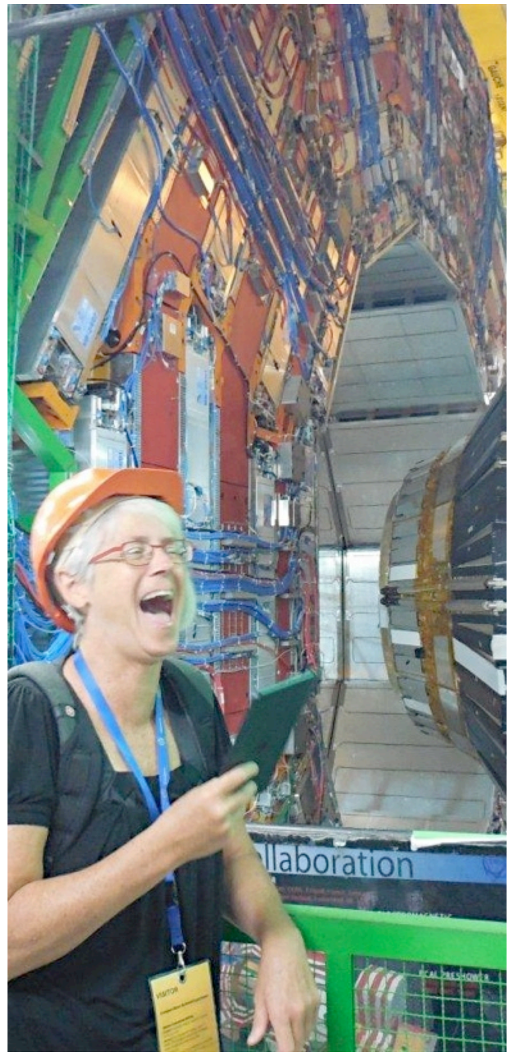


OAPT Newsletter

Autumn 2012

In This Issue

Ontario Association of Physics Teachers

You Are the OAPT

Tim Langford, editor
tim.langford@tdsb.on.ca

Sharing is Caring – for Yourself and Your Students

Welcome to another fabulous year of physics teaching. In this issue two of our PER experts give their next installments in nudging us towards more enlightened practice, and we learn about the Diffraction Dance! As a foil to all this pedagogy I present my first self-authored article for the Newsletter since becoming editor. I say my article is a foil because I merely tell a story. I hoped to convey that any member who wishes to contribute to the Newsletter need not be touting cutting edge pedagogy or revealing arcane physics. Whether you teach physics in the backwoods of Ontario's northland, in the inner city of Ontario's capital, or anywhere in between, your experiences are unique, but they likely have many commonalities with those of your physics colleagues across the province. For both of these reasons your stories are of value. Share them. Take the risk. We want to know what's really going on 'out there' in the classrooms. Where do you teach? How do you teach? Why do you teach? What makes physics teaching interesting or unique for you compared to the teaching of other subjects? What questions do your students invariably ask year after year? What preconceptions do they invariably display? What books about physics or physics teaching have you read lately? Share your thoughts and theories with us. Dig deeply. Reflect. The process of writing about your experiences forces you to focus your thinking and to reflect more clearly. And sustained reflective practice is the key to better teaching.

Drop me a line to let me know your writing ideas. If you like to teach but don't like to write, see your opportunity below...

Frames of Reference

Announcing ***Frames of Reference***, a new regular feature in the Newsletter. The concept is simple: you are the OAPT, and as such your point of view counts. We want to hear all the voices. If you are open to being interviewed, drop us a line. A Newsletter reporter will contact you to make arrangements. Interviews and published material will be kept brief, but questions will be open-ended in order to give voice to your ideas. Topics could range widely but will relate directly to the teaching of physics at either the secondary or post-secondary level.

Write to Us

Don't want to present at the conference but have something to share? Send it to us!

We are always looking for news about what's going on in the physics classrooms of Ontario. You don't have to be a PER or STEM expert to get published in the Newsletter! Send us your classroom anecdotes, physics jokes, project ideas or samples of student work. Send us your comments about the newsletter or about the direction that physics education is taking. We want to hear from you!

Submission Deadlines

September 1 — November 1 — February 1 — April 15

A Reminder About Submissions

Since we are now an e-newsletter, we can support multimedia content. Any photos, video, or links that would enhance your submission are welcomed.

Email to **newsletter_editor_8@oapt.ca**

Where in the World do you read Your OAPT Newsletter?

Each fall issue we feature an OAPT member reading the OAPT Newsletter in a location that we are privileged to be able to reach. Send us your summer photos!

Help Wanted

Sara Naudts
saara.naudts@icloud.com

Attention all creative minds!

We need your help to create the **2014 OAPT Grade 11 Physics Contest**. (See the **contest page**[1] for more info). The goal is to create mostly conceptual questions with a variety of difficulty levels based on the grade 11 curriculum that later can be shared with teachers.

You can choose from different levels of involvement to suit your schedule:

1. You can send in any number of original questions you feel would be appropriate. (Check the **question bank**[2] for ideas.)
2. You can be a reviewer. Once all questions have been edited we need to critically review their appropriateness, clarity, difficulty, inclusiveness, and so on.
3. Have your cake and eat it too: You can do both options 1 and 2 :)

Please **contact Sara**[3] to get involved. Many thanks!

Sara Naudts has been teaching physics in the Peel District School Board since 2004. She is passionate about professional growth and success for her students.

