Building a Better Undergraduate Physics Program

Kevin Pitts
University of Illinois
Outline

• Disclaimer
• Introduction
  – Our experience at Illinois
  – What’s wrong with the physics culture
• Why physics is an awesome major
• What we do academically to make it happen
  – Curricula
  – Courses
• Recruiting & retention
• Problems/concerns
Disclaimers

• Hopefully this talk has something for everybody. (not just faculty)

• I’ll probably say some things you disagree with. If so, let me know, I’m happy for this to be interactive.

• This is not “how to”. We’ve tried things that work and things that don’t work. This is an “our experiences” talk.

• What I’m describing is the work of many people over many years.

Number

from aip.org
Illinois Physics Majors

all physics majors

Issues (prehistory – 2010)
- Incoming class 100-120. More than half transferred out
- 4 year graduation rate ~40%
- Typical graduating class 40-45 students
Growth

• 60% increase in physics majors in 3 years
• How did we do it?
  1. University accepted more international students.
     • 2010: physics 18% international
     • 2013: physics 26% international
     • Number of international students more than doubled.
  2. More domestic students declare as physics major
     • Number of applicants up
     • “yield” of accepts up
  3. Retention rate improved significantly.
     • Retention rate never driven by academic performance
     • Lost students to other disciplines: engineering, etc.
More majors/better retention

• Getting more majors
  – Careers
  – Messaging (more than recruiting)
  – Don’t forget the parents

• Retaining majors
  – Inclusion
  – Find out what they want.
  – Help them find out what they want.

But first, why do we want more majors?
We need to talk about culture...
Is this us?

“Evidence indicates that the physics community remains in a traditional mode where the primary purpose of physics education is to create clones of the physics faculty. There are notable exceptions.”

– National Research Council: *Adapting to a Changing World – Challenges and Opportunities in Undergraduate Physics Education*
Cloning ourselves

• How do we measure success?
  – Students going to graduate school
  – Ph.D.’s going into academia

• “If a student wants to get a bachelor’s degree and get a job, he should be in engineering.”
  • UIUC Physics Faculty member

• Even if we don’t say it, students get the message.
  – Success is a Ph.D. followed by a career in academia. All other outcomes a consolation prize.

• If you think our job is to produce more faculty/researchers, then we shouldn’t grow our program
Perception

• For many (inside and outside the field) physics is seen as an “academic discipline”

• What jobs are there? research, teaching

• “I’m not trained to do anything.”
  • A high energy physics postdoc who was beginning a job search outside of physics research
A culture change

My claim:

• Physics is one of the premier majors for the 21st century.
• Physics can prepare a student for a wide variety of disciplines.
• You don’t need a Ph.D. to succeed.

• Note: I do not discourage any student from earning an advanced degree in physics.
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  – Our experience
  – What’s wrong with our culture

• Why physics is an awesome major

• What we do academically to make it happen
  – Curricula
  – Courses

• Recruiting & retention

• Problems/concerns
Careers

• Recruiters are looking for smart, well-trained people who can:
  1. solve problems
  2. learn new things quickly.
  3. work well in teams.
  4. analyze large amounts of data.
  5. communicate well.

• Answers are the same regardless of field
  – Engineering, software, consulting, finance, government, medical technology, ...

• Emphasis today is on “general” skills
  – Very different than what we heard 10 years ago.
Field of Employment for Physics Bachelor’s in the Private Sector, Classes of 2009 & 2010 Combined

- Engineering: 32%
- Computer or Information Systems: 21%
- Non-STEM: 26%
- Other STEM: 8%
- Other Natural Sciences: 8%
- Physics or Astronomy: 5%

STEM refers to natural Science, Technology, Engineering, and Mathematics.

http://www.aip.org/statistics
Knowledge and Skills Regularly Used by Physics Bachelor’s Employed in the Private Sector, Classes of 2009 & 2010 Combined

- Employment in Engineering
- Employment in Computer Science or Information Technology

- Solve Technical Problems
- Work on a Team
- Technical Writing
- Knowledge of Phys. or Ast.
- Perform Quality Control
- Use Specialized Equip.
- Design & Development
- Programming
- Manage Projects
- Work with Customers
- Advanced Math
- Simulation or Modeling
- Computer Admin.
- Manage People
- Manage Budgets

Percentages represent the physics bachelor’s who chose "daily", "weekly", or "monthly" on a four-point scale that also included "never or rarely".

http://www.aip.org/statistics
### Average LSAT Scores* by Selected Majors, 2009.

