drawer or closet. After a specified time, remove the papers and compare them with a magnifying glass. Prior to the experiment, have the class predict the outcomes.

Research Activities for Students

Activity #1: Have students determine their "energy footprint" based on their activities or equipment used. For example: Can they compare the energy that it takes for them to get to and from school, either in a car or by bus, or to use a computer for an hour?

Activity #2: Have students find out more about what fuel is used in the vehicles operated by their own school district or the community's municipal vehicles. What kind of fuel do these vehicles use?

Activity #3: How many gallons of fuel are used by the school district or the municipality to operate its vehicles each year? Can the estimated amount of fuel to be used during idling versus the amount of fuel used overall be determined?

Activity #4: Have students research other types of engines that are used in vehicles. Are they more efficient? Besides the way they operate the vehicles, do these impact the environment differently?

Activity #5: Have students learn about other forms of pollution control technologies, whether it is for reducing air or water pollution.

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Subject Area: Social Studies

Overview:

This section focuses on how EPA regulates air quality, what air quality is, and how it impacts our communities. Pollutants of concern are identified as well as some of the common sources that produce them. Students should be able to determine air quality and know what steps can be taken to reduce the impact of daily activities on the community air quality.

Community involvement with Idle-Management Policies and other pollution prevention measures will be touched upon. Free materials available on the EPA Web site that can be used to help educate the School Board and the City Council will be identified. (NOTE: Be sure to check the EPA Web site to get more information from the Clean Air Act, and read the EPA publication "The Plain English Guide to the Clean Air Act" (Publication Number 400-K-93-001), found via this link: http://www.epa.gov/oar/oaqps/peg_caa/pegcaain.html)

Teacher's Prep

After reading the Clean Air Act (see Overview above) and its implications on community air quality, discuss the National Ambient Air Quality Standards (NAAQS), how they are set; Hazardous Air Pollutants (HAPs); and Mobile Source Engine & Fuel Standards. Reference briefly other air quality concerns (e.g. chlorofluorocarbons [CFCs], etc.). Visit the following Web sites for more information:
Air Toxics: http://www.epa.gov/air/toxicair/newtoxics.html
NAAQS: http://www.epa.gov/air/urbanair/6poll.html
Mobile Sources: http://www.epa.gov/otaq/invntory/overview/examples.htm

Discuss what constitutes good or bad air quality. How does bad air quality impact our community's health, jobs, etc.?

Discuss the Air Quality Index (AQI) and EnviroFlash. Visit http://www.airnow.gov

Discuss actions that are recommended for the general community to take on poor air quality days.

Discuss what an Idle-Management Policy is, how it relates to pollution prevention, and suggestions for implementing a community or school policy.

Classroom Questions & Answers

Q: What is stewardship?
A: Stewardship is the act of taking responsibility for and caring for the Earth or any part of it. This includes taking responsibility for using resources and creating as little waste and pollution as possible.

Subject Area: Social Studies (cont.)

Classroom Questions & Answers (cont.)

Q: What is an "Idling-Management Policy" or "Idle-Reduction Policy"? Does your school have such a policy?
A: This policy is established by the school, the district, or the community. It specifies how much time a school bus should be idling during certain conditions. It should outline any special concerns pertaining to the bus driver, special needs children, safety, maintenance, and weather.

Q: What can our school district do to reduce air pollution from buses?
A: School districts can:

- Plan for routine maintenance of buses
- Encourage drivers to not follow other buses too closely (i.e., don't "caravan" too closely)
- Assign the newest buses to the longest routes
- Implement a reduced-idling program for the school or district
- Use free materials about the importance of reducing idling offered on EPA's Web site
- Create a comfortable space inside the school building or bus depot where bus drivers can wait and stay warm or cool.

Q: How can diesel exhaust harm our community?
A: Once diesel exhaust gets into the air, it can go anywhere that is open to it, such as fresh air intakes and open doors and windows.

Related questions/discussion points

Have you or your family ever practiced stewardship over your environment? In what ways do you do this?

What can we do to get the community involved in an Idle-Reduction Program?

Does your community meet EPA Air Quality Standards? Is your area in attainment?

