Improving the Air We Breathe

Practical opportunities to involve students aged 10-16 in investigating indoor and outdoor air quality in their communities

Photographs: Nel Smit and John Todd

By **Nel Smit** and **John Todd**

TASMANIA HAS SOME OF THE cleanest air in the world, yet from time to time can have significant air quality problems, especially in and around the major urban centres. Pollutants from vehicle exhaust, smoke from wood stoves, emissions from industry, open fires, evaporation from paints and solvents, aerial spraying of herbicides and pesticides, and many other day-to-day human activities add unwanted gases and particles to the air. In addition to outdoor air quality, air inside homes, offices, factories and vehicles often contains more pollutants than the air outside. Sources of air pollutants inside buildings range from mould spores to organic gases evaporating from paints and furnishings.

We found high school students we worked with generally had little knowledge or understanding of air pollution issues and their potential health impacts. To promote awareness and monitoring of air pollution, we developed an air quality web site for teachers (http://epa.tas.gov.au/epa/air-quality-education-resources) and piloted the activities with both teachers and students. We initiated a series of activities with students to encourage them to:

- focus on issues in their school, home and local environs,
- use simple tools to observe and measure air pollution, and take action to reduce it.

We found there was considerable confusion associated with climate change gases, ozone depleting gases and air pollutants. In classroom discussions most students thought of climate change gases, e.g. CO_2, as air pollutants, and were not aware that some everyday products release chemicals into the air resulting in health problems.

The following investigations and activities provide background resources for teachers of 10-16 year-old students which we hope will support understanding of air pollution and its sources so that students can take appropriate action. By raising awareness of the unwanted chemicals and particles in the air they breathe, and their sources, students will be better informed to take greater care to avoid these pollutants and make healthy lifestyle choices.

Why Investigate Air?

One of the reasons why understanding air pollution is so important is the sheer quantity of air that passes through our lungs every day. Children (6 to 13 years old) breathe around 10,000 to 12,000 litres of air per day and adults 12,000 to 15,000 litres. 12,000 litres of air weighs about 34 lb. When we are active, running or doing any hard manual labour, we breathe faster because we need more oxygen to burn to give us more power. Figure 1 shows some typical breathing rates for children. Because we breathe so much air, even very tiny quantities of pollutants in the air can be harmful.

Consider these classroom exercises to raise awareness of how much air we breathe

1. **How long can you hold your breath?** Students work in pairs. Have students hold their breath for as long as they can, holding their noses. Try again. What happened? Why did they let go? What does this tell us about how important breathing is compared to eating and drinking?

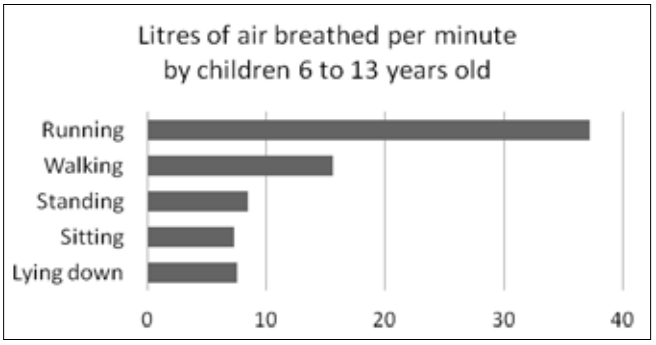


Figure 1: Examples of breathing volumes of children for various activities (adapted from Adams 1993)

2. **How many litres of air do we breathe every day? In a year?** Students time how long it takes them to breathe into a plastic bag which has been placed in a 2 litre jar (breathe in through the nose and out into the plastic bag). How many seconds does it take to fill the jar. Was the breathing normal?
3. **What is the weight of air breathed each day?** Students find the density of air on the internet. How does the weight of air compare to the weight of food and water consumed each day?

