NEWSLETTER

ONTARIO ASSOCIATION OF PHYSICS TEACHERS

An Affiliate of the A.A.P.T, and a charitable organization

February 2012

Canadian Light Source
Perimeter Institute
Uxbridge Secondary Schoool
Photos Taken by: Lisa Lim-Cole

Letter from the Newsletter Team

Now Fully Digital

We are now fully digitis! Please ensure that your OAPT membership is active in order to receive a copy by email.

The new digital version allows us to also include exciting photos and physics related artwork/photography. If you wish to share some of your own work or even some of your students, please feel free to send them to us.

Call for Articles

Have you or has a colleague of yours done something progressive or interesting with your physics teaching recently? Or perhaps you have the wisdom of many years of experience in teaching this difficult subject. Perhaps you teach Ontario's northland or in a rural area and have a different perspective or unique experiences to relate. SHARE your experiences! Write a brief (~400 word) article for the Newsletter and send it to newsletter_editor_8@oapt.ca.

The Prez Sez

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Run, do not walk, to your computer and register for the **OAPT Conference at the Perimeter Institute in Waterloo, April 26-28**! The theme this year is "Opening Doors - Opening Minds". The first half of the theme - Opening Doors - refers to the practical aspect of physics. Physics is useful. It can help get you a job or it can help you get the job done. Supporting this theme are such workshops as "Engineering with Electricity and Magnetism", a tour of the Institute of Quantum Computing, and an exploration entitled "Why Take Physics?". Other workshops explore how physics is connected to math, music, candy, art, games, and history.

The second half of the theme - Opening Minds – is what you would expect from a conference held at the Perimeter Institute. Many workshops will stretch your imagination in ways the other sciences can't match. Thursday evening features PI researchers in a panel discussion on "The Frontiers of Physics", followed by an opportunity to chat informally with these researchers over refreshments. Friday's highlights are a keynote by Dr. Neil Turok and a closer by Dr. Cliff Burgess, but in between there are 18 useful workshops.

This conference renews our commitment to support the physics strands in elementary and intermediate science. You are an important part of this work. Bring an intermediate science teacher to the conference or else go to the workshops that fous on the transition years and take the ideas and materials back to the teachers at your school. This will help the teachers, the students and you! The more we support our non-physics colleagues the more likely it will be that students choose physics in their senior years and succeed at it.

The financial support of PI and U of Toronto Engineering is helping make it easier for teachers to come to the conference. These funds are being used in two ways:

1) Again this year we are offering accommodation at just **$19.99 a night**. I strongly encourage you to make use of this bargain. Staying overnight allows you to take part in the more informal networking and discussions that can be just as valuable for your professional development.

2) **NEW!** We are offering travel subsidies of up to $500 for teachers coming from Sudbury or further north. Teachers in these areas are very isolated and rarely make it to the conference. Do you know of a teacher working in North Bay or Sault Ste-Marie etc? Let them know about this offer and have them email me for details.

A caveat: the conference has been growing rapidly over the past few years and the Perimeter Institute has only limited space. Don't delay and end up disappointed! This is going to be a great conference.

The Physics Education Research Column

Myth of a Great Teacher

Chris Meyer
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Personality vs. Understanding

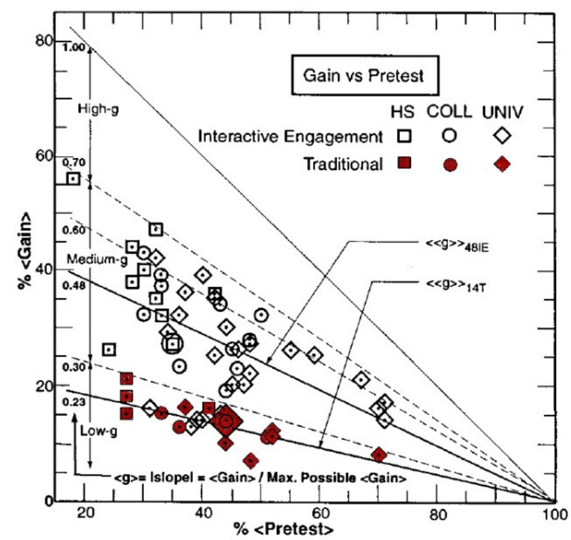
I had the very good fortune of starting my teaching career working alongside one of those teachers who had “the gift” for teaching. From my room next door I could hear his class routinely breaking out into laughter and whooping with excitement. Conversations with him revealed a deeply insightful and reflective practitioner who carefully crafted each lesson. Students adored his classes. He taught me a great deal about teaching and my role as the teacher. Perhaps the most important thing I learned was that I would never be a great lecturer. I could never conjure his wonderful combination of spontaneity, humour and insight.

