PWEN

New Faculty Training of TYC Physics Faculty Conference at Delta College on March 6-8, 2008.

Future Workshops:

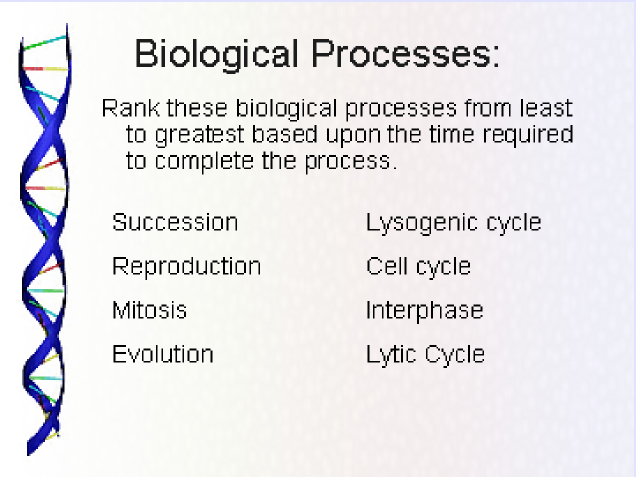
Tools for Introductory Physics at Estrella Mountain Community College on April 10-12, 2008.

For information go to: www.physicsworkshops.org

CYPRESS FAIRBANKS ISD: RANKING TASK WORKSHOP BY DEBRA HILL

John Henderson and I developed a TIPERS Professional Development Workshop for district teachers of 9th grade Integrated Physics and Chemistry (IP&C) and 10th-11th grade Chemistry. Teachers. Teachers earned a total of 6 Professional Development hours divided into three sessions.

Session 1 on January 23, 2007 (2 hours): Teachers were initially exposed to TIPERS by being given the two Ranking Task Exercises below. John and I decided to begin the session with the Movie Ranking Task Exercise because we wanted to start with a non-science example that teachers would be comfortable answering. At this point, we did not call this a ranking task exercise. The next Ranking Task Exercise we chose was an example from biology. This was chosen because we wanted to pick an example that this group of teachers would be less familiar with so that the teachers would start talking with each other to verify their answers. (*There is no one correct answer to the biological process ranking task.)



Biological Processes:

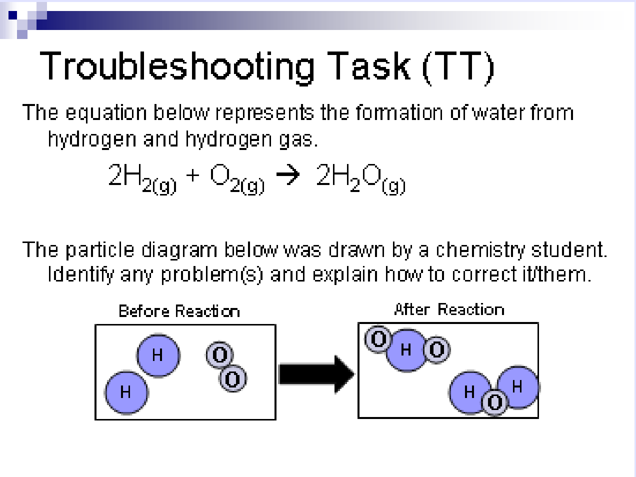
Rank these biological processes from least to greatest based upon the time required to complete the process.

- Succession
- Reproduction
- Mitosis
- Evolution
- Lysogenic cycle
- Cell cycle
- Interphase
- Lytic Cycle

Movies

- Rank the following Academy Award Winning Movies from most recent to oldest.

Following these introductory activities, teachers were given a general overview of best practices in teaching science, cognitive dissonance, and physics education research. John and I created Chemistry Examples and modified existing Ranking Task Exercises to model all the possible TIPER Formats (ie. CRT, WBT, LMCT). A chemistry example we created is shown below.



Troubleshooting Task (TT)

The equation below represents the formation of water from hydrogen and hydrogen gas.

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$$

The particle diagram below was drawn by a chemistry student. Identify any problem(s) and explain how to correct it/them.