Classroom Activities

Activity # 1: Team Posters* (3rd-5th grade level)

Materials Needed:
Poster paper, markers, and a main concept or issue related to clean air for each team.

Subject Area: Social Studies (cont.)

Classroom Activities (cont.)

Design team posters to promote the discussion of issues and concepts related to clean air and stewardship. The teams can hang their posters in school hallways or in the community to raise awareness.

Activity #2: Role Playing*
Have students participate in role playing discussions with their parents, bus drivers, and a school official concerning the school bus diesel idling issue. Find out some of the concerns – both pros and cons – in limiting school bus idling. Check out EPA's Web site to see if there are answers to the concerns that are raised. (www.epa.gov/cleanschoolbus).

Activity #3: Air Quality in My Community (7th-8th grade level)

Materials Needed: Inquisitive minds, access to the Internet or a library.

Time: 20-30 minutes

Find out how many days were good or moderate air quality days last year or last month in your community. Visit the AirNow Web site or talk with your State Environmental Agency's Air Monitoring Program to see if they can help you. Also, look at old copies of a major newspaper to see how many days had green or yellow as their air quality index indicator.

How many days were not good air quality days (i.e., denoted as orange, red, or purple)? Of the days that were not good air quality days, how many were school days, weekends, holidays, or days of school summer break?

Have students think of reasons why these were not good air quality days such as the number and types of sources of pollution, hot summer days that enhanced ozone, school days that may have had a weather condition (inversion) and may have had more people driving while factories were operating and more activity was occurring.

Activity #4: Teaching others:*

Materials Needed: Enough background information about air pollution caused by idling and its effect on the community to be able to discuss these subjects with someone.

Time: 30-60 minutes

Activities:
Teach another class what you have learned about school bus idling.
Inform neighbors who live around the school campus and near school bus parking areas about the benefits of idle-reduction policies.
Role play a school board meeting.

Subject Area: Social Studies (cont.)

Classroom Activities (cont.)

Gather a few other interested students and meet with School Board or City Council Members about idling concerns pertaining to school buses and other vehicles.

Activity #5: School and Community Outreach:*

Materials Needed:
Poster board, coloring pens, button making materials, index cards, and letter writing materials.

Time: 30-60 minutes

Activities:
Contact local grocery stores to decorate grocery bags with pictures from the Team posters on idle-reduction.

Educate bus drivers and recognize drivers who do not idle their buses with class-generated buttons they can wear.

Investigate and develop a school policy concerning the "No-Idling" issue.

Design cards inviting bus drivers inside the school building to a designated waiting area so they can avoid idling their buses while they wait.

Write decision-makers or your local newspaper about idling concerns and offer suggestions about policies that can be implemented to reduce idling.

Research Activities

Activity #1: Research what air quality is like in other countries. Have students make comparisons between industrialized nations like the United States and Canada to what is going on in developing countries like China. Are there ways that the United States and other developed countries are sharing information on how to improve air quality with these developing countries?

Activity #2: Does your community or state environmental agency have a way for citizens to find out about the air quality in the community? Help the students educate the community about air quality and actions they can take to reduce air pollution when the air quality is poor. See the EPA Web page, www.airnow.gov

Activity #3: Have the students work with the school's Transportation Department to determine additional measures that can be taken to reduce air pollution from school buses. Questions that should

Subject Area: Social Studies (cont.)

Research Activities (cont.)

be asked by the students include: "Does the school/school district have a maintenance schedule for the buses?" "How often are the buses inspected?" "What is actually done as a measure of routine maintenance?" "How old are your school/school district's buses?" "Are newer buses assigned to longer routes?" "Does the school district have an idle-reduction policy?"

To get free materials about improving air quality, go to EPA's Web site at: www.epa.gov/cleanschoolbus)

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Subject Area: Math

Overview

This section focuses on using math to determine how much time and potential energy is wasted when buses, cars, trucks, and other forms of transportation are left to idle. It should help students view their daily activities from a new perspective of saving time, fuel, and money, while curbing the amount of pollution emitted into the air.

Teacher's Prep

Fossil fuels, which continue to power our school buses, are at premium costs, and calculating savings by reducing the amount of fuel used while idling unnecessarily is something that might be useful for both the transportation manager and the students.

