Elementary-School Science Outreach in a General-Education Physics Course

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PHY 100: Elements of Physical Science

- Conceptual physics course for non-majors (very little math)
- Fulfills a general-education science requirement
- Addresses general-education goal to *develop analytical thinking skills*
- Emphasis on *conceptual understanding* of science over factual knowledge

PHY 100: Motivation for Service-Learning

Physics is hard: but why?

My guess: many students have…

- Strong preconceptions that aren't quite right
- Expectations that science classes will be based on factual knowledge
- Little experience constructing and testing their own conceptual understanding
- Math/science anxiety

Poll:

When do you believe is the easiest time to learn basic physics concepts (such as Newton's Laws)?

1. College
2. High School
3. Middle School or late Elementary School

PHY 100: Motivation for Service-Learning

I believe the easiest time to learn basic physics concepts is in late elementary school. And I'm not the only one:

Conceptual development about motion and force in elementary and middle school students

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"Our findings suggest that students as early as 6th grade can develop changes in ideas about motion needed to construct Newtonian-like ideas about force. Students' conceptions about motion change little under traditional physics instruction from these grade levels through college level."

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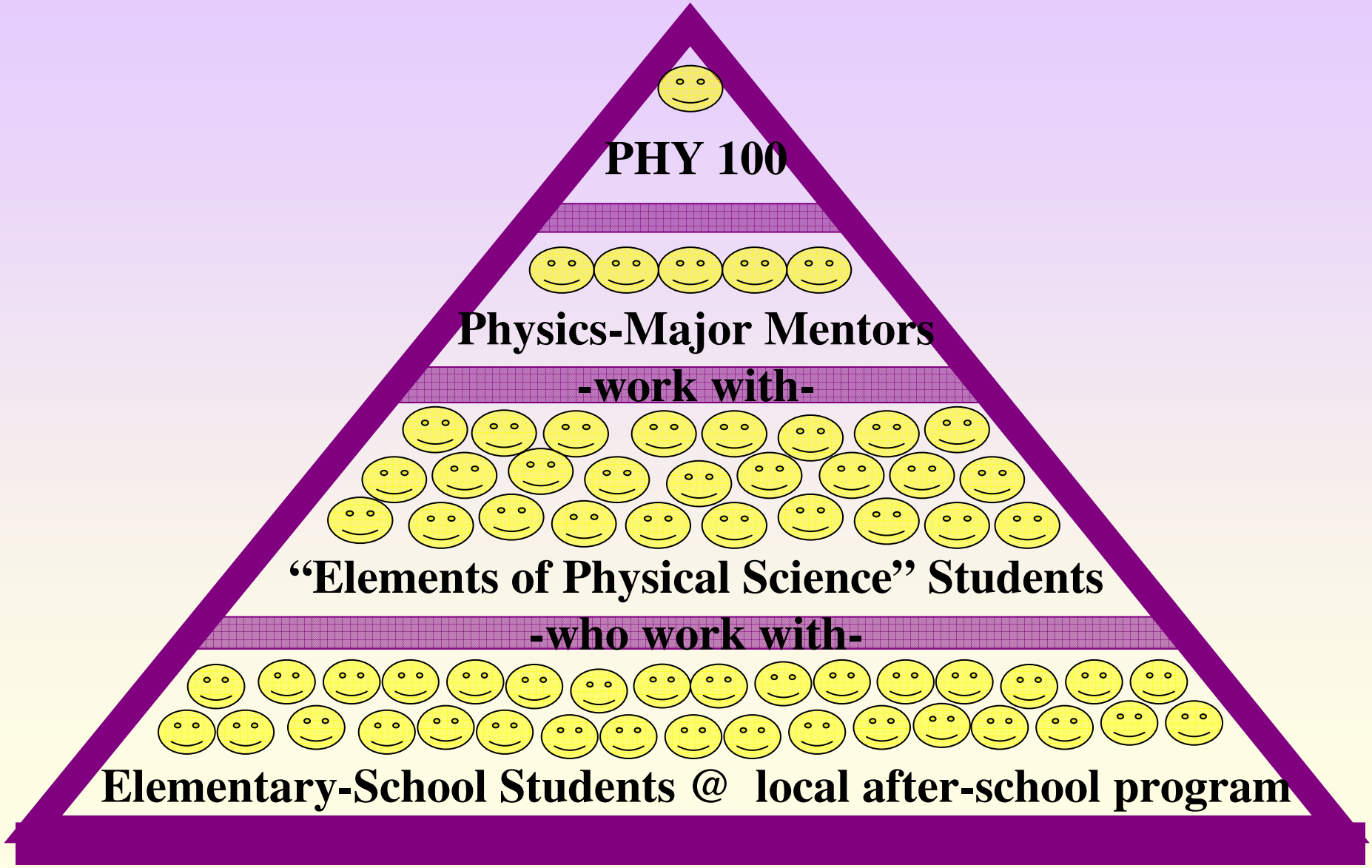
Structure of the Service-Learning Model