The teachers were then divided into smaller groups. Each group was assigned a different TIPER. We did not tell them anything about the formats ahead of time. The groups presented their TIPER and answers. As a large group we compared and contrasted each TIPER format to previous TIPER formats. After all the presentations, we did a general summary of each format and brainstormed different ways they could be used in the classroom.

Session 2 from January 23-February 22:
Individual work on TIPER:
Teachers were assigned the responsibility of developing a TIPER for use in their classroom. We provided teachers with an electronic template on which to identify the state objective addressed, the actual TIPER developed as well as complete answer key. Teachers were given 2 hours of professional development credit for developing the TIPER on their own time. They submitted an electronic copy of their TIPER and brought hard copies to the final session.

Session 3 on February 22:

Our introductory activity for this session was one that John and I experienced at the February Instructional Strategies in Introductory Physics Workshop. The teachers were divided into small groups and given what appeared to be the same TIPER-Work Done. In reality, the TIPERS all used the same graph (velocity vs time) but asked different questions. The teachers had to relate the velocity vs time graph to acceleration, forces, work or energy. Initially many of the teachers really struggled with the completing their assigned TIPER. (In their own minds, a velocity vs time graph was only connected only to the concept of acceleration.) This discomfort with not being able to answer a question provided John and I with a "teachable moment". A tremendous amount of content knowledge was added and/or restructured in the minds of the teachers after completing the activity.

TIPERS created by each teacher were then presented to the whole group. Teachers, like students, are more apt to question each other's explanations rather than instructor explanation. A tremendous amount of valuable discussion occurred as a result.

John and I plan to offer this workshop again and hope to put together a bank of teacher-developed TIPERS for chemistry, physics and biology teachers. All 19 teachers who participated were very positive about the experience and loved the fact that their brains were tired when they finished the sessions (tired in a good way of course!). As a side note, we only required the development of 1 TIPER but several teachers put together 2 or more to share.

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What did you learn participating in a Physics Workshop? How did you incorporate it into your classroom? How has it enhanced learning for your students? PWEN welcomes papers regarding your workshop experiences. In all submissions, please include the paper title and the author's name, school, and e-mail address. Submit workshop papers to Tom O'Kuma (tokuma@lee.edu) and Dwain Desbien (dwaindesbien@estrellamountain.edu).

Find information and apply now for upcoming workshops at www.physicsworkshops.org.

SOME THOUGHTS AND REFLECTIONS ABOUT THE INTRODUCTORY CALCULUS-BASED PHYSICS COURSE CONFERENCE* BY JOHN GRIFFITH

As I write this, I am sitting on an airplane going home from having attended The Introductory Calculus-Based Physics Course Conference, held in Arlington, VA this past weekend. Having had a couple of flight delays, I have had some time to reflect about the presentations and discussions from over the weekend. In the spirit of taking lemons and making lemonade, I have decided to write some of the thoughts and reflections down.

During the conference, the 150ish participants were exposed to many of the reform efforts related to the introductory course as well as some of the results that PER has found related to instruction at the introductory level. As all of this information has begun to sink in, I was, oddly enough, working on material for my introductory course for the coming week. It was during this time that it occurred to me that the issue of improving student learning is very analogous to one of those end of chapter problems that we assign in the introductory course. It is certainly a "blue-numbered" or "level III" (or whatever other designator a text might give to those challenging problems that you assign to the brighter classes). Certainly the issue of improving student learning in the introductory course is a complex problem the solution to which will require the use of multiple ideas connecting what may seem to be unrelated areas and will require multiple steps (and iterations!) to "solve".

As a TYC physics faculty member, issues related to all of the introductory courses are of obvious importance to me; as a physicist, the fact that this is an interesting problem that is ripe to be solved is exciting to me. The problem of improving student learning, however, is not a problem simply for those who are currently teaching the course, but is rather one for the entire physics community. I am, therefore, challenging the physics community to put its collective experience and problem solving skills to use in improving the introductory course. The complexity of the issue requires that the problem not be attacked by one individual. We must tackle it in groups. Fortunately, AAPT has already broken us up into groups called AAPT sections (as did AAPT sponsor, organize and secure funding from the NSF for the conference I mentioned above). If some amount of time is spent at each section meeting on the issue of the introductory course (I am not talking about simply having papers presented on the topic; there must be thought provoking discussions that take everyone out of their comfort zones and force them to think critically and thoughtfully about the issue) progress can be made on the problem much like progress is made in the various research areas of physics by making collaborations with other researchers in the field.

