OAPT Newsletter

Winter 2012

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The Prez Sez

by Roberta Tevlin
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Here's hoping everyone had an enjoyable summer!

Executive Changes

Lisa Lim-Cole has accepted the position of vice president, which means she is organizing next year's conference. Robert Prior has taken over Lisa's former position of epublisher to allow her to concentrate on this huge responsibility. Dennis Mercier is the member-at-large, meaning that he will join Elizabeth Dunning as the other half of our finance team. The other executive members have agreed to stay on in their positions for another year.

Volunteer Base

Thanks so much to all the new people have stepped up! We have over 40 active volunteers! For the full list see **http://www.oapt.ca/contact.html**. If you are interested in being a volunteer just let me know. We can find a task that suits your interests and time constraints.

Conference 2012

In case you missed it, this year's conference at the Perimeter Institute of Theoretical Physics was a huge success. There was so much interest that we had

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to close off registrations—something that has never happened before! I knew that PI was going to draw a big crowd but I didn't expect this! It was a real pleasure and honour to work with all the PI people who made the conference so fabulous. It is hard to know where to begin—the building, the guest speakers, the speed daters, the Outreach team and their teaching resources or the food. They also made it possible for seven teachers to attend by helping to fund the new northern travel subsidy.

Conference 2013

The University of Ontario Institute of Technology is hosting our next conference, May 2-4. We will once again have a huge range of workshops for you to choose from. We will also have a very strong focus on Physics Education Research which is being organized by our PER gurus Dave Doucette, Glenn Wagner and Chris Meyer. Thanks to the continuing generosity of the Department of Electrical and Computer Engineering at the University of Toronto we will once again be able to offer the amazing accommodation price of $19.99 per night! Watch for details at http://www.oapt.ca/conference/2013/ and mark these dates in your calendar now!

Newsletter and Website

Last February the newsletter went completely electronic. This saves paper and money, makes it easier for us to get the news out and adds richness to the newsletter using hyperlinked articles and more photos. Furthermore, the newsletter has now become a valuable resource and you will never lose any important article again. If you go to the newsletter page on the website http://www.oapt.ca/newsletter/, you can find issues going back to 2005. If you don't remember what issue a particular article was in, you can use the new Google search on the home page http://www.oapt.ca/ or go to the new resources page http://www.oapt.ca/resources/ where you can find all these issues in one searchable PDF file.

While you are at the resources page check out the other new resources:

- You can find the files from the summer camp that Dave, Glenn and I gave in Ottawa this summer at **http://www.oapt.ca/resources/otf_workshop_2012/**.
- You can find past OAPT Contest questions collected by topic and ready to use in your classrooms at **http://www.oapt.ca/resources/contestQB.html**.
- All of the Demonstration Corner articles have been gathered in one place. All the demos highlighted over 25 years by Ernie McFarland and his happy helpers in one easy-to-search location! (**http://www.oapt.ca/resources/democorner.html**)
- Check out the page about Concept Questions for Peer Instruction. This powerful technique is the easiest PER technique to use. (**http://www.oapt.ca/resources/conceptquestions.html**)

Many thanks to Rolly Meisel and his team for creating these resource pages this summer.

Summer Physics Camp

August 2012 featured the fourth and largest ever camp, generously funded by the Ontario Teachers Federation. Dave Doucette and I were joined this year by the amazing Glenn Wagner. The camp was supposed to be limited to 35 teachers but the demand was so insistent that they allowed everyone on the waiting list in, making a total of 48 participants. Once again I learned a lot from the presenters and from the participating teachers. Unfortunately, this may have been the last Physics Camp. The OTF is no longer able to provide funding. A small group of people have been working with me to put together an application for an NSERC PromoScience grant to allow it to continue. We'll know in early 2013 whether our application was successful. Many thanks to Cathie Bellingham and Caroline Burgess for help with the application and to all the teachers that wrote supporting letters.

Local Physics Teacher Alliances

There are a number of local PTA's that are continuing to run or are starting up this year: Toronto, Oshawa, Guelph, Waterloo, Thunder Bay and Montreal. These groups get together after school to share resources, ideas and friendships. This is a great development. One conference or camp a year really isn't enough. The OAPT is supporting these groups by advertising their meetings and providing a bit of money for pizza and pop. If you are thinking of starting a group like this be sure to let me know.