A decade later I began to learn about physics education research (PER) and discovered something that shocked me. Physicists had been using standardized tests to measure students’ gain in conceptual understanding over the duration of a physics course. The results revealed that even students of the most highly regarded lecturers had a surprisingly small gain in understanding. It was as if there was a limit to the educational power of even the most dazzling lectures.

“...students of the most highly regarded lecturers had a surprisingly small gain in understanding...”

Traditional Teaching vs. Interactive Engagement

The **research** I had come across was based on a widely used conceptual test: the **Force Concept Inventory (FCI)**. Six thousand students from high school, college and university wrote this test near the beginning and end of their physics courses. By comparing students’ pre- and post-test scores, a learning gain[1] was calculated to serve as a measure of the effectiveness of instruction. These results are shown in the diagram below where traditional instruction has the coloured symbols. It came as quite a revelation to me that no matter how insightful or entertaining a traditional lecture might be, students have a very limited average gain of 0.23. “A gain of 0.30 seems to be an upper limit on understanding from this mode of teaching. Note, however, that physics programs using interactive engagement techniques show considerably better results.



The low gains resulting from lecture-format instruction were also a surprise to Eric Mazur, a reknowned physics professor at Harvard University. Mazur was an outstanding lecturers who garnered perennial glowing reviews from his first year students. In this **video** he recounts the transformational experience of using the FCI. Listening to Mazur shattered my long-held mental model in which students’ understanding was the effect of a mythical “great teacher” at work.

An Experiment at UBC

The impetus to write this article came to me after PER recently made it into my local newspaper. The University of British Columbia conducted a **study** in their first year engineering physics classes that demonstrated the success of reformed teaching techniques in a clear and decisive way. All of the students were taught using the traditional lecture technique for the first 11 weeks of the course.

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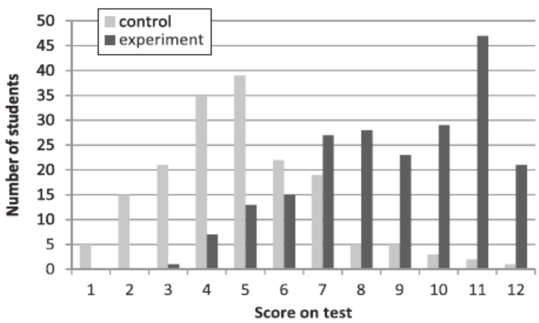
[1]<Gain>=(Posttest score – pretest score)/(100%-pretest score)

During the 12th week of the course half the students continued to be taught in this same fashion by a highly experienced and well regarded professor while the other half was taught by two inexperienced instructors who used interactive teaching techniques. After demonstrating the similarity of the two groups of students, the researchers measured students' engagement levels during the 12th week and used a standardized test to measure students' understanding of content introduced in the 12th week. The results were astounding; the control group scored 41% on the test while the experimental group scored 74%. The histogram below shows how little the two groups' scores overlapped. **Follow-up surveys** also demonstrated how the new interactive strategies were very well accepted by the students.

