PHYSICS Tempo

The Newsletter of the Saint Louis Area Physics Teachers
an affiliate organization of the American Association of Physics Teachers

Volume 10, No. 2 Fall, 1999

1999/2000 SLAPT Officers

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.... Frank Cange
................................Chuck Murray

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.... Michele Perrin

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.... Rex Rice

Upcoming Events

PTRA Workshop:
Lightwave Communication
When: December 11, 1999
8:00 a.m. - 12:00 p.m.
Where: Clayton High School
Host: Rex Rice
Cost: $16.00 or $25.00
Details: Adv. Registration Required: Must be received by December 6, 1999

Lightwave Communication Equipment Make and Take
When: January 29, 1999
Where: Clayton High School
8:00 a.m - 11:30 a.m.
Host: Rex Rice
Cost: To Be Announced
Details: Participants from Dec. 11 workshop can build lightwave communication equipment. Advanced payment for kits required by December 20, 1999.

Dueling Demos
When: February 5, 1999
8:30 a.m.
Where: Parkway Central H.S.
Host: Valerie Michael
Cost: Free
Details: Joint physics and chemistry teachers meeting

See the SLAPT Web Page

http://www.nerinxhs.org/physics/SLAPT.html

Area Physics Teachers Lead Workshops through the Physics Teaching Resource Agents Program

Five St. Louis area physics teachers have been trained to present workshops to high school physics teachers as part of the Physics Teaching Resource Agents program sponsored by the American Association of Physics teachers. This program, which started in 1985 has run nearly continuously since then with hundreds of teachers trained as leaders nationally.

The mission of the PTRA program is to improve the teaching and learning of physics and physical science in precollegiate education for all teachers and students in the United States. PTRA workshops give practicing teachers an opportunity to improve themselves professionally. At these workshops, teachers grow in the knowledge and skill associated with teaching physics and physical science. The knowledge and skills include, but are not limited to, leadership, classroom organization, physics content, teaching techniques, trends in science education and equity issues. External funding for the PTRA program is provided by the National Science Foundation and the Campaign for Physics.

The area physics teachers who have been trained at PTRAs and are currently active in the program include Bill Brinkhorst of John Burroughs School, Paul Kiefer of Fort Zumwalt North High School, Valerie Michael of Parkway Central High School, Debbie Rice of Gateway Institute of Technology, and Rex Rice of Clayton High School.

To date, the 42 workshop listed below have been developed in association with the PTRA program. Since 1992, when the first PTRA workshops were presented in the St. Louis Area, workshops have been presented in at least 17 of the areas listed. Some workshops, like the upcoming Lightwave Communication workshop is an example of a workshop that we are offering a second time in response to a turnover in the local physics teaching population and for the benefit of those who missed the workshop the first time around. Workshops that have been developed via the Physics Teaching Resource Agents program include:

THE ROLE OF...
active learning in physics teaching
laboratory activities in introductory physics teaching
demonstrations in introductory physics teaching
graphing calculators in introductory physics (T1-82 & T1-83)
women & minorities in physics
toys for teaching physics
calculator based laboratories in physics teaching
lasers in teaching introductory physics
physics in the mathematics classroom
quantitative reasoning in teaching introductory physics
chemistry in physics teaching
computer interfacing in physics (PASCO or Vernier)
physics in the human body
web pages & web sites in teaching physics

ACTIVE PHYSICS-
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communications
medicine
predictions
transportation
home

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color & vision
digital electronics
lightwave communication
elementary particles
electric circuits
electrostatics
fluids
geometric optics
kinematics
magnetism
cosmology
Newton's laws
radioactivity
simple machines
vacuum science
waves & sound
physics of music
phases of matter
global positioning systems
impulse & momentum

OTHERS
make & take physics demonstrations

If you would like to see one of the workshops listed above offered which hasn't been offered for a while, contact one of the St. Louis area PTRAs and we will consider offering it.

