The Alberta Science Teacher

Volume 34, Number 1 June 2015

Tree cookie art prepared by Grade 6 students from St Dominic Fine Arts School, in Calgary.

Contents

Editor's Message

I am excited to be part of the ATA Science Council as the new newsletter editor. Having served on the Science Council executive for the last three years as a conference codirector, then director, I am in awe of the dedication of science teachers in Alberta. I am inspired by their creativity, innovation and sharing nature, and I hope that the Science Council can continue to inspire and meet the needs of our members in the future.

This issue has a little bit of everything science. There are practical insights from experienced teachers discussing science skills necessary at all grade levels. A variety of successful collaborative learning opportunities are described to inspire others to try them with their students. Actionable and creative cross-curricular ideas are shared for those who are looking for that unique twist in their science program. And to round out the issue, a book review and some book suggestions provide some interesting food for thought.

I would like to thank Daniel Grassick for serving as the newsletter editor these last few years. I will miss his editorial rants on science education and his engaging and creative science opportunities for students. Who knows? He might contribute an opinion or two in future issues.

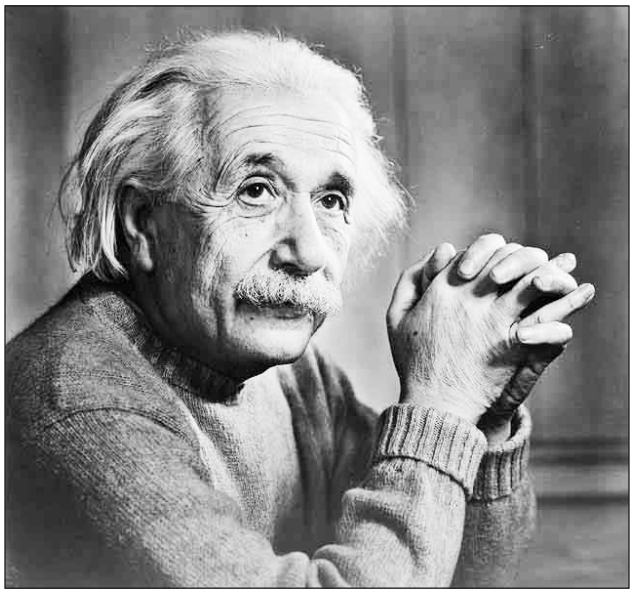
Do you have some great resources to share? Have you attended a fantastic PD activity? Or have you been doing something creative, innovative and inspiring with your students? If you answered yes, then share your experience with others by submitting an article for the next issue. Please submit to Trinity Ayres at ayres@shaw.ca.

A motto I like to live by:

> Learn from yesterday, live for today, hope for tomorrow. The important thing is not to stop questioning.
> —*Albert Einstein*

Looking forward to the next issue!

Trinity Ayres



President's Message

Welcome to 2015! I wanted to write something witty and inspirational for my first president's message, but that's all I could come up with. I can see an exciting year for science teachers here in Alberta. The 2014 conference in Banff was a terrific success despite Adam Savage dropping out at the last minute. Adam Kreek and Richard Zurawski gave engaging and motivating talks. I was absolutely amazed at Adam's story of rowing across the ocean. It put my life in a harsh perspective when I sometimes have a hard time just getting out of bed. In addition to our fabulous keynote speakers, the sessions were absolutely stellar. Ranging from numerous physics workshops to assessment sessions to problem-based learning and flipped approaches, the sessions crossed the entire education spectrum and left me feeling inspired and excited to incorporate new ideas into my teaching practices.

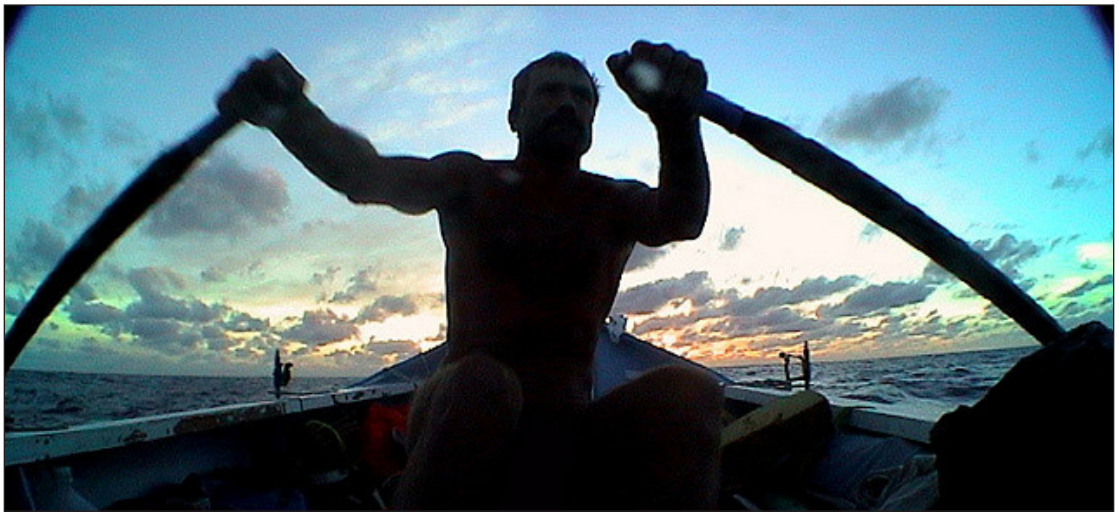
In the coming months, the Science Council will be collaborating with the Math Council to bring you Conference 2015. This joint conference will be held at the Fantasyland Hotel in Edmonton on October 23–25. We're bringing together the highest quality professional development opportunities from both disciplines, and I'm excited to say that one of our keynote speakers is Chris Hadfield! Registration opened on February 1. Hope to see you there!

Even though we're still 10 months away from the 2015 conference, planning is already under way for Conference 2016. We're in negotiations to go back to the wonderful facilities at the Banff Centre!

In addition to the annual conference, the Science Council is involved in a number of initiatives that involve providing regional professional development throughout the province. If you want to arrange a science-focused workshop or have an idea for PD but aren't quite sure how to get it started, contact me and I'll be happy to discuss how the Science Council can support you. I'll also be sure to let you know how you can support the Science Council. Remember, we are made up of teachers working for teachers. If you'd like to get involved in the Science Council by becoming an executive member or helping out in some other way, just get in touch with any member of the executive.

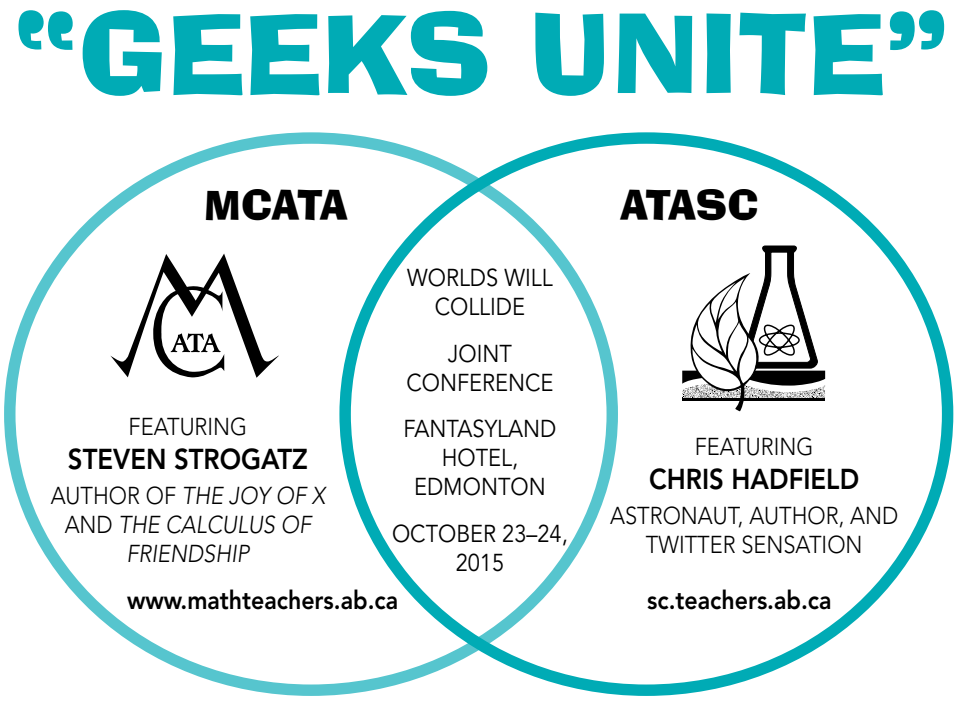
Have a great year! I hope to see you at the conference in October.

Ian Doktor



Conference 2015

Joint Conference of the Math and Science Councils



FINE PRINT: WE ANTICIPATE THAT THIS CONFERENCE WILL SELL OUT. REGISTER EARLY TO AVOID DISAPPOINTMENT. REGISTRATION LINKS ARE ON BOTH COUNCILS' WEBSITES.

Come join the Mathematics and Science Councils of the ATA celebrate their first joint conference "Geeks Unite" at the Fantasyland Hotel, West Edmonton Mall, Edmonton, Alberta.

Pick up your conference registration package at the conference registration desk from 6 to 9 PM, Thursday, October 22, and from 7 to 11 AM, Friday, October 23.

In your registration package, you will find your name tag. Wear your name tag at all times. It ensures your entrance to your chosen sessions. Your registration includes a ticket for the Friday buffet breakfast, Friday lunch, Friday wine and cheese, Saturday buffet breakfast and Saturday lunch. Your name tag will also be your entrance ticket to Chris Hadfield's keynote address. No reprinting of your name tag is possible.

What: 2015 Science Council Conference

When: October 23–25, 2015

Where: Fantasyland Hotel, Edmonton

Who: You, a famous astronaut and a few of your mutual friends

Why: Outstanding math and science education PD in the capital

How: Check out https://event-wizard.com/GeeksUniteMathScience/0/welcome/

The Mathematics and Science Councils are offering only one type of registration for the entire conference to the first 500 paid-in-full registrants. Once the 500 spaces are full, registration will close. Due to the popularity of the keynote speakers, we anticipate that the conference will sell out quickly. Don't be disappointed; register as soon as possible. Once registration is full, please sign up for the waiting list at mathematicsconference@shaw.ca. Your position on the waiting list will be the time stamp when your e-mail is received.