In addition, it is important for schools to recognize the important role they play in reducing emissions in their community, by reducing idling in and around school property. By implementing an Idling-Management Policy, sometimes called an Anti-Idling Policy or Idle-Reduction Policy, schools can make sure that their buses don't waste fuel and don't contribute unnecessary emissions to the community's air quality. Schools set an important example for other drivers in the community. These policies are intended to offer guidance on limiting the amount of time buses should idle during warm-up and while waiting for students. They should also identify any necessary safety and/or weather condition exemptions.

Special support to meet the needs of the bus drivers, such as the right locations for bus drivers to wait, queuing concerns, and having warming or cooling stations should also be discussed. Discuss what guidance specific to bus drivers should be given such as making a point of turning the engine off as soon as possible after arriving at loading or unloading areas.

Classroom Questions & Answers

Q: Do most drivers adhere to the Idle-Reduction policy, if there is one? If there isn't one, can you find an example policy on the Internet? (HINT: Visit www.epa.gov/cleanschoolbus for more information on idling).

Q: What is an average recommended time for idling school buses in standard weather conditions?
A: Five to 15 minutes.

Related questions/discussion points

How long do our school buses idle when they drop kids off or pick them up?

Subject Area: Math (cont.)

Classroom Activities

Activity #1: Team Audit*:

Create school campus questions for teams to investigate, analyze, and problem solve. This will be most useful for schools that haven't established an Idling-Management Policy or are not implementing or complying with their existing Idling-Management Policy.

If the school is actively supporting its Idling-Management Policy, then assume it isn't and think about what would happen if each school bus in the fleet was idling for at least an hour a day.

How many buses are used by the school every day? Do any of these buses make multiple runs to pick students up or drop them off? If so, how many trips do they make?

What type of fuel is being used to run the buses?

How much fuel is being used on a monthly or yearly basis?

What is the average cost per gallon of diesel fuel in your community?

How long are buses idling during morning pickup? (report in minutes)
How long are buses idling during afternoon pickup? (report in minutes)
NOTE: If school district/school has more than 10 buses, then you may request students to measure only five to ten buses.
What is the average bus idling time for the morning (in minutes)? What is the average bus idling time for the afternoon (in minutes)? Graph the various bus idling times, with the x-axis being the bus number (either morning or afternoon) and the y-axis being the number of minutes for idling. What is the median amount of time that all the buses idle?

Activity #2: Calculating the Cost of Unnecessary Idling
Take a look at how idling school buses unnecessarily can be wasteful.
Calculate the average additional cost of the fuel for buses that idle too long. Assume that the school bus uses a half gallon (0.5) of diesel fuel per hour of idling.

How long do the buses idle when they start up in the morning, on average? Report the calculation in minutes. If trying to save time for this activity, refer to Math Activity # 1's sample calculation.

How long do the buses idle when waiting for students at the end of the day, on average? Report the calculation in minutes. If trying to save time for this activity, refer to Math Activity #1's sample calculation.

Subject Area: Math (cont.)

Classroom Activities (cont.)

If both the start up idling time and the waiting idling time fall into the range of the school district's recommended idling times (typically five to 15 minutes), then the students may wish to assume that the buses idle 30 minutes in the morning and afternoon, just to demonstrate the savings.

Determine the amount of time your school district's idling policy allows per bus for these activities (This should be anywhere from five to 15 minutes for each bus and each idling event), and multiply that number times the number of buses in use for the morning bus run (report in minutes). Add all of the morning idling times of all buses together (report in minutes). Subtract the total idling time allowed under the policy from the total number of minutes buses actually idle in the morning. This calculation demonstrates how much unnecessary idling is occurring at the school, each day, in the morning. Repeat this exercise for the afternoon run. Report both in minutes. Add the morning and afternoon unnecessary idling times together and report in minutes. This is your school's daily unnecessary idling for one day (that was monitored), in minutes.

Determine the number of school days in a month and multiply that number by the amount of time your school bus fleet wastes on unnecessary idling for one day. This is your school's unnecessary idling for one month.

Find out if your school bus fleet manager knows how much fuel is being used by the fleet's buses when they idle. If the fleet manager doesn't know, assume a half gallon of diesel fuel is used for every hour (0.5 gallons/hour) the school bus idles.