Have a wonderful year and keep in touch!

Roberta

Upcoming Events

For the latest events and workshops, visit the OAPT website:
http://www.oapt.ca/events/

December 5

Wondering and Wandering about Fields

Chris Meyer

Location

Toronto, York Mills CI, 490 York Mills Rd. Rm 112

Time

4:00–6:00

Wondering About Fields? Wandering About the Fields?

Teaching Electric and Magnetic Fields Through Inquiry by Chris Meyer

Are you lost in the fields? Learn how to tackle this challenging unit the inquiry way! Find out how to turn your class into a hive of group-working activity using Chris's newly developed unit. After a quick introduction to teaching without lectures, you will get started exploring this topic and trying out the activities and investigations. You will leave with resources at hand (and online) that will allow you to start teaching fields the very next day (or once you track down your ebonite rods)! This topic is foundational for electrical engineering and biochemistry, so it's time we give fields their due. No more wandering!

December 11

Biophysics Lab Activities, Mars Rover, Nanotechnology Lab

Joanne O'Meara and **Martin Williams**

Location

Guelph, Guelph U McNaughton Building

Time

4:30–6:30

Mars Rover and nanotechnology Lab, presented by Dr. Joanne O'Meara and Dr. Martin Williams.

"I think it is hugely motivating for people to think about the future at whole new level. I believe physics can play a role in motivating people, and giving them hope and ambition for the future."

Dr. Neil Turok

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Doing Science in Tanzania

by Diane Hall

Do Science Tanzania is a project I conceived while climbing Mt Kilimanjaro in July of 2010. In Tanzania students have to decide in grade 9 if they want to follow a business or science stream, yet at that stage they haven't really experienced what it means to 'do science'. This bothered me a lot. After visiting schools in Tanzania I saw firsthand the lack of resources and minimal educational background for teachers. I couldn't help but imagine how a science teacher must struggle to teach in this system. I came up with an idea.

I acquired most of what I use in my classroom from networking with other teachers. Even the activities that I designed myself often resulted from having a conversation with another teacher where a nub of an inspiration was sparked. Do Science became a program where teachers are offered ongoing access to workshops where they are exposed to the use of equipment and given the chance to perform activities, sharing ideas and supporting each other through the challenges which have been limiting the amount of hands-on and minds-on science that has been part of their programs.

Do Science has a continually growing library of equipment that can be borrowed for use in the classroom. The impartial control of this equipment allows all schools equal access and reduces the cost for everyone. This equipment is owned and maintained by Do Science and there is no cost to teachers or students for using it.

This year the student scholarship program was added, where individuals or groups can contribute $100 towards school fees for one student for one year. Students apply; I review the applications and interview the candidates. Once chosen, I meet with the bursar of the school and make deposits into the bank account for the respective school in the name of that student. This year we were able to provide support for 18 students.

While conducting interviews I became aware that most students had few skills with which to make choices for career streams and post secondary studies. I started a series of career development workshops where students begin to learn about themselves and how to set themselves up for success. These were very popular and also led to some small group computer literacy classes which we held in a local coffee shop. Students who had never touched a computer learned to create a document, access the internet and create an email account.

The focus of the Do Science project is to give students what they need in order to decide to follow science or leave the field. It is only by finding out what 'doing science' means that they can make an informed decision. The funding so far is mostly private. We are looking for some corporate partners to support us financially. We thank the **Ontario Association of Physics Teachers** for the generous contribution made at the annual conference last spring. We would also like to thank the **Ontario Secondary School Teachers' Federation** which, through their International Projects Grant, helped us out a lot this year. The many individuals who have contributed make the whole program possible. Thank you to everyone.

For more information on Do Science, please visit the website: **www.dosciencetanzania.org** and the blog: **www.dosciencetanzania.wordpress.com**.

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Hands-On Cosmology for Grade 9 Astronomy

by Roberta Tevlin

This was one of the workshops that I presented at Physics Camp this past summer in Ottawa. You can find the student worksheets and files with detailed information for teachers the new OAPT resources pages: **http://www.oapt.ca/resources/otf_workshop_2012/index.html**.