First SLAPT Meeting of the Year, Sharing at Rosary

On Saturday, September 18, the Saint Louis Area Physics Teachers kicked off their 1999/2000 schedule with a sharing session held at Rosary High School. Frank Cange hosted the meeting which was attended by about 20 people.

After discussing the business of SLAPT, the floor was turned over to Hal Harris, Mark Schober, and Rex Rice, who informed participants of an Eisenhower grant that has been proposed with the purpose of bringing a Modeling Instruction in High School Physics workshop to St. Louis in the summer of 2000. Hal Harris appealed to participants to complete a survey aimed at demonstrating the need for such a workshop. Mark gave a short synopsis of the Modeling method.

During the sharing session, several very interesting presentations were made:

Kyle Stumbaugh and Semyon Volshteyn, showed activities they use for teaching 2-dimensional vector addition.

Frank Cange showed examples of student worksheets which give students various position vs. time graphs and require them to produce the corresponding velocity vs. time and acceleration vs. time graphs.

Gene Allard showed an experiment that he uses which allows students to determine a value for Planck's constant using light emitting diodes. The equipment for this experiment is relatively simple including 2 D-cells, a rheostat, multiple LEDs, and a voltmeter.

Bill McConnell demonstrated an activity he uses with regard to freely falling objects in which students are given a length of string and some washers and are asked to tie the washers to the string so that when dropped, a listener will hear the washers hit the ground equally spaced in time.

Michele Perrin made available handouts which give directions to simplify the process for using TI graphing calculators to graph and analyze experimental data. She also

Rex Rice showed some inexpensive equipment for experiments in kinematics. One was a uniform motion device in which students measure the position of a BB moving through an inclined glass tube filled with water. In the other experiment, designed for investigation of uniformly accelerated motion, students measure the motion of a wheel and axle unit moving down an inexpensive inclined track made out of EMT conduit tubing.

Mark Schober explained an experiment he uses in which multiple double slits or varying slit spacing are used with a laser to determine the effect of changing slit width on the spacing of interference maxima projected on a screen a fixed distance away. He also showed a transparency that he designed with a computer in which the multiple double slits were printed directly onto transparency material using a 600 dpi laser printer. A PDF (portable document format) file of his transparency is available from the Arbor Scientific web site

Hal Harris presented the results of some student research conducted at UMSL which examined the misconception about the reason that a water stream can be attracted with a charged hair comb. He cited multiple examples of recently published chemistry texts which explain that the stream is attracted to the charged comb to the polar nature of the water molecules. The research done by Harris' students shows clearly that the attraction due to the polar water molecules could not possibly be responsible for the significant deflection of the water stream. It shows that the effect is actually due to the charging of the water stream that occurs as it exits the spigot.

This meeting was informative and enjoyable. I have available PDF versions of the handouts from the presentations made by Rex (inexpensive motion equipment) and Mark (double slit transparencies). I also have available a PDF version of worksheets for interpretting kinematic graphs similar to those shown by Frank Cange. If you would like these documents sent to you as email attachments, email me and I will happily forward them to you.

Deadline is Near: Register Today for Lightwave Communication Workshop!

This newsletter is coming out very close to the deadline for registration for the upcoming Physics Teaching Resource Agents workshop on LightWave Communication. This workshop will be held on December 11 at Clayton High School. Deadline for the receipt of registration is December 6. Be sure to send in the registration form and fee as soon as possible to lock in your spot for Lightwave Communication.

Make and Take Workshop to Follow Lightwave Communication Workshop

On January 29, participants in the December 11 Lightwave Communication Workshop will be eligible to participate in a followup make and take workshop. Participants will build the equipment used in the earlier workshop to take with them for use in their own classrooms. The cost for this workshop will be announced at the December 11 workshop. Participants from the 1994 Lightwave Communication Workshop will also be eligible to participate in the workshop. For further details contact Rex Rice at (314) 826-2845 or via email at the following address: **cvb013@mail.connect.more.net**

Physics, Math and Science Get Their Own Day at Six Flags St. Louis

Six Flags St. Louis has announced that the Annual Physics Day will be held along with Math and Science Day. The event has been tentatively schedule for Thursday, May 4, 2000. For the first time in many years, the park will be closed to the public on this day, and will not include the music festivals that have been held jointly with Physics Day recently. We hope that this will reduce the time spend in lines and helpmake Physics Day the enjoyable and valuable physics education experience that was envisioned at its inception.