Conference session times follow:

Thursday, October 22

6:00–9:00 PM	Registration only

Friday, October 23

9:00 AM–7:00 PM	Displays
7:00–11:00 AM	Registration
7:45–8:30 AM	Breakfast
8:30–9:00 AM	Opening remarks and Mathematics Council Awards
9:00–10:15 AM	Keynote speaker Steven Strogatz
10:30–11:45 AM	Session 1
11:45 AM–1:00 PM	Lunch
1:15–2:15 PM	Session 2
2:30–3:30 PM	Session 3
3:45–4:45 PM	Mathematics Council AGM and Science Council AGM (separate rooms)
5:00–7:00 PM	Wine and cheese social and games night

Saturday, October 24

9:00 AM–1:00 PM	Displays
7:45–8:30 AM	Breakfast
8:30–9:00 AM	Opening remarks and Science Council Awards
9:15–10:15 AM	Session 4
10:30–11:30 AM	Session 5
11:30 AM–1:00 PM	Lunch
1:00–2:00 PM	Keynote speaker Chris Hadfield

For further information and ongoing updates, visit www.mathteachers.ab.ca or www.sc.teachers.ab.ca.

Keynote Speakers

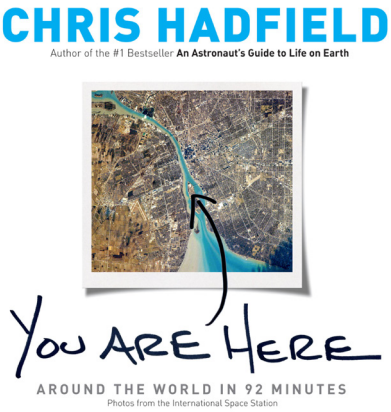
Chris Hadfield

"Good morning, Earth!" That is how Colonel Chris Hadfield—writing on Twitter—woke up the world every day while living for five months aboard the International Space Station. Through his 21 years as an astronaut and three space flights, Colonel Hadfield has become a worldwide sensation, harnessing the power of social media to make outer space accessible to millions and infusing a sense of wonder into our collective consciousness not felt since humanity first walked on the moon. Often called "the most famous astronaut since Neil Armstrong," Colonel Hadfield continues to bring the marvels of science and space travel to everyone he encounters.

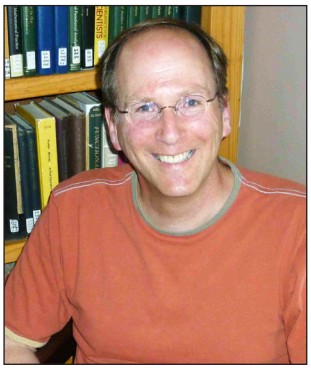
Colonel Hadfield is a pioneer of many historic firsts. In 1992 he was selected by the Canadian Space Agency as a NASA mission specialist—Canada's first fully qualified space shuttle crew member. Three years later, aboard Shuttle Atlantis, he was the first Canadian to operate the Canadarm in space, and the first Canadian to board a Russian spacecraft as he helped build space station Mir. In 2001, aboard Shuttle Endeavour, Colonel Hadfield performed two spacewalks—the first Canadian to do so—and in 2013, he was commander of the International Space Station—the first and only Canadian to ever command a spaceship, so far.

During his multifaceted career, Colonel Hadfield has intercepted Soviet bombers in Canadian airspace, lived on the ocean floor, been NASA's director of operations in Russia, and recorded science and music videos seen by hundreds of millions. His zero-gravity version of David Bowie's "Space Oddity" received over 10 million views in its first three days online.

A heavily decorated astronaut, engineer and pilot, Colonel Hadfield's many awards include receiving the Order of Canada, the Meritorious Service Cross and the NASA Exceptional Service Medal. He was named the Top Test Pilot in both the US Air Force and the US Navy, and has been inducted into Canada's Aviation Hall of Fame. He is the author of the internationally bestselling books *An Astronaut's Guide to Life on Earth* and *You Are Here: Around the World in 92 Minutes*, and has been commemorated on Canadian postage stamps, Royal Canadian Mint silver and gold coins and on Canada's newest five dollar bill (along with fellow astronauts Steve MacLean and Dave Williams).



Steven Strogatz

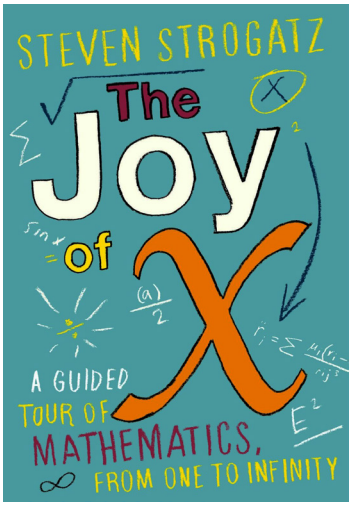


Steven Strogatz is a multiple award-winning researcher, author and professor. Currently the Jacob Gould Schurman professor of applied mathematics at Cornell University, he graduated summa cum laude in mathematics from Princeton, studied at Trinity College in Cambridge and completed his doctoral work in applied mathematics at Harvard, followed by a National Science Foundation postdoctoral fellowship at Harvard and Boston Universities. From 1989 to 1994, Strogatz taught in the Department of Mathematics at the Massachusetts Institute of Technology. He joined the Cornell faculty in 1994.

Strogatz has broad research interests. Early in his career, he worked on a variety of problems in mathematical biology, including the geometry of supercoiled DNA, the dynamics of the human sleep-wake cycle, the topology of three-dimensional chemical waves and the collective behaviour of biological oscillators, such as swarms of synchronously flashing fireflies. In the 1990s, his work focused on nonlinear dynamics and chaos applied to physics, engineering and biology. Several of these projects dealt with coupled oscillators, such as lasers, superconducting Josephson junctions and crickets that chirp in unison. In each case, the research involved close collaborations with experimentalists. He also likes branching out into new areas, often with students taking the lead. In the past few years, this has led him into such topics as the role of crowd synchronization in the wobbling of London's Millennium Bridge on its opening day and the dynamics of structural balance in social systems.

He has spoken at TED and is a frequent guest on National Public Radio's *Radiolab* and *Science Friday* programs. In the spring of 2010, he wrote a weekly blog about mathematics for the *New York Times*; the *Harvard Business Review* described these columns as "a model for how mathematics needs to be popularized." His second *New York Times* series, Me, Myself and Math, appeared in the fall of 2012. Strogatz has also filmed a series of 24 lectures on Chaos for the Teaching Company's Great Courses series.

He is the author of *Nonlinear Dynamics and Chaos* (1994), *Sync* (2003) and *The Calculus of Friendship* (2009). His most recent book, *The Joy of x* (2012), has been translated into 15 languages.



Specialist Council Conference Grants

The ATA Educational Trust is a registered charitable organization closely affiliated with the Alberta Teachers' Association. Each year, the Trust offers bursaries and grants to Alberta teachers and educational researchers. Through its bursary program, the Trust encourages teachers to advance their knowledge and teaching skills by enrolling in courses of study. The Trust's grant program encourages teachers to attend specialist council conferences and develop resources or undertake research in education that will be of practical value to colleagues.

Each year, the Trust awards a number of grants to help defray the costs associated with attending an ATA specialist council conference. Eligible expenses include registration, accommodation, fuel and food. Only expenses not covered by other grants will be considered for compensation. To apply for this grant, please complete and mail the application form by September 30, 2015. The form is included with this newsletter, but can also be downloaded from www.teachers.ab.ca/SiteCollectionDocuments/ATA/For-Members/Programs-and-Services/Grants-Awards-and-Scholarships/AR-ETF-5b%20-%20$400%20conference%20grant.pdf.

ATA EDUCATIONAL TRUST

Executive Contributions

Here's an Idea! Experiments in Science!

Currently, Alberta Education is in the process of reforming education. Inspiring Education has created a vision for educated Albertans in 2030, and, potentially, a curriculum redesign is on the horizon. What does this redesign mean for science educators? According to the *Curriculum Development Prototyping Guide* (Alberta Education 2013) sent to school boards, the essence statements for science are as follows:

Science is …

- engaging in the human pursuit to understand the relationships within the living and nonliving universe
- developing explanations and predictions that can be tested and refined through the process of scientific inquiry
- understanding systems consisting of interconnected living and nonliving components
- understanding static and dynamic balance of matter and energy
- understanding patterns of similarity and diversity
- understanding relationships between structure and function.

Traditionally, the programs of study in science have focused primarily on providing students with a firm understanding of such scientific concepts as the particle model of matter, the law of conservation of mass and Newton's laws of motion. It is this focus on conceptual understanding over a memorization of facts that has made our curriculum so strong globally. However, one essential part of science education has had its importance understated—the nature of science.

When looking at the essence statements, I see the need for students to be able to think scientifically. Students must know how to make observations and understand the difference between an observation and an inference. They should be able to design experiments to test the relationship between two variables. Students should know how to control all other variables that would otherwise influence the results of the responding variable. Students should understand why a control is necessary and have a basic idea of what the terms *accurate, valid* and *reliable* mean. Scientifically literate people know what the difference is between a law and a theory and understand that a correlation between two variables does not necessarily imply a causal relationship. The nature of science is certainly discussed in the programs of study for science, but it is not given the weight that it deserves.

For the last four years, I have been making it a priority to provide opportunities for my Division III students to engage in scientific problem solving as a strategy for teaching the content in the program of studies. This has been a challenge simply because there is so little time to allow students to perform experiments and cover all of the required topics. It has been a very messy process, but I would like to share some of my successes and strategies that have inspired the aha moments for my students.

Begin with Simple Observations

Most science teachers are shocked to find out how difficult it is for the average person to think like a scientist. I like to begin by having students observe a phenomenon and record their observations. My favourite thing to have students observe is a Newton's cradle. I drop one sphere—never

refer to them as balls in front of junior high students—and ask the students to record what they observe. They share their observations with a partner, then with the class. This simple think-pair-share activity leads into a discussion about the difference between an observation and an inference. Most students want to explain why the spheres behave the way that they do. They will say things like "a force pushed through the spheres to the one on the other end." Making inferences instead of observations is common, and once students learn how to separate the two, analysis and concluding is much easier to do. Soon enough, students observe two spheres dropping. When it is time to drop three spheres, I ask students to predict what will happen. This is when we make inferences and develop hypotheses. I do not perform the experiment until we have developed several good hypotheses. A typical number of well-made hypotheses for any given class is five. When the experiment is performed, the students who got it right cheer the loudest. At that point, I like to mention that getting a hypothesis wrong is what leads to the greatest discoveries, for example, the discovery of the atomic nucleus. Students must feel safe about having a hypothesis that disagrees with the outcome.

I saw a great session at the Science Council conference several years ago that involved mystery boxes. They all contained discrepant events, which of course led to the idea of making inferences, then ultimately designing experiments. The instructions in one box directed the teacher to pour 500 millilitres of water into a funnel causing 1,000 millilitres of coloured water to come out of a tube at the bottom.