The two lessons that we presented at the camp grew out of two frustrations I have been feeling for a long time. The first frustration is with math. The science courses in grade 9 and 10 have very little math embedded in them. The unfortunate result is that students are not prepared for the math in grade 11 chemistry and physics. The first lesson, Hubble's Law, has the students take some real galactic data and use this to practice their skills in graphing, units, powers of ten, interpolation, extrapolation, slope and equations. The need for the math skills is embedded in the work. They can write out all of the zeros involved in galactic sized numbers like 3,960,000,000 x 9,500,000,000,000 or they can use powers of ten $3.96 \times 10^9 \times 9.5 \times 10^{15}$. They can tape some paper onto their graph and extend it or they can use the equation of the line. They also get to experience some fun with a few short online videos:

- Minute Physics: How far is a second? **http://www.youtube.com/watch?v=Wp20Sc8qPeo**

- Alice & Bob in Wonderland: “Is that star really there?” **http://www.q2cfestival.com/play.php?lecture_id=8245&talk=alice**
- Minute Physics: The Oldest Light in the Universe, **http://www.youtube.com/watch?NR=1&feature=endscreen&v=_mZQ-5-KYHw**

The second frustration I have is that many (most?) schools provide very little time for the grade 9 astronomy unit. This is true despite that fact that students love to learn about space! It likely results from the fact that most science teachers have very little background in astronomy. This is where physics teachers like you can make a huge difference. If you help the science teachers in your school with the physics strands in science, you will find more students signing up for physics in grades 11 and 12. The second lesson should be especially easy to ‘sell’ to these teachers. It leaves the mathematics and has the students think about what Hubble’s Law means? I mean, really! Why are the galaxies moving away from us? Do we have galactic bad breath? Students explore the expansion of the universe with three inexpensive physical models. First they do an experiment with a set of linked elastic bands and paper clips as shown in the photo. Then they look at patterns on transparencies overtop of similar but smaller patterns on paper. Finally, they look at how light is altered by using a balloon. The lesson ends with an awe-inspiring short online video, *The Known Universe: Primordial Sound, Vibration, and the Cosmos Visually*, **http://www.youtube.com/watch?feature=endscreen&v=702kVrhOvL4&NR=1** from the Rubin Museum of Art and the American Museum of Natural History.

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Homework Problems & Problems with Homework

by Chris Meyer

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Homework is healthy, nourishing work that should be done—at home. It is the vital reinforcement of the day's hard earned insights. But mostly it's the missing link in our students' educational evolution. Let's try to understand the homework problem and push our students to a new level of physics understanding.

The Homework Problem

Each year I used to discover anew, somehow to my surprise, that my students hardly ever did their homework. Class after class I would feel the same existential despair while vainly asking who would like a question taken up. I squandered much class time demonstrating how well I could solve physics problems for the handful of kids who actually tried them. In the end, so I thought, the students must sink or swim. If they're not getting their homework done and benefit from my learned (nay, inspired!) solutions, it's their own darn fault.

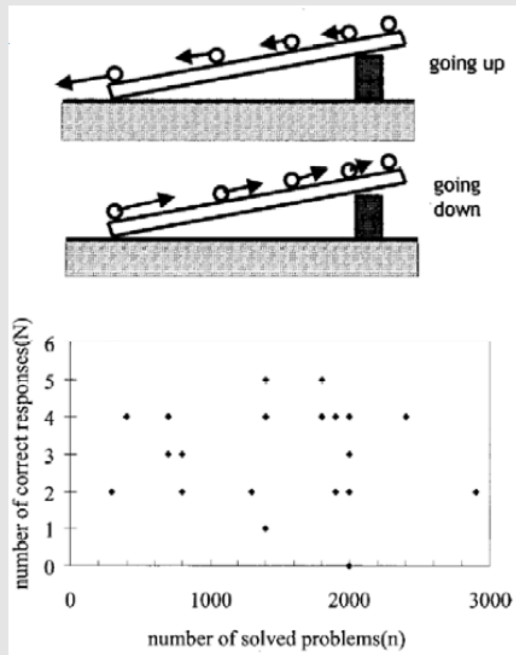
Fortunately I have calmed down since those days and reassessed this problem. My physics students, though attending an academic, high-achieving school, still need considerable hand holding and support in developing good learning skills. In many cases Gr. 12 is too early to be taking off the training wheels in service of the sink or swim mentality. If I let them they would wing it until they can't manage anymore and then, being so far behind, simply fail. Implicit in the sink or swim mindset is the belief that it is either acceptable or at least understandable that only a small fraction of our students ever learn physics well. I don't think I need to argue that this mindset has no place in the 21st century.