Impulse and Momentum Workshop Held at John Burroughs School

Valerie Michael Demonstrates Conservation of Momentum using soda cans and a firecracker

On Saturday, October 30, the first of this year's Physics Teaching Resource Agents workshops was held at John Burroughs School hosted by Bill Brinkhorst. Valerie Michael and Bill Brinkhorst led this workshop which was focused on the concepts of impulse and momentum.

The Teaching about Impulse and Momentum workshop is one of the newest workshops in the PTRA series and was produced by Bill Franklin of Waco, Texas. This workshop was presented for the first time to Physics Teaching Resource agents at the PTRA training workshop last summer in San Antonio, Texas.

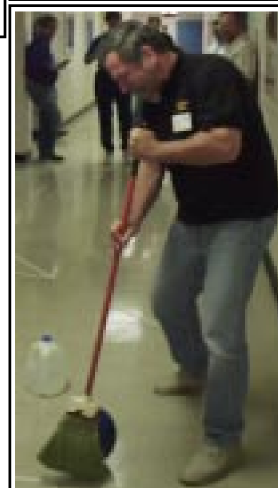
Bill Brinkhorst explains the finer points of using motion detectors and force probes in the study of Impulse and Momentum

Participants listen intently to the rules of Inertia Ball

This workshop was well attended as participants spent the morning engaged in a variety of activities centered on impulse and momentum.

Highlights of the workshop included a team contest called Inertia Ball. In this contest, a track is laid out in a hallway or on a level sidewalk which has various twists and turns on it. A bowling ball is moved along the course using a broom with points building up according to the time required to maneuver the course and the number of times the ball leaves the course or hits a pylon (made out of water-filled milk jugs). The team score is the sum of the points "earned" by each team member. Low score wins. This activity is useful in helping students understand the results of an external force, particularly the idea that to change the direction of an object's motion requires a force which acts perpendicular to the direction the object is moving.

Other activities of this workshop included a lab practicum involving a ballistic pendulum using a toy dart gun. Valerie demonstrated an application of the law of conservation of momentum using exploding soda cans. Bill showed the use of motion detectors and force probes on a Pasco dynamics cart track as an application of the impulse-momentum equation. He also explained how collisions on air tracks could be used to verify the law of conservation of momentum. A variety of other activities were shown which made use of the concepts of impulse and momentum during a well-received workshop.



John Koski demonstrates his skills at Inertia Ball.

PHYSICS TEACHING RESOURCE AGENTS

Bill looks on as Linda Kralina completes the PTRA paperwork

Physics teachers compare notes on ballistic pendulum calculations

Modeling Instruction in High School Physics

J. Mark Schober, John Burroughs School, St. Louis

Introduction:

Several St. Louis teachers are involved in David Hestenes' modeling approach to physics instruction. We are interested in teaching St. Louis area teachers the modeling approach through workshops beginning in July 2000. This article provides an introduction to modeling instruction describing the modeling approach from a teacher's point of view.

Why use modeling instruction?

The need for physics teaching reform is well summarized by Lillian McDermott. "Teaching by telling is an ineffective mode of instruction for most students. Students must be intellectually active to develop a functional understanding." "A coherent conceptual framework is not typically an outcome of traditional instruction. Students need to participate in the process of constructing qualitative models that can help them understand relationships and differences among concepts." Numerous studies (in addition to observation and experience) support Dr. McDermott's statement. David Hestenes summarized these observations in stating, "Results of lecture and demonstration type instruction are uniformly poor for all teachers . . . independent of the teacher's experience and academic background." The reason for this failure is that "most students systematically misinterpret what they hear and read in traditional introductory physics."