<table>
<thead>
<tr>
<th>Major</th>
<th>Mean score</th>
<th>Number of applicants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>161.5</td>
<td>180</td>
</tr>
<tr>
<td>Mathematics</td>
<td>159.7</td>
<td>336</td>
</tr>
<tr>
<td>Economics</td>
<td>157.4</td>
<td>3,047</td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>156.3</td>
<td>546</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>156.0</td>
<td>427</td>
</tr>
<tr>
<td>Chemistry</td>
<td>155.7</td>
<td>355</td>
</tr>
<tr>
<td>English</td>
<td>154.7</td>
<td>5,120</td>
</tr>
<tr>
<td>Biology</td>
<td>154.5</td>
<td>1,055</td>
</tr>
<tr>
<td>Computer Science</td>
<td>154.0</td>
<td>682</td>
</tr>
<tr>
<td>Political Science</td>
<td>153.0</td>
<td>14,964</td>
</tr>
<tr>
<td>Psychology</td>
<td>152.5</td>
<td>4,355</td>
</tr>
<tr>
<td>Pre Law</td>
<td>148.3</td>
<td>1,078</td>
</tr>
<tr>
<td>Criminal Justice</td>
<td>145.5</td>
<td>3,306</td>
</tr>
<tr>
<td><strong>All Majors</strong></td>
<td><strong>152.6</strong></td>
<td><strong>81,530</strong></td>
</tr>
</tbody>
</table>

*The scores in the table are for individuals who applied to Law school for the 2007-08 academic year. All test takers are not represented. Individuals may have taken the LSAT months or possibly years earlier.

**Source:** AIP Statistical Research Center compiled data from the Law School Admission Council, Newton PA.

[http://www.aip.org/statistics](http://www.aip.org/statistics)
### Average MCAT Scores by Selected Majors, 2009.

<table>
<thead>
<tr>
<th></th>
<th>Physical Sciences</th>
<th>Biological Sciences</th>
<th>Verbal reasoning</th>
<th>Number of applicants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomedical Engineering</td>
<td>10.9</td>
<td>10.7</td>
<td>9.6</td>
<td>1,005</td>
</tr>
<tr>
<td>Physics</td>
<td>11.1</td>
<td>10.3</td>
<td>9.6</td>
<td>207</td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>10.9</td>
<td>10.5</td>
<td>9.4</td>
<td>195</td>
</tr>
<tr>
<td>Economics</td>
<td>10.4</td>
<td>10.5</td>
<td>9.7</td>
<td>566</td>
</tr>
<tr>
<td>Neuroscience</td>
<td>9.9</td>
<td>10.6</td>
<td>9.5</td>
<td>1,066</td>
</tr>
<tr>
<td>Mathematics</td>
<td>10.3</td>
<td>10.1</td>
<td>9.6</td>
<td>374</td>
</tr>
<tr>
<td>English</td>
<td>9.4</td>
<td>9.9</td>
<td>10.3</td>
<td>434</td>
</tr>
<tr>
<td>Biochemistry</td>
<td>9.9</td>
<td>10.3</td>
<td>9.1</td>
<td>2,594</td>
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<tr>
<td>Chemistry</td>
<td>9.8</td>
<td>9.9</td>
<td>9.0</td>
<td>2,091</td>
</tr>
<tr>
<td>Microbiology (or Bacteriology)</td>
<td>9.0</td>
<td>9.9</td>
<td>8.7</td>
<td>775</td>
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<tr>
<td>Psychology</td>
<td>8.8</td>
<td>9.4</td>
<td>9.1</td>
<td>2,421</td>
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<tr>
<td>Biology</td>
<td>8.7</td>
<td>9.5</td>
<td>8.7</td>
<td>12,705</td>
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<tr>
<td>Premedical</td>
<td>8.3</td>
<td>9.0</td>
<td>8.4</td>
<td>663</td>
</tr>
<tr>
<td><strong>All Majors</strong></td>
<td>9.2</td>
<td>9.8</td>
<td>9.0</td>
<td>41,487</td>
</tr>
</tbody>
</table>

The Medical College Admissions Test (MCAT) has three sections of standardized multiple choice questions (total of 219 items) with an additional writing sample comprised of two essays. Scores of 9.5 to 11 in each section are considered competitive by most medical schools.