Being a firm believer that one shouldn't be critical without being willing to be a part of the solution, I offer what I see to be the issues that need to be addressed with the introductory course. This list is not exhaustive, but is intended to serve as a starting point for discussions. From my perspective, the following seem clear:

The physics community must agree that the topic of student learning of physics is

an important area of research. The APS has recently listed Physics Education Research (PER) as a viable research area in physics on similar footing to that of research into condensed matter, atomic and optical physics, high energy physics, etc. Those in the physics community dedicated to research in student learning should be given the same level of respect and incentive that a researcher in any other sub-discipline of physics research would receive.

We must hold to the a priori assumption that all students are capable of learning physics. The nationwide movement toward Physics First in the high schools must have as an implicit assumption that all high school freshmen are capable of learning physics concepts. If we believe that all high school freshmen are capable of learning physics, then we must tacitly assume the same of college freshmen. The seemingly common belief that we must fail or cause X% of the students initially enrolled in the introductory physics sequence to withdraw must be thrown out. In its place, we need to install a system with support such that all students have a realistic chance of not only surviving the sequence, but thriving in it.

We must start with the students we are given. Not surprisingly, one of the statements that I heard several times while walking around the corridors between sessions at the Introductory Calculus-Based Physics Conference had to do with participants questioning whether students came to the introductory course as prepared as they might be. (In my analogy above with the end of chapter problem, I liken this to students sitting around discussing the fact that they shouldn't be made to do this homework, they are never going to use this in the real world, etc.) While the discussion of how the system got to this state is an interesting discussion, that discussion distracts from the real issues at hand. It is time to restart the clock. Regardless of how it got there, the system is in some initial state (call it S_I). Our task is to take the system to a new (and hopefully, better) state. If course prerequisites are set appropriately, and we are familiar enough with the content in those prerequisite courses to know what is covered, then the issue is likely more one of language and contextual recognition and rather than ability. One of the things I do when I talk about something in class that I know was covered in a prerequisite course and yet get the "blank stare" is that I go and talk to colleagues in the other department (usually math) and find out what language and context was used in the previous courses and then go back into class and help make the connection for the student. I remember one day in lab I was giving the prelab introduction and asked a question and there was complete silence. I walked out into the hallway and asked one of the math faculty to come into the room. I explained the question and the faculty member looked at the class and said something like "I know you saw this last term" and all of a sudden about five students readily gave the answer (this was not a bashful group). What I think happened was that having the faculty member from math in the room caused the students to access a different file cabinet in their mind for the information. The students were in a different set of four walls with a different instructor and I think that when students are at the introductory level, they have trouble making connections in classes because they do

not yet have much experience in this area. The more we can do to explicitly make those connections for our students, the easier it will be for them to do on their own the next time around.

Students must be partners in the learning process. By making students partners (not necessarily equal partners, mind you) students are more likely to buy into changes that are made in the course. By having a vested interest, they might even suggest changes of their own and we should be open to those ideas as well, while making sure to maintain the integrity of the course. With a (very) little effort, we should be able to get a majority of students to participate as partners in the learning process for we are all curious people and our subject truly is useful since what we study is the world in which we live.

Information must be distributed or gathered in ways that address more than one student learning modality. We now have a large body of information that tells us that different students learn different ways. By giving students experiences that allows investigation of the topic through means that are accessible to multiple learning styles, we increase the absorption cross-section for a student to retain the concepts we hold so dear.

