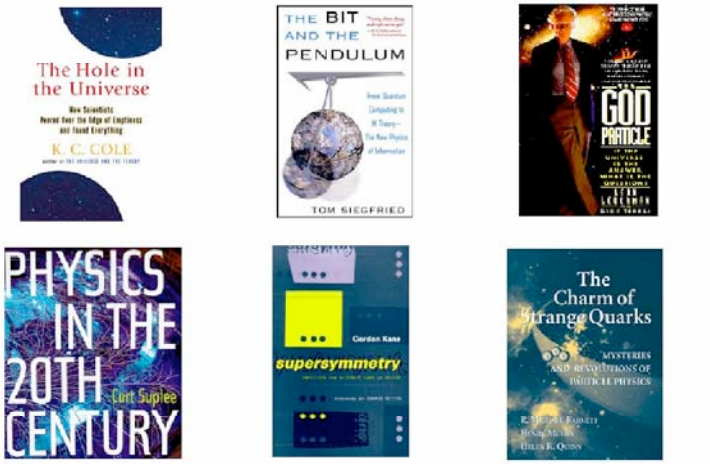
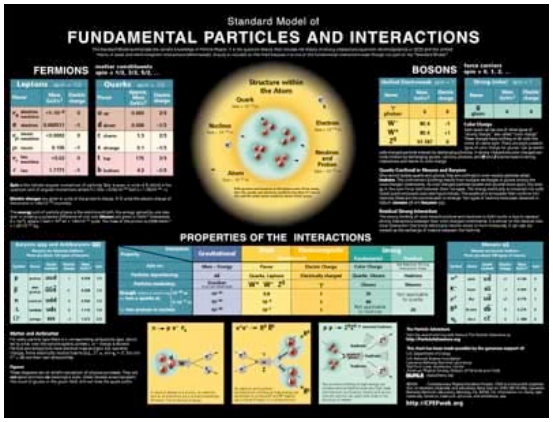
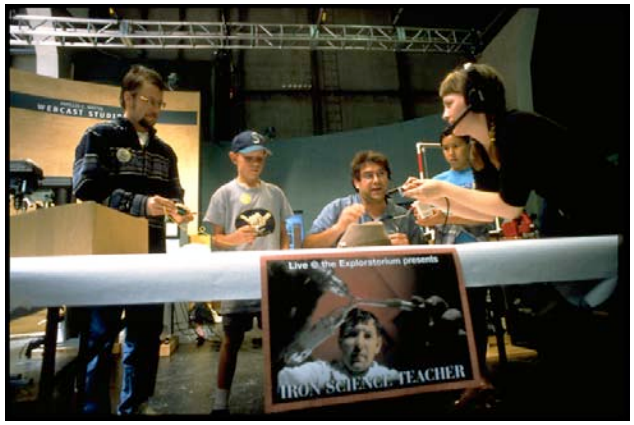


Physics Education and Public Outreach



Elizabeth H. Simmons
Michigan State University



Outline

- Benefits
- Preparation
- Examples
- Conclusions

References:

My Jan. 2005 *Physics Today* article lists many references. See also the DPF education website www.aps.org/units/dpf/education and the website of the Aspen Workshop on Education and Public Outreach www-ed.fnal.gov/aspen/ .

What are the Benefits of Popularizing Physics?

Popularizing Physics

- What:
  - Convey the inherent excitement and fundamental goals of physics to the public
  - Help the public appreciate the beauty and creativity of the scientific endeavor
- Why:
  - Inspire the next generation of scientists
  - Promote scientifically-informed public policy
  - Maintain support for continued funding of physics
  - Help our families understand why we love physics

Who is this “public”?

Participation

Who should get involved?

All of us: the stakes are high

Should we all start composing monographs or lecturing people in the grocery checkout line? Probably not…

Some of you may be thinking:

- I don't want to visit grade school classrooms - what can I do that I'd be comfortable with?
- I'd like to be part of an outreach program, but don't know how to get started.
- How do I know my efforts will make a real difference?

