NEWSLETTER

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The Demonstration Corner

To See Or Not to See - TIR is the answer

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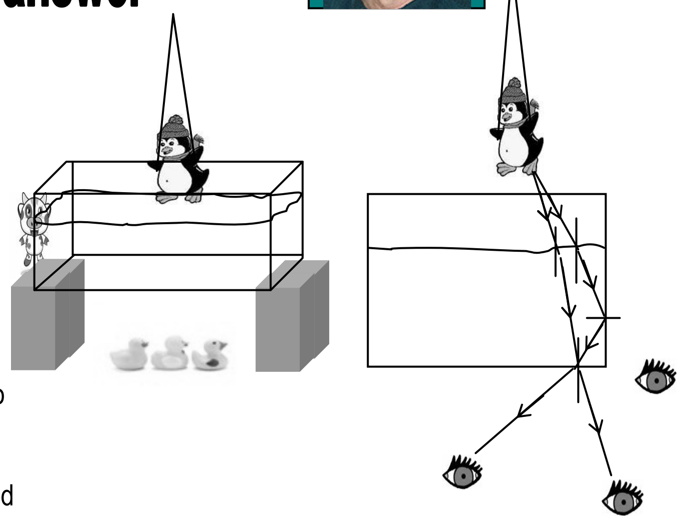
A fun example of total internal reflection can be created with an aquarium tank or similar transparent container filled with water. Students enjoy wandering around the tank with objects placed around on all sides including above and below.

Sometimes you can see what you appear to be looking at and sometimes not. Students are challenged to draw ray diagrams to show why you cannot see certain objects but can unexpectedly see others from certain angles. One example is shown here. It's definitely a good seed for discussion. Probably a good coffee table display for your parties too.



Instead of seeing what's behind this side, see TIR of the Penguin… To See something unexpected!

Incident Angle much smaller here. No TIR…To See!

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

Section Representative Report

Submitted by Marina Milner-Bolotin, OAPT Section Representative, July 2008

Canada was the host of the Summer AAPT National Meeting. The meeting took place on July 19-24 in Edmonton, Alberta and was hosted by the University of Alberta and the local APT Section. More than 700 physics educators from 14 countries attended the meeting. Canada was represented by a few dozen attendees, the bulk of whom not surprisingly were from western Canada. The meeting was a success, which was clear from the level of presentations and interest from the audience. The list of invited speakers included Prof. Eric Mazur from Harvard University (Peer Instruction), Prof. Carl Wieman (a Nobel Physics Laureate from UBC), Prof. Michio Kaku (from the City University of New York), Prof. Janis McKenna (from UBC), Prof. Gary Gladding (from the University of Urbana Champaign), etc. A popular CBC science show "Quirks and Quarks" received an AAPT award for an outstanding science reporting. For more information about the meeting, visit the AAPT web site (see www.aapt.org). The next meetings will take place in Chicago, IL in February 2009, and in Ann-Arbor, MI in July 2009. We hope to see you there.

Dave Doucette's PER Corner

'Bridging Research into Practice'

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Not Quite Ready for Broadway

Who thought the photoelectric effect could prove entertaining and even hilarious? Well, it certainly can be when role-played by physics teachers at Perimeter Institute's (PI) 2008 EinsteinPlus[1] program. Four groups of teachers in this summer Outreach program scrambled to come up with a skit illustrating the central features of the photoelectric effect. Ten minutes later they danced (believe it!), skipped, and generally hammed it up as electrons, photons and metal atoms. Not quite Tony material but it was challenging to keep from laughing aloud. Actors struggled to remember lines, timing and choreography. They had altogether too much fun.

The failure of traditional classroom lecture and cookbook lab activities to produce effective student learning is well documented. In response, a variety of instructional strategies have been created to engage students, cognitively and socially. One of the less explored methods is role playing. On a broad scale role-playing can imply staging an ethics-based scenario with complete stakeholder roles. This article examines a less ambitious example, choosing a modern physics concept and mechanical roles.

The Play's the Thing

'America's Lab Report: Investigations in High School Science, 2006'[2] [flow chart below] identified four broad principles to maximize science learning.