Learners must be active in the process. Most of the students we typically see in the introductory course cannot learn by a passive exposure to the course content. They must in one form or another be actively engaged. Think of it this way: I doubt many of us in the discipline are accomplished figure skaters. Yet we have probably watched figure skating on several occasions during the Olympics and such. As you watch these very accomplished skaters, we are given commentary on what they are doing well as well as given warnings about what you don't want to do such as come out of a double axle with our toe pointed the wrong way. (In keeping with the analogy above, we warn our students not to draw a centripetal force on a correctly drawn FBD.) So, if we have seen so many examples of good figure skating and been given commentary on what to do right and what is done wrong, we should be able to just put on a pair of ice skates and go at it, right? It is little surprise that our students (metaphorically) fall on their face.

All aspects of the course must be coherently interrelated. This may seem like a no-brainer, but I know of situations where, for example, students start geometrical optics experiments in lab almost a full month before they encounter the topic in lecture (and the lab activities these students go through are not designed with the idea that this is the students' first exposure to the topic so that the activity would be inquiry-based) . Recitation TAs shrug their shoulders when asked a question about lab and respond "I don't teach the lab" or lab TAs respond likewise about the recitation and neither may have a good handle on what is being done in the lecture component or may use language or symbols that are different than those in the text and lecture when discussing problem solutions with students. All of these things frustrate students to the point of wondering why they should care about learning the material when those presenting it seem to have no clear vision of what it is that needs to be learned and the curve will likely get them through.

A set of realistic course outcomes or learning objectives must be developed for each course in the introductory sequence. The number of topics in the introductory course is currently too large to expect that students will be able to realistically master them all. The phrase "Jack of all trades, master of none" comes to mind. By paring down the number of topics in the introductory course, students will be able to spend more time and gain a deeper understanding of those topics than they do now.

Students must be held to a standard. I am not suggesting that we diminish the rigor in the introductory course. I am a firm believer that students will rise (or fall) to the level of expectation placed upon them. I am, rather, suggesting that we take steps to actively engage students and ease back a little on the number of topics so that students may better live up to our (and their) expectations.

Both successes and failures must be discussed openly and documented within the community. Just as it should be OK for students in the introductory course to give an "incorrect" response when asked a question about an idea as they are being introduced to it, so should it be OK for those wrestling with improving instruction to make a misstep. As with any experiment, we are likely to learn more from what doesn't work right initially than what does. It is nonetheless important to go ahead and document those early challenges (as well as solutions to those challenges as we find them).

So, there I have done it. I have put the target firmly on my back. I hope that the commentary here has evoked a reaction that makes you want to respond. As I mentioned before, more progress is made by working in groups than alone and all roles are needed in the group such as skeptics, experts (which I readily admit I am not), taskmasters, etc. Let's get to work on solving this problem and infuse the introductory sequence with an energy that has our students look forward to coming to our classrooms and offices.

* Introductory Calculus-Based Physics Course Conference was held in Arlington, VA during October 31 – November 2, 2003 (see http://www.aapt.org/Events/2003CalcConfProc.cfm)

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"All Science is either Physics or stamp collecting."

--Ernest Rutherford

MAGNETISM IN INTRODUCTORY PHYSICS: WHAT AND HOW? BY DAVID MALONEY

How is the topic of magnetism usually taught in introductory physics?

If one looks at most General Physics textbooks you find one, or two, chapters on magnetic forces and fields and a chapter on E-M induction. These chapters typically describe how to calculate the forces on moving charges, on long, straight current-carrying wires and on current-carrying circular loops; the geometries of the magnetic fields produced by long, straight current-carrying wires, current-carrying circular loops, solenoids, and perhaps bar magnets; and motional emfs of various "types". These ideas are presented, as Tom O'Kuma, Curt Hieggelke and I found out when developing the magnetism TIPERs, as a group of separate "rules", such as the right-hand rule, that the students essentially have to memorize as isolated items.

The topic itself as part of an introductory physics course has several identifiable characteristics that present strong challenges for the students. First, the students have little, if any, experience with magnetic phenomena. If they are lucky they have played with bar magnets and maybe have played with iron filings to show magnetic fields. Many of the concepts—field, flux, E-M induction—are quite abstract. For example, flux is a scalar, sort of, since it is actually a signed scalar. The situations are fully three dimensional, i.e., you cannot reduce the analysis by simplifying to two dimensions. The magnetic force is the only velocity dependent force encountered and it is the only one that does not act along the line connecting the agent and object. And to make matters worse, the mechanism for the magnetic force is never identified (for good reason I might add).