Take the annual idling time for your bus fleet (number of hours/month) and multiply that number by the amount of fuel used when the bus is idling (0.5 gallons per hour of idling) to determine how many gallons of diesel fuel are being wasted on unnecessary idling in one month.

Multiply the cost of diesel fuel, per gallon, by the number of gallons of diesel fuel used every month to find out how much money the school or school district is wasting on unnecessary idling every month. Determine how many months are in a school year. Multiply the number of months in a school year by the number of gallons of diesel fuel used every month on unnecessary idling. This is the amount of money being wasted on unnecessary idling in a school year.

Estimate the amount of time other vehicles use when idling.
In addition to school buses, what other vehicles come to school? (For example: food or supply delivery trucks, mail trucks, UPS trucks, cars dropping off / picking up students). Do any of these vehicles leave their engines running (idling) while at school? Estimate the amount of time that they idle.

Subject Area: Math (cont.)

Classroom Activities (cont.)

Estimate the amount of time a car idles when used by parents who transport their kids to school. Count how many parents or caregivers pick up students after school. Estimate the average time that the parents/caregivers wait. Do they idle their cars?

Activity # 3: Story Problems
Here are some fun "story problems" for students to test their skills:
(addition/subtraction)

It's cold outside and the bus driver decides to turn off his school bus engine and wait inside the school for the kids to come out. He waits a total of 20 minutes inside because it's very warm inside the building. For eight of those 20 minutes, he reads the newspaper. He also talks to another bus driver for six minutes. The bus driver gets a phone call. How much time does the bus driver have left to talk on the phone if he needs to go back to the bus after spending a total of 20 minutes inside the school building? (Answer: six minutes)

(addition/subtraction)

Twenty-seven kids are lined up to board the school bus. They make sure to they do not stand near the tail pipe of the engine so they avoid breathing the diesel fumes. There are 42 seats on the school bus. How many empty seats are there? (Answer: 15)

(addition/subtraction)

The bus driver picks up a total of 24 kids at three different bus stops. At the first stop, there are 10 kids. At the second stop, there are 5 kids. How many kids are at the third bus stop? (Answer: nine)

(multiplication)

There are four idling school buses that are parked with their engines still running. On each of the four buses, there are seven kids sitting down with the windows open. If you multiply the number of kids the number of buses, how many students total may be affected by the idling engines? (Answer: 28)

Research Activities

Activity #1: Find out how many students ride school buses each year throughout the United States. How many students are riding the bus in your school district?

Activity #2: Talk with the Transportation Director of your school district to find out how many buses there are in the fleet and how many seats are available on the buses. Calculate the passenger capacity and find out how different it is from the number of students riding the buses every day.

Are there large disparities between buses? For example, are any of the buses used for multiple runs to and from school, or do some buses have a lighter than normal load?

Subject Area: Math (cont.)

Research Activities for Students (cont.)

Activity #3: How much time do students in your school district spend on the bus over a whole year? Report it in each of the following ways:

- As a fraction of a year.
- As the total number of hours in a year.
- As the total number of minutes in a year.
- As the total number of seconds in a year.

Have students think about other activities that they do routinely, then have them calculate the amount of time for those same activities. Examples include the amount of time they are in school, the amount of time they spend doing homework, the amount of time they spend actively or exercising, and the amount of time they spend watching television.

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Appendix A: Word Search

Clean Buses = Clean Air Level 1

M T Z F N I L W J M U P
V D V A U U D T X S W M
F M E Y N M J L N A C V
U L P G J F E F E S D A
C A S B U S R S W N S R
S E L C I T R A P T E E
D I E S E L R C H V N H
J F U I O E O M I I A E
E E W D T U A R G I E A
P O H L G D D N R O T R
A F I H K Z E R O D O T
D F H K I D L E Y V V W

AIR BUS COUGH DRIVER EPA FUMES IDLE ODOR
ASTHMA CLEAN DIESEL ENGINE FILTER HEART LUNGS PARTICLES

Appendix A: Word Search

Clean Buses = Clean Air Level 1 Solution

```
+ + + + C D S E M U F R
+ + + + + L I + + + I E
F I L T E R E E + + D V
S G N U L + + A S + L I
+ + + + + + + + N E E R
+ + + + + + + + + H L D
A S T H M A + + + G O +
P A R T I C L E S U D +
H E A R T R + + B O O E
E N I G N E I U + C R P
+ + + + + + S A + + + A
+ + + + + + + + + + + +
```