Choreograph the Skills

When I began as a science educator, I liked to do many labs but put little emphasis on the report. I felt that formal reports were laborious and defeated the purpose of having students learn the concept behind the lab. I realized, however, that the key skill students needed to design their own experiments was report writing. Therefore I had to choreograph their lab-writing skills so that they could independently design experiments.

I like to begin with cocreating criteria for a well-written report by examining an exemplar. I show the portions of a report that I have made up and have students discuss what aspects of the exemplar make the report a good one. We start with the problem, look at the variables, then the hypothesis, materials and procedure. I typically stop at the procedure before having them design their own experiment. Students use the criteria that they have made as a guiding tool to design their experiment, typically a simple study between two variables. Once their experiments are designed, I teach them how to complete observations, make an analysis, then a conclusion. Together, we cocreate the criteria for a scientific report. When it is time for students to conduct their experiment, it is noticeable how few of them need any assistance. After all, they have complete ownership of the design, quality and assessment of the experiment.

Have Students Design a Simple Experiment

The program of studies is full of opportunities to design simple tests of two variables. For example, in Grade 7 Structures and Forces, students can design an experiment to determine how the number of spaghetti pieces bundled or grouped together affects its overall strength. This is quite open-ended, but it allows students to design an experiment with variables that need to be controlled. I always insist that the manipulated variable be tested in multiple quantities in the experiment so that a pattern can be made. For example, the students would test the strength of spaghetti by starting with one piece, then adding one more until they reach ten. Having a range of data is superior to only two data points, and the pattern can be graphed to analyze the nature of the relationship.

When students design more complex experiments, they will learn that if they observe a chaotic pattern, it means that a variable was not

controlled. There must always be a pattern between two variables if all other variables are controlled. Variables must increase together or decrease as one increases or no effect will be observed. It is essential to assess the experiment and determine ways to improve the design. This experimental evaluation can be done in the conclusion.

Students Appraise Experimental Design

Once the students have some experience designing experiments, they can use the experience to evaluate the accuracy and validity of tests performed by others. There are numerous examples of pseudoscientific claims on the Internet, and it is exciting for students to look at experimental processes and critically break down the design flaws. This activity follows with a discussion about why being scientifically literate is important. Scientific claims are made regularly that involve only a small sample of data. Students learn that they cannot simply accept all claims without first looking at how investigations are carried out.

Assessment

To assess laboratory skills and nature of science, I go back to the criteria that we created as a class and have students self-assess. At first, I have to spend some time explaining that the assessment is not their mark. The self-assessment is a record of their current understanding with the intent to improve it. The mark is an evaluation that only the teacher can perform, and it is always an evaluation of each individual—never a group. As students meet more of the criteria, their evaluation increases and low marks are replaced with high marks. I do not believe in averaging, because an average does not indicate a valid score of current understanding. Students become extremely motivated by this process because they understand what is required of them to produce a high-quality product.

Finally, I like to include nature of science questions on tests as written-response questions. I will ask students to design or evaluate experiments and make analyses and conclusions of data.

When I began to make the nature of science a major theme in all of my science lessons, I realized the degree to which Division III students need to be taught how to think critically. Teaching concepts followed by a cookbook-style lab activity did not encourage the growth of these skills. The concepts in the program of studies have become the underlying context of what needs to be tested next. Rather than having slide presentations of facts to remember, my students were designing ways to test relationships between variables. This way the vocabulary becomes necessary to articulate their understanding rather than some strange words to be memorized for a test.

It is my hope that if a curriculum redesign does occur, that the nature of science is placed at the forefront of the Scope and Sequence for Science. Teachers of science often struggle to complete outcomes in the time period set out for them, especially in classrooms with students of varied needs. I have found that most students, regardless of their special needs, tend to shine when given challenges associated with thinking scientifically if given the opportunity to learn the skills gradually. Perhaps if the new curriculum allows science teachers to take the time required to explore using student-designed experiments, then we will be able to produce a more scientifically literate population of critical thinkers. Many of the greatest issues that we face today, such as the enhanced greenhouse effect, require the society at large to work together. Scientific literacy is essential in this endeavour.

Reference

Alberta Education. 2013. *Curriculum Development Prototyping Guide.* Alberta Education website. https://education.alberta.ca/media/7779143/curriculum%20development%20protoypting%20guide.pdf (accessed April 8, 2015).

Greg Wondga
Division III Director

Grade 4 Environmental Leadership Academy

We all know it takes a village to look after children. That can also be said about our environment. Not one person or one group of people can do this on their own.

As part of Crestwood School's Leadership Academy, in Medicine Hat, Alberta, we will be asking all of the teachers and students in the school to join us in reaching our goal: all Crestwood students and staff will have a vested interest in the environment with a wider circle of influence growing as they teach their families about conservation and healthy environmental practices.

How We Will Do This?

- Through the science curriculum unit Waste in Our World, the Grade 4 students will become facilitators trained to lead Crestwood School into becoming environmentally friendly by giving presentations, miniclassroom inservices on correct procedures (how to rinse milk cartons), awareness updates (what we found in the paper recycling bins—yuck!) and announcements on the PA system (upcoming contests, tips and facts on recycling).
- The Grade 4 student teams will begin with the end in mind and adopt a class to present conservation and recycling presentations to classes in late October. The teams will visit this class during the year to promote different activities; for example, a lights-off contest; a caught-you-recycling pencil giveaway; a litterless lunch day (working toward an increase in daily litterless lunches); an increase classroom oxygen awareness day, with a spider plant for each classroom; the 2015 classroom energy diet challenge, sponsored by Shell and Canadian Geographic, as well as a milk jug stomp for charity.
- An EvLA (Environmental Leadership Academy) blog will be established.
- All grade levels will send two students to a monthly green team meeting. These students will then become leaders in their own classes and help rekindle our green school activities challenge.
- As was mentioned before, for an environmentally friendly community to be effective, everyone in the school must be involved. Becoming personally vested creates ownership for responsible environmental stewardship. The area of need is vast.
- Each grade level will be responsible for an area of their choice; for example, Grade 4C collects paper and milk cartons, Grade 4B collects whiteboard markers and Grade 4A collects used batteries, Grade 6 collects juice boxes and Grade 2C collects pop can pull tabs.
- We ask that every class sign up to be responsible for two weeks of playground litter clean up. Classes will have two weeks to ensure the playground is litter free. Then the playground litter clean up torch will be passed on to another class. By taking turns looking after the playground, students will start to take ownership of it. They won't accept their peers throwing trash on the ground if they have to pick stuff up for an extended period of time.

This Environmental Leadership Academy is not just for Grade 4. It's for all of us. We hope to make it a habit to be environmentally accountable at Crestwood School.

Audrey Pavelich
Science–Elementary Director

Book Review:

An Astronaut's Guide to Life on Earth: What Going to Space Taught Me About Ingenuity, Determination, and Being Prepared for Anything

Chris Hadfield

Chris Hadfield is synonymous with his YouTube hit "Space Oddity." He is not only a good musician but also an excellent writer. In his memoir of his career, he recounts all the paths, obstacles and training he encountered in his three visits to space.

While the book is filled with all the training one can expect in an astronaut's career, it also contains numerous lessons drawn from the training. While not everyone will have to undertake astronaut training, these lessons are applicable to everyday life. It is these lessons and nuggets of insight that I found the most interesting.

For example, astronaut training emphasizes attention to detail ("sweating the small stuff"), teamwork and developing competence. Competence not only means being able to complete a task but also encompasses "ingenuity, determination, and being prepared for anything." Chris Hadfield defines success as "feeling good about the work done throughout the long, unheralded journey" to space. That message should be taken to heart: life should not be measured only by the end goals but by small victories along the way. A change in perspective is necessary in order to remain optimistic and focused to the task.

While I had initially expected a detailed account of the training Hadfield received as an astronaut, I was pleasantly surprised by the life lessons that could be extracted from his story. In fact, by midway through the book when he describes his cosmonaut training in Russia, I had become disengaged from the book. By then, I was more interested in the wisdom that he espouses from the book. While the book is not categorized as self-help, it certainly offers an industrious, optimistic, but yet humble way to live one's life. While it should be read by all, it is a must-read for young adults and those seeking change in their lives.

Leon Lau
Science—Division IV Director

Homework—An Educational Benefit or a Fruitless Burden?

In the study of science, where hands-on learning and complex experiments enhance a student's experience, does homework effectively reinforce concepts? Surveys indicate that students are spending an increased amount of time on homework, yet American students place somewhere in the middle of international academic rankings, according to an article in the *New York Times*.

Titled "The Trouble with Homework," an article by writer Annie Murphy Paul argues that the quantity of homework is not as important as its quality. "New research suggests that a lot of assigned homework amounts to pointless busy work that doesn't help students learn, while more thoughtful assignments can help them develop skills and acquire knowledge."

Homework ranks very low in a study of influences on student achievement in author John Hattie's latest book, *Visible Learning*.

Personally, I have no fascination with homework, especially the repetitive type assigned on a daily basis. We may all agree that it is important to reinforce concepts. However, my take on this need is simple and practical. It is better to provide an opportunity in class where the teacher is available to guide students through concepts, especially in the study of science, than arbitrarily assigning homework.

If there is a compulsion to hand in homework for grades, some might simply copy hurriedly from friends or books and hand it in without understanding it. This defeats the original purpose of assigning homework and does little to improve a student's skill set.

Homework also has a negative connotation to it. It is the feeling of forced work that takes away from spending quality time with family, learning a sport, developing a hobby, acquiring some life skills and much more.

Students are more motivated to pay attention and work effectively in class when they are aware that once they leave the classroom, homework will not follow them around. Additionally, a teacher can supervise their work, making for an effective learning environment which might aid more for student achievement.

References

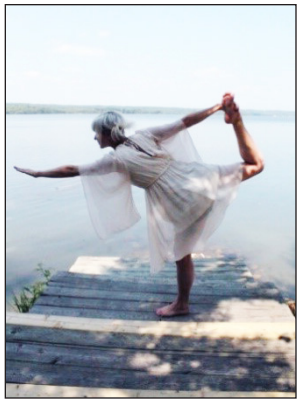
Murphy Paul, A. 2011. "The Trouble With Homework." *New York Times,* September 10. http://learning.blogs.nytimes.com/2011/09/14/does-your-homework-help-you-learn/?_php=true&_type=blogs&_r=0 (accessed April 17, 2015).

Hattie, J. 2009. *Visible Learning.* http://visible-learning.org/hattie-ranking-influences-effect-sizes-learning-achievement/ (accessed April 17, 2015).