Links

1. **http://www.oapt.ca/grade_11_contest/**
2. **http://www.oapt.ca/resources/contestQB.html**
3. **saara.naudts@icloud.com**

The PER Corner

Teaching Forces PERsuasively
Part I – Interactions

Chris Meyer
York Mills Collegiate Institute, Toronto

christopher.meyer@tdsb.on.ca

www.meyercreations.com/physics

Getting to the Bottom of Things

Science gets exciting whenever we discover that there is a deeper explanation behind our observations and current theories. The deeper explanation often allows us to see beyond distracting surface features to connections and patterns that otherwise lie hidden or unappreciated. When such an explanation is found, our understanding can grow in very surprising ways.

Forces are the bread-and-butter of physics teaching (mmm… butter). Most of us spend a good chunk of grades 11 and 12 teaching Newton's Laws and their applications. We regard Newton as a starting point for a healthy understanding of how our universe operates. But what if there is a deeper idea, one that force emerges from and that subsumes it? There are alternate interpretations of Newtonian mechanics (e.g. Lagrangians, Hamiltonians, thespians) that dispense with the idea of force and hint at something more fundamental. An important part of this deeper level of physics is the idea of **an interaction**. Two particles may interact with each other and exchange fundamental physical quantities such as momentum and energy. This idea may easily be expanded to include quantum mechanics where quanta of the fields interact and exchange other quantities like charge, spin, and lepton number. Interactions can be thought of as the basic units of change, and therefore causality in our universe, and they arise in just four types: strong, weak, electromagnetic and gravitational. We usually call these fundamental interactions "forces", but they do much more than just change the velocity of a particle.

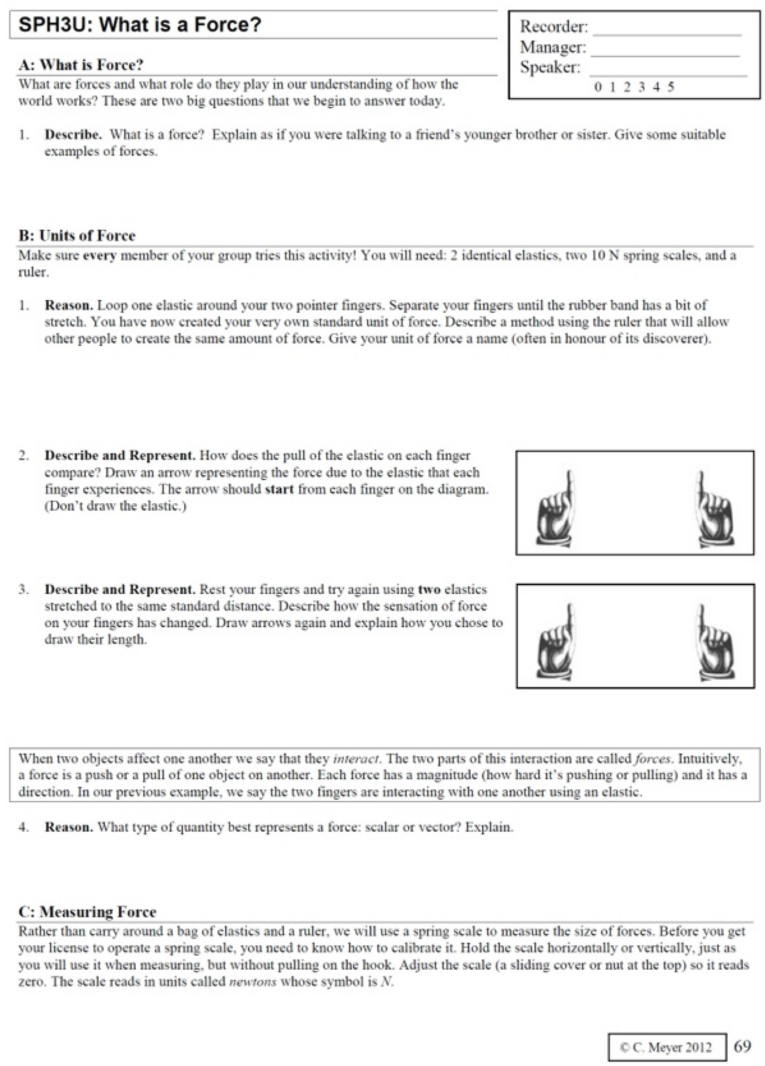
For now we will put aside the quantum world and examine a classical model of an interaction. In this idealized world-view, we can imagine two particles colliding. The mechanism of the collision (normal forces → electromagnetic interactions → virtual photon exchange → loop quantum gravity?) is not our focus here. We are simply interested in comparing what we know about the particles before and after the interaction. Due to the collision interaction, the velocity of each particle has changed. If we were to watch one of the particles we would say that it behaved as if it were pushed or pulled somehow. The results of the interaction correspond to our intuitive everyday notion of force, but we should be cautious. When we use the word force, we really mean: “that aspect of an interaction that causes the velocity of a particle to change”. The interaction also caused energy and momentum to be transferred. If we go looking for this force, it dissolves away as we go deeper into the mechanisms, but the energy and momentum transfer are still there. The term “force” is just shorthand for *a part of an interaction*. If we were especially observant we might notice that the other particle in our interaction also changed its velocity, meaning it experienced a force as well. In classical mechanics without fields, we notice that interactions always give rise to a pair of forces with a remarkable set of properties, hinting at the reciprocal nature of an interaction.

So What?

None of what I describe above is breaking news but it does lead us to a powerful pedagogical strategy: from the beginning, teach students to think first about the interactions between objects, reinforcing our understanding that an interaction is a two-way street. Then you can teach them how to shift their focus from one object to the other and examine the parts of the interaction that we are interested in — the forces. Approaching forces in this way marks a deep conceptual and pedagogical shift with the purpose of packaging in one idea — the interaction — an array of force concepts that usually remain disconnected in students’ minds. Furthermore, the “distinct” topics of force and energy become much more firmly linked when students realize that they both involve the tracking of interesting quantities during the same interactions. One of the guiding principles of physics education research (PER) is that it is worth the time at the beginning to lay things out very carefully. The investment we make with extra time spent delving deeply into the fundamentals of our discipline is justified by the rich results shown on conceptual tests [1, 2]. We must find the time to teach well.