**Source:** Association of American Medical Colleges, Data Warehouse

http://www.aip.org/statistics
What’s a Bachelor’s Degree Worth?
Typical Salary Offers by Campus Recruiters, AY 2008-09

Bachelor’s Field
Chemical Engineering
Computer Science
Electrical Engineering
Physics
Mechanical Engineering
Mathematics
Civil Engineering
Finance
Nursing
Accounting
Marketing
Chemistry
Secondary Education
Psychology
Biology / Lifescience

Starting Salary in Thousands

Typical salaries are the middle 50%, i.e. between the 25th and 75th percentiles.

Reprinted from the Fall 2009 Salary Survey, with permission of the National Association of Colleges and Employers, copyright holder.
Observations

• Companies who have hired recent Illinois physics (bachelors) 2011-2013:

• Good news: many companies like physicists.
  – Tell the NSA story

• But: where do they start a physicist?
  – Some practical skills help!!
Good news & bad news

• Bad news:
  – Physics does not provide a single, clear-cut career path.
  – Also hard to identify physicists in industry, because they aren’t called physicists.

• Good news:
  – A degree in physics offers great flexibility
  – Lots of opportunities for interdisciplinary work

• Our job:
  – Help students use their degree, perhaps supplement it, to prepare for many career options
  – Educate employers who probably think that physics majors are smart and irrelevant.
Skill set of Physics majors at the University of Illinois at Urbana-Champaign

Our physics majors have a strong background in mathematics and fundamental science. We feature degree programs that can be tailored to emphasize knowledge in topics such as computation, electronics, biophysics, acoustics and sustainability. Our program is highly ranked and includes a strong laboratory component. In addition, students trained in physics are highly motivated and possess the following skills:

- Critical thinking and problem-solving
- Collaborative approaches and teamwork
- Agility and adaptability
- Effective oral & written communication
- Accessing and analyzing information
- Processing and synthesizing large data volumes
- Curiosity and Imagination

For more information contact:
Toni Pitts
Coordinator of Recruiting Advising & Special Programs
2902 Loomis Lab of Physics
1110 West Green Street, MC 704, Urbana, Illinois 61801
tpitts@illinois.edu or 217.244.2948
http://www.physics.illinois.edu/education/undergrad/
Career Awareness

• Challenge to communicate the diversity of career opportunities to students.

• We’re trying multiple approaches:
  – Send them to career fairs
  – Blog
  – Town Hall meetings
  – “What can you do with a physics degree” talks
Physically Speaking (Blog)

Filter blog posts: View latest 15 posts

2/7/2012
11th Annual Undergraduate Research Symposium
Undergraduates give presentations on their research!

2/7/2012
Talking Antimatter with the Saturday Scholars
Talking to 700 high school students about antimatter is an interesting experience!

2/2/2012
Get Physically Speaking Updates Via Twitter
Follow me on Twitter and I’ll tell you when I update the blog.

1/26/2012
The Undergraduate Women in Physics Conference Rocks!
One of our undergraduate students tells us what a great time she had at the conference.

1/25/2012
Welcome to Merissa, our new Academic Advisor
A guest blog post about academic advising from Merissa.

1/14/2012
Undergraduate Women in Physics Conference
Young physicists across the country are getting together this weekend!

1/9/2012
Rankings
Rankings can be useful, but don’t put too much stock in them.
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  – Courses
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• Problems/concerns
Our old Physics Program

Physics:
• 3 semesters introductory physics
• 2 semesters mechanics (includes special relativity)
• 2 semesters E&M
• 2 semesters quantum mechanics
• 1 semester thermo/stat mech
• 1 semester classical lab
• 1 semester modern lab (or electronics lab)
• Other undergrad courses available (not required)
  – Condensed matter, subatomic, optics

Supporting Courses:
• Math: 3 semesters of calculus + diffeq + linear algebra
• 1 semester of CS, Chemistry
Broadening the appeal

• Introduce flexibility in curriculum, allow students to tailor program to their interest.