My Homework Solution

My solution is a fairly regimented homework routine. The hope is that when they get to university and the training wheels are snapped off, they will have passable skills to fall back on—skills which they had little choice but to develop. In my course homework assignments are an important part of their mark. I check homework randomly and it is worth very little unless it is done my way. The first missed check or two is painful, but can easily be recovered from. And here is the deal, just like the one between Mr. Miagi and Danielson: paint the fence (try to imagine his voice), sand the floor, wax the car and you will become a physics/karate master. (**last semester**[1] my median student scored 87% on the FCI where 85% is recognized as Newtonian mastery). My way is certainly more work, in fact an order of magnitude more compared with the scratches that usually get passed off as homework, but I try to strike a balance.

More Just Means More

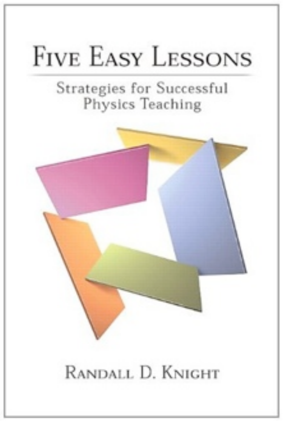
Learning does not take place when work is done thoughtlessly. This is an important point from the much abused **10 000 hour expert theory**[2] (good theory, bad people who quote it without having read the original research). Only deliberate practice under expert guidance can help one to become an expert. I can recall a sullen student who explained to me how she did every problem in the chapter review and still managed to disappoint on the test. I have trained physics teachers who have had a very traditional, rote education and who have surprising difficulty explaining basic concepts. This also explains why after 30 years I still type slowly on the computer using two fingers. In Korea, students often go to bonus school after their regular school to get extra practice with their physics problems. **Results**[3] show that this 'practice' provided no measureable gain on simple, conceptual questions. One such question is shown in the illustration where a student was asked to draw acceleration vectors for an object on an incline. The graph showing the correlation between number of practice questions solved and success on simple conceptual questions has scattershot that would even embarrass Dick Cheney. So much for those 10 000 hours.



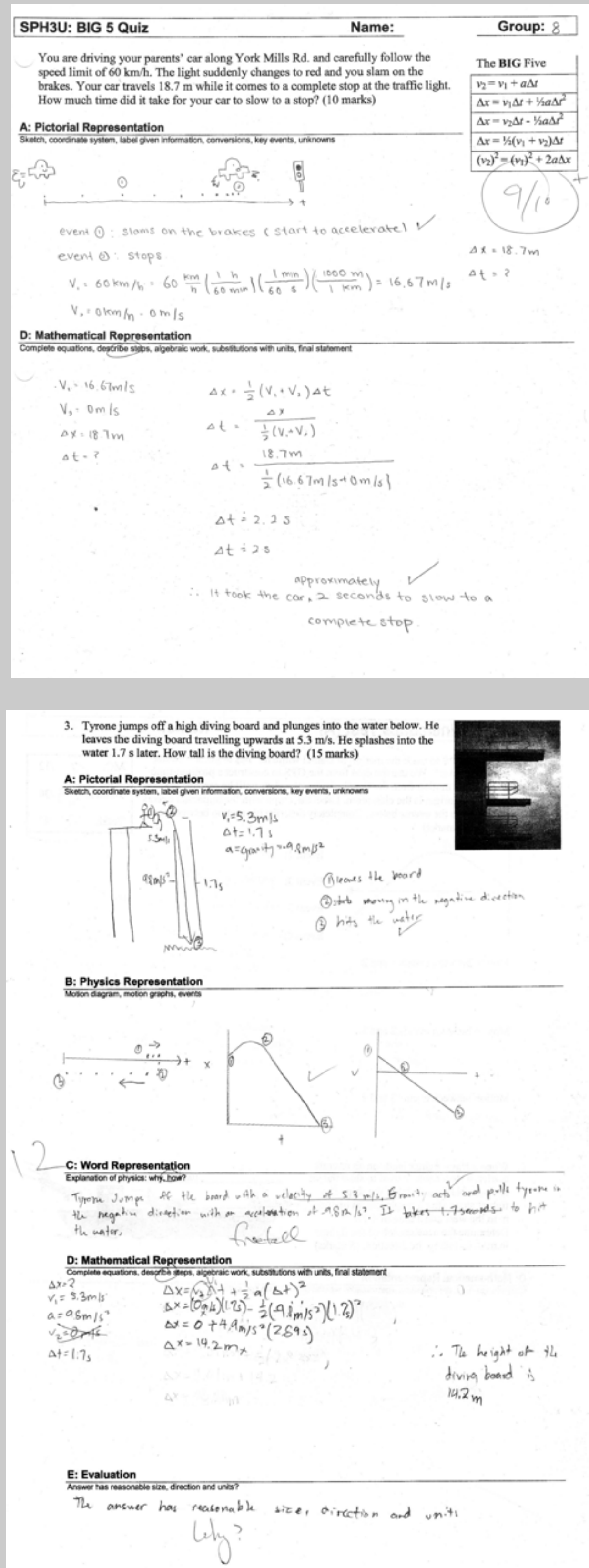
Correlation between practice problems and conceptual understanding