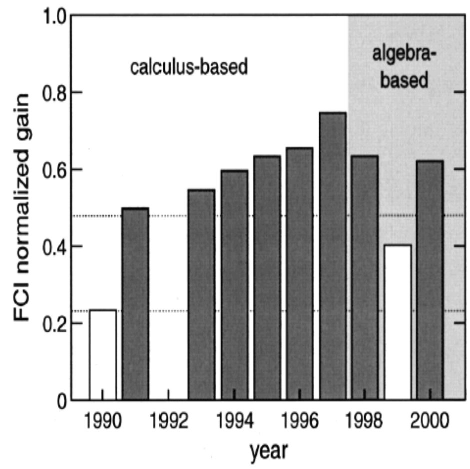


A New Hope

Our faculties of education must seize upon these results, which demonstrate that we really can "build a better teacher". We now know of clear, concrete ways to help teachers improve their students' understanding of physics. It may not be an exaggeration to say that there is an immediate improvement once a teacher steps away from the lecture podium or chalkboard and begins actively engaging her or his students.

"...decades of physics education research strongly suggest that the power of a teacher's personality cannot transform a poor way of learning into a good one."

Consider the results of Eric Mazur shown in the **graph below**. He first used the FCI in 1990 and discovered how little his students were learning. The following year he introduced a reformed physics course and learning gains doubled. Gains steadily increased for a few more years as he gained skill using the new techniques and refined his course.



There is something very special about a teacher whose personality can enthral and energize students. I still admire these teachers. And I still believe that enthusiasm and inspiration are critical for helping students find their way and muster the energy to work hard. But decades of physics education research strongly suggest that the power of a teacher's personality cannot transform a poor way of learning into a good one. Where teaching charisma falters active engagement techniques succeed. A reformed teaching practise can dramatically change your classroom and help your students achieve levels of understanding and engagement that even great lecturers will envy. On a personal level, knowing this has freed me from trying to be the teacher that I am not. Instead, I can focus my energies on building my skills and developing materials for the active engagement of my students.

An Invitation

For four years I have been teaching lecture-free using guided-inquiry investigations and cooperative group learning. If you are interested in trying it my **website** contains all my teaching resources and materials to help you get started. If you would prefer to see these strategies in action please feel free to send me an **email** to arrange a time to visit my classroom. You might also want to attend one of my presentations on interactive learning:

- the Feb. 8 Toronto PTA meeting (at York Mills CI),
- the Feb. 17 TDSB Eureka Conference, and
- the April 26-28 OAPT conference at the Perimeter Institute for Theoretical Physics in Waterloo.

PER with Dave

Dave Doucette

Richmond Hill High School

Pardon my absence for the past two years as I was kept pretty busy with OAPT presidential duties. Good to be back. This article focuses on brain-based research and its application to the physics classroom. Why? Simple – it is the focus of my upcoming workshop at our 34th Annual Physics Conference at Perimeter Institute in April. So I thought it timely to give readers a heads up – and also to baldly plug my workshop.

Effective physics teaching is considered to be composed of 3 elements: content knowledge, pedagogical content knowledge[1] (PCK), and ***pedagogical knowledge.*** PCK refers to physics education research (PER) and its application to physics instruction. Pedagogical knowledge is not limited to physics - taking a broader view of the student as a social and physiological creature. And I do mean creature! I know – I have three of these at home! We're talking teens here. I'm assured they eventually emerge from their creature cocoon into young adults. I'm in a watch and wait mode.

Why is brain-based research (aka *pedagogical knowledge*) important? It is entirely complementary to content expertise and PCK – consider it a third pillar to be a maximally effective teacher. It puts into perspective the contradictory and puzzling (to us) nature of the adolescent brain. Even more importantly, it has the potential to grow sections. Physics sections, I'm talking. Important stuff.

