NEWSLETTER

ONTARIO ASSOCIATION OF PHYSICS TEACHERS (An Affiliate of the A.A.P.T., and a charitable organization) Nov 2010

Making Groups Work

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Editor's note:
This is the second in a series of articles by Chris Meyer describing his experiences implementing a Workshop Physics program. To help guide Chris's ensuing articles, please give him feedback or ask him questions by emailing him directly.

"Life would be simple if not for other people".
"To really screw things up requires a committee".

We have all experienced the good, the bad, and the ugly of working in groups. By the time they reach our physics classes, so have our students. Their experiences are as varied as our own, and many students are justifiably concerned when the time comes to work in groups. How can we help students overcome bad or ugly experiences and derive the greatest benefits from group work? This installment will describe how to:

1) Make clear the value of cooperative group work,
2) Provide coaching and strategies for effective habits, and
3) Create an environment that encourages collaborative learning.

Changed Teaching Practice

Physics Education Researchers have measured student gain in conceptual understanding for a variety of instructional models[i]. One of the findings is the significant educational value of working in groups. Edward Redish of the University of Maryland calls this the *social learning principle*. "For most individuals, learning is most effectively carried out via social interactions." [ii] Social learning helps students who don't yet have the inner mental debate that allows them to effectively probe, explore and confront new ideas on their own.

The outstanding learning results produced by courses founded upon group work far outstrip those achieved by the most carefully reformed lecture-based courses[iv]. Two examples of very successful collaborative learning programs are *Physics by Inquiry*[v] at the University of Washington and Dickinson College's *Workshop Physics*[vi]. The evidence strongly suggests the shift from teacher- to student-centred learning needs to be made.

Explain the benefits

In a traditional physics course we may place students in cooperative small groups (to perform lab work, for instance), implicitly expecting them to acquire the skills of collaborative learning simply by virtue of working in groups. If, instead, the teacher explicitly addresses these skills students will better understand the value of group work and will improve their experiences in small groups.

Cooperative small group work generates skill building and ancillary benefits in the following areas:

(i) **The Power of Explanation**. If we cannot use our native tongue to explain new ideas to a friend, then we simply don't understand those ideas. In a teacher-centred classroom students have very little opportunity to apply their own powers of explanation and even less opportunity to get feedback on their ability to explain. In contrast, in a small group environment application and feedback are constantly taking place between students and with the assistance of the facilitating teacher.

(ii) **Peer Tutoring**. A weak student working in a small group has the opportunity to get regular assistance through group discussion that exposes him to others' thought processes. Strong students benefit equally. Many traditionally "strong" students are quick to memorize and recite answers but may possess surprisingly little understanding. The obligation to discuss and explain allows them to confront inconsistencies in their own thinking, furthering their understanding.

(iii) **More Teacher Attention**. Liberated from the demands of lecturing, teachers can turn their attention from their own train of thought to that of their students. A few tours of the classroom during a 60-minute activity can provide time to check in with every student, if only briefly, every day.

(iv) **Teamwork**. Oft cited as a highly prized skill[vii].

(v) **Responsibility**. Students begin to learn that it is their effort and energy that produces understanding and helps build skills. The traditional "lazy" way of learning - copying down notes, and memorizing laws and solutions has been largely eliminated.

Explain how groups work

What can the teacher can do to allay student concerns about group work and encourage a positive group experience? Begin by providing a detailed introduction to the group work programme of the course. Discuss:

(i) **Consistency and Regularity.** Making group work an everyday feature of the course will allow student get used to this structure. In time they will consider it normal and accept it. Using group work infrequently is problematic: students can choose to "wait it out" and not invest themselves in the process.

(ii) **Structure**. Provide clear structure for and training in the functioning of a group. This is often done using a system of rotating specialized roles and responsibilities. A typical cooperative small group has three members: a manager, a recorder and a sceptic[viii].

(iii) **Composition**. A group of three students of heterogeneous ability is the best composition and should be chosen carefully by the teacher when possible. Shuffle the groups periodically – every unit or every three to four weeks. The group is together long enough to commit to one another, but not so long that the group interactions get stale.

(iv) **Seating**. Group members need to sit facing one another. Working side by side often leaves one student out. A common workspace, such as a large whiteboard or chart paper, facilitates participation by every member.

(v) **Problems.** What do you do when a group is not functioning at its best? Most students simply don't know. Typical problems that crop up in small groups are: one member dominating, one member not contributing or lacking commitment, the group wandering off track, or a personality conflict. Address these potential problems at the outset, before they occur, and provide helpful suggestions for their resolution[ix].

(vi) **Time constraints**. Most students have evolved, by the senior grades, to be *competitive*. The goal of group work is to deepen students' understanding through *collaboration*. Encouraging this requires a fine balance. Provide enough time for vital discussion and tutoring to take place, but not so much that a sense of exigency disappears. Adequate time pressure will encourage the group to remain on task; unreasonable time pressure will simply encourage the dominant student to take over just to 'get it done' in the time allotted.