• Format
  – All students take same base physics courses (fixed core)
  – Students must choose from additional physics courses (flexible core) including a lab class
  – Student must choose an “elective option”
    • Option course might not be in physics, but they count as part of the physics major.
Elective options

• Students who want to pursue grad school and a research career choose the “Professional Option” which is basically our old curriculum.

• Students who want to do something else choose a different option.
  – They are basically “trading” 4-5 advanced physics courses for courses in another area.
New Curriculum “Cores”

• Fixed core:
  – 3 sem intro
  – 1 sem mechanics
  – 1 sem E&M
  – 1 sem quantum

• Flexible core: choose 3 from:
  – 2nd sem mechanics
  – 2nd sem E&M
  – 2nd sem quantum
  – Stat/thermo
  – Must choose at least one lab course

This forced us to move material around in 2-semester courses. Could no longer assume all students get both semesters. All “must know” material goes into 1st semester.
Elective Options

• Allows students to tailor curriculum to their needs and interests.
• Examples:
  – Professional Physics *(this is the grad school track)*
  – Astrophysics
  – Biophysics
  – Bioengineering
  – Computational Physics
  – Materials Science
  – Physical Electronics
  – Earth Science
  – Science Writing
  – Pre-law
  – Pre-med
  – User defined

New options:
• Nuclear physics
• Energy/sustainability
• Management
• Atmospheric science
• ...
Recent user defined options

- Electrical Engineering Technical Option
- Geology/Geophysics
- Pre-Optometry
- Mathematical Physics
- Prep for Grad School in Library Science
- Economics
- Acoustic Engineering
- Atmospheric Sciences
- Acoustics
- Biomedical Engineering
- Nuclear Physics
- Sustainable Technology Commercialization
Class of 2011

About 55 grads, where did they go?

– 50% grad school in physics
  • Fields: Atomic and molecular optics, biophysics, high energy physics, astrophysics, condensed matter physics, quantum computing, nuclear physics, nanotechnology.

– 20% grad school in other field (CS, EE, NuclE, MatSE, Math)

– 20% industry
  • Software engineer (CISCO Systems), manufacturing systems (Intel), information technology (Simplex Investments, Accenture Consulting), finance (Belvedere Trading Company), public policy.

– 5% teaching

– 5% military (service or teaching)
Class of 2012

About 60 grads, where did they go?


- Grad school in other fields: economics, applied physics, architectural acoustics, biomedical engineering, secondary education, law school, neuroscience, astronomy and materials science

- Jobs: software firms, the Department of Defense, IBM, Google, and HRL Labs
Class of 2013

- Total number of graduates: 60
- Physics grad school: Minnesota, Maryland, Michigan, MIT, Princeton, Case-Western, Ohio University, UIUC, U Chicago, Virginia, Johns Hopkins
- Other grad school: MatSE, Finance, Applied Stats, Law, Geophysics, ECE, Journalism, CS, Math, Nucl Eng
- Jobs: Viasat, Studio 222, IMC Finance, EPIC (2), Inservice Engineering, Creat-a-Soft, U-Line distributor, Qualcomm, Google, Twitch LLC, HS teaching (3), software startup, Jump Trading, Green Line, Olenick & Associates
- Several people “looking” taking a “gap year” or staying here for a year of research.
Comments on new curriculum

• 60-70% in “professional” option.
  – Want to go to grad school
  – Or have enough room in schedule to do the full physics program and still get benefits of subject matter courses.

• Other 30% are students we would have (mostly) lost.
  – Students reporting that option courses are helping them get jobs.

• I didn’t expect the number of students going to grad school in other fields.
Operational Experience

• Students like the flexibility.
  – But they tend to put off decisions.

• This system requires more proactive academic advising
  – For course selection
  – To help tie course selection to career path or graduate school
  – For custom option construction.