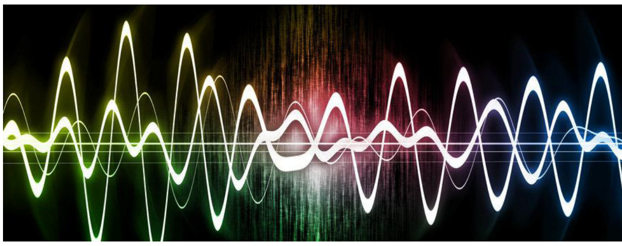
Physics content knowledge and PCK allow you to maximize the learning of physics concepts by strategic implementation of myriad instructional strategies. But these alone may not resonate with students if their social and physiological needs and interests are not met. Attention to brain-based research helps to ensure engagement of teen minds. Hate to admit it – but I see it in my own classes. Sometimes my best laid plans fail to galvanize students and basically fall flat. On reflection it is often a failure to consider emotional engagement – to 'set the stage' for learning to occur. Often because I am in a rush to finish some 'crucial content'. I know – bad teacher ! – my 'old school' roots showing.

But hope abounds. Brain-based research may serve as a compass to guide us through the shadowy world of the teen brain. The Science Teacher (January, 2007) advises "…neuroscience research can provide explanations for a plethora of behaviors in teenage students, ranging from emotional outbursts over seemingly trivial matters to disorganization and inability to plan ahead. As adults and science educators, we now have a growing understanding of the underlying neurological changes occurring during adolescence. Current advances in neuroscience can provide teachers with valuable understandings to help students navigate this time of rapid brain development."[2]

Author suggestions include: firm time lines for due dates (news to administrators!), providing choice in assignments/assessment (differentiated instruction), maintaining emotional neutrality (don't yell) and explicit organizational aids for completing assignments. Overall an implicit assumption is to not treat them as young adults, but rather as adolescents – the creatures I referred to earlier! They do not yet possess the cognitive architecture to be influenced by the same social and intellectual motivators that resonate with adults. We need to reach them at their level. The challenge is to find it. It can be a labyrinth.

Back to the baldfaced self-promotion . How will my upcoming OAPT workshop help participants to grow as professionals and firm up the 3rd pillar of effective teaching? I intend to refer to a leading researcher, Eric Jensen, and weave his 10 'brain-based learning strategies[3]'into activities. The workshop will, as always, model best practices, echoing Lillian McDermott's refrain, "Teachers should be taught in the manner in which they are expected to teach.[4]" The specific subject focus will be ***waves & sound***, as I have focused on electricity and optics in recent years am keen to present new material. Along the way, we will tour complementary ***inquiry learning*** activities (process of science) and ***guided-inquiry*** worksheets (concept attainment and application). And we will have fun. It's not just teens that need nourishment for the soul. I can't guarantee you will grow your physics sections, but I can at least make it an 'election promise'. That removes personal accountability, doesn't it? Sorry – couldn't resist.

So I hope to see you at our conference at Perimeter Institute, April 26-28, 2012. Perhaps even at my workshop! Forgive me – I have to plug this as the lineup of presenters is so impressive. So many speakers – so little time. Ah well, if you don't get to see us all – you'll just have to come back next year! What a hook. And don't forget to take advantage of the $19.99/night room rate. You can't even get a campsight for that price. And these are bear-proof. What a deal. Yagottaloveit.



References

1. "An especially critical aspect of teacher knowledge is the knowledge of how to help students master concept knowledge and the processes through which it is constructed, in a pedagogically appropriate environment; this is known as "pedagogical content knowledge" (PCK). PCK is what distinguishes a content expert from an effective teacher of the same subject matter."
Teacher Education in Physics Research, Curriculum, and Practice. David E. Meltzer, Arizona State University, Peter S. Shaffer, University of Washington. This book is available for free download at www.PhysTEC.org.

2. Megan Hall, Open School, St. Paul, Minnesota, and Georgia Brier, Department of Neuroscience, University of Minnesota, Minneapolis, Minnesota. The Science Teacher, January, 2007.

3. Eric Jensen, Brain-Based Learning Strategies. Website: http://feaweb.org/brain-based-learning-strategies. 'Brain-Based Education is the purposeful engagement of strategies that apply to how our brain works in the context of education.'

4. Lillian C. McDermott, Peter S. Shaffer, University of Washington. Physics Education, Volume 6, Nov 2000. Actual quote, "Teachers should study each topic in a way that is consistent with how they are expected to teach that material." p73.