Rekha Dhawan
Chemistry Director

Human Systems and Yoga: Biology 20 Unit D

This past summer I completed my 200-hour integrative yoga therapy teacher training, a world-renowned intensive therapeutic yoga teacher training that certifies students to be internationally recognized through the yoga alliance. I was fortunate to participate in this training in my beautiful hometown of Lac La Biche, Alberta. Doing morning practice to the beautiful sunrise, basking in the sun on a lunch hour kayak excursion and practising a yoga nidra (yogic sleep) each day guided me into the most relaxing summer I have ever had. Learning an in-depth analysis of our anatomical structures in terms of physical and mental self, I couldn't help but fantasize how I could use these practices to better myself as a teacher. The science teacher in me scrutinized the effects particular asanas (poses) and pranayamas (breathing techniques) have on the body. The biology teacher in me was particularly intrigued learning asanas that focused on the excretory system and detoxifying the body and how practising them encouraged my body to urinate more often than I was used to. I couldn't help but smile thinking of leading a session in my Biology 20 class when we talk about the kidneys. Planning a lesson to include asanas that are good for the digestive and circulatory systems, and pranayamas that are good for the respiratory system is an integrative way to educate students about health and to get students out of their desks.



Namaste

References

Alberta Education. 2007. *Biology 20–30*. Edmonton, Alta: Alberta Education.

Danika Richard
Biology Director

Effects of yoga on the various body systems:

Body System	Information	Alberta Education (2007) curriculum connection
Muscular system	Muscles are highly vascular and stretching provides a squeeze and soak effect that can bring up to five times the amount of blood into a muscle.	20–D4.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions • obtain and interpret data to demonstrate a direct correlation between energy use by muscle cells and heat production
Muscular system	Stretching removes waste products such as lactic acid from the muscles.	20–D4.1k explain that concepts, models and theories are often used in interpreting and explaining observations and in predicting future observations • analyze the effects of exercise on muscle fibre
Muscular system	When combined with healthy strengthening, stretching facilitates optimal functioning of the muscles by creating maximum contraction and maximum relaxation.	20–2.4k summarize and explain the role of ATP in cellular metabolism; • muscle contraction
Muscular and circulatory system	The arteries are smooth muscles. Stretching releases chronic contraction and facilitates the expansion and contraction necessary for optimal blood flow.	20–D4.1k explain how the motor system supports body functions (i.e., digestive, circulatory, respiratory, excretory and locomotory), referencing smooth, cardiac and striated muscle
Respiratory system	Pranayama practices increase breathing capacity and efficiency of the lungs, which energizes the body and purifies it of waste products. Pranayama also increases oxygenation of the blood, which allows for better supply of nutrients to the cells.	20–D1.2s conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information • perform an experiment to examine the mechanics of breathing, such as lung volume, breathing rate
Digestive system	The digestive system is highly muscular (smooth muscles). The intestines use a rhythmic muscular contraction called peristalsis to move food through the digestion and elimination process. These muscles are susceptible to stress and relax through stretching. Yoga is unique in its emphasis on stretching the abdominal organs in exercises such as Agnisera Dhauti (abdominal pumping).	20–D4.1k explain how the motor system supports body functions (i.e., digestive, circulatory, respiratory, excretory and locomotory), referencing smooth, cardiac and striated muscle

2014 Conference Speaker Contributions

We know that not every science teacher in Alberta can attend the annual Science Council conference, so here are some ideas and resources that were provided by speakers who presented at the conference in Banff.

Books for Science Teachers

I am a staunch advocate of reading as widely as possible in order to amass a host of stories concerning scientists' lives, scientific theories and scientific developments. With sufficient stories at hand, I feel it is possible for us to leaven lecture material just enough to entertain our audiences and help explain what might otherwise appear to be rather dull content dreamt up by countless pasty white guys in lab coats over the last few centuries. This year I encountered many captivating books, 10 of which I wish to bring to your attention.

If you have encountered other worthy reads of late, please send the details to me at ian.phillips@epsb.ca.

Chris Turner, *The War on Science: Muzzled Scientists and Wilful Blindness in Stephen Harper's Canada*, Greystone Books, 2013 (176 pages).

This is a shocking and revelatory read on what has happened, and continues to happen, to Canadian government scientists, their research and the research facilities they staff. Stephen Harper has visited the North annually for about seven years now arranging as many photo ops as possible while trumpeting his government's commitment to the North. However, the only weather and research station in the far north that is crucial to gathering evidence about climate change, the effects of which are more pronounced in the Arctic, has suffered slashed funding! The cuts mean that we will no longer collect the kind of data needed to keep tabs on climate change with any confidence. The planned closure of the world-famous experimental lakes area, which has been rescued for the moment by monies from Kathleen Wynne's Ontario government, and the cancellation of the long form census are but two acts of wilful blindness perpetrated by our current federal government. I should point out that, despite its title, this book is no liberal diatribe—it offers praise or heaps brick bats as necessary on politicians and governments of both the left and the right. The seminal work of the Environment Canada during the Mulroney era is much lauded.

Chris Wood and Ralph Pentland, *Down the Drain: How We Are Failing to Protect Our Water*, Greystone Books/The Gordon Foundation, 2013 (297 pages).

If you were not already worried about the quantity and quality of the water supply in Canada, you should be once you've read *Down the Drain*. Trust me, you will think seriously about the future of our water every time you turn on the tap or flush the toilet. Following a history of water management in Canada, the authors relate the

multitude of ways that federal and provincial governments have botched the job of protecting the water we rely on for consumption, recreation and people's livelihoods. The current drought in California is one harbinger of the future effects that climate change will have on the overtaxed water supplies of Canada, most particularly in Alberta. Ongoing farmers' requests for irrigation water from the Oldman River are projected to exceed the total flow of that waterway as the spring flow ebbs with the reduction in winter snows in response to climate change.

Simon Quellen Field, *Culinary Reactions: The Everyday Chemistry of Cooking*, Chicago Review Press, 2011 (288 pages).

The precise chemical reactions of the acids, bases, proteins, carbohydrates and other ingredients in our food that occur when we execute even the simplest of recipes available are endlessly fascinating. This book and its scientific recipes for making a variety of foods is one that shall remain on my shelf for a long time; this most out-of-the-ordinary book has no best-before date in my opinion.

Dan Riskin, *Mother Nature Is Trying to Kill You: A Lively Tour Through the Dark Side of the Natural World*, Touchstone, 2014 (272 pages).

This is a fantastic and very funny read on the multitude of fascinating, messy and frankly gross lives of many organisms. The section on the insidious effects on behaviour of human parasites is riveting. All the stories in this book are viewed through the lens of natural selection.

Sam Kean, *The Violinist's Thumb: And Other Lost Tales of Love, War, and Genius, as Written by Our Genetic Code*, Little, Brown and Company, 2012 (416 pages).

If a biology teacher ever wanted a story to tell about genes, genetics and its history, brain size and intelligence, and the blind alleys followed by early scientists, you will find it in this comprehensive but eminently readable book. Sam Kean is the author of another excellent book, *The Dissolving Spoon*, an explanation of the world through the periodic table (the title of the German edition roughly translates to the order of all things).

Daniel Chamovitz, *What a Plant Knows: A Field Guide to the Senses*, Scientific American/Farrar, Straus and Giroux, 2013 (192 pages).

A superb slim volume that investigates the history and the latest research on plant senses. This beautiful and inexpensive little book is essentially an intriguing description of how plants experience their surroundings. The topics are recounted in sufficient detail to satisfy the expert with a PhD, yet accessible enough to fascinate the biology high school student. Aspects of plant physiology, such as their response to touch and light (phototropism) required of the Science 10 curriculum, are covered exquisitely.

Last summer, just to show you that I am in fact interested in topics other than the physical sciences, I read a quartet of rather interesting books on the science of learning and some attendant education myths.

Tom Bennet, *Teacher Proof: Why Research in Education Doesn't Always Mean What It Claims, and What You Can Do About It*, Routledge, 2013 (232 pages).

Philip Adey (editor), Justin Dillon (editor), *Bad Education: Debunking Myths in Education*, Open University Press, 2012 (297 pages).

Daniel T Willingham, *When Can You Trust the Experts? How to Tell Good Science from Bad in Education,* Jossey-Bass, 2012 (272 pages).

These three books offer veritable prescriptions, checklists and sound advice that will help inoculate you against the pressure to implement many education myths in your teaching (left-brain right-brain thinking, multiple intelligences,

streaming of students based on ability, social and emotional intelligence, dyslexia, multitasking, the benefits of Smart Board technology, and formal and informal education to name a few). Tom Bennet's *Teacher Proof* is very entertaining, most particularly when he discusses how to accommodate classroom observations by school inspectors (common in the UK) and when you are being asked to implement changes in your teaching methods that are based on ideas of a shaky or nonexistent research basis. One telling comment from *Bad Education*, I paraphrase, points out that many of those countries languishing near the bottom of the PISA and TIMMS assessments used pretty much the same teaching methods and so on as those jurisdictions that ranked near the top! *When Can You Trust the Experts?* is a most apropos analysis of the "truth" behind the oft grossly exaggerated "based on the latest research" label that accompanies so many new education games, programs and philosophies.

Daniel T Willingham, *Why Don't Students Like School: A Cognitive Scientist Answers Questions About How the Mind Works and What It Means for the Classroom,* Jossey-Bass, 2010 (240 pages).

This other Willingham book, focusing as it does on student difficulties with schooling, supplies a large number of explanations to illuminate the host of reasons students these days find school challenging and stressful. This book emphasizes the crucial aspects of story, emotion, memory, context and routine in constructing knowledge and developing learning experiences that stick. Willingham incorporates simple but impactful diagrams illustrating how memory functions in many chapters. These diagrams evolve meaningfully in subsequent chapters of the text. I feel compelled to share them with my students; perhaps I might put them on my classroom wall and refer to them now and then.

Bibliophiles rule,
Ian Phillips
Ross Sheppard High School, Edmonton

Awesome and Free PD Opportunities

I have had the opportunity to attend to two camps sponsored by Honeywell. Did I mention they were free?

The first one was a space camp that was held in Huntsville, Alabama. I met teachers from all over the world as we were given classroom ideas and participated in simulations and flight missions. We got to keep our really cool flight suits, too!

Last summer I was selected to attend the second camp called the Green Boot Camp, which took place in San Diego. Teachers from all over the world met to look at the many new innovations being used in the areas of energy and sustainability.

Lots of great ideas for science teachers were shared. I have been or will be incorporating ideas from both camps in my classroom. I encourage you to apply for these camps.

One activity I now use with my students is called the $50 planetarium. At the 2014 Science Council conference, I will take you through this activity so you can apply it in your own classrooms.

Editor's note: These programs are scheduled around an American school calendar that wrap up around June 19. Some preplanning with your administrator is required if you're interested in attending these events as part of your annual professional growth plan since you will most likely need to miss a week of school in June.

The week-long Space Academy takes place at the US Space and Rocket Centre in Huntsville, Alabama, in June every year. Applications for the Space Academy program are available at https://educators.honeywell.com/application.