Consider the NSF's Merit Criteria

- Intellectual merit
- Broader Impact [many components]
  - advance discovery and understanding while promoting teaching, training, and learning
  - broaden participation of underrepresented groups
  - enhance infrastructure for research and education
  - disseminate results broadly
  - confer benefits upon society

www.nsf.gov/pubs/1999/nsf99172/nsf99172.htm

…and some examples NSF gives

Research + Education	Broad Dissemination
– Involve students (K-G) in proposed activities – Help in training of K-12 science/math teachers – Involve grad students, postdocs in UG teaching – Integrate research into your teaching (K-G) – Encourage student participation at conferences	– Make data available electronically – Present results in formats useful to Congress & industry – Participate in multi- & inter-disciplinary conferences – Publish & present results in non-technical venues

www.nsf.gov/pubs/2002/nsf022/bicexamples.pdf

Lessons

- Education & Outreach activities can satisfy the “broader impact” criterion for an NSF proposal.

- Like “broader impact”, education & outreach encompasses a variety of activities
  - Some, we already do as a matter of course
  - Many will directly enhance our research efforts
  - Possibilities exist to suit any set of talents
  - Examples and suggestions abound, even on the NSF site

Write popular articles

Visit schools

Create museum exhibits

Go on local radio

Judge science fairs

Give public lectures

Be a museum docent

Train teachers

How can I choose what to do?

Mentor K-12 students

Be an APS intern

Run an REU/RET program

Run a vacation/summer science camp

Train museum staff

Create a local TV show

Host a book club

Write books

Do `science theater'

Host a conference for K-12 students

Match up with an audience

- Your interests
  - Topics? Type of audience?
- Your talents
  - Writing? Cartoons? Live demos? Q&A? training research students?

- The intended audience
  - What do they find interesting?
  - What is their science and math background?
  - What are their goals?

Frame your ideas accordingly

–Relate your favorite topic to their interests

–Tailor your communication to their level

–Choose your actions to help meet their goals

A town in need of physics outreach?

Contact your potential audience

- What education/outreach activities and materials are already being used by your audience?
- What do they need in addition?
  - Extension/enlargement of existing programs?
  - New programs or materials?
  - Coverage of different topics?
  - Translation of existing materials into another language?
  - Help making practical use of new information?

Find Resources to Assist You

- What existing items can aid your efforts?
  - Contents of your university's demo room (borrow!)
  - Your lab's outdated equipment slated for disposal
  - Websites about others' outreach efforts and materials

  (see e.g. links from www.aps.org/units/dpf/education)
- What local individuals, organizations, or informal networks can you partner with?
  - Can you start by joining an existing outreach effort?
  - Are local museums, radio stations, scout troops, or rotary clubs looking for volunteers with science expertise?
  - Are other physicists in your area interested in outreach?
  - Does your local physics students' club have ideas?

Avoid Common Pitfalls

- Barriers to effective communication
  - Lack of solid metaphors & analogies

(Be aware of their limitations, though.)

- Expert's knowledge, assumptions, and jargon …

Credit: ScienceCartoonsPlus.com
[Used one time with permission on 10-22-07]

- Barriers to effective communication
- Formatting errors
  - Reading → hypnotism
  - Too much information
  - Too little information
  - Lack of humor or surprises
  - Absence of action or suspense

www-sk.icrr.u-tokyo.ac.jp/doc/sk/

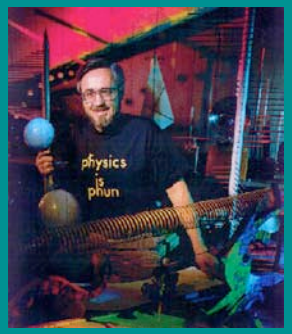
www.wfu.edu/~matthews

- Barriers to effective communication
- Formatting errors
- Lack of followup
  - Did the data you provided arrive in a readable format?
  - When the equipment you donated goes haywire, can the recipient cope?
  - When future questions occur to your audience, do they know where to get more information?

See Aspen EPO workshop www-ed.fnal.gov/aspen

What have others done successfully?