Minute to Win It! In-Class Resource

By Nadia Camara
Richmond Hill High School

The start of every school year brings with it the question of how to make the first day effective. Among the goals you may have on the first day are to: 1) set the tone for expectations for effective classroom practices, 2) serve as a diagnostic to help you start appropriately, and 3) get students interested in the subject matter. I also want day to be fun and engaging. In an effort to fulfill all of these criteria, I have adapted a version of the game show *Minute to Win It* for use in physics class. The activity is to be used on the first day of school and revisited periodically, including as a culminating activity.

On the First Day:
Students are put into groups and instructed on expectations for group work in physics class. Each group is given a specially selected Minute to Win It challenge. They are asked to practice the challenge and discuss the physics of the challenge within their group, arriving at an explanation that all group members agree upon. Each group then presents their challenge and explanations to the class. **Diagnostic complete!**

Challenge Revisited:
During their study of mechanics the students encounter topics that relate to the challenge they examined on the first day. Students are excited to try the challenge again, this time focussing on the principles of physics, which they now understand better. As the course proceeds students periodically revisit and modify the challenge they were given on the first day. The groups are asked to use the new concepts they have learned to

explain the newly redesigned challenge. Each group presents these new challenges accompanied, by explanations of the physics involved, to the whole group. Culminating activity complete!

Generating Excitement:
We decided to make this a school-wide event to generate some excitement about physics amongst our younger students. Each group set up a booth during a class period and grades 9-11 were invited to attend. Visitors were given the challenge and had one minute to complete it. After the first attempt the senior students explained the physics to them and they were given a chance to retry the event. Our stats demonstrated that the challenge was easier to accomplish once people understood the physics. **Physics teachers' goal complete!**

What the Higgs is going on at the LHC?

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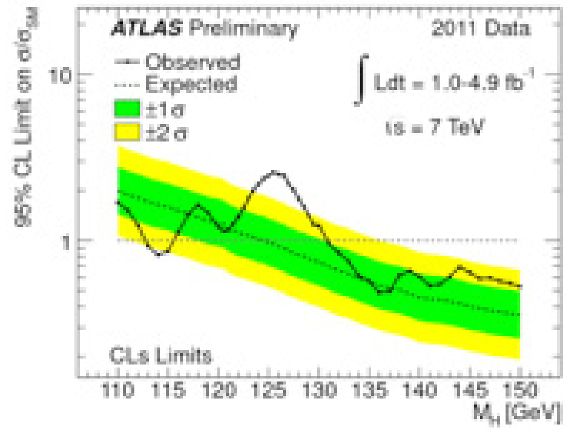
As teachers, our work influences the next genera-Excitement about the Large Hadron Collider (LHC) at CERN is building with every rumour published in the blogosphere. One week the Higgs has been found, the next week it has been disproven. Throw in a few “faster-than-light” neutrinos and interest in high energy physics has never been higher!

What is all the excitement about? The Higgs boson is the only particle in the Standard Model of particle physics not yet observed. Finding the Higgs boson would be a huge step forward in our understanding of nature. The Higgs boson is associated with the Higgs field. Fundamental particles, like quarks and leptons, interact with the Higgs field and experience inertia. Inertia is the property of matter associated with mass. If the LHC is able to produce Higgs bosons it will confirm the existence of the Higgs field and give new insight into why fundamental particles have mass. The LHC is colliding particles at 7 Tev (in 2011), which is more than enough energy to create a Higgs boson if it exists.