(Over,Down,Direction)
AIR(8,11,NW)
ASTHMA(1,7,E)
BUS(9,9,SW)
CLEAN(5,1,SE)
COUGH(10,10,N)
DIESEL(6,1,SE)
DRIVER(12,6,N)
ENGINE(6,10,W)
EPA(12,9,S)
FILTER(1,3,E)
FUMES(11,1,W)
HEART(1,9,E)
IDLE(11,2,S)
LUNGS(5,4,W)
ODOR(11,7,S)
PARTICLES(1,8,E)

Appendix A: Word Search

Clean Air = Clean Buses Word Search Level 2

B M R W C R G Q L P C B M T Z
Y R U L P J T X Q E U D Z B V
O U E Q A G G D M S S I D L E
M A I A R P D H U Z B E S L N
N T Y V T A M H T S A P I C V
N R R R I H V P G K O E R D S
H A C B C O I N F L N H E M C
T E R Z L R U N L I A R V J H
S H A P E L P U G X I D I B O
T E S L S U T N J X R V R Z O
W P M O T I E O S C Q E D W L
W Z Q U O H D F I L T E R J W
E L D N F T U Z R U Y H Q G S
S H A R N C H G U O C W J S V
W Y U O G N D Q B D L L Q T R

AIR
ASTHMA
BREATHING
BUS
CLEAN
COUGH
DIESEL
DRIVER
ENGINE
EPA
FILTER
FUMES
HEALTH
HEART
IDLE
LUNGS
PARTICLES
POLLUTION
SCHOOL
SOOT

Appendix A: Word Search

Clean Air = Clean Buses Word Search Level 2 Solution

```
B + + + C + + + L + + B + + +
+ R + L P + + + + E U + + + +
+ + E + A + + + + S S I D L E
+ A + A R + + + + + + E + + +
N T + + T A M H T S A P I + +
+ R + + I H + + G + O E R D S
H A + + C + I N + L N + E + C
+ E + + L + U N L I A + V + H
S H A P E L + U G + I + I + O
+ E S L S + T N + + R + R + O
+ + M O T I E + + + + + D + L
+ + + U O H + F I L T E R + +
+ + + N F T + + + + + + + + +
+ + + + + + H G U O C + + + +
+ + + + + + + + + + + + + + +
```

(Over,Down,Direction)

AIR(11,8,S)
ASTHMA(11,5,W)
BREATHING(1,1,SE)
BUS(12,1,SW)
CLEAN(5,1,SW)
COUGH(11,14,W)
DIESEL(14,6,NW)
DRIVER(13,11,N)
ENGINE(7,11,NE)
EPA(5,9,W)
FILTER(8,12,E)
FUMES(5,13,NW)
HEALTH(1,7,SE)
HEART(2,9,N)
IDLE(12,3,E)
LUNGS(6,9,NE)
PARTICLES(5,2,S)
POLLUTION(12,5,SW)
SCHOOL(15,6,S)
SOOT(3,10,SE)