The Interaction Diagram

How can we help students to focus first on the interactions? Start at the very beginning of the forces unit. My students' first lesson on forces in grade 11 [Figure 1] involves playing with elastic bands. They explore the effect of the elastic on their fingers, with the goal of noticing that two similar forces are involved in the single elastic interaction. Shortly after, we develop a new tool, the *interaction diagram* (sometimes called a system diagram or system schema [3, 4]), which visually represents the interactions between each object. Students begin by listing all the objects involved in the situation. Next they draw lines between the objects which represent each interaction. These lines are given single-letter labels indicating the type of interaction, the same labels that will eventually be used on their force diagrams (g = gravity, n = normal, and so on) [Figure 2]. An ID (interaction diagram) is a very schematic and abstract representation of a situation, but it proves very valuable when it comes time to construct the force diagram. (Incidentally, I never refer to force diagrams as free-body diagrams anymore. Does the term "free-body" *mean* anything to our students? Don't teach them meaningless things!)



SPH3U: What is a Force?

Recorder: ____________
Manager: ____________
Speaker: ____________
0 1 2 3 4 5

A: What is Force?

What are forces and what role do they play in our understanding of how the world works? These are two big questions that we begin to answer today.

1. **Describe.** What is a force? Explain as if you were talking to a friend's younger brother or sister. Give some suitable examples of forces.

B: Units of Force

Make sure **every** member of your group tries this activity! You will need: 2 identical elastics, two 10 N spring scales, and a ruler.

1. **Reason.** Loop one elastic around your two pointer fingers. Separate your fingers until the rubber band has a bit of stretch. You have now created your very own standard unit of force. Describe a method using the ruler that will allow other people to create the same amount of force. Give your unit of force a name (often in honour of its discoverer).

2. **Describe and Represent.** How does the pull of the elastic on each finger compare? Draw an arrow representing the force due to the elastic that each finger experiences. The arrow should **start** from each finger on the diagram. (Don't draw the elastic.)

3. **Describe and Represent.** Rest your fingers and try again using **two** elastics stretched to the same standard distance. Describe how the sensation of force on your fingers has changed. Draw arrows again and explain how you chose to draw their length.

When two objects affect one another we say that they *interact*. The two parts of this interaction are called *forces*. Intuitively, a force is a push or a pull of one object on another. Each force has a magnitude (how hard it's pushing or pulling) and it has a direction. In our previous example, we say the two fingers are interacting with one another using an elastic.

4. **Reason.** What type of quantity best represents a force: scalar or vector? Explain.

C: Measuring Force

Rather than carry around a bag of elastics and a ruler, we will use a spring scale to measure the size of forces. Before you get your license to operate a spring scale, you need to know how to calibrate it. Hold the scale horizontally or vertically, just as you will use it when measuring, but without pulling on the hook. Adjust the scale (a sliding cover or nut at the top) so it reads zero. The scale reads in units called *newtons* whose symbol is *N*.

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Figure 1: A first lesson in forces

Consider the example of a dynamics cart, with masses on top of it, rolling on a track. The cart is being pulled by a string attached to a counterweight hanging over a pulley. The objects involved are the cart, masses, counterweight, track and earth. We don't consider the string to be an object since the string is “massless”. Moreover, the strength of the frictional interaction is small compared with the other interactions, so we ignore it.

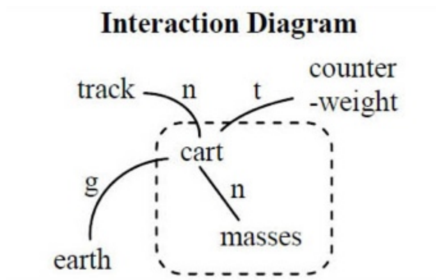

Figure 2: An interaction diagram

Before a force diagram (FD) can be drawn, we need to focus our physics lens by choosing a system to study. Introduce students to the idea of a *system*: a collection of objects whose properties we will track. Other objects in our situation that are not included in the system are part of the *environment*. We can choose the cart and masses as a system of objects and draw a dashed line around them in the ID. With the help of this system boundary, we can classify the different interactions as either *internal* (between system objects) or *external* (between a system object and the environment) to the system.

Explicitly introducing systems early in the force unit is crucial to the development of deep understanding. Choosing a system is a good example of the “hidden curriculum” — a key element in expert thinking that is often never explicitly taught. Instead, we expect students to acquire it through their own diligent practice. They seldom do. Choosing the correct set of objects to group as the system and understanding the consequences of that choice is both subtle and powerful. I used to routinely see my students flounder with this in multi-object problems like the classic “find the force in hitch between the 10th and 11th train car” problem. Students often first encounter the idea of a system when they meet the topics of energy or momentum. I used to jump right in, talking about closed or open systems while my students were simply wondering what a system is — yikes! Using the system concept throughout the topics of force, energy and momentum helps to cement a deep connection between these seemingly distinct and unrelated concepts.

The Force Diagram

Now we can finally construct a FD! Drawing the ID will quickly become second nature for students if you make them practice it. Only then will the ID serve as a useful primer for thinking about the forces. Begin a FD by representing the system as a point particle — not a box. This helps to make clear a fundamental assumption that we routinely choose in introductory physics: our mental model of most objects or systems is that of a point particle possessing the mass of the system but no noticeable physical dimensions. (The point particle is similar to an object’s centre of mass, but I do not mention this. The concept of centre of mass should be explored carefully as a bridge between the point particle model and the analysis of extended bodies, but we do not cover extended bodies. Note that the point-particle model is not capable of experiencing torques and rotation. All models have limitations, but this one can easily be extended to a point particle and lever arm when necessary.) Once the system is represented by a point, draw vector arrows that represent any forces acting **on** a system object from **external** interactions. Scale is not important for the force vectors, but our diagrams should make it visually clear which forces are equal in size or which might be greater. Draw multiple forces vectors acting in one direction tip-to-tail. This helps connect what students learned about vector addition when studying two-dimensional motion and makes visually clear, for example, how all the upwards forces compare in size with the downwards forces.

