

**TEACHING AND RESEARCH:
inseparable responsibilities of the modern scientist**

**Eric Mazur
Harvard University**

**MPS Advisory Committee Meeting
National Science Foundation
13 April 2000**



We have a problem

80% of American adults generally support science...

We have a problem

80% of American adults generally support science...

...but only 20% view themselves as well-informed

We have a problem

Should we worry?

We have a problem

We'd better!

We have a problem

"I took four years of science and four years of math...

**A waste of my time,
a waste of the teacher's time,
and a waste of space...**

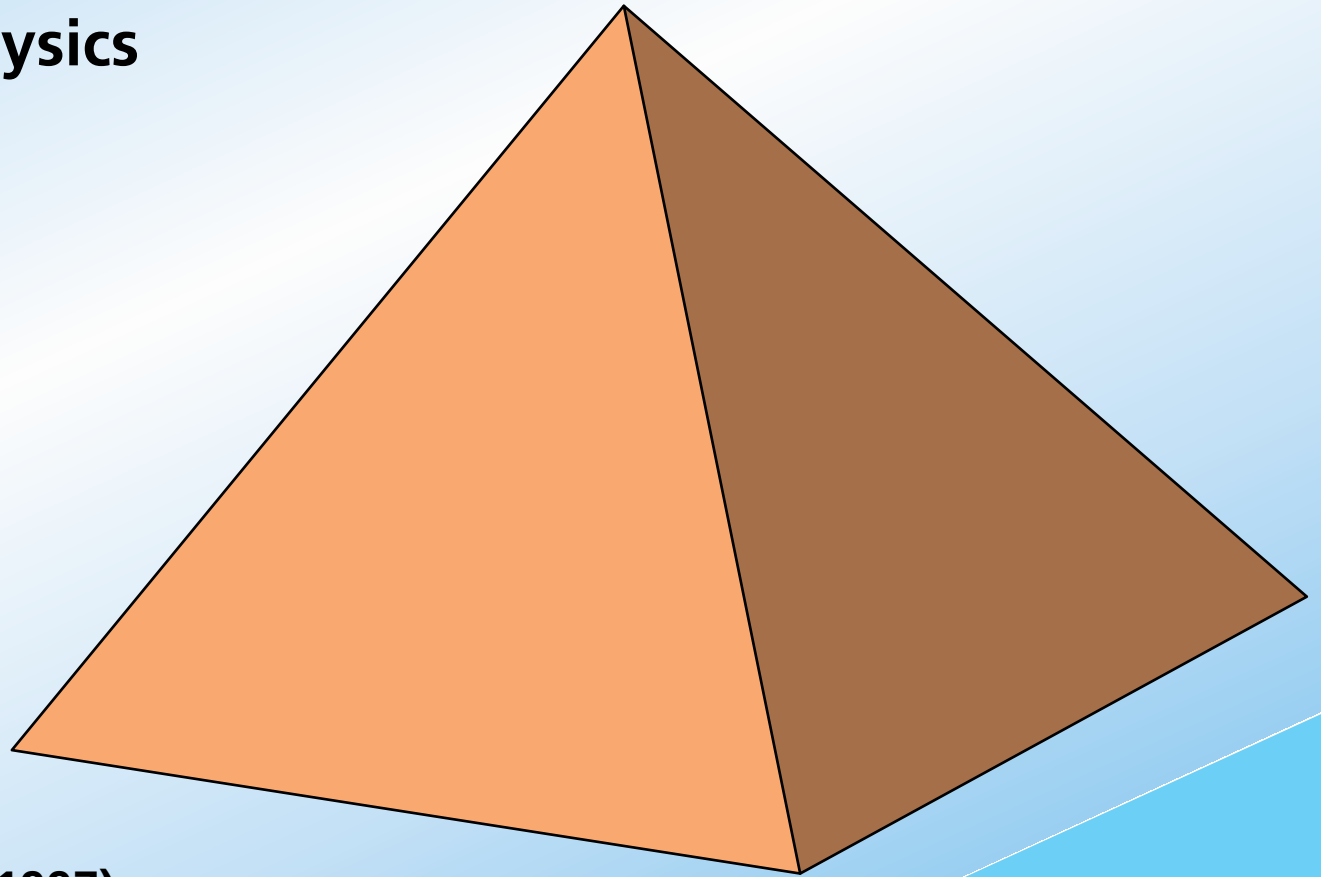
**You know,
I took *physics*.**

For *what?*"