Appendix A: Word Search

Clean Air = Clean Buses Word Search Level 3

M H A H O R D P S O R U W F Q J Z N S W I E C M N
P H X E E H T N N R Z C H F B X G G B I O X I L Q
P O F T J A O P A R T I C L E S N M F D W H X R Q
Y X L B N I L J N T W I Z V S U I T R L J A I K P
G I I L S W E T W N I U S C L W H H O E E U L O L
F F H S U D G G H P Y K M E Z Q T C G O H S E R A
X J I G A T M R S M D D N O I J A E F A S T O I F
V M P A U I I V N S G J G S Z G E L O G A P U A Z
E T O H K O F O Q G K S R S N F R Y V V Q T I Q M
R J B S V O C Y N A J B F Y L I B E F W F S K Q D
N K T R H B X Z J C K C R O O G C E L Z E X K O Z
Z Q M K L L T T S I T L C E D H O D Y L N A E L C
G R Y J S G P C F J R W L A V I U I H L A S W G D
C M B W U W H O N U A P S V F I F O S S I L L M D
T N E M N O R I V N E T G O M S R I C P S C Q W V
S K U D O U H V R B H L F M Z E Q D L X O S K M R
A K J L E P A I H M N K G N L E S E I D U A O L Q
F C J N M X M D A D L E A Q V A Z R L B D D X L E
E O K I M Q B C M D F Z O X E O Z O N E O N R K N
T L X D J V A B W P F H D H W K W E G R K Q W P I
Y L O F K U J K B E M N P F O Y W H C J T L M Y G
W R E S H P D B S Y N X R V N H W D E X T Q O H N
Z C Y X X C C P Y U Q G G N Z Z F L W K T O T I E
J U D L U N B L S I F K T W Z G T B V U K Q W O T
U W H N C L K D U F X I C Q N Y D X V Z R Z Z Q K

AIR
ALLERGIES
ASTHMA
BREATHING
BUS
CLEAN
COUGH
DIESEL
DRIVER
EMISSIONS
ENGINE
ENVIRONMENT
EPA
EXHAUST
FILTER
FOSSIL
FUEL
HEALTH
HEART
IDLE
LUNGS
ODOR
OZONE
PARTICLES
POLLUTION
SAFETY
SCHOOL
SMOG
SOOT

Appendix A: Word Search

Clean Air = Clean Buses Word Search Level 3 Solution

```
+ + + H + R + + S + + + + + + + + + S + + E + + +
P + + + E + + N + + + + + + + + + G G + I + X + + +
+ O + T + A O P A R T I C L E S N + + D + H + + +
+ + L + + I L + + + + + + + + + U I T + L + A + + +
+ I + L S + + T + + + + S + L + H + O E + U + + +
F + H S U + + + H + + + + E + + T + + O + S + R +
+ + I G + T + + + + + + + + + I + A + + + S T + I +
+ M + + U + I + + + + + + + + + G E + + + + + + A +
E + + + + O + O + + + + + + + + + R + + + + + + + +
+ + + + + + C + N + + + + + + + + B E + + + + + + +
+ + + + + + + + + + + + + R + + + + + L + + + + + +
+ + + + + + + + + S + T + + E + + + + + L N A E L C
+ + + + + + + + C F + R + + A V + + + + + + A + + + +
+ + + + + + + H + + U A + S + + I F O S S I L + + +
T N E M N O R I V N E T G O M S R + + + + + + + +
S + + + O + + + + + H L + + + + + D + + + S + + +
A + + L E P A + + M + + + + + L E S E I D U + O + +
F + + + + + + + + A + + + + + + + + + + B + D + + E
E + + + + + + + + + + + + + + + O Z O N E O + + + N
T + + + + + + + + + + + + + + + + + + + R + + + + I
Y + + + + + + + + + + + + + + + + + + + + + + + + G
+ + + + + + + + + + + + + + + + + + + + + + + + + N
+ + + + + + + + + + + + + + + + + + + + + + + + + E
+ + + + + + + + + + + + + + + + + + + + + + + + + +
+ + + + + + + + + + + + + + + + + + + + + + + + + +
```

(Over,Down,Direction)

AIR(24,8,N)
ALLERGIES(21,13,NW)
ASTHMA(14,13,SW)
BREATHING(17,10,N)
BUS(20,18,NE)
CLEAN(25,12,W)
COUGH(7,10,NW)
DIESEL(20,17,W)
DRIVER(18,16,NW)
EMISSIONS(1,9,NE)
ENGINE(25,23,N)
ENVIRONMENT(11,15,W)
EPA(5,17,E)
EXHAUST(22,1,S)
FILTER(1,6,NE)
FOSSIL(17,14,E)
FUEL(9,13,SE)
HEALTH(4,1,SE))
HEART(11,16,N)
IDLE(20,2,S)
LUNGS(15,5,NE)
ODOR(23,17,SW)
OZONE(16,19,E)
PARTICLES(8,3,E)
POLLUTION(1,2,SE)
SAFETY(1,16,S)
SCHOOL(9,12,SW)
SMOG(16,15,W)
SOOT(21,7,NW)