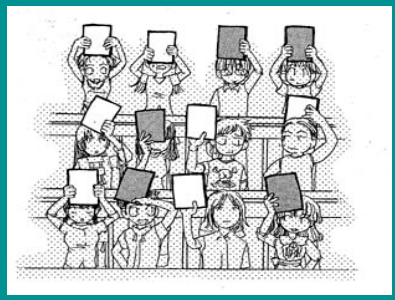
Involve Lecture Audiences



- Richard Berg (Maryland) runs Physics is Phun -- his Physics IQ Test gets the audience to predict the outcomes of demonstrations
  www.physics.umd.edu/outreach/

- Eric Mazur (Harvard) created Peer Instruction -- getting the audience to discuss conceptual puzzles and vote on the answer
  mazur-www.harvard.edu/

- Masako Bando (Aichi) lectures to non-scientists -- turning the audience into an experiment modeling complex phenomena, learning by “being”
  leo.aichi-u.ac.jp/~bando/



Experiencing a Phase Transition

If your current age (in years) is an odd number, please stand up now. Otherwise, stay seated.

1. Each time I say "check," see if more of your 4 nearest neighbors [front, back, left, right] are currently on their feet or seated.
2. Each time I say "act," move as follows:
   - If more of your neighbors in step 1 were on their feet, you stand. If more were seated, you sit.
   - If there was a tie (2 standing, 2 seated) in step 2, you sit down (no matter what your previous position)

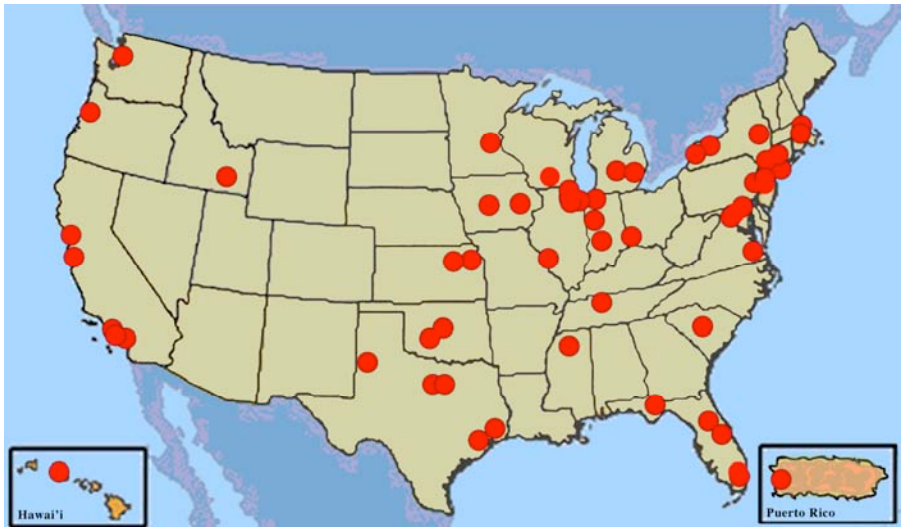
Variations (cf. Bando): linear Ising model, other spin systems, chain reactions from nuclear decays (give audience paper balls to throw as "neutrons")

Involve students and teachers in ongoing physics research

QuarkNet

The QuarkNet Collaboration

Year 8: now in 25 states & Puerto Rico



52 centers: 208 mentors & 507 teachers

Associated with 11 experiments conducted at 7 DOE labs & CERN

quarknet.fnal.gov

M. Bardeen Aspen, July. 2004

Getting Particle Physics into the Classroom

(sample QuarkNet educational module)

Title: Use conservation of momentum to calculate the top quark mass from D0 data
Subject: Physics
Grade Level: Introductory courses at high school or college level
Abstract: Students use momentum conservation to calculate the top mass. This activity examines the fingerprint of a top/antitop event that took place in the D-Zero Detector at Fermilab on July 9, 1995. Builds on student understanding of vector addition and depends upon only a small amount of particle physics explanation.
Learner Description/Environment: Suitable for a typical introductory physics class either at the high school or university level. We provide two methods of delivery, a traditional activity introduced and led by the teacher or an on-line version where the students control their own learning.
Time Frame: One or two days
Learner Outcomes: Students will know and be able to:

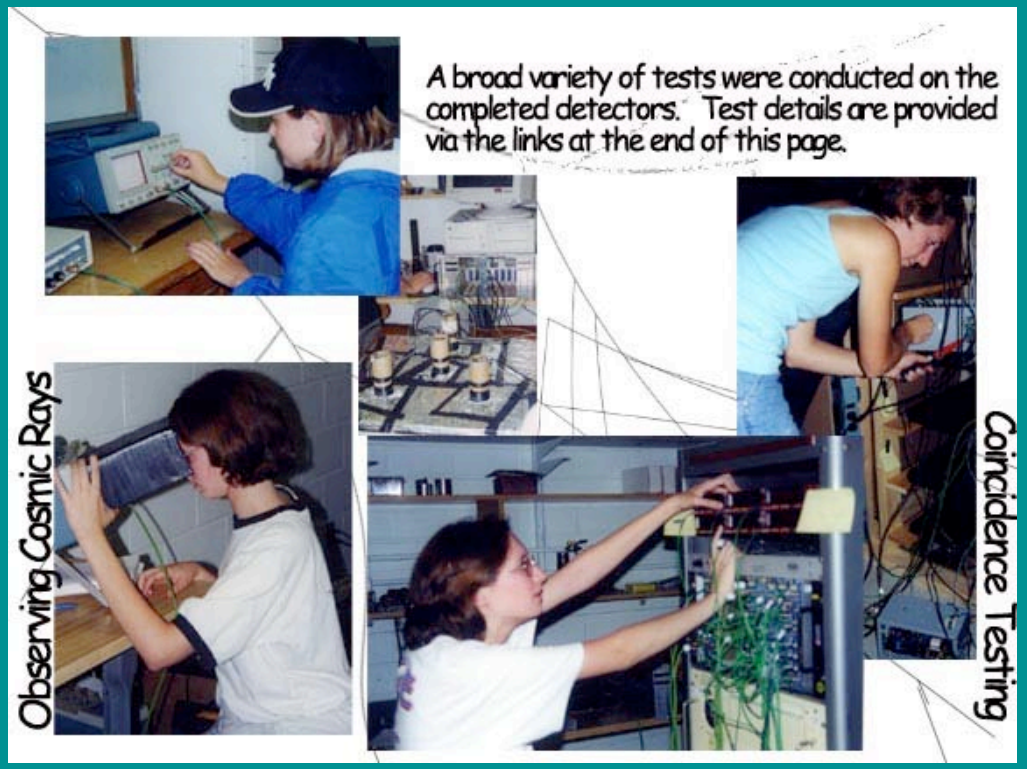
- Calculate the mass of the top quark from real data
- Apply what they have learned about vector addition to a real problem.
- Apply their understanding of conservation of momentum to real data.

NOTE: website includes guidelines based on trying the project in actual classrooms

www-ed.fnal.gov/samplers/hsphys/activities/top_quark_intro.html

Create Research Consortia Based in High Schools

csr.phys.ualberta.ca/nalta/



marian.creighton.edu/%7Ebesser/physics/crop.html

NALTA is a collaboration of experimental groups in Canada and the United States engaged in the study of high energy cosmic rays. What makes NALTA unique is the involvement of high-schools and colleges in this endeavor. Teachers and students actively contribute to the physics research while learning about an exciting area of modern science.

Notes from NALTA participants:

- Tremendous excitement about
  - building & maintaining own equipment
  - large-scale research via local measurement
- Must work with teachers to integrate NALTA into the regular physics curriculum
  - all of their students can benefit
  - new student researchers will be recruited
- Good source of science fair projects
- Biweekly follow-up needed (e.g. phone)
- Experienced teachers can mentor new ones
- MS or college students can assist college faculty with support of school teams

Convey Scientific Content to those skilled at reaching the public

kicp.uchicago.edu

Participants' Comments

My after-the-show audience discussion will be affected immediately. I am now planning at least two new public shows…

It would be an extraordinary project for you to create content, video or otherwise, that we would all use in our domes. I can't stress that point enough.