One of these - *community centered environments* - involves listening and articulating to peers in safe, active learning environments. The critical importance of *student discourse* is identified in brain-compatible research as well as PER and is core to role-playing. In order for a group to prepare their play, they must communicate and listen effectively. As one researcher notes, "The interaction between the students as they play their roles in the role-play develops the students' social competence as the students become an active part of a social scenario. Playing a role and arguing with the other students develops the students' communicative competence as they need to express themselves in a precise manner to get their arguments accepted by the other students."[3]

Assigning discreet roles to members of the group, such as director, choreographer, principal actors, and prop manager can help get the show started. Sufficient time for planning and rehearsal is required, ideally with each group in a discreet location. I frequently utilize role-playing for layered concepts such as superposition, velocity selectors or the photoelectric effect. When concepts involve multiple components, students need time to incubate and organize the discreet elements into a conceptual whole – a schema. Role-playing, exemplifying a *learner centred environment*[2], encourages such focused conceptual discussion, as the cast works to ensure their scenario is a reasonable representation of the physics involved. "It is much more important to allow time for the concepts to be truly understood and learned, even if this means including less content, versus loading more content into a lesson to catch up. Allow time for repetition, as this strengthens learning."[4]

Learner Centered Environments
engage students with activities to challenge misconceptions

Knowledge Centered Environments
ground knowledge through multiple contexts, scaffolding and reflection

How Students Learn
Principles of Learning Informing Integrated Instructional Units

Community Centered Environments
listening and articulating to peers in safe, active learning environments

Assessment to Support Learning
opportunity to revise and improve learning combined with flexible teaching

So, You Think You Can Act Physics?

Ensuring a non-threatening, active learning experience precludes summative assessment of the role-playing. To encourage compliance, however, formative assessment can be tactfully employed. Taking advantage of popular talent contests, this could be staged as a 'So You Think You Can Act Physics' competition, using a rubric for overall cast performance. Effective staging requires myriad modalities such as creative, dramatic, linguistic, kinesthetic and spatial. Teams can be judged against a rubric designed to focus on multiple intelligences[5]. In modern lexicon, this would be an example of differentiated instruction with rich interpersonal dimensions. "Adding a sympathetic, generally human element to science is often encouraging to students with science and math anxiety. Lessons can use role-playing to emphasize the value of feelings and of creativity as well as of knowledge"[6].

All the World's a Stage

At PI, the role play was followed by an impromptu challenge. Each group was given a photoelectric effect scenario to mime. Observing groups had to accurately describe the scenario. For example, one group was challenged to mime a situation in which the ejected electrons had insufficient energy to cross against the 'stopping potential'. To turn this into a friendly competition, other groups write down their interpretation and are scored (formative only) on accuracy and detail.

This impromptu challenge is an example of a *knowledge centered environment*[1], in which multiple contexts for a concept are provided, with time for reflection, student discourse and scaffolding of ideas. The unique structure of role playing to socially bond members of your classroom can produce improvements in attitude which go on to generate gains in attention and learning, "Emotions directly influence attention, meaning, and memory, all of which are enhanced when we create lessons to engage emotions in a productive way."[4] Needless to say, role-playing should not replace lab activities, simulations or Socratic instruction but is scripted in as a supplement.

The last element to maximize the role playing experience is *assessment to support learning*[1]. It is critical to formulate questions which speak to the experience. In addition to standard numerical questions involving $KE = h \cdot f - W_o$, also require students to interpret or describe behaviour of photons and electrons. For example, 'You are directing an actor playing the part of an electron being struck by a photon with energy greater than the stopping potential. This actor is confused about the physics involved. Explain to this actor how he will interact with the photon and how he will behave after being struck. Be certain to elaborate on the physics principles involved.' Or, 'You are watching a mime of the photoelectric effect. An actor, playing an electron, is thrown a red ball which she catches and immediately runs across the stage to the prop representing a negative electrode. She speeds up as she runs across the stage to the electrode. I)What did the red ball represent in this scenario? ii)What does the actor's behaviour tell you about the red ball's energy level? iii) Why was the actor incorrect in speeding up as she ran across the stage? How should she behave, and why?'

Broadway bound?

As with any new learning venture, take role playing in small steps, allowing you and your students to become familiar with the exercise. Then progress in depth and detail according to needs and comfort level. Who knows, you might find the hidden director inside you and go on to author a Tony-winning Broadway physics production like Michael Frayn's, *Copenhagen*. Or perhaps just settle back to watch and grin, as we did this summer at PI's EinsteinPlus, watching middle aged teacher-electrons scamper across the stage, screaming 'I'm free, I'm free'. Break a leg.