Structure of the Service Learning Model: Sessions at YWCA After-School Program

- Hour-long session focusing on a particular topic
- 1 ten-minute "introductory station," run by a physics-major mentor, introduces the day's topic
- 5 activity stations, each designed & run by a team of 2-3 PHY 100 students and focusing on a different aspect of the topic, are set up around the room
- YWCA elementary students are divided into groups and rotate among the 5 activity stations, spending 10 minutes at each station

Structure of the Service Learning Model

- Topics are covered in class before each session
- “Practice runs” of activity stations are held the class before each session
- Activity stations count for 45% of course grade
- 6 sessions during the semester, on 6 different topics:
  - Motion and gravity
  - Simple machines
  - Sound and music
  - Phases of matter
  - Electricity and magnetism
  - Light and optics

PHY 100: Learning Objectives

- To build student's confidence and ability to test new ideas and make sense of how the physical world around them works. This includes:
  - Realizing and challenging preconceptions
  - Observing the world more closely
  - Identifying assumptions and determining if/when they are reasonable
  - Reaching and testing conclusions
  - Making connections between ideas
  - Explaining concepts to others

Evaluation of Activity Stations

- Significance and Relevance
- Encouragement of questions
- Challenge to assumptions
- Physics Accuracy
- Clarity
- Engagement
- Creativity
- References/Citations

Assessment of Service-Learning Pilot Course

- Student Assessment of Learning Gains (www.salgsite.org)
- Final Exam Results
- Post-survey of YWCA students
- Pre/post online homework and online journals

Results: Student feedback: Frustrations

- “I gained a little it's just it's a hard class and hard concepts for me to make huge gains in in one semester.”
- “I learned very little in this class. I only know what the children know. Because that is how we had to teach it.”
- “The biggest skill that i improved on in this class was how to organize a demo so that it is easily followed by others, however … my skill improved because of my own desire to improve in that area, not because we learned how to do so in class.”

Results: Lessons Learned

- Fewer topics: Less breadth and more depth.
- Keep the groups the same!
- Give topics/experiments for the first session.
- Train the mentors!
    -Make it an independent study for them?

Results: Student feedback: Learning Gains

- "[The service-learning] helped a lot because i had to be able to turn around and reteach the material. i feel i have a better understanding of the material i had to teach as opposed to my off weeks"
- "At first I did not have any type of interest in this subject but now I am more aware of what it consists and how important it is to society."
- "[I learned] that explaining issues to others is the best way to learn."
- "I will take [from this class] the ability to show younger people how to have fun with science."

Results: Positive Outcomes from Pilot

- Final Exam: Similar performance to other classes, and outstanding performance on collaborative portion
- Post-survey from YWCA students confirms their enjoyment of the activities and positive science-related attitudes
- SALG survey indicates that doing activity stations helped students' learning more than any other assignment or aspect of the class

Conclusions

- A simple-but-effective Service-Learning Model for a physics class aimed at “non-science” students: Students develop science activities for elementary-school students.
- This model can meet course objectives for college students, while better engaging different learning styles and benefiting elementary students.
- Modifications to the pilot model are needed to improve students’ comfort level with the course.
- Suggestions/ideas/discussion welcome!
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