Green Boot Camp applications are accepted in February and March of each year. Selected teachers are notified in April. The camp is usually held the last week of June. Check out www.honeywellinteract.com/greenbootcamp/.

Cathy Schneider

Action Science: Relevant Teaching and Active Learning

How can you get young people interested in science and mathematics? What efforts are there to integrate the experiences of middle school students into the things they need to do and learn in school? How can action sports, like skateboarding and bicycle motocross BMX, be used to teach physics, algebra and data collection, and help students to grow in their engagement and motivation in science and mathematics?

Often, students will ask their teacher, "What is the point of this?" or "Why are we doing this anyway?" They want to know exactly how the material they're learning in class will apply to their everyday lives because, at times, it seems disconnected from what they do. Physical science concepts are often taught quite traditionally in school, and in an almost clinical manner, isolated to a specific circumstance within a classroom. This is what disconnects the tools and the content from the students' experiences. There is a real need for educators to explore and connect content in settings that are both authentic and relatable for students.

This is what I set out to do through action science, which makes science real to students and makes learning relatable. For me, skateboarding is a great way to do that. For example, in skateboarding, one trick you need to master is the ollie. The ollie, a skater's technique for flying through the air, showcases the principles of flight by demonstrating that you have to overcome gravity with lift, and friction (or drag) with thrust. And in this way, the physics principles of flight are the same for a skateboarder as they are for an airplane. When students understand these ideas, they're not just skateboarders. They become scientists riding around in a field laboratory, engaging in concepts of motion, forces and simple machines.

I've been an educator for over 20 years, a journey that's taken me from being a middle and high school teacher to an associate professor of science education. I've also been a skateboarder for over 37 years. I started riding my board when I was a seventh grader in my hometown of Richmond, Virginia, and stayed with it because it was fun and something I could do with my friends. Skateboarding quickly became my passion. It's still part of my everyday life and continues to influence the way in which I see the world.

Dr Skateboard was a nickname I earned as a skateboarding educator. I've made it my mission to inspire students toward pursuing goals in education along with their own personal interests. My inspiration for choosing skateboarding to teach physics came from my work with middle school students who were not interested in the topics of science class until I showed how much of physics,

such as forces and motion, were found in things they did regularly, such as skateboarding.

The skateboard itself has a number of simple machines that make it functional and fun. Modern decks have an upturned nose and tail. Each work as levers for the rider and help a skateboarder to lessen the force exerted while performing tricks on ramps, in the street or on the flat ground. Additionally, the trucks on a skateboard deck are fulcrums, and they allow the rider to control the movement of a trick by applying or releasing pressure on the levers. Another simple machine on the skateboard is the wheel and axle, consisting of the urethane wheels with sealed bearings and the axle that extends through the truck. On a skateboard, the wheels and axles help the rider to roll, spin, grind and carve. By definition, the skateboard is a compound machine, as it has more than one simple machine.

As an educator and a skateboarder, I knew I would have unique opportunities to instruct and to work with students and teachers, and the development of my recent book, *Action Science: Relevant Teaching and Active Learning*, is a practical example. Through skateboarding and education, I have learned creativity, practice, patience, discipline and goal setting. Many of my audiences of students and parents typically don't see the connection between skateboarding and science. They often wonder, if you have a PhD, why do you ride a skateboard? The answer is because it's fun and it's part of who I am.

Action Science was written as a resource for teachers to integrate practical learning opportunities linked to skateboarding and BMX in order to bring physics to life. This book looks to provide solutions for dilemmas educators face in teaching physical science concepts in a relevant context for the modern learner. The main idea is to place the content in an interesting format with action sports as the focus, and this, combined with the use of constructivism, presents a fun way to energize the classroom.

The book helps the teacher to connect important science applications through the use of hands-on activities and engaging video and graphical content. Teachers need to utilize technology in teaching and learning, and this book is designed as a crossover text that integrates video and high-quality images as well as demonstrates an interactive strategy of content immersion for students. The book is not a workbook or a series of activities in and of itself; it is a professional development resource for teachers which utilizes a constructivist approach that can be integrated into the classroom pragmatically.

The importance of an active environment for learning that integrates oral, visual and kinesthetic strategies by the teacher allows for learning to be student centred. In this approach, teachers become change agents, linking the relevant life experiences of the students to the content of the curriculum, and in no area is this more needed than in middle school science. The teacher must establish connections within the learning communities and engage their students in active learning projects that require them to interact with individuals inside and outside the school. For the constructivist science teacher, learning needs to be extended into the fabric of students' lives, not solely as a subject to be explored uniquely in a classroom.

The purpose of the book and video resources is to provide middle school teachers with a curriculum supplement that will help them to be better equipped to instruct students through rich and compelling content that is motivating and engaging. *Action Science* is about modern students in today's classrooms and is designed to help teachers with relevant and practical approaches in science instruction. As with all middle school students, but even more so with marginalized students, science education needs to be transformed, and *Action Science: Relevant Teaching and Active Learning* is a great example of student-focused transformative resource designed to reach the modern learner. This is the way you wish you were taught and certainly the way in which you would want your children to learn.

As a teacher, I've seen that by first providing students with educational experiences, then introducing content, it maps better to how the modern student learns. So, under the banner of action science, and through the use of skateboarding, motivation and engagement become central ideas for both students and educators alike.

So, how can this be of practical use for the educator? Inherently, the teacher has to know the students in his or her classroom, recognize their interests and understand how to integrate those interests into daily lessons. In my experience, skateboarders share the same traits as scientists in that both are trying to use a method based on experimentation to produce a result that is predictable and replicable. That is the purpose of action science—to put concepts in physical science into the realm of youth culture, and in effect, to make science approachable, relatable, and (possibly) even cool to learn.

Learning happens when you go to areas of high risk and high ambiguity. Yet it's not just enough to learn—the goal should really centre on mastery. To master something takes a long time, which skateboarders at a local park know fundamentally. The longer I am in the field of education, the more I believe that it's less about what you know and more about what you can master. When you master something, you know what it takes to be successful, then you can apply that ability to other aspects of your life. Whether a student is mastering skateboarding, painting, the guitar, a new language, science or mathematics, developing one kind of mastery can help him or her master something else. Teachers need to inspire others to use their gifts in their education and thereby connect them to their dreams and aspirations.

Video Resources

The History of Action Science:
www.youtube.com/watch?v=HC9oBH04qWY&feature=youtu.be

Learning the Physics of Skateboarding Engages Kids in Science from Edutopia: www.youtube.com/watch?v=6bu_9sI7QTI

Action Science book video interview: www.youtube.com/watch?v=5KT6upO2rv8&list=UUz1Tebxdy6VG645tdlWF9AQ

TEDxElPaso Talk—Dr Skateboard's Action Science:
http://tedxtalks.ted.com/video/Dr-Skateboards-Action-Science-D
Dr Skateboard website:
www.drskateboard.com

William H Robertson, aka Dr Skateboard
University of Texas at El Paso

Inspiring Energy Leaders

Inside Education

The Generate 2015 Youth Energy Education Summit was held March 12–15, 2015, at the Banff Centre. This unique conference was an opportunity for teachers and students to explore the science, issues and innovations related to Alberta's energy future.

> It gave my students the chance to not only see the importance of energy to Alberta but also how important their understanding of it is to Alberta's future. It gives me the chance to explore energy questions and concerns with my students in an informed manner.
> —Owen Morris, Generate 2013 participant

At Generate 2015, teachers and students had the opportunity to learn directly from leading energy experts and collaborate with like-minded peers from around the province. They gained exposure to multiple perspectives and the confidence to think critically and step forward as informed energy leaders. Best of all, they left with knowledge and tools to initiate a meaningful energy education and action project in their schools and communities. Find out more at www.gener8.ca.

> This experience will be remembered as a time of learning and going out of my comfort zone to better myself and form opinions on issues.
> —Sharon, Generate 2013 student

Inside Education has a variety of ways to help you enhance your science lessons with topics related to the environment and natural resources. Learn more about how we can support your teaching at www.insideeducation.ca or by visiting us the ATA Science Council Conference.

Bekki Hall

Little Words Mean a Lot

Understanding the root of a word is a useful decoding tool for vocabulary development. Back in elementary school, we used a magical book for our weekly spelling lessons. At the end of each lesson, at the bottom of the page, was a little box with information about the origins of the words of the week. It fascinated me. I continue to be giddy when I look at a big new scientific term such as *pneumonoultramicroscopicsilicovolcanoconiosis*. It's as though you are looking at a crowd of strangers and suddenly recognize familiar faces within the crowd.

Our students can benefit from the same decoding skill using the wonderful world of etymology: the understanding of word origins and how meanings change over time. This is especially useful when students are bombarded with a plethora of new terms every day. Also, consider how helpful this may be for students who do not have English as a first language, for nonreaders and for Harry Potter fans who want to understand all the spells.

Here's a quick look at how to approach this:

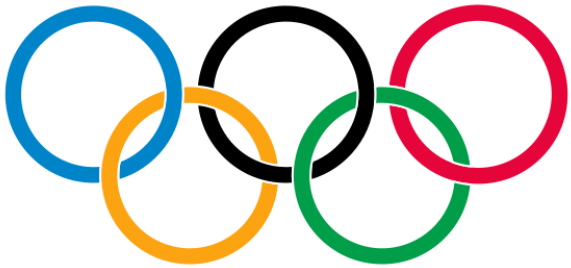
1. Pick a topic such as parts of the cell.
2. List the terms being introduced: cell membrane, cell wall, cytoplasm, endoplasmic reticulum, Golgi body, large central vacuole, vesicle, lysosome, nucleus, chloroplasts, mitochondrion, ribosomes (the basic terms of plant and animal cells). I don't know about your students, but mine mix up cytoplasm, chloroplasts and endoplasmic reticulum.

3. Look up the word origin for each term (deconstruct).
   Cyto: having to do with the cell
   Reticulum: network, net
   Chloro: pale green
   Endo: inside
   plasm and plast: to form, plastic, substance formed
4. Reconstruct the words with their meanings: endoplasmic reticulum is a network inside the cell.
5. Find other terms with those little words: reticulated giraffe, reticulated python and find the common thread! Super good fun for all!

Beware! Do your research before you teach the lesson. Why? Well, look up the word origin for epithelial cells. 'Nuff said.