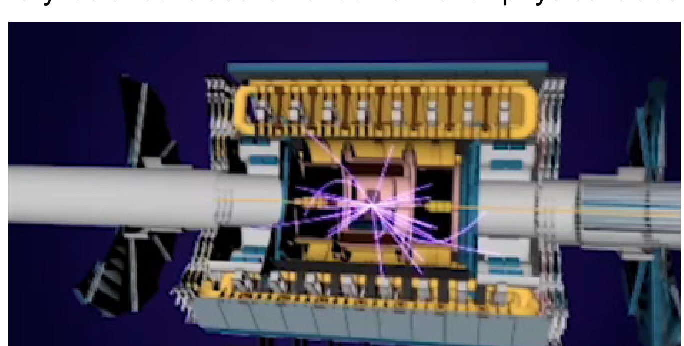
The LHC completed its 2011 proton collision run on October 30th, having far surpassed CERN’s original data goals. Results released in December (see the plot of ATLAS data, left) point to a possible Higgs candidate in the 124-126 GeV range. Researchers are now busy completing the analysis of over four hundred trillion collisions in search of the elusive Higgs and other new physics. Formal announcements from CERN are anticipated throughout 2012. The Perimeter Institute for Theoretical Physics (PI) is ready to respond to any significant findings. PI researchers involved in LHC projects have agreed to participate in interactive panel discussions to be live-streamed on the Internet whenever significant announcements are made. **Teachers and their classes will be invited to participate in these discussions.**



To coincide with these exciting developments PI is releasing a **new Perimeter Exploration** this spring. **Beyond the Atom: Remodelling Particle Physics** is a 30-minute video featuring state-of-the-art animations, researcher interviews and informative narration that introduce students to essential concepts of particle physics, starting with Rutherford and ending at the LHC. Researchers explain the basic science of particle physics in clear, easy-to-grasp language. Analogies are explored and animated to give the audience a scientifically valid description of how the Higgs mechanism explains the mass of fundamental particles.

The **classroom resource** that accompanies the video contains five classroom activities and extensive background material to help teachers bring the excitement of high energy physics into their classroom:

1) The Scattering Experiment activity engages students in a series of physical analogs of Rutherford’s famous gold foil experiment.
2) The Taming the Particle Zoo activity invites students to participate in the process of science by analyzing collision data to find patterns and predict the existence of new particles. These activities are adaptable and can be used in either an introductory science class or a senior level physics class.



3) In Bubble Chamber Detective students use conservation of charge, conservation of momentum and right hand rules to analyze two historical bubble chamber photographs. 4) In Finding the Top Quark students analyze data from Fermilab's DØ detector that leads to the measurement of the top quark. The second part of this activity has students working with a computer simulation to identify Higgs events.

The anticipation amongst physicists of forthcoming data from the LHC is palpable. Your students can share in the excitement. Physics did not stop with Newton, Maxwell, or Einstein; science is still moving forward with new discoveries at the LHC.

Go to **www.perimeterinstitute.ca/outreach** to order your copy of this new resource or attend one of our teacher workshops* to see what this newest resource has to offer.

*Workshops are being offered at the TDSB Eureka Conference on Feb. 17th , at the OAPT Conference at Perimeter Institute on April 28th, and at various locations throughout the province this spring.

Why Take Physics?

An OAPT Workshop Sneak Preview

by **Caroline Burgess**
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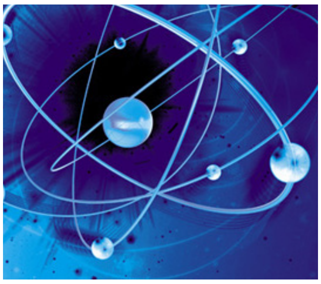
High school students can be so focused on getting into university that they sometimes make career decisions that limit their options as undergraduates and affect their ability to get out and move on to satisfying careers. They may also tend to have a "silo mentality" when it comes to science: for example, while they understand that a major in biology has a prerequisite of grade 12 biology, they may not appreciate that a degree in biology will also require them to take at least one course in physics at the university level. University admission requirements do not help in this regard since their focus is on admission to a Level I program – "getting in" – and often do not include all of the prerequisites required to move on to honours programs in Level II. Many students in a Level I Science program find themselves having to take an "equivalent to 12U" physics course in their first year of university in order to have the prerequisite for the Level I physics course required for admission to an honours program in Level II. Apart from the extra cost, the more serious consequence is that they are placed in a non-standard stream, competing for a seat in a course where the number of seats is limited and in a term when it is more likely to conflict with another course required for their program of choice.