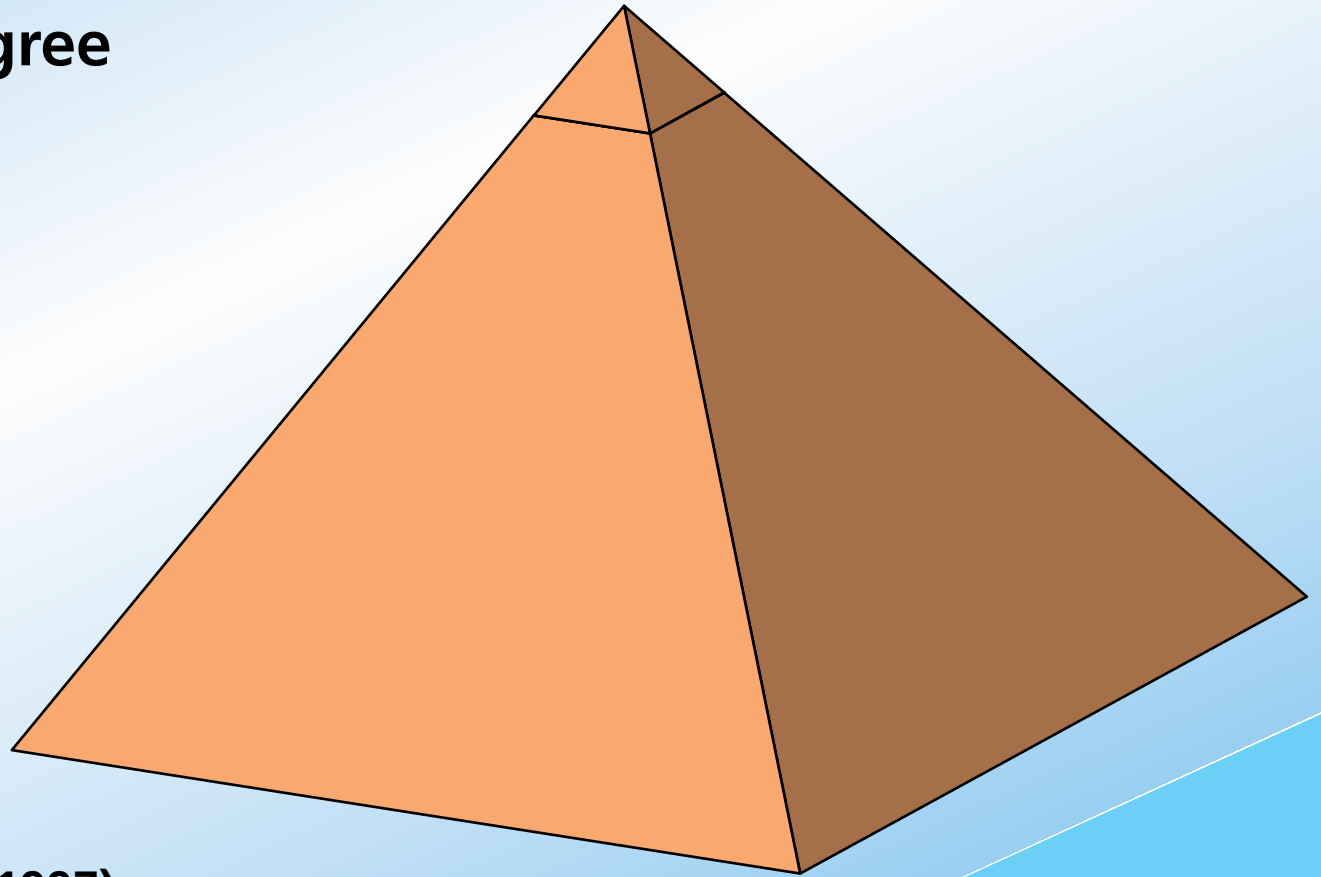
We have a problem

**380,000 students take
introductory physics
each year...**