References

1. The EinsteinPlus workshop is a one-week, intensive residential workshop for international high school teachers that focuses on key areas of modern physics — including quantum physics, special and general relativity, and cosmology. It also incorporates sessions on innovative teaching strategies suitable for all areas of physics. See website: http://www.perimeterinstitute.ca/Outreach/Teachers/EinsteinPlus/
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Creating a Dialogue

between High School-University Teachers and University Undergraduate Students

By Tetyana Antimirova, John Atherton, David Doucette, James Ball, Marina Milner-Bolotin, Glen Wagner and Patrick Whippey

The OAPT Annual Conference hosted by Ryerson University featured many events that could have become a focus of this report. However, there was one event that in our view deserves special attention: a student-teacher panel that took place on Saturday, May 24th, 2008 during the lunch. The goal of the discussion was to start a dialogue between physics teachers from high schools and universities and college undergraduates from the sciences and engineering. This dialogue was our attempt at building bridges between high school and university physics courses in order to make high school-university transition more successful, and as a result help retain more students in sciences and engineering. During the discussion the participants raised various issues such as the difference in the teaching styles in high schools and colleges; the use of different notations and representations for physical quantities; gaps in assessment used in high school and at the university, such as open ended assessment, versus the multiple choice; student lack of experience of independent work in high school and bad study habits such as procrastination, late assignment submissions, relying on memorization and rote learning, etc.; the lack of knowledge of university instructor of the high school curriculum; poor mathematics and laboratory skills, etc. During the discussion, the participants not only outlined problems, but also brainstormed possible solutions that are described in detail in the extended paper published on the Ontario Association of Physics Teachers Web site (www.oapt.ca).

The participants of the Panel came up with the list of behaviors that often characterize the students who are successful at the high-school – university transition. High school and university instructors should be aware of it, so they can discuss it with their students. For the list of behaviors of successful students read the complete paper (www.oapt.ca).

Some of the panelists suggested developing a workshop of an hour or so that would enable students to create their personal plan for college success. The students would be asked to report back early in the semester on how they were doing, and where necessary, faculty/teachers would gently suggest some strategies to help those who were struggling.

Comments from the undergraduate students were passionate and revealing - a litany of complaints about the disconnect between high school and university experiences. At first blush, one wonders how such a wide gap can be narrowed! But this gap may already narrowed by acknowledging it, identifying and publishing the results. Our dialogue begins. How we foster this dialogue will determine the depth and effectiveness of our next steps forward! These steps must involve richer, more frequent meetings between univerty, high school and elementary teachers; sharing experience and expertise, with an eye on developing concrete steps towards more coherent student programming. This coincidentally develops important networking opportunities. High school or elementary teachers establish familiar contacts for questions on subject content or enrichment. The university professors similarly gain contacts to inquire about student pre-knowledge or emerging methods of instruction, for example, differentiated instruction - which are common in elementary classrooms but decidedly rarer in a university setting. To facilitate dialogue, PD days could be allocated to begin focused dialogues - assuming administrative support!

In this era of data-based decision making, it would be strategic to undertake the effort with short and long-range plans for measuring success. We need to establish baseline scores on current student attitudes, knowledge and skills as they transition into first year university programs. These can be compared to any 'pilot' projects that emerge from the dialogue. Clearly this transition initiative will require a generation to produce lasting, systemic benefits. But by narrowing the scope initially, including anecdotal reports, we can nourish support and inform our progress by closely tracking student transition from high school to university and their achievements and struggles in the first year university physics courses.

So what? This may be our biggest hurdle - the 'so what' factor. The physics community is passionate about the importance of physics education. How do we convince important shareholders - from Ministry officials to principals - that this is a priority interest? We must pursue support at these levels while at the same time develop grass-roots connections between classroom instructors. And the significance of political and press support cannot be underestimated. Such a broad-based campaign has significant challenges but will yield significant rewards. The goals we seek will produce systemic changes to the education system.

As physicists of Ontario, we have a real-life 'rich context' problem to solve: How do we help our undergraduate students succeed in their physics courses? Luckily problem-solving is the heart of our discipline, so let us get on collectively with the business of solving it. Let's talk.