On top of these features physics education research has made clear another aspect of teaching any topic within physics and that is the common-sense knowledge about how the physical world works that students bring to their study of physics. The research has shown that such ideas exist in all domains of physics including magnetism. Consider some examples.

Most physics instructors already know that many students think all metals are magnetic. In addition there is evidence that students have the idea that magnetic fields can push and pull on each other and that this is the mechanism by which objects are attracted or repelled magnetically. Students will say things like "the wires repel each other thus the currents should be antiparallel, right this is because the magnetic fields would then be in the directions to deflect each other from each other" or "the current in wire two should be in the opposite direction because then the magnetic field of the cable will be opposite in direction to that of the current in wire one".

Research has also shown that students think magnetic poles have net electric charges, or behave as if they do, so they can exert forces on charges at rest. Usually they will take a N pole as positively charged and a S pole as negatively charged, but a significant minority reverses these associations. So they think that a positive charge placed at

rest near the N pole of a bar magnet will be repelled.

Considering all of these aspects, it is reasonable to ask if the way magnetism is usually taught is the way we want students learning about magnetic phenomena? And if not, what is a reasonable alternative?

I would not advocate that we try to develop an understanding of the mechanism for the magnetic force since doing so requires relativity, but we can use some of the representations developed in the first semester more and have a coherent story line tying the magnetism phenomena together and to the major earlier concepts such as force better. One way to do this is to focus on force throughout. For example, we could start with reviewing the basic phenomena of the forces two permanent magnets exert on each other and the force on a long, straight current-carrying wire near a permanent magnet. Then bring in the right hand rule and the way to calculate the force in the latter case as well as free-body diagram representations of the geometry. This exploration would introduce the students to the fact of the three dimensionality of the magnetic force and to the fact that the force does not act along the line connecting agent and object. We could also do iron filing mappings of magnetic fields of permanent magnets and long, straight current-carrying wires, along with the right hand rule for the latter.

As an aside, I do not see a way to describe the right-hand rule other than as a phenomenological rule. It would be nice to have a way to tie the RHR conceptually to the situations but I don't see one. If any of you know of a way, I would love to hear about it.

Then we can develop electro-magnetic induction by applying force analysis first to electrons in a metallic bar moving through a uniform magnetic field using the nature of the magnetic force to determine which way the electrons will move within the bar. Then move to the analysis of a closed rectangular loop just entering or just leaving a magnetic field. This analysis would start by using the direction the magnetic force moves the electrons in the segment of the loop within the field to determine how the electrons "piling up" at the ends of that wire segment would set up the electric field within the loop, and which way the current would be. Next one could use this analysis to show that the case of the bar moving on two connected wires can be analyzed the same way.

Then one can show that the case of a closed loop sitting in a uniform field whose magnitude is changing cannot be analyzed this way. That leads to the recognition of the need, as Knight (2004) has said for some "new" physics, i.e., the concept of flux and changing flux. The latter can then be shown to handle the earlier cases and give the same results as the force analysis did. This approach has several major advantages. First it starts with the concept of force and the related representations; thus, treating magnetic forces as just another example of those types of interactions. Second, magnetic fields are introduced by an examination of basic phenomena. Third, the development of E-M induction starts by using the magnetic force to explain how and why there is an induced current. Then a situation is presented where this explanation does not work and the

students are given a reason for introducing the flux concept. Finally, the flux concept is shown to be able also to explain the earlier cases of E-M induction, so its general value is established.

This alternative approach does not overcome all of the difficulties inherent in teaching magnetism, but it is a much more coherent approach which makes better use of the concept of force and the relation to electric phenomena than the currently used procedure.

References

Knight, R. D. (2004) Five Easy Lessons, New York, N Y, Addison-Wesley.

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The most beautiful thing we can experience is the mysterious. It is the source of all true art and science.