Bringing Change to the System

Consider the problem below (one that I like to use with the OISE pre-service teachers) and ask yourself which answer your students are most likely to choose [Figure 3]:

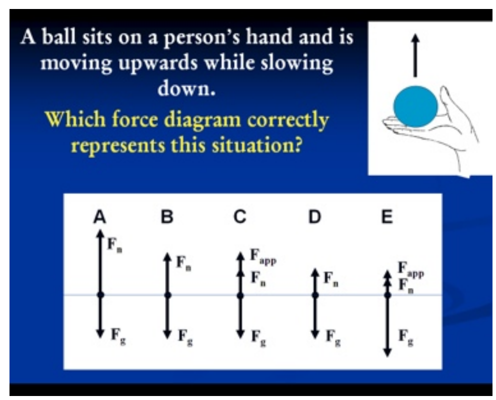

Figure 3: Force diagram problem

Most students are convinced that there are three forces in this situation: a gravitational force, a hand force and an “up” force. The ID for this situation is shown below [Figure 4].

Training students to start with IDs is a good way to get them thinking that there is only one interaction between the hand and the ball, which must be the normal force. (Part of the problem here is that students often don't understand that the “applied” force is just a normal force.)

The real power of interaction diagrams is illustrated in the next two examples from grade 12. Consider the classic two-block question pictured below [Figure 5]. A hand pushes horizontally on the first of two blocks, causing them to accelerate along a frictionless surface. (This type of situation should be treated only in grade 12. While you can have grade 11s mimic demonstrated solutions to this problem, they won't understand it.)

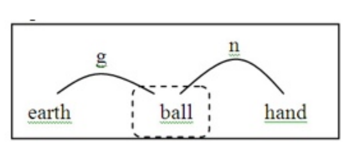

Figure 4: Interaction diagram for ball-on-hand problem

If we were to ask your students what forces act on block B, what would they say? Many would say the push of the hand, of course! Time for an ID with block B as the system [Figure 6].

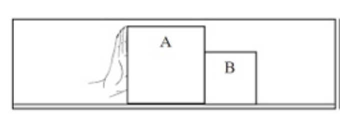

Figure 5: Classic two-block

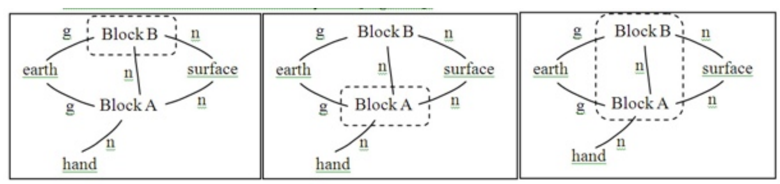

Figure 6: Interaction diagram for two-block problem

Taking time to carefully think through the ID prompts students to recognize that the hand only interacts with block A. From the ID the student can see that there are three external interactions with block B and none of them involve the hand. Now they have the correct starting point for a FD. The dividends from the ID investment continue to accumulate if we ask the student about the forces on block A. Since the third law is built into the ID, the student is naturally led to consider that block B also pushes on block A. A quick change of system highlights the four external interactions with block A and a careful FD can be produced. But wait — there's more! Chances are we are interested in the acceleration of the collection of boxes. Here the system idea shows its greatest power. Choose the system to include both blocks. Since the system (a point particle) has the combined mass of the two blocks, we can draw one gravitational force, one normal force due to the surface and one normal force due to the hand. The interaction between block A and B is now *internal* and does not appear in our FD. Students learn that choosing a different system has a dramatic effect on the FD.

Switching between different systems for the same situation is a powerful problem solving tool, especially if all the system objects are constrained to move together with the same acceleration. Such a system is a *composite object* — a useful label. Now you can refer to an Atwood machine as a composite object and this label has important meaning for the students. Now (and only now!) can a student learn how to skillfully choose a system for one purpose (to find the acceleration) and then switch to another (using the acceleration to find a particular force). Does all of this seem a bit complicated? Yes? That's because it is! And we have been asking our students to basically figure it out without any of this support. Before I used IDs I told myself that my students just need to practice FDs enough and they would understand. This never happened. The better students simply memorized the solution process. That was poor teaching.

The Innovation Challenge

Push yourself out of your comfort zone and try out interaction diagrams. It did take me a while to get used to them and to figure out how to teach them, but they now find a place at the core of my teaching praxis. You, however, can take a peek at how I implemented them in my grade 11 and 12 courses and save yourself much of that trouble! All my electronic course materials are available online at **www.meyercreations.com/physics**. If you would like to see IDs in action, just drop me a line and we can arrange a visit to my class. The door is always open.

Chris teaches physics at York Mills C.I. in Toronto. He runs a reformed physics program that applies physics education research to the classroom.