Kim Hula-Hetu
W P Wagner School, Edmonton

How to Make Science Olympics a Schoolwide One-Day Event at Your School



Kids always have fun at Science Olympics. Over the past 18 years I have been involved in taking students to various Science Olympics events (Science Centre and APEGA) held in Calgary. The few students who do this are privileged to have a great experience. But that is just it. Only a few students are able to take advantage of these activities at off-campus venues. So, 14 years ago, we made Science Olympics a schoolwide event so that all the students in the school could have a positive experience with a fun science day. Being a junior high school of about 700 students, we developed a program of events that would allow all students to do different events and have teachers capable of leading the events. Part of the planning is that each grade does different, curriculum connected events. We planned seven events per grade. One event was a day-long activity that students could work on as the day progressed, so that any extra time could be used to work on this. Two of the events were whole-class events where each class competed against each other. The remaining four events were done in classrooms, and the class was split into six teams.

One difficulty we faced to make this day great was to get the rest of the school staff on board. The best way to do this was to make the day very easy for them. As a science team, we planned, organized and prepared kits for each teacher and each of their classes. The kits contained teacher instructions and bags with all the materials and instructions for each group. The class teachers just had to get the students going, then act as judges for any testing. This meant that all the staff could feel comfortable doing science in an easy way. More complex activities were done in the science rooms by teachers whom we knew could handle them.

As the years went on, the planning and choice of activities got better and easier to do. Our school became a Grades 5 to 9 middle school, and we were able to modify the program to continue with all five grades. We even changed to a short-day schedule for some years. This is the kind of day activity that makes students want to come to school and ask for more.

My session at the ATA Science Conference will give you all the experience we have learnt over the years to organize a Science Olympics day at your school. I will have all the activities, schedules and planning for several types of days available for you to work with. We will go over planning, timelines and all aspects for the day. This is your chance to learn how to do a schoolwide Science Olympics day and have all your questions answered. This is a package-to-go session so that you can get started this year with a great Science Olympics day.

Mike Tyler
CBE Science Learning Leader and Teacher

Pop Quiz: Do You Know What Radon Is?

1. What is radon?

Radon is a radioactive gas that is produced when uranium breaks down in the soil. It is a noble gas, found in group 18 of the periodic table. Like the other noble gases, radon is colourless, tasteless and odourless.

2. What are the health effects of radon?

Radon is the leading cause of lung cancer in nonsmokers. The health effects are not immediate but rather occur after long-term exposure to radon.

3. How does radon enter buildings?

Radon enters buildings through cracks in the foundation, exposed soil or rocks, and pipe and utility openings to name a few entry routes.

4. How is radon detected?

Once in the home, radon begins to build up and over time can reach high levels, thus increasing the health risk. Radon can be detected by performing a test, which is both easy and inexpensive.

If radon levels in a home are higher than the Health Canada guideline (200 becquerels per cubic meter or Bq/m^3), it is recommended that appropriate measures be taken to decrease the radon levels.

5. How can the risk of radon be minimized?

The most common method used to minimize the risk of radon is active soil depressurization. This method involves the installation of a pipe that runs from underneath the foundation to the exterior of the home. A fan attaches to the pipe and runs continuously to draw the radon from below the home and release it outdoors.

Although radon is the leading cause of lung cancer in nonsmokers, awareness of this gas remains low in Alberta. The Lung Association, Alberta & NWT (TLA) is working to change that. TLA is developing a radon-related classroom resource that will focus on Grade 9 Environmental Chemistry but will have applications across the curriculum.

Amy Elefson
Program Specialist—Environment and Health
The Lung Association, Alberta and NWT

One Teacher's Journey to Accepting and Embracing Project-Based Learning in Junior High Science

The only thing constant in life is change—such wise words and so true of the teaching profession. In this age of 21st-century learning and curriculum redesign, we are constantly learning to redefine our practice. For me, this came to a head two years ago when I was hired to teach at a brand new school that would be opening in our district. The school was to have a focus on collaborative and authentic learning for the 21st century and project-based learning.

When I learned that I had been hired for the junior high science position, I was ecstatic. I thought to myself, "Now this is where I am meant to be, and this is what I want to do." I really believed that I was already well versed in project-based learning. I just needed the proper platform, and I would be on my way. Then reality hit. Late September or early October I realized that while I was adept at incorporated hands-on learning, this was not exactly project-based learning, and I needed to shift my thinking and planning to better meet the goals of our school.

What followed was several months of frustration as I struggled to wrap my head around what a project is and how that differs from any other activities. I had read books. I had gone to conferences. I really wanted to embrace and embody what our school philosophy was, but I knew I was just saying the right things while still not really getting it. The reason I am telling you this is because I don't want to sugar-coat anything. For some people this journey is going to be tough. If it's not, then I applaud you. But even if you are one of the lucky ones who get it right away, you will still have to work with people who will struggle. I hope my journey will help show people that, even if it seems impossible at times, the end result is worth the struggle.

It started with a simple separation lab that I had developed years earlier where students separated cornstarch and icing sugar in Science 8. Instead of giving them the lab and discussing each step in the procedure before carrying it out, I sat down and figured out how I could use the lab to do the learning. I created a premise that the two materials got mixed up while I organized the lab prep supplies and that we needed to figure out how to separate them. I planned every step: when we would do scaffolding activities and when we would go back to the over-reaching problem, and in the end the students would design their own separation procedure, carry it out and evaluate how well it worked. In the end, one lab became the focus for half of the Mix and Flow of Matter unit. Was this a project? No, not yet, but I started to understand how to use a driving question to bring focus to a large amount of content curriculum. I was starting to get it. It was a lot of work to plan this way, but I found myself getting excited each class when I would see students' eyes widen during a lesson, then start writing in their science journals because they'd figured out a step. I was the facilitator, not just the instructor. The students were constructing their own knowledge and understanding, and I could see the bricks being laid before my eyes.

The first authentic project that I was a part of involved integrating science and math in Grade 9, and it was the true turning point for me. Students worked to design, build and wire a scale model

home for an architecturally controlled development in our community. For this project, my teaching partner and I had to work together to plan each step of the project so that it would make the most sense to the students. It was less important to ensure that they were doing the math part in math class and the science part in science class than it was to have them create their homes in a logical progression. We worked together to plan and build the initial skeleton of the house, so we could see where many of the roadblocks might occur in the beginning. In junior high, the timetable can be a problem. Fifty minutes is nothing when you are working on a project, especially when it takes 10 minutes to get going and 10 minutes to clean up at the end, so we found ways to make it work for us. If we had the classes back to back (one science, one math class) then we allowed students to keep working in the space and simply taught our other classes in other rooms. When we were getting closer to our deadlines, we needed more time, so we found places to borrow time. It was something different from anything I have ever been a part of before. It was collaboration in the truest sense. It was not about what was easiest for us, it was about what was best for the students' success. Everyone came together to make the project work.

We set a concrete deadline for our project showcase, which created a sense of community among the students as well. No one wanted to be the one to make the showcase less than successful. They worked together to help each other whenever they could, and the pride in their final creations was amazing to see. My partner said it best when he claimed, "No student has ever come up and said, 'Look! I'm done my math test. Come and see!'" The day of the showcase, our students shone. They were so proud and so eager to show anyone and everyone their homes. We set up the showcase like a new subdivision show home reveal. We invited family members, community members, home builders and other classes in the school. The gym was abuzz with activity all day. The best part of the whole project was discovering that all of the rubrics we had initially come up with for assessing either didn't accurately apply or students had achieved all outcomes, so grading became incredibly easy. The students had succeeded. For the first time ever in science, I was able to give each student an A. What a feeling!

Once you've been a part of a project like this, it changes you. I now look at my planning from a completely different viewpoint. I want to find ways to bring everything together to a single focus. I've been fortunate now to have been a part of several integrated, cross-disciplinary projects, and I am excited to take part in more. I often get asked, "Is this all you do? Is everything a project?" The answer is absolutely not. Sometimes a project doesn't fit. And that is OK. We have also found, through our own unanticipated learnings, that we can have project fatigue. Projects are intense. They are rigorous and take a great deal of energy for both the students and the teachers. There can really only be one large-scale project going on at a time to get the best out of all of us. We have learned to plan as a team to ensure that we are being fair and respectful of all disciplines. We have spent time discussing what it means to call something a project. Many things I used to call projects are really just good assignments, labs or tasks, and that is OK, too.

At the Science Council conference, I will be talking about project-based learning in junior high science, but it is important to understand that my ability to discuss this subject comes from a long journey of self-discovery that isn't complete yet, and I don't know that it ever will be. But I know now that I am ready to continue it. I hope you will join me!

Julie Arsenault
Michael Strembitsky School, Edmonton

Engineering Better Assessments: A Quick Primer on Basic Assessment Statistics

Assessment is an important part of every teacher's work. We continually refine the type of feedback provided to students during and following assessments. Strong feedback lets students know where their strengths lie and which skills or knowledge outcomes might require more focus. It also informs our approach throughout the school year.

With so much riding on the results of our assessments, it's important to take the time to consider how well those assessments are doing their job. Class averages are one measure of an assessment, but even together with a score distribution they offer a very incomplete picture. To understand why, we must ask what criteria make an assessment good. Every assessment should

- reflect students' varied levels of understanding;
- be fair (that is, students with a better understanding should see that reflected in their results); and
- measure student understanding reproducibly.

These three criteria correspond closely with three important measures of assessment items (that is, questions) and of assessments as a whole. They are, respectively,

- item difficulty,
- item discrimination and
- assessment reliability.

In this article, I'd like to offer a brief introduction to these three common measures and a peek at what lies beyond. As a teacher, I became involved with assessment analysis while looking for better feedback (for my students and me) than that offered with traditional marking systems. Over the past several years, I have developed and released Smarter Marks, an online system for the scoring and analysis of multiple-choice and numeric-response assessments.

Item Difficulty

The difficulty of an item can be estimated using a class's average score on that item. Careful! Paradoxically, this means that a difficult item might have a difficulty of 10–20 per cent, while an easy item might have a difficulty of 90–100 per cent. When you read *difficulty*, think "class average for this item."

Item difficulty is about much more than "are the students happy?" Consider an item that is much too easy and that all students get right. We can ask ourselves:

- Is this result helpful to students? Certainly it's encouraging, and for a few students it may represent the result of a lot of learning. For most of the class, however, the result is likely not surprising; that is, it's a confirmation of something they already knew before the assessment.
- Is this result helpful to teachers? Probably not. Most teachers can point to objectives in their curriculum that, while important, are also universally (or near universally) well understood by their classes. Again, the result of the assessment is confirmation of something they knew beforehand.

Scaling doesn't fix this problem. If all students score 100 per cent on a question, no amount of scaling will tell us which students have a stronger understanding of the material. Questions that are too easy or too difficult simply give predictable results for students and teachers both. Though such questions can play a role in a balanced assessment, where assessment items exhibit their

greatest power is when the results tell us something new.

Which questions give the greatest information? If a hypothetical assessment is much too easy, all students will score 100 per cent. An assessment that is much too difficult will yield an average score that depends on the type of question; for example, such an assessment containing only four-choice multiple-choice questions will give a distribution of scores around 25 per cent.