--Albert Einstein

ATE Program for Physics Faculty
Participant "Facts"
(so far and including the NFTC)

149 Participants

73 High School Participants – 49.0%
68 Two-Year College Participants –45.6%
8 University Participants – 5.4%
55 Female Participants – 36.9%
94 Male Participants – 63.1%

Representing Institutions in 34 States, America Samoa, and Puerto Rico

American Association of Physics Teachers: Find information at www.aapt.org.

AAPT reminders:

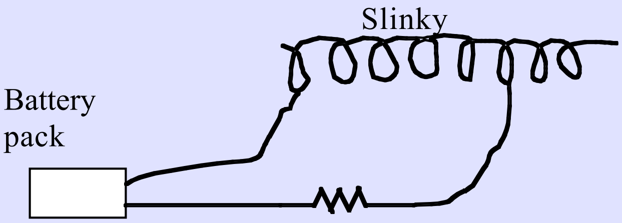
2008 Winter Meeting
Baltimore, MD
January 19-23, 2008

2008 Summer Meeting,
Edmonton, Alberta, CA
(Passport Required)
July 19-23, 2008

A SLINKY AND MAGNETIC FIELD SENSOR: AN OPEN-ENDED LAB BY DWAIN DESBIEN

Each time I teach the second semester calculus based physics course I like to do a lab that requires the students design an experiment. Typically, I have the students investigate the magnetic field inside a solenoid (a slinky with current running through it). This lab is done before they have derived the equation for the magnetic field and thus is not a verification lab, but rather an exploration lab (in other words they do not know .)
The students are told they are to investigate how the field depends on the number of loops in the solenoid, the current in the solenoid, or the length of the solenoid. They are to pick which they would like to investigate and design an experiment to determine the relationship between one of the three variables and the strength of the magnetic field.

In designing the experiment students must be careful to keep the other variables constant. For example, if they are investigating the number of loops and how it affects the field, the length of the solenoid must be kept constant. Thus, they would have to fix the length of the solenoid and merely allow more loops of the slinky to be between where the wires supplying the current are connected to the slinky. A sketch of the experimental set up is shown below. Please pardon the slinky drawing, as it is very difficult to do!



The resistor is to limit the current as the slinky has a very small resistance. You will need to tell the students they must have this resistor in place. I have the students use a CASTLE kit light bulb for their resistor. D cell batteries work fine and the holder from the CASTLE kit works well. The students take data by inserting the magnetic field sensor into the center of the slinky to measure the magnetic field. Data can be quite good if students are careful and keep variables other than the one being investigated constant. The data should yield nice linear graphs for students investigating how current or the number of loops affects the magnetic field. You get a nice inverse relationship for the length.

From my experience the most common thing students decide to investigate is the number of loops. When doing this they often do not keep the length constant and will come to the conclusion that the number of loops does not affect the magnetic field. This is easy to spot and is one of the most common mistakes.

After the experiment you can take the results of the experiment and nearly create the solenoid magnetic field equation. I use this as a lead into the derivation of the equation from Ampere's Law. It is a good experimental design lab, if done

carefully, yields quite nice results. If you decide to try this, please let me know how your students do and what kind of issues arise.

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> **The important thing is not to stop questioning.**
>
> **--Albert Einstein**

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Some Interesting High School Physics "Facts"

From the 2005 Nationwide Survey of High School Physics Teachers conducted by the American Institute of Physics, (see website: http://www.aip.org/statistics/trends/hstrends.html)

1,100,000 students took a course in high school physics (an 18% increase since 2001).
This is 33% of all students who graduate from high school!

47% of high school physics students are female. This has been about the same percentage for the last 8 years.

31% of high school teachers who teach physics are female. This 3% more than there were in 2001!

In the last 8 years, the number of high school physics students by ethnicity has increased
4% for Asian students
4% for White students
7% for Black students
9% for Hispanic students

The percentage of high school physics teachers who have a degree in physics is now 33% with another 11% with a degree in physics education.

The percentage of high school physics teachers describing themselves as specializing in physics teaching is now 57% (up 9% in the last 8 years).

The percentage of high school physics teachers who are members of AAPT is now 22%.

The number of high school that are Physics First Schools is now 330 private schools (~9% of all) and 450 public schools (~3% of all).