While there are potential negative consequences to dropping Physics in high school, my OAPT 2012 workshop, Why Take Physics?,will have a more positive focus. Over the past several years, I have been collecting statistical and anecdotal evidence that makes a compelling case for taking physics (and more physics) at the university level. Physics underlies all other sciences, including the life sciences. Its power comes from this fact and the fact that training in Physics includes transferrable skills in experimental design, modeling, computing, critical thinking and problem solving. Physics graduates are employed throughout the economy and, according to recent studies, 97% of graduates say their physics training has contributed to their career (regardless of what they do). They are well-prepared for teaching, law school and, with a strategic selection of electives, for medical school, dentistry, and graduate school in a number of areas, including physics, astrophysics, biophysics, engineering physics, geophysics, materials engineering, medical physics, meteorology, neuroscience, physical chemistry, economics and finance. **Physics graduates are 98 % employed and enjoy the highest mid-career salaries of any science.** In a recent salary ranking based on 50 majors, the Wall Street Journal placed physics graduates sixth, ahead of most engineering graduates and far ahead of business majors.



Less Teaching, Smarter Learning

by Sean Clark
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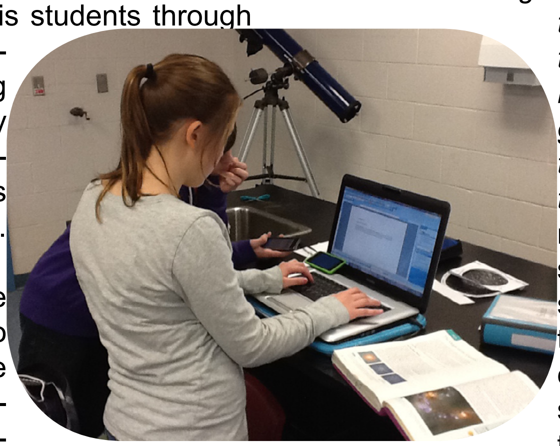
OCCDSB, Stittsville

At the 2011 STAO I attended a session in which Neils Walko described his technique of teaching grade 11 chemistry using student-centred collaborative inquiry. Similar to Carl Wieman's project-based physics courses at UBC, Neils guides his students through tutorials and resources available on the Web, while holding them to the standards of mastery learning. He has stopped "teaching" (presenting notes), and has become a facilitator of learning.



I began to consider how these techniques could be applied to the grade 9 science unit on The Study of the Universe. The development of a modular unit using blended learning (employing both in-class and digital resources) and allowing students to explore the myriad of topics relating to astronomy was certainly possible while still meeting the expectations of the provincial curriculum. By letting students choose their individual topics and work in collaborative groups towards the learning objectives I could have the curriculum cake and they could eat it too!

I began by narrowing the Ministry Guideline for this unit down to 13 learning goals and a comprehensive vocabulary list. Each learning goal was given its own page on my website and a full buffet of learning resources was collected. Students could choose to watch a video from the Kahn Academy, read a relevant section from their textbook, check out a set of PowerPoint slides, work through a Gizmo from ExploreLearning or watch a podcast from the CSA or NASA website. Once students think they have achieved the learning expectation they choose a recommended assignment or simply picked a topic to demonstrate/explain to the teacher using any of a variety of methods.

The topics in the Study of the Universe unit can be learned in any order. This lack of a prescribed sequence makes the unit perfect for allowing students to explore whatever strikes their fancy, literally learning what they want, when they want, and in a manner that appeals to their personal learning style.

So, for this unit, I surrendered my whiteboard to my students. I still conducted the occasional class demonstration, but most of my teaching moved to small groups, which in many cases made for lunar phases was done with a couple of styrofoam balls and a flashlight for some students. *The next day, I got to watch as they repeated the demonstration for a couple of their classmates who had been researching the formation of the solar system the previous day. Seeing the styrofoam balls, one of the researchers then grabbed a glue stick and explained accretion to my lunar learners and the snowball started rolling.* A roomful of computers and a site license for an astronomy software package proved not to be necessary. I showed a couple of students how the software works and let the technology work its magic. By the end of the unit most of my students were proficient enough with the software to demonstrate retrograde motion of Mars or Venus over several weeks, all from just two old desktop computers.