(vii) **Assessment**. Assessment must be carefully balanced between process and product. Students need to be allowed to make mistakes; otherwise, the especially marks-anxious individuals will take over the group. Analyze the activities in advance to judge which ones lend themselves to the assessment of care and thoughtfulness in process and which ones would be better assessed based on the accuracy of students' results.

Positive results

I have designed and constructed an active-learning grade 12 physics course based on group work, using guided inquiry activities and problem solving challenges. (See my resources freely available at: www.meyercreations.com). I invest a considerable amount of time and energy, especially at the beginning of the course, in instructing my students on the value of group work and techniques for its success. The results compare as day to night with my old teaching practices. The level of student engagement is considerably higher; students remain intellectually active for the majority of the class. Problems still arise, and no strategies work for everyone, but when my students aren't sweating too much they often give away how much they enjoy physics in groups.

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[i] See Force Concept Inventory as one example: http://se.cersp.com/yjzy/UploadFiles_5449/200607/20060705142003187.pdf

[ii] Redish, E. *Teaching Physics with the Physics Suite*, Hoboken, NJ: John Wiley & Sons, 2003, pg. 39, http://www2.physics.umd.edu/~redish/Book/

[iv] Redish, E., pg. 176 and 179

[v] http://www.phys.washington.edu/groups/peg/pbi.html

[vi] http://physics.dickinson.edu/~wp_web/wp_homepage.html

[vii] One recent example: Toronto Star, Sept 27, "Toronto scientist shaking up field of infectious disease", http://www.healthzone.ca/health/newsfeatures/article/866651--toronto-scientist-shaking-up-field-of-infectious-disease

[viii] An excellent manual describing many aspects of group work: http://groups.physics.umn.edu/physed/Research/CGPS/Green%20Book/chapter3.pdf

[ix] U of T Practicals: Teamwork Module – Student Guide, http://www.upscale.utoronto.ca/Practicals/Modules/Modu

CALLING ALL WRITERS!

We are always looking for great articles! Forward all contributions to Tim Langford or Lisa Lim-Cole via www.oapt.ca!

If writing is not your thing… How about a cartoon?

Readers' Corner

Back-of-the-Envelope Physics

By Clifford E. Swartz

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Swartz, C. (2003). *Back-of-the-Envelope Physics*. Baltimore and London: The John Hopkins University Press. ISBN: 0-8018-7262-6, 155 pages. **Sample chapter available at Google books.**

Rating: **** Highly recommended

For a half century Clifford Swartz (1925 – 2010) was a prominent figure in physics education in the United States and worldwide. His books have been translated into many languages. Swartz was an active member of the AAPT and long-time editor of *The Physics Teacher* (1967-1985). For his numerous contributions to physics teaching Professor Swartz was honoured with numerous awards, including the AAPT Oersted Medal (1987) and Melba Newell Phillips Award (2007).

Back-of-the-Envelope Physics is a 'must read' for every physics educator and curious physics student. Its aim is to help students and teachers *make meaning* of the principles of physics. Swartz's method is application of these principles to practical problems from everyday life. He wanted his students to develop a 'physics intuition' and tried to steer them away from 'formula picking' or 'pattern matching'. Swartz realized that the art of order-of-magnitude estimation, also called 'back-of-the-envelope' estimation, needs to be a major component of physics teaching if we want to help our students develop a true physics intuition and to see physics as a vehicle for exploring the real world around us. In this short (155 page) and very accessible book, Swartz provides more than 100 examples of how these estimates can be done using a few fundamental physics principles and a few lines of basic algebra.

The book is divided into ten chapters reflecting common topics included in most introductory physics curricula: Forces and Pressure, Mechanics and Rotation, Sound and Waves, Heat, Optics, Electricity, Earth, Astronomy, Atoms and Molecules, and Particles and Quanta. Each chapter has a number of interesting problems in which the reader is asked to make a simple estimate. Example are the safe spacing of nails in the "bed of nails" demonstration, the tension force provided by the biceps when you hold a rock, and the amount of money you could save if you could stop using batteries and replace them by the electrical energy "coming out of the wall".

Clifford Swartz helps us find answers to the strangest questions our students might have asked us or we might have been thinking about, such as a negative calorie diet that consists of ice, the variation of your weight with the location on Earth, or the relationship between the height of the mountain, the strength of the planet's gravitational field and the latent heat of fusion of the mountain rock.

I strongly recommend this book to physics teachers and students alike. You will enjoy every page of it! It will inspire you and make you excited to come to class and share your love for physics with your students, classmates, and colleagues.

The President's Corner

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32nd OAPT Annual Conference was Outstanding!