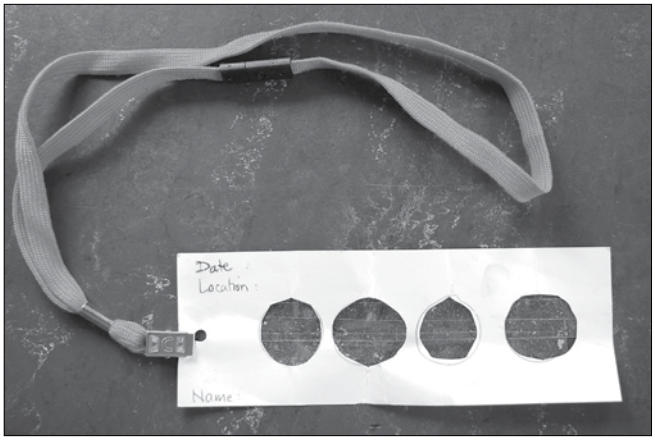
Testing for Suspended Particles: Simple experiments with particle collectors

Method One

Equipment: Cardboard, ruler, sticky tape

Cut a sheet of cardboard the size of a ruler. Cut holes with a diameter the width of a piece of sticky tape, and put sticky tape over the holes. Punch a hole in one end and attach a string to hang the collector. Select different sites around the school and neighbourhood to hang the samplers. Leave them in place for about a week and then examine them with a magnifying glass.

Design a results sheet. Record the date, place and describe particles. Compare results.[2]



Method One

Method Two

Method Two

Equipment: Sheets of plastic film, petroleum jelly, graph paper

Cut squares of plastic film. Stick them onto windows in various parts of the school. Smear the film with petroleum jelly. Place graph paper behind the window and count the number of particles.

After one day, use a hand lens or microscope to observe

What is in the air we breathe?

Clean, dry air is made up of oxygen (21% by volume and essential to most life on earth) and nitrogen (78% by volume and relatively inert). The remaining 1% is a mix of argon (an inert gas), carbon dioxide (the main greenhouse gas) and many trace gases. Along with a bit of water vapour to humidify the air, this provides the perfect mix to sustain healthy human beings.

Nowhere on earth is the air perfectly clean. There are 'natural' contaminants such as pollens and salt particles from the oceans. Some pollens cause allergic reactions or cause people to get hay fever and aggravate symptoms of asthma. The air also contains smoke particles from forest fires; this smoke is toxic, and breathing too much can increase the risk of respiratory disease and cancer. Of most concern to scientists and regulators are the many hundreds of compounds released into the air as a result of human activities. Just as rivers and oceans have been used for millennia to dump our unwanted wastes, the atmosphere has been used to disperse unwanted gases and particles from all manner of day to day and industrial activities. These air pollutants cause or aggravate many serious illnesses. Every year millions of people around the world die because the air they breathe is contaminated; the World Health Organization estimates about 3.3 million premature deaths each year due to air pollution.

There are two main groups of air pollutants: some pollutants affect our health immediately, especially in high concentrations; other pollutants may cause health problems many years after we are exposed to them. Some examples of air pollutants with immediate effects are carbon monoxide (high exposure causes death in minutes), sulphur dioxide (even moderate concentrations can cause coughing fits and nausea), and fine particles. Some examples of air pollutants with long term effects are asbestos fibres, tiny lead particles, and benzo(a)pyrene (a carcinogen that can cause lung cancer).

what has been collected. What different particles are there? Count particles and observe their size, shape and colour.

Examine the results of the experiments, and discuss air pollution in and around the school environment. Which area had the most, and least, particles? Where did they come from?

Particles in the Classroom

An effective tool we used in the classroom was the "*DustTrak*" which accurately measures concentrations of small particles in the air. "*DustTrak*" is a model of a particle counter used by air pollution professionals for measuring particles with a diameter of 10 microns or less. It might be possible to borrow this, or similar, equipment from local pollution control authorities, as schools can do in Tasmania.

At our school, students recorded elevated levels of particles from burning candles and incense, provoking strong reactions. Students did a tour of the school and accurately measured particulates in different areas such as the woodworking area, the food preparation area and the road.