One tool that has been used extensively to evaluate instructional effectiveness is the Force Concept Inventory (FCI). Dr. Richard Hake studied Force Concept Inventory scores of over 6000 students and confirmed that in a lecture-demonstration classroom environment, the skill of the instructor does not affect the amount that the students learn. Typical normalized FCI gains are .24. However, Hake found that various methods of interactive engagement resulted in typical normalized FCI gains of .48. Modeling teachers achieved the higher gains in Hake's study and experienced modeling teachers have produced even higher gains, demonstrating that within interactive engagement instructional modes, the skill of the instructor does make a difference.

Effective instruction requires a variety of interactive engagement tools such as Socratic dialogue, individualized instruction, multiple representations of phenomena, kinesthetic experiences, cooperative learning and emphasis on coherency of concepts. Numerous research-informed curricular materials that employ interactive engagement methods are available; they are typically lab and workbook based. Students are required to make predictions, elucidate misconceptions, observe phenomena and reconcile their understanding with what they observe while following the curriculum's carefully structured concept development. Although research-informed curricular materials are excellent, they do not teach themselves, and more importantly, most of them are necessarily aimed at a specific audience, making them rather inflexible.

In contrast, Modeling Instruction is a curriculum design, rather than a fixed curriculum. Modeling provides teachers with an overall instructional methodology that enables effective utilization of physics education research and curricular reform, which ultimately helps students to learn more effectively. Within a "modeling mindset" the instructor can flexibly adapt the conceptual development strategies from research-informed curriculum to best suit their own course level and student ability.

What is modeling?

The way we make sense of the world is to construct mental models to organize natural phenomena. A model is a primary unit of coherently structured knowledge. For example, as physics teachers we want our students to understand the effect of a constant force on a particle. However, when we teach traditionally, we seldom explicitly structure our curriculum and class activities to guide students through the construction of a constant force model. Instead, we teach a long list of topics like force diagrams, force vectors, Newton's second law, gravitation and friction. Although the coherence of these topics is clear to us, students see a fragmented picture of disconnected ideas.

In Modeling, on the other hand, instruction is organized around a storyline of concept flow specifically designed to develop a model. A variety of representations of natural phenomena are used, and connections between conceptual representations and the physical model are explicitly developed.

How does the modeling approach affect the classroom?

Modeling instruction is based on the modeling cycle, which is a refinement of the learning cycle. Development of a model begins with a paradigm lab in which students define the system and develop verbal, diagrammatical, graphical, and mathematical representations for the phenomenon being studied. For example, pendulum motion could serve as the paradigm lab for the simple harmonic oscillator model. Students would identify the relevant system as the earth and pendulum, describe the motion in words, create diagrams to represent the motion, identify variables in order to collect data and produce a graphical representation and finally describe the graph mathematically.

Students further develop the model through worksheets, readings and additional labs. At each step of the process, extensive "post-mortem" analysis is conducted. Working in collaborative teams, students write their lab results or homework solutions on 24" x 32" dry-erase whiteboards and explain their solutions to the class, subject to Socratic questioning.

The teacher-student and student-student discourse around the whiteboards is the most critical aspect of modeling instruction, and the quality of this discourse is what ultimately determines instructional success. The questioning strives to reinforce key ideas and definitions; confront misconceptions; and provide students with opportunities to elucidate the model, extend the model to new situations, applications and contexts, and establish connections among the verbal, diagrammatical, graphical, and mathematical representations of phenomena.

See Modeling, Continued on page 5

Modeling, Continued from page 5

The students' model is then tested. Lab practica require the model to be put into practice, and written and oral tests emphasize problem solving through application of the model.

How is modeling instruction different from curricular reforms?

Modeling is not a curriculum. Modeling is an approach to teaching in which a small number of key models of physics are explicitly developed. Modeling can flexibly utilize a variety of curricula that the instructor finds conducive to developing the models.

Although modeling is not a curriculum, example models and supporting materials have been prepared to provide teachers with working examples while learning the modeling approach. These materials (which are available at the modeling project website: http://www.modeling.la.asu.edu) have a rather traditional appearance, but remember that these materials merely form the starting point for the rich classroom discourse in which learning really occurs.