• Also requires oversight and updating.
  – Including non-physics courses in physics major.
Comments on recruiting

• Students like physics.

• Parents (and students) concerned about lack of employment options
  – What can you do with a physics degree?
  – Note: other fields use the perceived employment issues to poach.

• Emphasis on careers makes a huge difference
  – But it needs to be sincere.
  – Back to culture. A bachelor’s and a job can’t be considered a consolation prize.
Important Retention Factors

1. Quality of introductory courses (SPIN-UP)
   – We put physics majors in with engineers.
   – Physics education group uses flipped class.

2. Transition from introductory to advanced courses.

3. Quality of first tier of intermediate courses.
   – I put our best instructors here.
PHYS 225: Easing the transition

• We introduced a “bridge” course:
  – PHYS 225 Relativity and Math Applications
  – 2 credit hours, take concurrently with 2nd semester of intro sequence (E&M) and Calc III

• Syllabus:
  – Spend 7 weeks on special relativity.
    • It’s fun, interesting and connects students to “modern” physics sooner.
  – Spend 7 weeks on math methods.
    • Vector calculus and Diff EQ as applied to physics problems in mechanics and E&M.
    • Serves as a warm up and transition into advanced courses.
Relativity and Math Applications

• One hour lecture per week.

• Learning mostly through “guided discovery” done in group work in a 2 hour discussion session.
  
  http://online.physics.uiuc.edu/courses/phys225/fall13/

• Course now an integral part of program.
  – This is now an “imprint” course
  – Important to have the right instructor

• Removed SR from intermediate mechanics, freed up time for fluids, stress tensors and in some cases GR.
PHYS 199REL The Relevance of Physics

• New course spring 2012
• For Physics majors only
• Discuss the societal relevance of physics...
  – Energy, space travel, nuclear power, weapons, electricity, light, radiation, climate
...and the relevance to physics majors
  – Careers, funding, education
• Project-based
  – Career project, poster project, position papers, videos.
• In class discussion & debate
PHYS 199REL The Relevance of Physics

Projects

• Careers in physics (not research, faculty)
  – In class presentation
• Team poster project
• Position paper on some alternative energy technology
• Interview a faculty member and report on research in physics (team)
  – In class presentation
• Video (team)
Nuclear Waste: Reusable?
Lingyi Kong (lkong5@illinois.edu), Robert Osio (osio2@illinois.edu)

Case Study: France

The French Nuclear program rose out of the 1973 oil crisis and the Messmer plan which dedicated France to producing much of its energy from nuclear power. Today France produces more than 75% of its domestic energy from Nuclear power.

What is Nuclear Waste?

Nuclear waste is the left over material from nuclear power plants. This can be from re-processing, various processing and refining to spent nuclear fuel. There are two types of nuclear waste-low level radioactive waste (LLW) and high level radioactive waste (HLW). HLW consists mostly of spent nuclear fuel, and LLW is often found in other forms (6). More than 99% of radioactivity is found in HLW, whereas LLW takes up 85% of entire nuclear waste generated (3).

The Danger of Nuclear Waste

The danger of nuclear waste is radioactivity. Radiation exposure is measured in rems (roentgen equivalent in man). The bigger the number, the more radiation a person receives, which means a more hazardous effect. Exposure of 25 rems will have detectable effect on humans(2). 100 rems will cause short-term illness, and above 300 rems will be lethal (1). Spent fuel emits millions of rems when removed from reactors. The danger of nuclear waste makes nuclear waste disposal an important issue.

What’s the situation?

“...the global volume of spent fuel was 220,000 tonnes in the year 2000, and is growing by approximately 10,000 tonnes annually.” (Greenpeace) (5)

Geological disposal has been the most favorable solution for dealing with nuclear waste (6). HLW is often buried in deep underground in lead-seal, lead-lined containers, as it can take hundreds of thousands of years to give off all its radioactivity (6). LLW, on the other hand, is often stored in near-surface burial (6).