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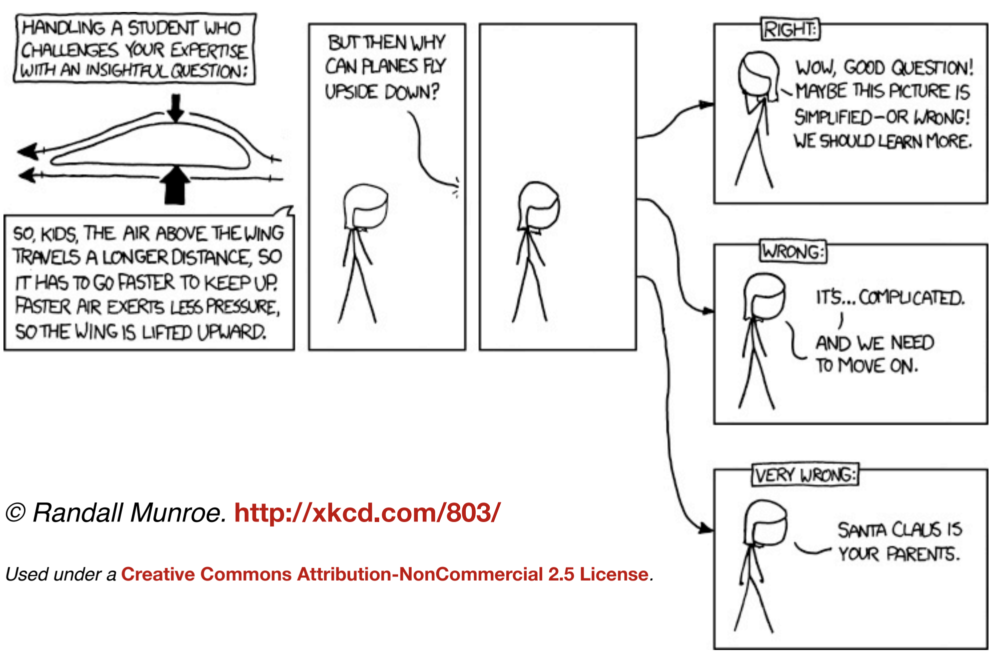

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Articles

Physics at the Root of STEM Education

Dave Doucette
Richmond Hill HS
David.doucette@yrdsb.edu.on.ca

The theme for our 2014 conference is STEM (**S**cience, **T**echnology, **E**ngineering and **M**athematics) education. I want to tell you why physics teaching is at the root of this educational movement that is sweeping the planet.

An international paradigm shift in education is occurring, driven by ideology, practicality and economics. It has the potential to usher in a remarkable renaissance in education. STEM initiatives focus on a coherent K-12+ curriculum with emphasis on engineering solutions to technological, social and environmental problems. STEM represents a shift from primarily a language/arts-based curriculum to problem-based critical thinking rooted in science, technology and mathematics. This isn't radical to science educators — a neat repackaging of constructivism, higher-order thinking skills and inquiry learning. But this time the audience is global. We have the attention of economists, industry leaders and politicians. It seems our train has arrived and the engine seems to be physics.

Physics — the gateway to engineering — is cited by the STEM literature as a model course in which STEM subjects are integrated. Physics teachers have long been aware of this and of the challenge involved in effectively scaffolding learning. Fortunately, physics education research (PER) has provided a data-rich toolkit to make STEM learning amenable to almost all learners.

Why STEM?

There is a growing international employability skills crisis. STEM employment grew three times more than non-STEM employment over the last twelve years, and is expected to grow twice as fast by 2018 (Atkinson & Mayo, 2010). Yet a scant proportion of graduates, particularly in

North America, have the requisite skills to work in emerging STEM-based occupations. This stalls economic growth and impoverishes the human resource pool. Using intelligent educational design to improve graduates' opportunities for gainful employment early in their careers is not just good policy, it is crucial to our economic survival and to environmental sustainability.

The need to produce graduates with a sound understanding of basic scientific and technological principles continues to grow. Advanced technologies now impact every facet of society. Good effects we applaud; bad ones we ignore at our peril. Solutions to future problems will involve strategically managing existing technologies or creating new ones. As Einstein famously said, "The significant problems we have cannot be solved at the same level of thinking with which we created them." To solve these problems we need to disseminate advanced technological skills and expertise beyond that tiny subset of society affectionately called *geeks*. "Geekiness" needs to become normative.

The good news is that the cognitive skill sets attributed to geekiness appear to be learnable. Once considered an inherited capacity, recent research in neuroplasticity suggest the attributes associated with geekiness can be acquired by *deliberate practice*. (This term denotes an area of active research.) Our aim should be to teach all students to think analytically and critically. As critical thinkers permeate business, politics and community, they will collaborate on innovative solutions to collective global problems: a lofty goal to make Einstein proud!

What does this mean to physics teaching?

Imagine a K-10 curriculum that provides a solid foundation in science process and content, mathematics, and engineering. Imagine many more students filling up the seats in physics — and chemistry, biology, earth & space science — classrooms. Picture these students with mindsets altered from those of present day: apprehension of mathematics and physics replaced by enthusiasm and creativity. This will not happen overnight — it will take at least a generation. The way is paved with clear obstacles. Early US data suggests only a small fraction of K-12 teachers currently possess the content knowledge and cognitive skill sets required of STEM educators (Wieman, 2012).

Upgrading of education needs to occur at the at the teacher level. Teacher re-training is poised to be led by a small coterie of *master teachers*. President Obama is planning for a master teacher corps of 100 000 within a decade. Master Teaching will become an official designation and those so designated will be provided time, opportunity and compensation to mentor colleagues and shepherd the systemic changes needed for STEM education to flourish. At least in the U.S., this will create career ladders that allow ambitious teachers to remain in the classroom. Administrative leadership will remain as important as always but educators will be able to choose the pathway that best matches their skill sets.

Canada is far better positioned than the US in terms of both student achievement and teacher preparedness, according to PISA scores, though Canada similarly has an unfortunate mismatch of graduates and jobs. Many bright, talented graduates remain marginally employed while we continue to import skilled tradespeople and engineers from distant shores. Clearly a long-term action plan is needed, acutely so here in our own province. Ontario's economic challenge in preparing for a growing STEM economy is not as daunting as America's, but the stakes are equally high. We need a Canadian solution, and soon, before we fall further behind this global trend.