Do Less, Really, Really Well

To make room for more thoughtful homework practice, I have curbed my reflexive habit to assign questions 1–7 at the end of each day's section in the text. Instead, I choose just a couple of decent, somewhat insightful questions and expect them to be done well. To help my students do their work in a thoughtful manner, I provide them with a solution sheet (**blank**, **model**, **sample**)[4] that emphasizes multiple representations. Students have a much better chance of developing a deeper, more nuanced understanding of physics if they can explain a situation from a number of different physics angles using a variety of tools. Even the **College Board**[5] of AP Physics fame has caught on to the value of multiple representations—which means this is well overdue.



My own solution sheets are modeled after those presented in Randall Knight's fine tome **Five Easy Lessons**. To get credit for their homework, my students must solve their problems according to this format. The amount of detail and thinking that goes into one solution, even for a lackluster textbook question, becomes impressive. A crucial benefit of multiple representations that is it allows students to begin to think about self-consistency. Does the force diagram agree with the position graph? Do the events labeled in the sketch coincide with the right moments in the motion diagram? This is an instinctive process for many experts but is seldom ever practiced by novices. Another benefit is how abstract equations become more meaningful. Students learn to see in many ways what those odd symbols and numbers represent. My tests and quizzes follow up on this new process asking for particular parts of the solution or the full monty. Notice that I don't ask students to memorize the detailed procedure—that's not the point. I reproduce the solution outline on their tests and quiz pages and instruct them to use the headings as a checklist. The headings are also great for quick feedback as well.


SPH3U: BIG 5 Quiz | Name: | Group: 8

You are driving your parents' car along York Mills Rd. and carefully follow the speed limit of 60 km/h. The light suddenly changes to red and you slam on the brakes. Your car travels 18.7 m while it comes to a complete stop at the traffic light. How much time did it take for your car to slow to a stop? (10 marks)

The BIG Five
$v_2 = v_1 + a\Delta t$
$\Delta x = v_1\Delta t + ½a\Delta t^2$
$\Delta x = v_2\Delta t - ½a\Delta t^2$
$\Delta x = ½(v_1 + v_2)\Delta t$
$(v_2)^2 = (v_1)^2 + 2a\Delta x$

A: Pictorial Representation
Sketch, coordinate system, label given information, conversions, key events, unknowns

D: Mathematical Representation
Complete equations, describe steps, algebraic work, substitutions with units, final statement

3. Tyrone jumps off a high diving board and plunges into the water below. He leaves the diving board travelling upwards at 5.3 m/s. He splashes into the water 1.7 s later. How tall is the diving board? (15 marks)

A: Pictorial Representation
Sketch, coordinate system, label given information, conversions, key events, unknowns

B: Physics Representation
Motion diagram, motion graphs, events

C: Word Representation
Explanation of physics: why, how?

D: Mathematical Representation
Complete equations, describe steps, algebraic work, substitutions with units, final statement

E: Evaluation
Answer has reasonable size, direction and units?

Sample quiz and test

The (try to be delicate) Inadequacies of Textbook Problems

I get really frothy and shout at my computer a lot when I review textbooks—I'm glad the cat is my only witness. When I reach the practice questions I usually go bonkers. What should be a lively slice of the wide and wonderful world of physics is somehow all about boxes—talk about thinking inside the box.