Future Waste Strategy

Mankind’s evolving energy needs demand a unified strategy to deal with nuclear waste. An effective strategy must include ways of addressing existing waste and future energy production. Investments in reprocessing would enable countries on the once through fuel cycle, like the US, to reduce their current stockpiles of nuclear waste. In the long term, power generation needs to minimize waste produced. Advances in thorium reactors show great promise in meeting future energy demands while producing much less waste. The lack of alternative base load, carbon neutral, energy sources almost guarantees Nuclear energy a place in humanity’s future.

Case Study the US

The US produces 19.6% of its electricity from Nuclear power but is the world’s largest producer. (11) United States nuclear power runs exclusively on the once through fuel cycle.

Nuclear Waste Storage

Since the United States doesn’t reprocess waste it must store all Nuclear waste after use. One form of storage involves the use spent fuel pools. Nuclear waste is submerged in 20 feet of water or more which shields workers from radiation. (12) Pools provide several risks of operation. One stems from the high temperatures associated with the spent fuel. Pools need to be cooled to prevent the water from boiling off and releasing radiation into the atmosphere. The other major risk involved with storage pools is Radioysis, the disassociation of molecules via radiation. Water molecules exposed to the waste can produce hydrogen which if left unmonitored and uncontrolled could cause explosions like at Fukushima.

Space in spent fuel pools is limited and during the 70’s and 80’s a need developed for an alternative storage option. To fill this need the industry started investing in Dry Cask Storage. Dry Cask Storage takes spent fuel already cooled in fuel pools and surrounds them with an inert gas. This space is then enclosed in a steel cylinder surrounded by more steel, concrete, and other materials (12). It is estimated that the United States now has 65,000 tons of nuclear waste in temporary storage (13). Plans for a national Nuclear waste repository at Yucca Mountain Nevada have been suspended amid controversy and much legal action. Without a national repository, waste sits on sight at the plants where it was generated. Limited space has forced some plants to shut down to accommodate storage of their waste (14).

References


Example video from PHYS 199REL

http://courses.physics.illinois.edu/phys199rel/sp2012/project5team1final2.wmv
Did you learn this in a class?

• In what class did you learn the following?
  – How to write a research paper.
  – How to document your research.
  – How to “approach” research.
  – How to put together a good talk.
  – How to make and present a poster.
  – How to write a grant proposal.
  – How to apply to grad school.

• And how much practice did you get??
PHYS 496/499 “Senior Thesis”

Emphasis on research and communication (speaking/writing)
# Physics 496 Introduction to Physics Research  Spring 2012

Syllabus and Homework Assignments
Laura H. Greene, Swanlund and Center for Advanced Study Professor of Physics
Celia M. Elliott, Director, External Affairs and Special Projects

Revised 04/03/2012

Homework assignments are to be deposited in your Dropbox file by 5 p.m. on the due date.

<table>
<thead>
<tr>
<th>Wk</th>
<th>Date</th>
<th>Writing Workshop (257 LLP) (Usually 2:00–2:50 p.m., unless noted otherwise)</th>
<th>In Class Activities (322 LLP) (Usually 3:00-4:50 p.m. unless noted otherwise)</th>
<th>Homework Due Today</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jan 20</td>
<td>Intro to Writing Workshop—goals and rationale WW #1—Getting something written down</td>
<td>Course introduction and expectations (lhg) The “hows” and “whys” of research (lhg) Technical communications in science (cme) Evaluating a science talk (cme)</td>
<td>None</td>
</tr>
<tr>
<td>2</td>
<td>Jan 27</td>
<td><strong>11th Undergraduate Research Symposium</strong> 2:00–6:00 p.m., 141 LLP; attend the talks in lieu of class—no Writing Workshop today; no homework due today</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Feb 3</td>
<td>WW #2—Using the right word</td>
<td>Using persuasion in scientific communications (cme) Tools for the scientific skeptic (lhg) Abstracts and titles (cme)</td>
<td>#1—Evaluating Scientific Presentations</td>
</tr>
<tr>
<td>4</td>
<td>Feb 10</td>
<td>WW #3—Them thar</td>
<td>Using online resources for research (lhg) Writing effective paragraphs (cme) Documenting research (lhg)</td>
<td>#2—Abstract</td>
</tr>
<tr>
<td>5</td>
<td>Feb 17</td>
<td>WW—Literature search (team exercise)</td>
<td>Creating good figures (lhg) Effective figure captions (cme) Using analogies to explain science (lhg)</td>
<td>#3—Paragraphs</td>
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<tr>
<td>6</td>
<td>Feb 24</td>
<td>WW #4—Getting only in the right place</td>
<td>Giving a talk (cme) Effective slide titles (cme) Presenting information in tables (cme)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Mar 2</td>
<td><strong>No WW—go directly to Room 322</strong></td>
<td>Professional ethics for physicists (lhg/cme Ethics case studies (group activity)</td>
<td>#4—Analogy</td>
</tr>
</tbody>
</table>
Undergrad Poster Session (November)
Undergrad Research Symposium (January)
Senior Thesis Sequence