What do I need to do to get ready?

Continue learning how to teach more effectively. Become familiar with the language of pedagogy and the numerous tools provided by the physics education research (PER) community. Attend PD opportunities — like our annual OAPT conference or the OAPT summer camp — to improve content knowledge and pedagogical practice. Most importantly, stretch yourself and your students in the classroom. Be willing to take risks and accept occasional failures in exchange for the joy of new successes. Barrie Bennett, a prominent Canadian educator, claims it takes a solid 10 years of purposeful training to become an effective teacher. A degree in education merely allows you to play in the game. Strong coaching and extended purposeful practice can make you a truly effective player — maybe even a master teacher!

Content and skill sets we presently teach will be elevated substantially in coming years as a new breed of student enters our classrooms. We need to prepare for changes mediated by STEM education and for parallel skills associated with 21st century thinking & learning. Becoming a more effective teacher will require gaining deeper and broader content knowledge (CK) — a scalable obstacle — while at the same time ensuring the content is taught with sound pedagogical content principles (PCK) — the bigger challenge. Members of the OAPT steering committee are passionately committed to supporting our colleagues in this endeavour.

How does the 2014 OAPT conference fit in?

The 2014 OAPT conference provides a healthy balance of content knowledge and pedagogical content knowledge and practice. Professors speak on exciting developments in their fields of study and on changes to teaching and learning in undergraduate programs. OAPT's own select cadre of master teachers provide hands-on workshops, modeling effective classroom practices under the mantra "Teachers should be taught in the manner they are expected to teach". Enthusiastic colleagues put you in touch with potential mentors, mentees, and resourceful peers. Attend for the full two days to maximize your networking opportunities! Take advantage of our outrageous rate of $19.99/night! It is a very high quality PD opportunity of which we are very proud.

One goal of the 2014 conference is to connect teachers with exciting programs and leading professors in engineering fields, leaving them better prepared to advise students of opportunities provided by an engineering career. This was one motivation for holding this year's conference at the University of Toronto Electrical & Computer Engineering (ECE) department, strong supporters of the OAPT. Many thanks to ECE for their continued support.

STEM education seems tailored for physics educators. The 2014 conference is a step forwards in our quest to inspire and prepare a generation of master teachers. Our time is approaching — come join the parade!

Dave Doucette is lead physics teacher and head of science at Richmond Hill High School. With a background in cognitive psychology, Dave is interested in bridging physics education research into classroom practice and in explicit modeling of exemplary classroom practice.

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The Diffraction Dance: role playing the behaviour of light

Robert Emrich
Grand River Collegiate Institute – Kitchener, Ontario
robert_emrich@wrdsb.on.ca

When I was teaching waves for the first time (in grade 10 optics and grade 11 physics), I needed to find a way to model diffraction and refraction for students. I could have used a ripple tank, but I wanted students to be able to "jump into a wave" and experience first-hand how waves behave. I first saw a role-play of refraction when previewing a Bill Nye episode (the demonstration occurs at ~5:30 in the video. You can find an episode preview on **Bill Nye's website**[1]). I wondered if I could extend this to more than just a change in medium.

Demonstration

Guidelines

- Stand shoulder to shoulder.
- Link arms.
- Walk at a consistent pace and synchronise your pace with the people on either side of you.

1. Propagation:

Start with students standing in rows shoulder to shoulder (5 rows of 5 or whatever works). Have them link arms and focus on walking in straight lines while maintaining a steady pace and consistent distance from the row ahead of them.

The distance between rows correlates to the wavelength and the speed at which the students walk is the propagation speed. The frequency does not change.

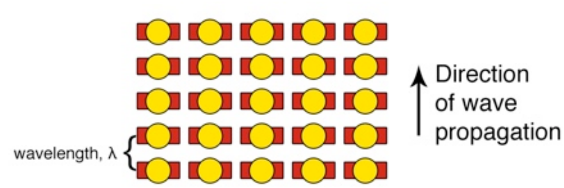

Figure 1: Students walk in formation at a consistent speed.

2. Refraction:

Find a place with a line on the ground. I typically go outside and find the transition from asphalt to grass, but a line on the gym or cafeteria floor would suffice. This represents the interface between a high-speed medium and low-speed medium. Have the rows of students walk along the 'normal' at first. As they pass from one medium to the other, they must adjust speed accordingly. I like to have them pretend they're stepping off a hard surface into knee-deep mud. Naturally, the spacing between rows will decrease as the speed decreases. Then have them switch around and go from slow to fast. They should see the opposite effect.

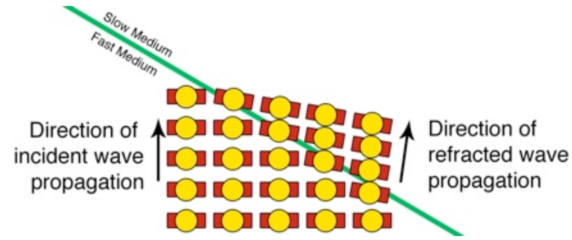

Figure 2: As students transition from fast to slow medium, the wave direction will turn toward the normal.

Next, have them approach the interface at an angle. As they pass from one medium to another they should see the direction of wave propagation change. Stop them midway and have them look at one row of students who have partially crossed the interface. This will illustrate that in any one medium they travel in only one direction and that the change in speed is what produces the change in direction.

3. Diffraction around a barrier:

I find this works best if you have only two groups: those acting as the barrier, and those acting as a single wave.