Then there are all those "plug and chug" questions. Students need surprisingly little practice with their math (you heard me, surprisingly little—but that's for a whole other article). What they really need is lots of practice thinking, testing, applying, extending, explaining, judging, planning and a few other quality "-ings". There is remarkably little latitude for thought in a typical textbook question. It is usually obvious which single equation is to be used and which quantities should be plugged in.

How a Student Interprets a Typical Textbook Question

It is very important that you learn about traxoline. Traxoline is a new form of zionter. It is montilled in Ceristanna. The Ceristannians gristeriate large amounts of fevon and then bracter it to quasel traxoline. Traxoline may well be one of our most lukized snezlaus in the future because of our zionter lescelidge. Answer the following questions in complete sentences. Be sure to use your best handwriting.

- What is traxoline?
- Where is traxoline montilled?
- How is traxoline quaselled?
- Why is it important to know about traxoline?

http://umdperg.pbworks.com/w/file/fetch/52234596/GIREP2009%20Math%20Symposium.pdf

Standard questions seldom draw upon a range of physics within one problem—even the chapter-spanning unit review questions. These uninspired problems cement the compartmentalization of student's physics knowledge. Force problems are only about force, graphs of motion disappear right after kinematics ends, and other topics like sound, electricity and energy are scattered around students' minds like disembodied limbs after the walking dead have been through town.

Real Problems for Real Students

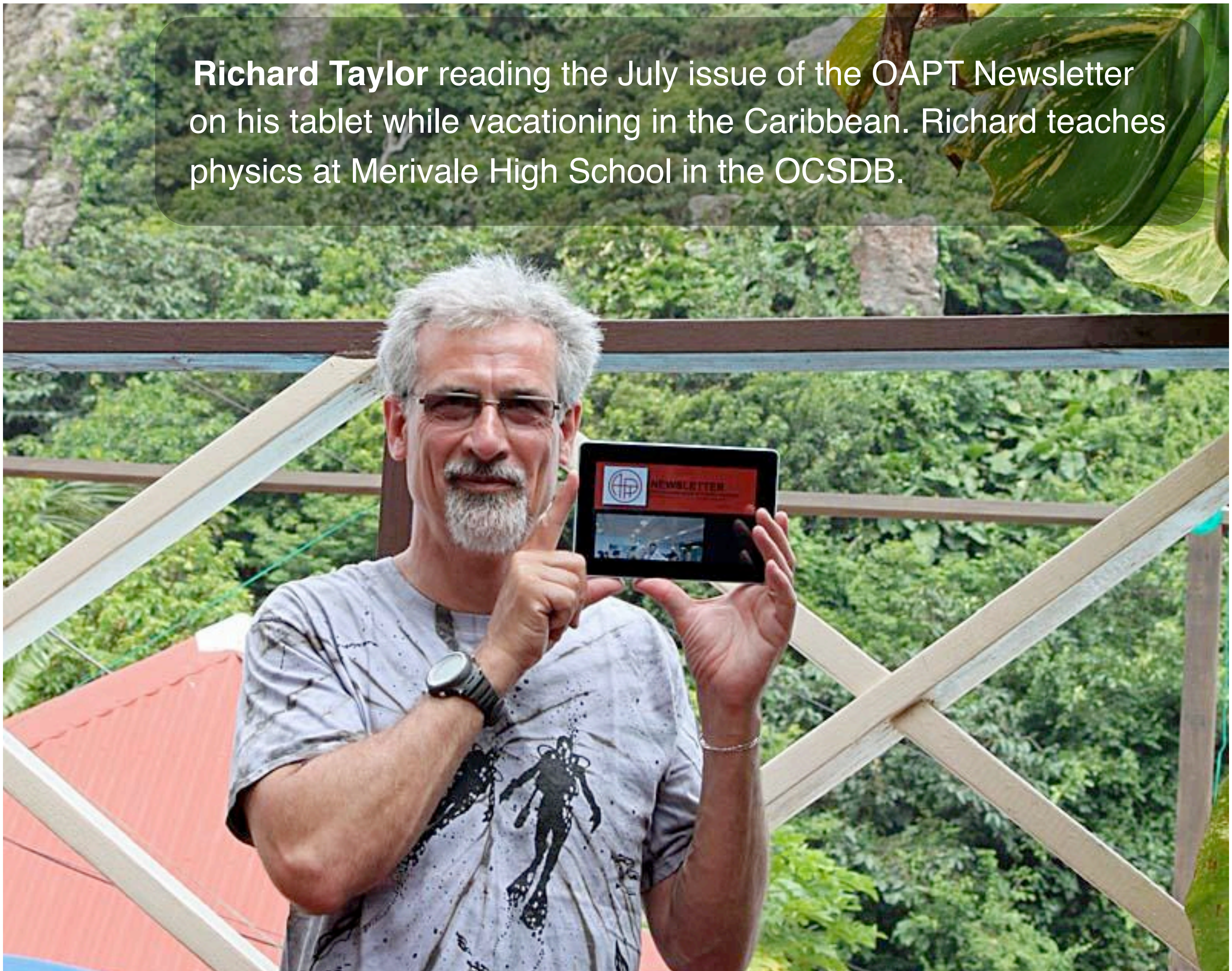
Good questions are rich in context and read much more like stories. They are plausible situations presented in casual language and do not ask students to solve for "x". Multiple steps require the student to form a clear picture of the problem and develop some thoughtful planning. A typical student can't look at a good question and say, "I know how to solve this". Instead they say, "hmmmm… I have to work this out". That is exactly when they start to build the skills we are looking for. I'm not sure I saw a single question of this caliber in the last textbook review cycle. Pioneering work into context-rich problems has been done by Pat and Ken Heller at the University of Minnesota and I highly recommend their extensive **online resources**[8]. I try to provide some additional nuanced questions for my students, but I have only so much time. The solution process I have described helps add vitamins (or steroids — but I won't be caught like Lance) to the more typical textbook problem.