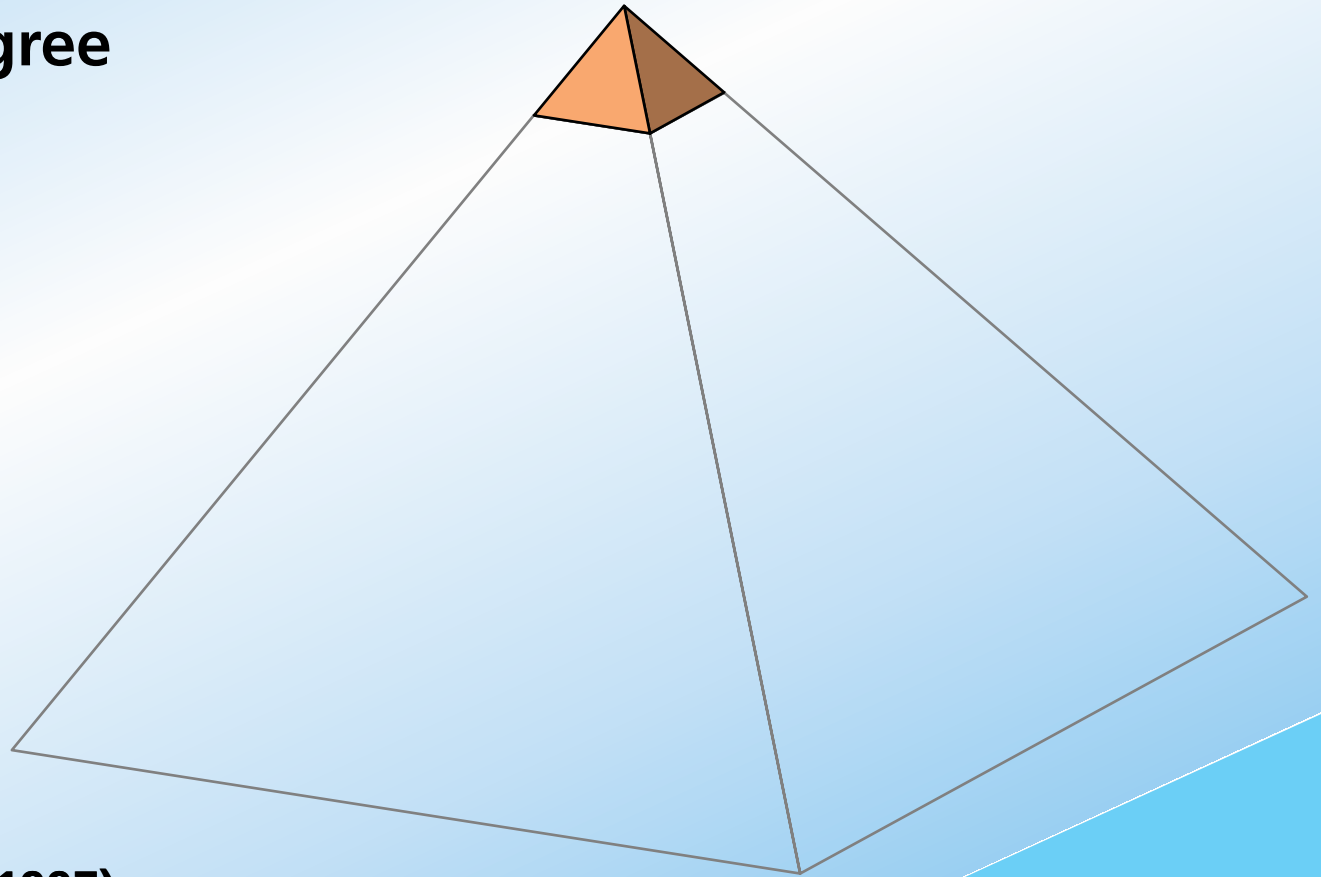
We have a problem

**about 1% of these get
a bachelor's degree
in physics**