The part of the wavefront that hits the barrier will reflect. The students heading directly towards the barrier must unlink arms from the students on either side of them and make the reversal of direction (hopefully without actually striking the students acting as the barrier!) The rest of the students walk past the barrier on either side and mostly continue in a straight line, but as the distance from the plane of the barrier increases, they curve a bit to fill in the space behind the barrier, leaving a 'shadow' of unfilled space behind the barrier.

4. Diffraction through an opening:

The approach this is similar to the last. Have the middle three students in each row pass through the opening. Have the centre student continue in a straight line while the two flanking students diverge, suggesting a circular wave.

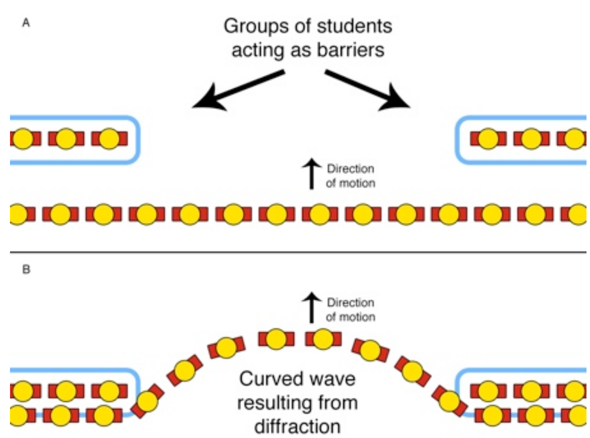

Figure 3: Curved wavefront results from diffraction through an opening in a barrier.

A nice extension is to have the students notice that as the wave travels out, the distance between them increases. If you think of humans as packets of energy, the energy concentration per meter of wavefront decreases, and so the amplitude decreases.

Closing Remarks

I hope that some of you will be able to use this in your class. Make adjustments as you see fit. Email me if you manage to develop a role play of thin film interference.

*Robert Emrich has been teaching physics for five years in the Waterloo Region. He co-founded WARPED (**Wa**terloo **R**egion **P**hysics **Ed**ucators), our local chapter of OAPT members.*

Links

1. **http://www.billnye.com/for-kids-teachers/episode-guides/**

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Summer School is Not What It Used To Be

Tim Langford
Newtonbrook S.S., TDSB
tim.langford@tdsb.on.ca

I don't know what I would do with myself in July without summer school. Actually, I do: I would spend money instead of making it, a mistake if one hopes to make ends meet living in the GTA. Quite apart from the financial benefits, summer school provides a routine and a structure to the month of July that I now realize is good for me. I suspect that I am not alone in this. Many of us entered the teaching profession partly because we enjoyed our experience in school. The most dominant feature of public schooling is its fairly rigid structure: the timetable, the school rules, the predictability of the holidays, and the primacy of the curriculum. Consciously or not, both I and likely a substantial fraction of my colleagues actually take solace from this imposed structure. Just ask an investment broker: teachers are not renowned for being risk takers. Summer school is even more tightly structured than regular day school, a necessity, since timelines are so short that not a minute can be wasted. We hug the core curriculum even more tightly, endeavouring as we are to deliver it in a mere three-and-a-half weeks.

Interestingly, within that structure there is freedom in summer school. In fact I would like to argue that the structure actually creates the space within which freedom can reign. Let me explain. We had excellent administrators at our site. They held a late June meeting for the staff and a first-day assembly for the students that laid out very clearly everyone's responsibilities and what the boundaries were. They then followed up very strongly in the first week, enforcing rules such as no hats and no presence in the halls without a hall pass. Doing these simple things gives teachers the freedom to teach without having to waste precious time on discipline. Absenteeism is not tolerated: a student who reaches three absences is demitted. A teacher need make very few, if any, calls home. On the curricular side, it is critical that the teacher pre-plan every minute of every class before the summer school session begins. Having done so allows the teacher to spend her/his energies focusing on the students. If feedback from them indicates that the schedule needs to be altered then this can be done, but having the schedule in the first place is definitely freeing to the teacher.

Not What It Used to Be

There is another great freedom within the tight crucible of summer school: I was there only as a physics teacher. My students came from all over the city. They were great kids but they do not spend long enough with me to become "my kids". I hadn't taught them in grade 9 or 10; I hadn't watched them grow and mature over four years; I didn't know their parents, and I didn't feel like the judicious parent-away-from-home. I got to know them, just a little, as people. Then they disappeared from my life forever. There was no sadness in this parting, no requests for them to come back and visit. What many researchers (Hargreaves, 2000; Isenbarger & Zembylas, 2006) have referred to as the emotional labour of teaching simply does not have time to germinate at summer school. I can easily imagine how a skilled craftsman feels having completed his small portion of a renovation project of which he was neither the architect nor the general contractor.

The summer school site I was at was a new site dedicated entirely to new credit offerings (what teachers in some areas of the province would call 'reach ahead'). My students were remarkably bright and motivated to succeed. I taught and evaluated the same way I do in regular day school, and by the final report 25 of 29 students had achieved 80% or greater. Teachers spending their July with high-achieving students may be symptomatic of a new trend: in week two a local TV news team visited to shoot a story on the changing face of summer school. In the TDSB summer school enrollment was up this year by about 25% over 2012 figures. Take a look at "**Summer School is Not What It Used to Be**[1]" on the ctvnews.ca site. In the piece they attribute the increased enrollment to a combination of additional sites (supply creating demand?) and the removal of the OAC year (uh, that happened ten years ago). In my view, what we are seeing is increasing numbers of career-savvy students, keenly aware by their grade ten year of the marks they need to reach their post-secondary goals. They are willing to spend their July learning physics in order to lighten their course load for the following year, or to make room to take additional credits and raise their average.