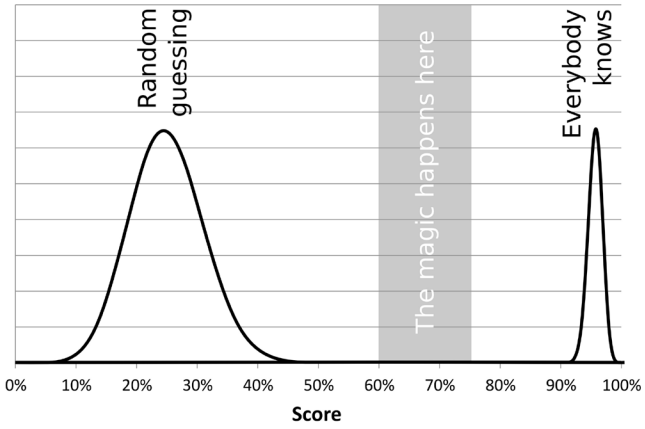


Figure 1: Hard, Easy and the Magic In-Between

Questions yield the greatest information when they are about halfway between these (see Figure 1), or, rather, about 5–10 per cent above that due to the spread in the random guessing case. Ideal item difficulties are given below for a number of common question types:

Question type	Ideal difficulty
True-false	80–85%
3-choice multiple choice	70–75%
4-choice multiple choice	65–70%
Numeric response	50–60%

This table highlights a weakness in true-false questions, and in multiple-choice questions with weak distractors. A true-false assessment is at its strongest when it gives a class average of over 80 per cent. Lower than this, and the absence of information yields an assessment that reflects which students were lucky as much as what students understood.

For assessments that are strictly pass or fail (certification exams, for example), all items should have a difficulty as near as possible to the passing grade. In the classroom, however, we would like to know which areas even our strongest students might work to develop further, and which strengths might give struggling students a way in. Difficult questions give more information about stronger students, while easier questions tell us more about students who are struggling. In much the same way that an HDR photo includes contributions from over- and underexposed shots, the inclusion of a few easier and more difficult questions can have a positive impact on the strength of a classroom test.

Item Discrimination

If item difficulty were the entire story, then grade distributions would be enough to develop strong assessments. Consider, however, a class's performance on a hypothetical question, plotted against each student's actual (and in practice unknowable) ability in the subject area, as in Figure 2. Even without knowing the average score, the shape of this plot tells us a lot about the quality of the question.

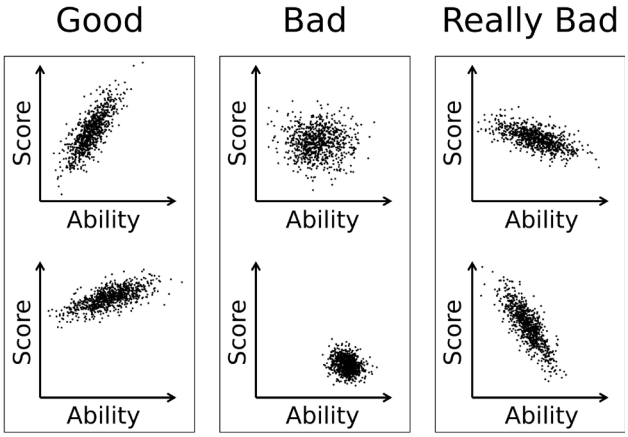


Figure 2: Correlating Item Scores and Student Ability

The good plots represent questions whose scores correlate strongly with the student's

ability. The bad plots, on the other hand, show no correlation at all between score and the student's ability, while in the really bad plots, the situation is even direr, with stronger students tending to do worse on this question.

Item discrimination is an estimate of how well student performance on a single item correlates with their understanding of the material being assessed. Because student understanding is not known beforehand (if it were, assessment would be unnecessary), in practice item discrimination is estimated by correlating students' scores on the given question to their scores on the assessment as a whole.

Item discrimination falls on a range between -1 and +1, with the plots in Figure 2 corresponding to roughly +0.8, 0.0 and -0.8. For classroom assessments, item discrimination can be interpreted as follows:

Value	Description
Less than 0.1	Poor discrimination
0.1–0.3	Fair discrimination
Greater than 0.3	Good discrimination

Items which are too difficult or too easy, and which therefore give little information about student understanding, tend to have unpredictable item discrimination and should be treated cautiously.

Low or even negative item discrimination can highlight a number of problems in a question, many of them familiar to any teacher who has ever wondered why their strongest students were getting that question wrong. Most commonly, problems with item discrimination indicate a question which is incorrectly keyed, or which is worded confusingly. Less commonly, but perhaps more interestingly, low discrimination can also indicate a misconception which is equally common for students at all levels of understanding, but which once identified is easily corrected. Assessment analysis can therefore help not only in building better assessments but also in improving classroom practice.

Assessment Reliability

Whereas item difficulty and discrimination measure individual questions, reliability is a measure of the assessment as a whole. The results of any assessment are scattered over some range of grades, most simply (if perhaps unrealistically for small sample sizes) modelled as a normal distribution, as in Figure 3.

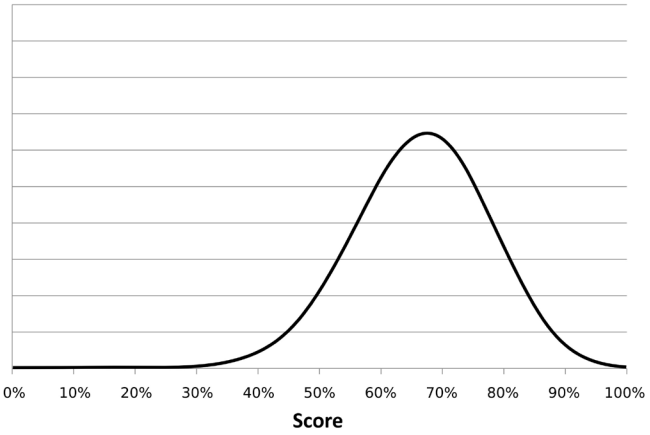


Figure 3: A Hypothetical Score Distribution

The grade distribution leaves open an important question, however. Is this distribution the result of several identical students taking a rather imprecise test? Or perhaps it's the result of students with a range of abilities taking a precise test? The width of the distribution (the standard deviation) is a product of two very different effects: uncertainties in the measurement of each student's understanding (the standard error of measurement) and differences in understanding from one student to another (which we want to measure).

Assessment reliability helps us estimate the measurement error in an assessment. It falls on a range between 0 and +1 and can be interpreted as follows:

Value	Description
Less than 0.6	Needs revision
0.6–0.8	Good for a classroom test
Greater than 0.8	Very good to excellent

The higher the assessment reliability, the smaller the measurement error and the more precise the assessment. In practice, a test whose items exhibit good difficulty and discrimination statistics generally also shows good reliability.

Some Final Words

Assessment analysis need not be limited to these basic statistics, and an analysis of student responses that goes further may be suitable for more heavily weighted assessments. Examining the test score distribution for students who gave particular responses to a multiple-choice item, for example, can shed light on questions such as:

- Was the correct response chosen by the students who scored highest?
- Did distractors draw equally and from the same groups of students?
- Does the response pattern for some distractors suggest important misconceptions that can be addressed in class?

Whether you choose to do a basic assessment analysis or something more detailed, understanding item difficulty and discrimination and assessment reliability can do a lot to help you make the most of your assessments. Using tools like Smarter Marks that are now widely available, a basic assessment analysis can take just a few minutes to review and can do a great deal to help teachers refine assessment items and classroom practice over time.

Jason Cooper
Smarter Marks

The New Alberta Tomorrow Brings Inspiring Education Alive Today

Alberta Education recognizes that as our world changes at an unprecedented rate, we need a curriculum that equips students with the knowledge and skills necessary to adapt to this change. A curriculum that creates engaged thinkers and ethical citizens with an entrepreneurial spirit will allow the students of today to prosper now and in the world of tomorrow. Learning resources that instill the 3Es while covering cross-curricular competencies are a necessary and essential part of this new curriculum.

Alberta Tomorrow (www.albertatomorrow.ca) is one such learning tool that not only creates engaged thinkers and ethical citizens but also uses real data from Alberta and GIS technology to look at a very real problem in Alberta: how to balance economic growth with environmental protection.

Balancing our land use in Alberta is an issue that has gained more publicity in recent years due to government initiatives such as the Land-use Framework. Recognizing that we need to grow and prosper as a province, but that our growth has both intended and unintended consequences, the Land-use Framework strives to find that balance between economic growth and protecting our ecosystems (which support our population and resource production).

Alberta Tomorrow is an effective educational tool that explores the complex issues land-use planners encounter when trying to balance the environment and economy. The simulator, which is based on a professional version that is used by both government and industry, has students view a series of short videos on land uses, such as oil and gas development and agriculture and forestry, and environmental indicators, such as water quality, mammal habitat, greenhouse gases and natural landscapes.

Using real data from Alberta, students can time travel back to 1884 and see what the landscape looked like along with the corresponding levels of environmental and socioeconomic indicators. This allows students to make connections between a change on the landscape and the economic and environmental well-being of Albertans. Future projections to 2044 allow students to see what might happen if our current land-use trends continue for another 40 years.

Using Alberta data, students are challenged to set goals for the future and create a land-use plan that achieves their goals. This highly interactive tool has students soon realizing that finding a balance between our environmental quality and increasing economic growth is challenging. Students are forced to think about what can be done to strike that balance, for example, using best practices.

There are links to the science curriculum in numerous grades. Some of the strongest links are found in Grade 4 Science when discussing Alberta's eco-regions, Science 7 in intended and unintended consequences and Biology 20, as Biology 20 teachers can teach all biogeochemical cycles through videos and simulations as well as how humans interfere with these cycles.

A land-use field trip with water quality testing and invertebrate sampling is available for teachers to use. The mobile capability allows water data and land-use observations to be entered and saved on the satellite imagery while in the field! Lesson plans for the current curriculum are available and ones for the new curriculum are in the works. This tool is perfect for cross-curricular projects with social studies, English, mathematics and geography and can be used to demonstrate all of the cross-curricular competencies outlined in Inspiring Education.

The Alberta Tomorrow simulator is a powerful tool to demonstrate that changes in our land-use policy and personal lifestyles are essential to ensure a sustainable future for our children and grandchildren.

It's not always easy for us to see the effects of today's actions in the future, but Alberta Tomorrow makes it possible.

A limited number of classroom visits are available free of charge through the Alberta Tomorrow Foundation. Look for the Alberta Tomorrow session at the upcoming Science Council conference in Banff. Please contact Jennifer Janzen (jjanzen@albertatomorrow.ca) for more information.