Create Web Resources

Science NetLinks

www.sciencenetlinks.org

particleadventure.org/particleadventure/

Thinking About Physics

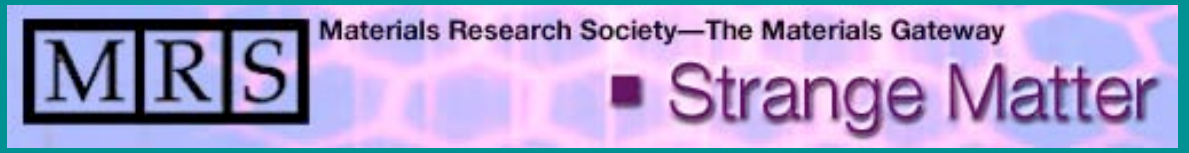
www.amherst.edu/~physicsqanda

microscopy.fsu.edu

nucoutreach.msu.edu

Contemporary Physics Education Project

www.cpepweb.org



www.mrs.org/strangematter

Encourage Students to Lead

- Undergraduate (or graduate) student groups can design and lead dynamic and successful outreach programs in which faculty serve as volunteers.
- A couple of examples from Michigan State:
  - Science Theatre is a longstanding student-led outreach group that performs interactive educational demonstrations at schools and science fairs across mid-Michigan.
  - Spartan Science Day is an annual event organized by the Multiracial Alliance of Lyman Briggs College for the benefit of elementary students from Flint, MI (and soon from Lansing, MI).





LYMAN BRIGGS COLLEGE

1967 2007

Lyman Briggs is an undergraduate, residential learning community at MSU, devoted to studying the natural sciences and their impact on society. Its building houses laboratories, classrooms, and student residential, dining, and recreational facilities. With 1800 students, LBC offers the "best of both worlds": the benefits of a liberal arts college and the resources of a great research university.





Flint schools & teachers participating in Spartan Science Day

Brownell Elementary School
Ms. Catanja Harrison

Williams Elementary School
Ms. Karen LaLonde

50 miles apart

5th grade students visiting from Flint, waiting for the program to begin.

MSU's student-run Science Theatre performs demonstrations:

… including a Dance of the Sound Vibrations…

… Flint students get in on the act!

Making slime with Dr. LaDuca

Microscopes & Cells with Drs Luckie, Smith & Urquhart

Perspective from Flint teachers

- **Many of my students come from homes where no one has ever gotten past high school.**
- **When I talk to my students about college and career plans they say "My mom says poor kids can't go to college…." This trip helps counter what they're hearing at home.**
- **Many students didn't know what a college was before this day and had never set foot in one before… they left the program saying "I want to go there!"**
- **The MSU students were awesome with the kids, even with those who usually present behavior problems. There was a spirit of camaraderie.**
- **One of the best field trips EVER!**

Perspective from Student Organizers

- **[T]he kids we were targeting are among the least privileged kids in the entire state - some coming from families that earn less than $8000 per year. Many of those kids have no idea what it means to go to college …. I am hopeful that as they grow up, they'll remember the fun they had at MSU and will see college as a realistic goal, not as an unrealistic dream.**

- **At the end of the day, just before the kids left, we asked how many of the kids would like to go to college someday. And when almost every single one of them raised their hand, that gave me all the satisfaction and reward that I needed for all the work that was put into it.**

- **Getting ten and eleven year old kids excited about science experiments, physics demonstrations and the use of technology could be paramount to their desire for education.**

- **I know I gained a greater sense of appreciation for my education, and those that have guided me along the way, i.e. parents and teachers.**

End of the Program

(Can you spot the physics handout?)

Conclusions

What can you do?

- Think broadly about education & outreach
  - You are probably already doing some … more is always needed
  - There are many ways to contribute (talks, consulting, writing…)
- Join existing programs or create new ones
  - Your work will have impact if you prepare well (assess audience needs, form partnerships)
  - The effort involved will be minimized if you take advantage of existing resources (networks, materials, examples)
- Support the efforts of others:
  - Encourage your students & postdocs to become involved
  - Help out with a program a junior colleague is starting
  - Make sure your unit values education & outreach when promotions and raises are discussed