Teaching the space unit in this manner might not be for everyone. A couple of ingredients are essential. The teacher needs to be familiar enough with the content to be able to answer questions and guide students "off the script". A bank of resources is vital to let students choose how they want to learn, but there need not be class sets of anything as scaffolding makes for more effective learning all around. Having well vetted videos, animations, etc., is essential as students can easily become mired in the cornucopia of fluff available on the Net. A familiarity with the overall curriculum is needed so that you can make sure that students are not spending too much time on topics that will be covered in subsequent courses or falling short of learning objectives critical for the following year.

I have my sights set on other units I want to teach in this manner: grade 9 electricity and grade 10 optics. Who says you need to know how a static charge forms before you build your first parallel circuit? Why is a lightning rod more important to understand than the grounding rod at a gas pump? And does a student really need to be able to draw the ray diagram for refraction through a diverging lens if she can manipulate the lens equation more effectively to find the properties of the same image? This teaching method may not be for everyone or every subject, but it certainly has exciting possibilities in the physics strands!!

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Submissions describing demonstrations will be gladly received by the column editor.

Notes to the teacher:

Be careful loading the mousetraps. If one goes off unexpectedly, it can cause pain or even break a finger.

You can sometimes buy ping pong balls cheaply at larger dollar stores.

A Canadian Magnus effect experimental aircraft that actually used a giant analogue of a ping pong ball was the Van Dusen LTA (Lighter than Air). You can find images on the Internet by Googling "Van Dusen LTA."

Fun with Ping Pong Balls

Rolly Meisel
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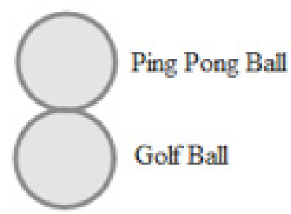
Ping pong balls make up an important part of the physics teacher's bag of tricks. Here are three disparate but entertaining and instructive uses for ping pong balls in the physics classroom.

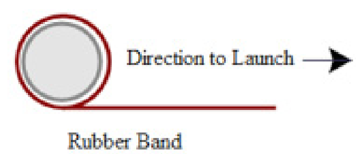
Apparatus:

- ping pong balls
- golf ball
- long rubber band
- mouse traps
- covered aquarium

Procedure:

1. Hold a ping pong ball on top of a golf ball as shown. Drop the two balls onto a hard floor, preferably concrete or similar. The ping pong ball will be launched some distance into the air. Try to find a room with a high ceiling, or do the demonstration outside. This should lead to an interesting discussion on ***energy and momentum conservation*** in elastic collisions. **More fun:** Perform the demonstration using two "superballs," a large one on the bottom and a small one on the top. You should do this one outdoors. The small one will fly quite a distance into the air.





2. A rotating ball flying through the air can generate lift. This is the "trick" behind a baseball pitcher's "floater." To demonstrate this wrap a long, thin elastic band around the ping pong ball, leaving some of it to be stretched. Stretch the band while holding the ball, and then release the ball to launch it horizontally. This may take a little practice, but you should be able to get it to gain altitude rather than losing altitude along the expected parabolic arc of a projectile. This method of generating lift is known as the ***Magnus effect***, and has been used on some experimental aircraft. The ball can be replaced by a rotating cylinder. For more information on the use of the Magnus effect in aircraft, ships, and high-altitude wind turbines search Google using the keywords "Magnus effect."
3. You can demonstrate a model of a ***nuclear chain reaction*** using a couple of dozen mousetraps loaded with ping pong balls. To ensure that the chain reaction occurs, you need to confine the mousetraps in a "reactor" such as a large dry aquarium with a rigid top to reflect the balls. The effect is quite dramatic after you drop in one ball to model a neutron "trigger" to split the first "atom." There are several dramatic video clips available, one of which features several thousand mousetraps. Search YouTube using the keywords "mousetrap ping pong ball."