My Challenge to You

Try this out. Give a persuasive pitch why high-thinking homework is so valuable. Provide some samples and train your students in the new process. Keep a stack of solution sheets readily available in your class and even put it online if possible. Follow this up in your tests and quizzes. See the difference it makes. You may even smile again at the thought of homework.

Links and References

1. *Results: Concept Surveys*. Chris Meyer (**http://meyercreations.com/physics/resources/Survey%20Results%20-%20March%202012.pdf**)
2. *Giftedness and evidence for reproducibly superior performance: an account-based on the expert performance framework*. K Anders Ericsson, Row W. Roring, and Kiruthiga Nandogopal (**http://www.psychologytoday.com/files/u81/Ericsson__Roring__and_Nandagopal__2007_.pdf**)
3. *Students do not overcome conceptual difficulties after solving 1000 traditional problems.* Eunsook Kim and Sung-Jae Pak (**http://sdsu-physics.org/sdsu_per/articles/ProblemS_ConUnderst.pdf**)
4. *Homework Resources.* Chris Meyer
   - **http://www.meyercreations.com/physics/resources/HomeworkSheet-Forces&Motion.doc**
   - **http://www.meyercreations.com/physics/resources/SampleSolution-Forces&Motion.doc**
   - **http://www.meyercreations.com/physics/resources/kinematics%20homework.jpg**
5. *Multiple Representations of Knowledge: Mechanics and Energy*. (**http://apcentral.collegeboard.com/apc/public/repository/Physics_Multiple_Representations_of_Knowledge_SF.pdf**)
6. *Sample Quiz.* Chris Meyer (**http://www.meyercreations.com/physics/resources/BIG%205%20Quiz%202.jpg**)
7. *Example Test*. Chris Meyer (**http://www.meyercreations.com/physics/resources/test.jpg**)
8. *Online Resources for Cooperative Group Problem Solving*. Pat Heller and Ken Heller (**http://groups.physics.umn.edu/physed/Research/CGPS/GreenBook.html**)



Richard Taylor reading the July issue of the OAPT Newsletter on his tablet while vacationing in the Caribbean. Richard teaches physics at Merivale High School in the OCSDB.

Where in the World?

Our members see physics in all sorts of interesting locations. If you have a photograph of yourself reading the OAPT Newsletter in an unusual location, send it to the editor.

You can see more pictures of our members reading the OAPT Newsletter on the OAPT website:

http://www.oapt.ca/newsletter/

New OAPT Resources

- Files from the 2012 OAPT summer camp in Ottawa at **http://www.oapt.ca/resources/otf_workshop_2012/**.
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- Concept Questions for Peer Instruction. This powerful technique is the easiest PER technique to use. (**http://www.oapt.ca/resources/conceptquestions.html**)

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