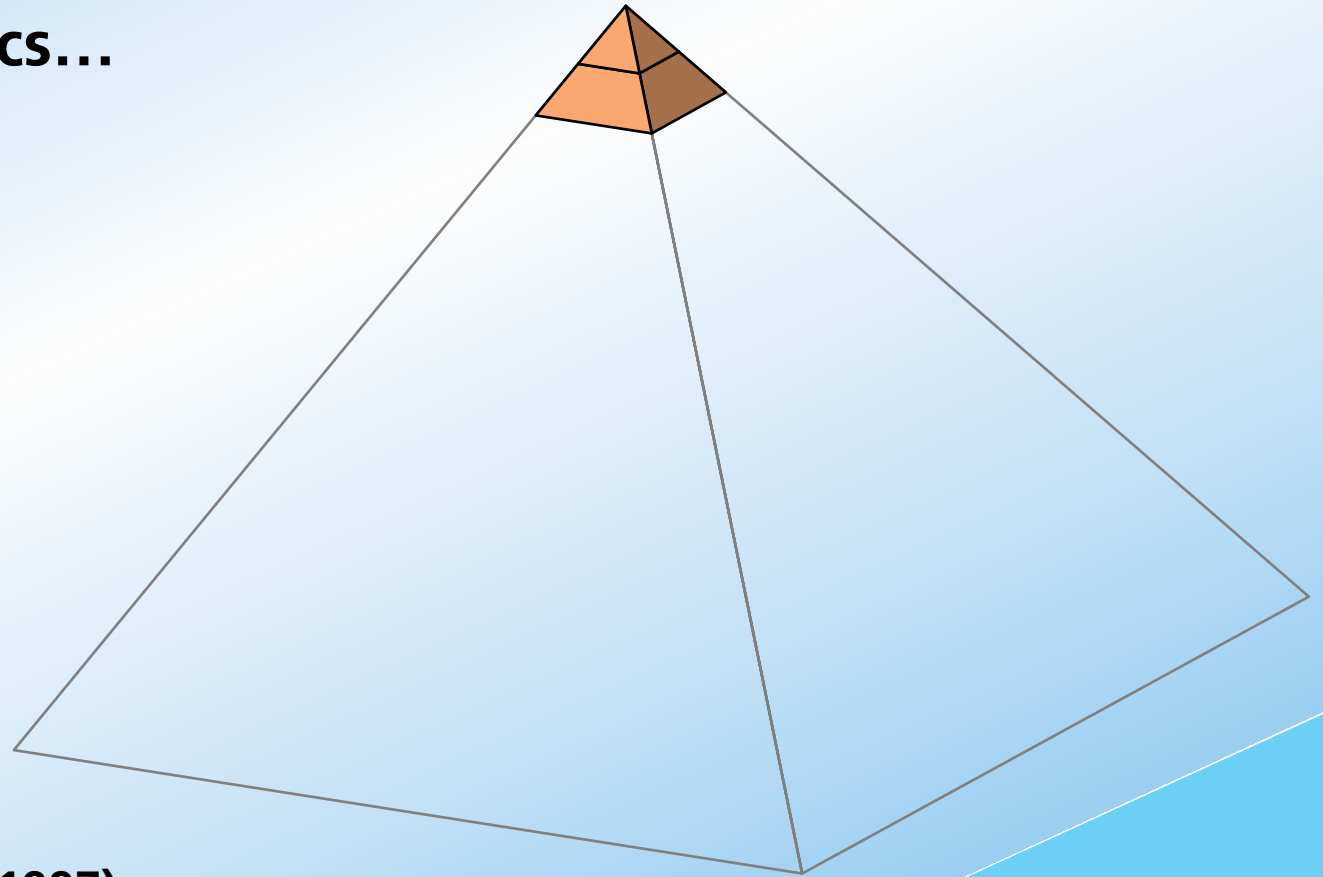
We have a problem

**Of the 4,300 students with
a bachelor's degree
in physics...**



We have a problem