Eat, Sleep, Breathe Physics

The short timelines of summer school are problematic, to be sure, in a number of ways. Encouraging disciplined 'sprint-not-marathon' thinking can help turn this problem into an opportunity. Each day I printed a message in capital letters on the board: "EAT, SLEEP, BREATHE PHYSICS". Each night I gave them the equivalent of four nights' worth of homework. "This is what you're doing in July," I told them. "In August you can rest". It occurs to me that this intensive approach is mostly how adults learn in the 'real world': they take on projects that typically dominate their thinking for weeks to months at a time and result in deep learning. I wondered more than once, this past July, whether the summer school model of learning mightn't be superior to the regular day school model that forces students to change hats four (or six, or more) times a day, no matter how deeply they might be engaged in learning when the bell rings.

Educational researchers have, of course, wondered about this for decades. Honebein et al (1993) remind us that the mass schooling model is only a little more than a century old. Previously all students had learned through an apprenticeship model. The apprenticed student spends extended periods of time with the instructor, observing, emulating actions, asking questions. It is a very constructivist approach. The summer school format is similar to this in some ways. The difference is that the students are essentially apprenticed to each other. I am following **Chris Meyer's workshop physics program**[2], in which the students work in cooperative groups of three, each group consisting of one high-achieving, one low-achieving, and one average student. Although they have explicitly assigned roles (manager, recorder, speaker), there are implicit roles because the high-achieving student tends to play the role of ‘master learner’, sharing expertise with the other two. The group stays together long enough for them to gel as a team. In regular day school the continuity is harder to maintain: tardiness and absences wreak havoc on the group dynamics. Moreover, when completing only one activity per day students tend to view the activities as isolated tasks. At summer school attendance is near perfect and students complete a block of four activities in a day, allowing them to more easily grasp the overarching argument, of, say, motion or force.

Going back to school in the heat of July is perhaps not so wonderful as a vacation, and it doesn’t, I have discovered, prevent the onset of the teacher dream in early August. However, if you are fortunate as I was to teach physics at a well-run site with students who have proactively chosen to be there, it can be both a fun time and a great way to hone your skills. In the city it has the added advantage of taking you outside the demographic and routines of your regular school to allow you to find out what’s going on ‘out there’. And, needless to say, with only a month off instead of two it’s easier to remember, come September, just what to do when faced with a roomful of students again

Tim Langford has taught physics, science, and technology for ten years in Ottawa and eight years in Toronto. He has been editor of the OAPT Newsletter since 2009.

Links

1. **http://www.ctvnews.ca/video?clipId=964530**
2. **www.meyercreations.com/physics/**

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Isenbarger, L. & Zembylas, M. (2006). The emotional labour of caring in teaching. In *Teaching and Teacher Education , Vol. 22* (1), January 2006, pp. 120-134. **http://dx.doi.org/10.1016/j.tate.2005.07.002**

Upcoming Events

Bookmark the Upcoming Events Page!

Andrew Moffat
amoffat@bss.on.ca

I am excited to have joined the OAPT as keeper of the **Upcoming Events** page. This is where you can find out about workshops, activities, and fun the OAPT is serving up to teachers and students this school year. Don't miss out! Bookmark the page and check it often. New events are being added all the time.

Bookmark the Upcoming Events Page

If you are planning an event for physics teachers or students please email me the details so that I can include them on the page.

Andrew Moffat has been teaching physics, math and design technology at The Bishop Strachan School in Toronto since 2007. Interested in inquiry-based and project-based learning, Andrew is always looking for great new demonstrations, ideas and projects.

Links

http://www.oapt.ca/events/index.html

New PI Resources and Workshops for Unit A: Scientific Investigation Skills and Career Exploration

Roberta Tevlin
Danforth CTI, Toronto
Roberta@Tevlin.ca

Very few teachers teach Unit A as a separate unit, and that is probably a good thing. However, I also suspect that — like me — many teachers don't give this material the attention it deserves. Two new resources from the Perimeter Institute can help change this.

The Process of Science has a variety of activities dealing with investigative skills. It could be used in any secondary science course. Traditional physics labs tend to focus on the skills involved in Performing and Recording, lending an impression that doing science is mostly about carefully following instructions. In contrast, the activities in this resource emphasize the skills that come *before* an experiment — Initiating and Planning — and those that are needed afterwards — Analysing, Interpreting and Communicating.

Career Moves: Skills for the Journey was designed primarily for the grade 10 Career Studies course, but several of the activities in this resource are particularly well suited to helping students in senior courses make informed decisions their educational careers. Inside you will find activities and information that emphasize the importance of STEM skills and knowledge for future jobs.

You can order these **free resources** online from the **Perimeter Institute**[1]. However, I recommend attending one of the **free workshops** being held in southern Ontario this fall. These workshops include lunch and **<u>supply coverage</u>**! They will allow you to explore the content and share ideas with other physics teachers. Find the workshop in your area:

Wed. October 23 Toronto 9:00 - 3:00 Danforth Collegiate Institute, 800 Greenwood Ave, Room A76 Presenters: Roberta Tevlin and Tim Langford Sign up: **roberta.tevlin@tdsb.on.ca**	FULL **Wed. October 30 Waterloo 9:00 - 3:00** Perimeter Institute, 31 Caroline St. North, Room TBA Presenters: James Ball and Olga Michalopoulos Sign up: **James.Ball@ugdsb.on.ca**
Friday November 1 Uxbridge 8:45 - 2:45 Uxbridge Secondary School, 127 Planks Lane, Library Presenters: Lisa Lim-Cole and Jane Kennedy Sign up: **Lisa_Cole@durham.edu.on.ca**	**Thurs. December 12 Brampton 9:00 – 3:00** North Park Secondary School, 10 North Park Drive, Room TBA Presenters: Sara Naudts and Greg Macdonald Sign up: **saara.naudts@icloud.com**

Links

1. **https://www.perimeterinstitute.ca/store**
2. **http://www.oapt.ca/events/index.html**

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