'If you build it they will come'. And come they did: more than 140 enthusiasts, including a wave of new and pre-service teachers. From the Thursday night barbeque to the tours of the U of T physics labs, to **Dr. Stephen Morris'** clever and compelling address, to Dave Doucette's impassioned closing, it was non-stop physics in action. **Dr. David Harrison's** Friday morning keynote workshop was a perfect launch to *Research into Practice*, as he masterfully articulated the need to support reforms to physics education. Thirty busy sessions followed, the majority modeling best practices: with teachers in the role of active, engaged students. The presenters took to heart the PER adage, *"Teachers should be taught in the manner they are expected to teach.[1]"*

The energy was so palpable as to prompt past-President (2004) Patrick Whippey to gush "I haven't seen such synergy in years!" Numerous participants echoed Patrick's sentiments. Many thanks to the more than 20 presenters who conducted stellar workshops. And a tremendous thank you to **Dr. Jason Harlow** who was our 'point person' at U of T, handling TA's, workshops, food and beverages and an array of logistical concerns. And, of course, our gratitude to **Perimeter Institute** for continuing to act as co-sponsor.

So, what say we do all this again sometime – like **May 12-14**, 2011, at **McMaster University**?

Physics rules!

[1] McDermott, L.C., P.S. Shaffer, & C.P. Constantinou (Nov., 2000). "Preparing teachers to teach physics and physical science by inquiry". *Physics Education,* 35 (6), 411.

The Demo Corner

Buoyancy and Newton's Third Law of Motion

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Submissions describing demonstrations will be gladly received.

This article is excerpted from *Physics in Canada*, Volume 61, No. 2, (2005), pg. 87-89, with permission of the Canadian Association of Physicists (CAP).

Since the publication of Eric Mazur's book *Peer Instruction* (Prentice Hall, 1997) the active engagement of students in physics classes has become increasingly common. A classic Mazur strategy is to pose a multiple-choice question, ask the students to discuss the question in small groups, and then survey the students for their individual answers by a show of hands or remote-control technology ("clickers"). This strategy can be used to elicit predictions about the possible outcomes of a lecture demonstration. The instructor displays the demonstration apparatus and describes what will be done with it but does not perform the demonstration nor hint what the result will be. Students discuss the possible outcomes in small groups, make their own personal judgments, and select an outcome from a multiple-choice list. The demonstration is then performed to show what actually happens, and the relevant physics is discussed, usually with the instructor leading a full-class discussion this time.

Figure 1 shows the apparatus for one of my favourite demonstrations. A beaker of water is balanced on a triple-beam balance sitting on a table and the mass of the beaker and water is noted. Beside it a wooden dowel is clamped vertically to a retort stand. The bottom of the dowel is at a vertical level below that of the water surface, as shown. The question is: What will happen to the balance if the dowel and stand are picked up and moved sideways and then downward, so that the bottom end of the dowel is now submerged in the water? The dowel will still be attached to the retort stand, which will again be resting on the table. Will the apparent mass, as indicated by the balance, of the water + beaker + submerged dowel be greater than, equal to, or less than the previously noted mass of water + beaker only? This particular demonstration almost always produces a roughly equal split among the three possible answers, even if the audience consists of professional physicists! What do *you* think will happen to the apparent mass? To find out, try the demo yourself. A couple of ways to think about the physics that's involved will be given in the next Newsletter and (if you can't wait that long) will also be available at www.oapt.ca (click on the "Newsletter" button).

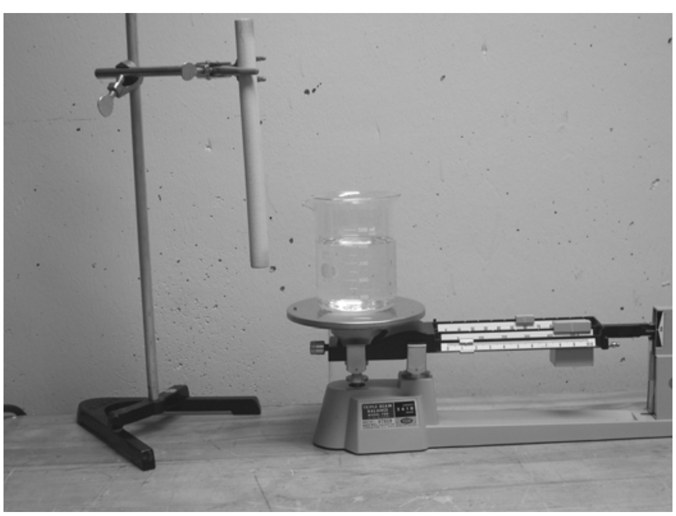

Figure 1: The apparatus: a wooden dowel attached to a retort stand, and a beaker of water on a pan balance.

We Want Your Input!
New Name? Go Green!

Dear OAPT members,

The OAPT Steering Committee thinks it may be time for the Newsletter to jump into the 21st century. Here are the changes we are considering:

- Drop the word "Newsletter" from the name and choose a **catchy new name** for this publication;
- Go with an **e-Newsletter** format to reduce our paper usage, reduce mailing/printing costs, and offer colour and imbedded digital tools.

We want your opinion! Please visit http://www.oapt.ca/ to vote on a new name and tell us whether you'd like an e-version of the newsletter.

Five New Name Suggestions*

"Quark Quarterly" "The Little Bang" "The Laser"
"The Vector" "The Comet"

***Make your own suggestion** for a new name for the newsletter at http://www.oapt.ca/. If your suggestion gets adopted you will not only have bragging rights but will receive a **free two-year membership** to the OAPT.