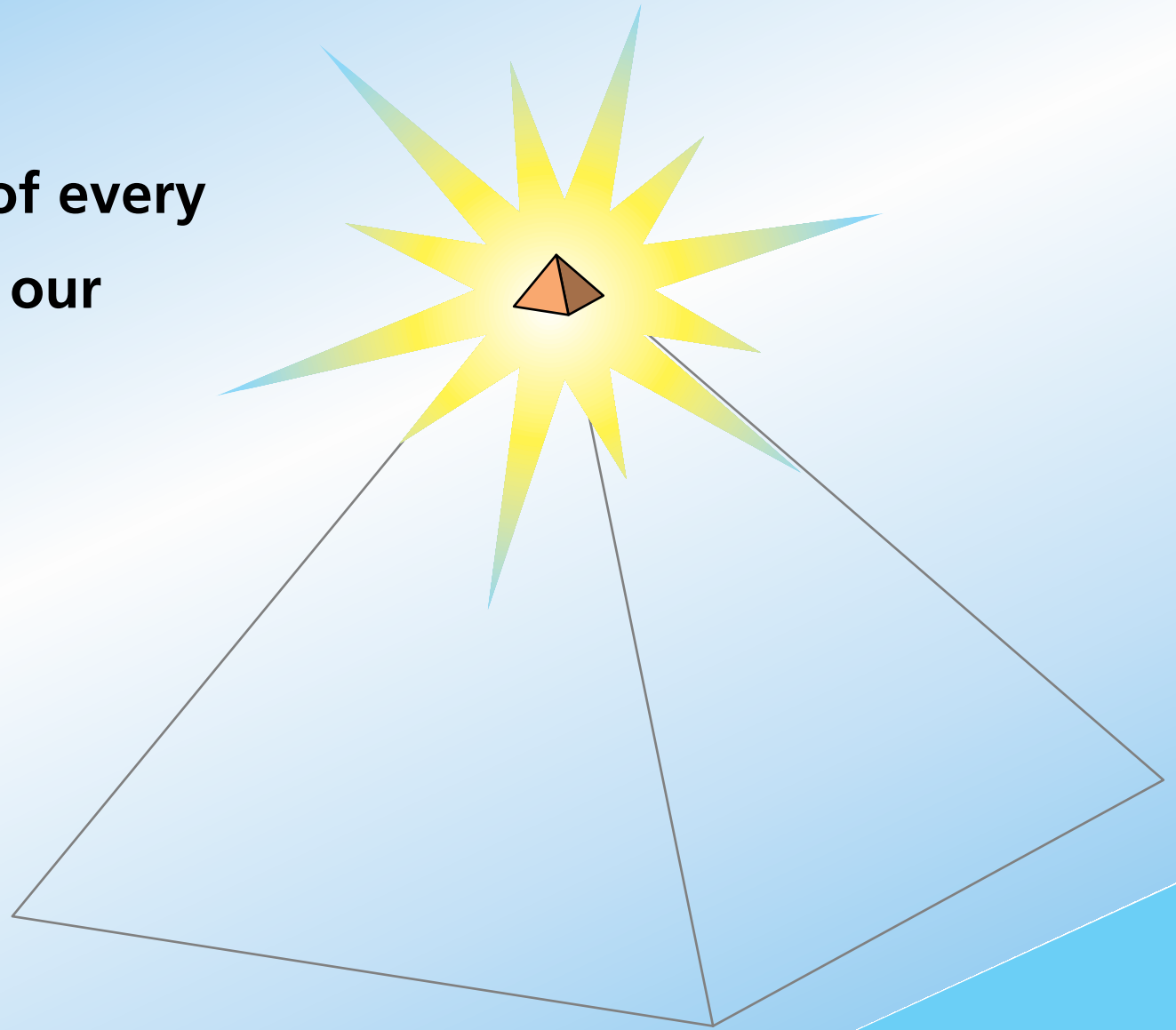
**about 35% go on to get a graduate
degree in physics...**



AIP Report R-151.33 (1997)