Consider:

- Various averaging times to show that the air is not uniform, and that particle numbers change naturally over time.
- Compare particle levels when the room has been empty for half an hour with levels when the room is full or when the class is moving about.
- Place the *DustTrak* inlet close to someone's clothes and rub them - fine dust particles collect on clothes, even if they are washed regularly. Rubbing releases the particles, sometimes giving very high particle concentrations for a short time.
- In the classroom, when is there more dust in the air? Why?

Particles from Motor Vehicles

Motor vehicles are one source of fine particles. Diesel engines, especially when under load, emit many fine particles. All vehicles stir up particles from the road surface as they move, mostly from tyres and brakes. You can design some experiments to measure particle concentrations along major and minor roads.

Consider:

- Do weather conditions influence your results? Why?
- How far from the road must you be before you can no longer see increased pollution levels?
- How high are particle readings before you can smell the exhaust pollution?

The *DustTrak* can be used from a moving vehicle by attaching a plastic tube to the air inlet with the other end out the vehicle window, extending about 10 cm from the side of the vehicle to avoid dust from the wheels in the turbulent air close to the vehicle. A test can be conducted to demonstrate the higher particle levels on busy roads compared to minor roads, or to show the high particle concentrations when travelling behind a large diesel truck or bus.

A student using a DustTrak to measure particles generated by traffic

Green Driving

Traffic is a major source of air pollution in cities. Being conscious of environmentally friendly driving strategies will promote safety as well as reduce air pollution. The combined effects of thousands of drivers over a lifetime of good driving habits will have a significant impact on air quality in urban areas.

When it is not possible to walk, bike or use public transport, students can drive smarter to minimise vehicle impact on the environment. Have students make a checklist of good driving habits, using language they think will communicate their message to young learners. Some facts might include:

- **Don't idle** unnecessarily. Turn off the engine if you are waiting longer than 30 seconds.
- When **refuelling** minimize the time the petrol cap is off to reduce gas evaporation.
- **Lighten up** - Reduce weight in the car by removing unnecessary luggage. Remove roof racks when not in use to reduce drag.
- **Close windows** at high speed to lessen drag.
- **Tune In** - Check tyre pressure, alignment and treads to reduce fuel consumption.
- **Chill out** - Don't tailgate; reduce unnecessary braking and accelerating, thus reducing fuel consumption and particle emissions from brake linings.

The warning on this can reads: 'Inhaling contents can be harmful or fatal. Keep out of reach of children... If skin or hair contact occurs remove contaminated clothing and flush skin and hair with running water"

- **Obey speed limits** - the faster the car goes the greater the fuel consumption. Leave with plenty of time to get to your destination.
- **Cruise** Reduce short trips - cold engines emit more pollution because the catalyst in the exhaust doesn't work as well.

Ideas for lessons:

- Invite students to design an original green driver license which incorporates green driver tips.
- Have students assess their own green driving performance.
- Investigate other ways of communicating green driver tips to others at school and in the community. For example, write a letter to driver education schools inviting them to consider including green driving tips.
- Invite a driving instructor to respond to the checklist of good driving habits and respond to student questions.

Indoor Air Pollution

Most people spend up to 90% of their time indoors, so most of the air we breathe is indoors. Outdoor air pollutants will find their way into buildings, so outside air quality has a big influence on indoor air quality.

Indoors there are many other sources of air pollutants. Some building materials, furnishings and household products, including air fresheners, release small quantities of pollutants continuously. Other sources, like smoking, unvented stoves and heaters, cleaning products, pesticides, and paint strippers can produce high concentrations of pollution which can be trapped in the air for long periods. There is a custom in many European homes to freshen indoor air daily by opening doors and windows for a short time. [3]

Make an anemometer or use light streamers of paper, soft feathers or a strand of cotton taped onto a pencil. Watch the air flow in different parts of the room. [4]

Air Fresheners & Cleaning Products

It is estimated air fresheners are used in 75% of households. Air fresheners are commonly used to mask unpleasant indoor smells but do not get rid of source of the smell. [5]

Consider:

- Make a list of the active ingredients in air fresheners and cleaning products and research their health effects. Do all the products list the ingredients? Are there safety warnings?
- Research the function and health effects of phthalates (pronounced thalates).
- Compile a class survey to calculate how many air fresheners and cleaning products are used at students' homes. Find out if people are aware of the ingredients and their effects.
- What alternatives are there to air fresheners? Design a flyer to inform your community about maintaining good indoor air quality.
- Interview the cleaning staff at the school about the cleaning products they use. Are they effective? Is the staff affected by the fumes? Do they use protective clothing and gloves when using toxic chemicals? Do they take other safety precautions such as aerating cleaning spaces? What do they think about the cleaning products they use?