What are the advantages of modeling?

Trying a new teaching approach for the first time is a bit nerve-wracking. However, even in my first year of modeling I found the approach highly successful and satisfying, as did my students.

My students developed a better grasp for the physics content and were better able to apply it. Their Force Concept Inventory scores partially quantify that statement. Before I began Modeling, my students' FCI posttest mean score was 53%. In my first year of modeling, my regular physics students' posttest score averaged 65% with a normalized gain of .56, which is quite good according to Hake's study. (Experienced modelers have even higher average gains.) Additionally, students learned Socratic questioning by my example and got used to asking productive questions of their peers and of themselves, helping them to become self-directed learners. Knowing they had to present ideas to their peers, they also became very involved in presentations made by their classmates to make sure they understood what was going on.

My students liked the classroom interaction and recognized why it helped them learn. One student said, "I thought [the whiteboards] were worthwhile because they forced you to understand the answers you got rather than just following examples. They helped me tie things together (which I think is really important) with all the questions [the teacher] asked. You don't really understand something until you can explain it, and the whiteboards gave us the opportunity to do this." As a result, I got to know my students far better. I write many reports and letters of recommendation for my students, and the active role of the students in modeling made me intimately aware of each student's strengths and weaknesses.

Modeling fills a need for high school physics teachers since the research-informed workbook curricula are designed for particular audiences, often not fitting the many-varied contexts of high school. However, my experience with modeling has helped me to better analyze, adapt and use the concept flow from various research-informed curricula.

Modeling also helped me to better define and become aware of the models I use in physics. Models are quite different from textbook unit titles, and seeing physics in terms of well-organized models was a great revelation.

Other modeling teachers have many of the same positive responses to modeling that I did. What I find striking is the success of modeling with junior high physical science courses, regular, honors and AP high-school courses and university courses, all taught in very different situations to very different students by very different teachers. This demonstrates that the successes of modeling are portable to teachers who learn and implement modeling instruction.

What training is needed to use modeling instruction?

If there's a drawback to modeling, it's that modeling takes a significant amount of time to learn to do well. I participated in the modeling workshops, requiring a month of training in each of two consecutive summers. I also had prior experience with microcomputer-based labs and a number of excellent research-informed physics curricula, which I found instrumental in my smooth transition to modeling instruction.

Getting involved in a modeling workshop is essential to learning modeling. In the workshop environment, teachers become students and the workshop leaders teach the models just as they do with their own students. In this environment you get a feel for leading paradigm labs, the modeling cycle, whiteboarding, questioning strategies, lab practica and the structure of the example models. At the same time, you have the opportunity to use microcomputer-based lab equipment and learn how to use it effectively in your class. Homework for the course includes readings to better understand student difficulties and misconceptions in various areas of physics.

The second summer of the modeling workshops focuses on identifying and developing models for "second semester" physics topics. This exercise helps teachers get to the heart of modeling theory. Understanding the structure and essence of models enables teachers to revise or build models carefully tailored to their own classes. As part of the process, teachers study exemplary curricula with an eye for concept flow and the kinds of questions and activities used.

In conclusion, teaching structured around models and using the modeling cycle is a powerful way of providing coherent physics instruction. Right from the start, it has proven to be highly effective in my classroom and for the other teachers involved in the modeling project. I highly encourage you to get involved.

A St. Louis Area Modeling Workshop?

Due to the hard work of Hal Harris, chemistry professor at UMSL, an Eisenhower grant has been applied for which, if approved, would bring a modeling workshop to St. Louis. This workshop would be led by area high school teachers who have been trained in modeling, and would be held during the summer of 2000. Notification of grant approval will be given in February. Watch this space for information on how to participate in the summer workshop if we are fortunate enough to be funded.

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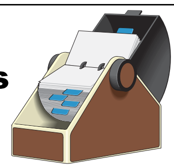
The Physics Teacher's ROLODEX®



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