Jennifer Janzen, Executive Director
Alberta Tomorrow Foundation

Wondering How to Engage Your Students in a Conversation About the Alberta Oil Sands?

Alberta's oil sands is a topic we Canadians are hearing more and more about. It's on everyone's radar, from oil companies advertising on television to Neil Young addressing the topic live. Even Leonardo DiCaprio, the American-born movie star with no ties to Canada, drew global attention to the oil sands by partnering with the Fort Chipewyan community to nominate Prime Minister Stephen Harper to the ALS ice bucket challenge. It's such an important subject, but many teachers are afraid to address this and other controversial issues in the classroom. Without a comprehensive understanding of oil sands development in Canada though, this next generation is largely ill-equipped to face the associated current and future consequences.

As teachers ourselves, we at GreenLearning Canada recognize the difficulties educators face when introducing contentious and polarizing issues to students. This is why we have begun development on our Oil Sands Sustainability Education Dialogue (OSED). Instead of loud debates, disinformation and intractable opinions, our OSED program facilitates informed dialogue and positive collaboration between students, classes and regions. The program emphasizes critical thinking through the inquiry method in an authentic context. Students will be presented with a focused problem and information from a variety of stakeholders who have a vested interest in the topic, then work together to develop collaborative solutions for moving forward. It is a model for addressing controversial issues that can be applied to any topic.

What would you need in order to tackle this tricky topic in your classroom? We would love to hear what you have to say. At GreenLearning Canada we always ask teachers to shape the program to suit their needs. Please take a moment to fill out our quick survey at www.greenlearning.ca/programs/development on the creation and implementation of the Oil Sands Sustainability Education Dialogue (OSED), designed to engage students in a conversation about the multiple stakeholder interests associated with the development of Canada's oil sands. And while you're at it, check out our other wonderful programs at www.greenlearning.ca. Thank you for helping us to continue to make the best, free energy and sustainability educational resources, by teachers for teachers.

The GreenLearning Canada Foundation is a not-for-profit organization that provides teachers with free, online education programs about energy and sustainability that empower students to create positive change for our evolving world. All programs meet provincial core curriculum for multiple grades and subjects. They are complete with online and printable lesson plans, teachers' guides, video tutorials and assessment rubrics and require no special software to use. Most important, all of our programs are developed by teachers for teachers.

Beckie Granatstein
Executive Director, GreenLearning Canada
www.greenlearning.ca

Ultralight DIY Alcohol Stoves in the Chemistry Laboratory

It's always encouraging when aspects of the hobbies you enjoy mesh with your work as a high school science teacher. Every weekend and many weeknights after work, no matter what the weather, I head to the outdoors to mountain bike and/or hike in the summer and fall, or to backcountry or cross-country ski in the winter and spring.

I am a Brit who enjoys a fresh brewed cup of tea at all times of the year, whether on a bitterly cold day or an infernally hot summer outing. In the winter I boil some water on the stoves in most backcountry huts. During summer and fall I used to light a campfire in a designated firepit. These fires, as small as I could make them, used a lot of wood and were uncomfortably warm on those sweltering summer days. That said, whenever a local or provincewide fire ban was in place, such campfires were no longer an option.

For a while I did use an excellent little MSR Firefly stove to boil water for tea. This stove can use mixes of propane, butane and isobutene depending on the brand you buy, and it operates at temperatures above –10° Celsius. The bulk of the fuel canister is a wee bit of a nuisance, and it is always awkward to gauge just how much fuel remains when it is running low.

I have always been on the lookout for a much more portable, compact, lighter and cheaper (I'm Scottish) alternative to wood fires and gas stoves, and I have found it. DIY alcohol stoves, such as the tuna can stove, the fancy feast stove and the pop can stove, are all fairly easy to make and small enough to fit inside a typical 500 millilitre metal cup. This is perfect and, as we shall see, has excellent possibilities in the chemistry laboratory. These very light and hot burning stoves run on fondue fuel (mostly methanol) or ethanol, fuels that are easy to purchase and to transport in a myriad of shapes and volumes of Nalgene bottles. Any one of these stoves can boil 500 millilitres of room-temperature water in about 5–7 minutes—a time that compares favourably to most LPG stoves.

A stove made from a snack tuna can heating a large pot of water.

Let me assure that these stoves are easy to make from repurposed cat food, tuna or pop cans. (I have even seen trials of a burner/stove made from the foil cup from a tea-light candle with a piece of motorbike exhaust wrap for a wick that looks worth investigating.) A quick Google search on any of these terms will locate a veritable avalanche of how-to videos perfect for those who want to make their own alcohol stove. For many of us of course, a one to two hour workshop showing just how easy it is to make and use these devices would be an excellent shortcut to all that Internet trawling and experimentation. I must come clean and tell you that I have submitted proposals for just such a workshop to a few teachers' conferences around the province.

What on earth has all this got to do with the high school laboratory I hear you say? Well, it turns out that most students could make one of these stoves in about 10–15 minutes from a can that might otherwise be recycled at home, using simple tools like scissors, push pins and possibly a single-hole paper punch. One of these stoves massed and loaded with less than 10 grams of fuel can be used to warm a can, a pot or a beaker containing 100–200 millilitres of water from 10–60° Celsius in less than five minutes. If the fuel is not completely consumed, these burners are easily snuffed out under an upturned beaker or can. It is a simple matter to have teams of students (1) make the stove, (2) perform the experiment and (3) perform two repeat trials—all in one 80-minute laboratory period. Alternatively, if a stove is provided for every pair of students, they can do the experiment, then run other trials that investigate ways and means of mitigating heat losses, again all in one period.

The temperature and mass data from these experiments can be analyzed to calculate enthalpies of combustion of ethanol and methanol or manipulated to calculate the heater efficiency and the effects of insulation, chimneys and so on. Wait a minute, surely you can use spirit burners to do the very same experiment! You are right, but remember the burners in these experiments can be entirely student manufactured—made as they are from ridiculously cheap materials with simple tools. (I have to confess that spirit burners are what you need if you want to heat water by burning liquid hydrocarbons/biodiesel, which are fuels unsuitable for the alcohol burners. Lightweight LPG stoves with small canisters are also excellent for collecting data to calculate stove efficiency.)

A colleague and I noticed that it is possible to burn methanol in the presence of certain metal compounds (especially copper(II) chloride) in a pop can stove and get very bright eye-catching flame colours that last for a considerable time—essentially a long-lived flame test. This is an excellent illustration of one aspect of qualitative analysis in Chemistry 20.

So start Googling DIY alcohol stoves in earnest or be on the lookout for a workshop by yours truly in the near future.

E-mail me at ian.phillips@epsb.ca if you want a worksheet on these labs or you have helpful suggestions.

Ian Phillips
Ross Sheppard High School, Edmonton

Science Council Executive 2014/15

President
Ian Doktor
Bus 780-408-9000
iandoktor@hotmail.com

Past President
Rose Lapointe
Bus 780-639-0039
rose@ualberta.net

President-Elect
TBA

Secretary
Brenna Toblan
Bus 403-243-8880
brtoblan@cbe.ab.ca *or*
toblanbr@telus.net

Treasurer
Randy Proskiw
Bus 780-645-4491
randy@askaway.ab.ca

Conference Codirectors 2015
Carryl Bennett-Brown
Bus 780-459-5702
carryl.bennettbrown@ata23.org *or*
cbennett-brown@gsacrd.ab.ca

Alicia Taylor

Ania Ossowska
Bus 780-425-6753
anialyda.ossowska@gmail.ca

DIRECTORS

Division III
Greg Wondga
Bus 780-473-4560
greg.wondga@epsb.ca

Biology
Danika Richard
Bus 780-798-3840
danika.richard@nlsd.ab.ca

Chemistry
Rekha Dhawan
Bus 403-230-4743
rddhawan@yahoo.com *or*
rddhawan@cbe.ab.ca

Physics–Division IV
Cliff Sosnowski
Bus 780-435-3964
sosnowskic@ecsd.net

Science–Elementary
Audrey Pavelich
Bus 403-527-2257
audrey.pavelich@sd76.ab.ca *or*
apavelich@shaw.ca

Science–Division IV
Leon Lau
Bus 403-817-3400
lhlau@cbe.ab.ca *or*
leon.lau@gmail.com

Journal Editor
Wytze Brouwer
Bus 780-492-1074
wytze.brouwer@ualberta.ca

Newsletter Editor
Trinity Ayres
trinity.ayres@cssd.ab.ca

Technology Director
Deepali Medhekar
mrs.medhekar@gmail.com

Website Manager
Deepali Medhekar
mrs.medhekar@gmail.com

Postsecondary Liaison
Brad Pavelich
pavelich@mhc.ab.ca

Alberta Education Liaison
Wes Irwin
Bus 780-422-2928
wes.irwin@gov.ab.ca *or*
wirwin@telusplanet.net

PEC Liaison
Sean Brown
Bus 780-458-6101
sean.brown@teachers.ab.ca *or*
sbrown@gsacrd.ab.ca

ATA Staff Advisor
Marv Hackman
Bus 780-447-9488 *or*
1-800-232-7208
marvin.hackman@ata.ab.ca

REGIONAL COUNCILS

Calgary Junior High
Joy Bader
Bus 403-243-8880
jobader@cbe.ab.ca

Edmonton Biology
Morrie Smith
Bus 780-476-4646
morrie.smith@epsb.ca

Edmonton Chemistry
Dan Leskiw
Bus 780-408-9000
dan.leskiw@epsb.ca

Edmonton Physics
Vlad Pasek
Bus 780-476-6251
pasekv@ecsd.net

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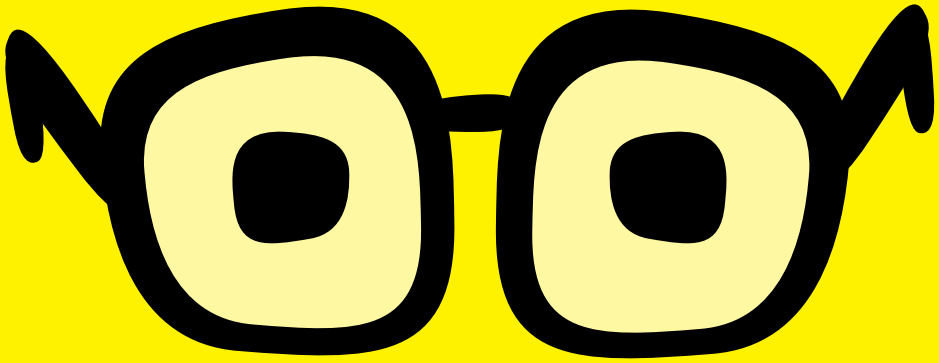
"GEEKS UNITE"



WORLDS WILL COLLIDE

Joint conference of the Mathematics Council of the ATA and the ATA Science Council