• Feedback from students is incredibly positive.
  – Most cite it as their best course.
  – They report back from grad school that they are far ahead of their peers when it comes to doing and reporting research

• Challenges/limitations
  – Finding research spots (and funding) for all students in the class.
  – Course limited to ~24 students per cycle.
  – We are fortunate to have a writing guru.
  – Course is aimed at grad school bound students.
REU

• We’ve propagated aspects of Senior Thesis to our REU program

• Seminars on:
  – Doing research
  – Ethics
  – Poster presentations
  – Giving talks
  – Science Writing
  – Grad school

• Students make lots of presentations.
Other new/improved courses

• PHYS 100 pre-intro sequence
  – Followed by enrichment supplemental courses

• Significant upgrade of our modern physics laboratory course

• Physics of music laboratory course

• Senior level Biophysics course

• Senior level Atomic Scale Simulations course

• Improve freshman orientation course

• New seminar course about undergrad research
  – Coming in spring.
More thoughts on retention

• Community – students are a part of your department.
• Student organizations
  – Physics Society, Society for Women in Physics, Physics Van
• Support what they want to do.
  – Pizza party, lab tours, tutoring
• Get their input – Student Advisory Committee
  – Told me we need a Computational Physics class.
  – Told me that we need to use active learning in advanced physics courses.
• Involve students in recruiting, outreach, advising
  – They want to help!
• Are undergrads coming to colloquium?
Midwest Conference for Undergraduate Women in Physics Jan 18-20, 2013
More thoughts on recruiting

• Your students are (by far!) your best recruiters.
  – Phone bank.
  – Peers advisors (Ohmies!)
  – Admitted student day
  – Outreach
Media

• Using online & social media to improve recruiting and student experience.

• Facebook

• Twitter

• Mailing lists

• Blog
Challenges

- Enrollments
  - Big classes!
  - E&M, mechanics, quantum all over 100

- Advanced labs
  - Limited equipment/seats

- Access to courses in other disciplines
  - Options might require CS, ECE, etc.

- Intercollegiate transfer students
  - Difficult transition from community college.

- Diversity
  - Still horrible.

- More majors/minors does not mean more money or faculty lines. (total IUs matter more)

- Getting faculty to adapt to changing student attitudes and needs.
What’s missing?

• We still haven’t gotten numerical methods integrated into our curriculum
• Increasing undergrad research opportunities.
  – 120 students doing undergrad research this summer does not growing meet demand.
• Broadening participation in our senior thesis sequence.
  – Students not going to grad school could benefit from some aspects of the course.
• Increasing corporate internship opportunities.
• Better long term tracking of graduates
More to do

• Better tracking of graduates
• **Getting alumni involved more**
  – Career advice, contacts, internships
• Generate more internships
• Generate more research opportunities
  – Opportunities and funding
• Deal with larger enrollments
  – Access to courses
• Find ways to help faculty deal with bigger classes.
Grad program

• Some ideas propagating to our grad program
• Graduate careers seminars ([here](#))
• Job postings, career fairs
• Ties to alumni (LinkedIn)
• Better mentoring

• We’re not talking anybody out of research/academia. We are giving them tools to make wise career choices.
Summary

• We’ve made some significant course and programmatic improvements
  — Not every experiment worked.

• Enrollments are up and retention improving.

• We still have lots to do.
  — More curriculum development, student support, internships, research opportunities.

• Must make young people aware of the potential that physics offers.
• Culture changes slowly...