Spray Deodorants

There is a teenage culture of extensive use of aerosol deodorants in Tasmania. In some schools spray deodorants are banned. Our school visits often involved running the gauntlet of the stink of these deodorant sprays as we passed the locker rooms! Asking students to research the ingredients of these products encouraged them to address this air pollution issue from a personal perspective.

Attitudes regarding personal hygiene vary greatly around the world. In some cultures, intense body odour is considered desirable. In some countries such as South Korea people accept sweating as natural and do not use deodorant. In parts of Asia people use lime juice as a deodorant, and in Russia apple vinegar is traditionally used.

Consider:

- Research the ingredients of deodorants. Spray deodorants contain t–butyl alcohol and isoproyl myristse. Stick deodorant contains trimethylglycerine and ozokerite. Research these two chemicals and assess their relative health effects.
- Investigate how many students in the class use spray deodorant. Invite students to devise an experiment to research the effectiveness of aerosols, stick, roll-on, antiperspirants, and natural crystal deodorants compared to no deodorants or natural products such as lime juice and vinegar. Report on the social, environmental and economic impacts.

- Undertake a survey of adults in the community to indicate the percentage who use deodorants. Investigate gender and age differences in the responses.
- Create a recipe and container design for a natural deodorant, incorporating its benefits to air quality.

Inside New Cars

The smell of a new car comes from solvents evaporating from plastics. These can cause headaches, dizziness, nausea and drowsiness. Many of the same chemicals causing indoor air pollution are also found inside a car, and yet they are in a much smaller, sealed and compact space. A two-year study by the Australian Government found that dangerous toxic emissions could be so potent as to take effect within minutes of being seated in a new car. One of the chemicals, benzene, a carcinogen, was detected at levels five times those recommended for safety.

Recommendations for New Car Owners:

- Keep the car well ventilated for the first six months of use;
- Avoid long journeys in the new car if possible;
- Park in the shade (heat makes the chemicals more volatile).
- Do not use chemical air fresheners – they will add to the problem.[6]
- Investigate the smell of new cars. What do you notice about the smell?
- Make a list of recommendations for new car owners.

Nel Smit is an environmental educator in Tasmania, Australia, and the winner of a National Excellence in Teaching Award (2007) and the Bob Squires National Award for Excellence in Science Teaching (2006). **John Todd** is an Adjunct Professor at Edith Cowan University in Western Australia. He lectured in environmental studies from 1978 to 2002 at the University of Tasmania and now is the Director of a small consulting firm specialising in air quality and energy efficiency in Tasmania. Together, they developed the Air Quality Education website for the Environmental Protection Authority in Tasmania, http://epa.tas.gov.au/epa/air-quality-education-resources. More suggestions for classroom activities are provided on the website.

Notes:

1. Adams, WC, 1993; *Measurement of Breathing Rate and Volume in Routinely Performed Daily Activities*, Report A033-205; California Air Resources Board Sacramento, USA

2. From *Clean Air – what's in it for us, An Air Pollution Program for Secondary Schools, Air Watch, 2008, p.40*; available from www.epa.vic.gov.au publications

3. Additional facts on health risks from cleaners, air fresheners, and other products can be found online at: <www.lung.org/healthy-air/home/resources/cleaning-supplies.html>

ScienceDaily (May 24, 2006) <www.sciencedaily.com/releases/> 2006/05/060524123900.htm

<www.naturallifemagazine.com/0810/airfresheners.htm>

4. www.energyquest.ca.gov/projects/anemometer.html

5. www.nrdc.org/health/home/airfresheners/airfresheners.pdf

6. www.pollutionissues.co.uk/new-car-smell.html