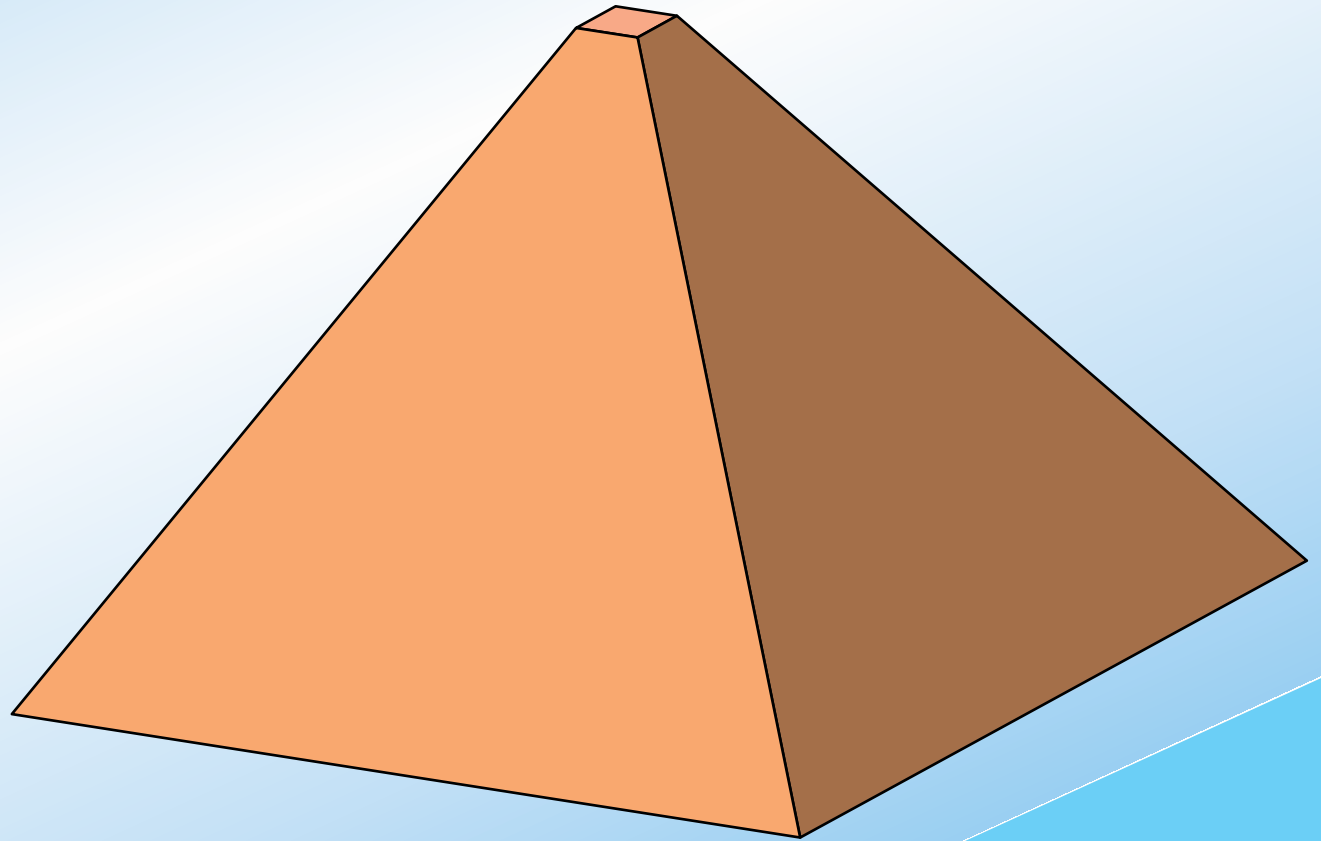
We have a problem

**That's one out of every
260 students in our
introductory
courses!**



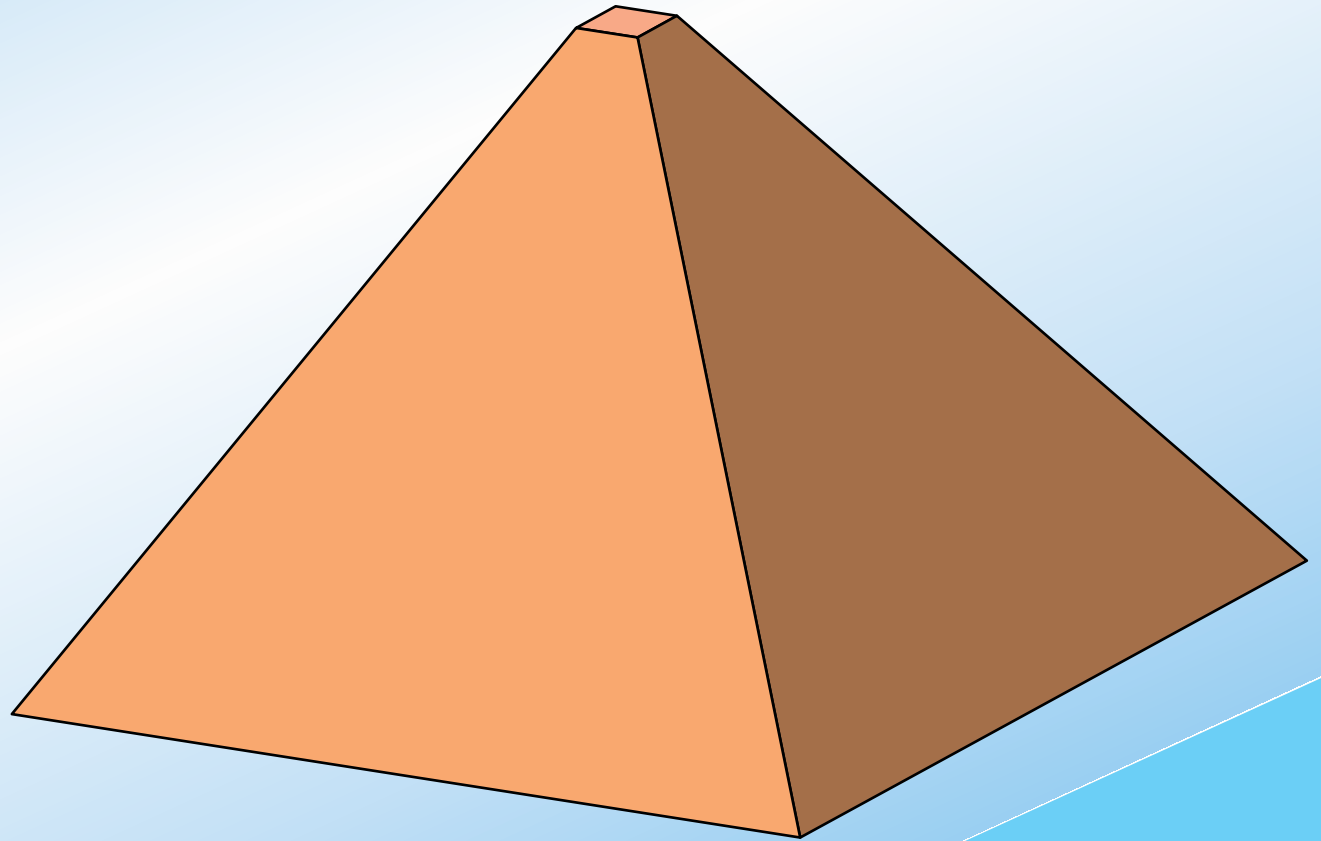
We have a problem

**What about the
other 259...?**



We have a problem

**What do we know
about these
students?**



We have a problem

Some disturbing symptoms:

- ▶ **frustration**
- ▶ **lack of understanding**
- ▶ **lack of basic knowledge**

We have a problem

They know the jargon:

- ▶ **circular motion**
- ▶ **barometric pressure**
- ▶ **light radius**
- ▶ **something to the power times ten to the something**

We have a problem

They are aware of their lack of knowledge

- ▶ **I graduated from college but I didn't study *astronomy***
- ▶ **It's been a while since I've had physics**

We have a problem

They are aware of their lack of knowledge

- ▶ **I graduated from college but I didn't study *astronomy***
- ▶ **It's been a while since I've had physics**

...and they don't care!

We have a problem



We have a problem



**Math suks (math suks),
Math suks (math suks)
I'd like to burn this text book
I hate that stuff so much
Math suks (math suks),
Math suks (math suks)**

**Jimmy Buffett
on *Beach House on the Moon***

We have a problem



I don't know and I don't care

**Another song by Jimmy Buffett
on *Beach House on the Moon***



Why do we have this problem?

Why do we have this problem?

What are our three most important objectives?

Why do we have this problem?

What are our three most important objectives?

- ▶ **excellence in research**

Why do we have this problem?

What are our three most important objectives?

- ▶ **excellence in research**
- ▶ **excellence in teaching**

Why do we have this problem?

What are our three most important objectives?

- ▶ **excellence in research**
- ▶ **excellence in teaching**
- ▶ **education of graduate students**

Why do we have this problem?

What are our three most important objectives?

- ▶ **excellence in research**
- ▶ **excellence in teaching**
- ▶ **education of graduate students**
- ▶ **education of undergraduates**

Why do we have this problem?

What are our three most important objectives?

- ▶ **excellence in research**
- ▶ **excellence in teaching**
- ▶ **education of graduate students**
- ▶ **education of undergraduates**
- ▶ **education of non-majors**

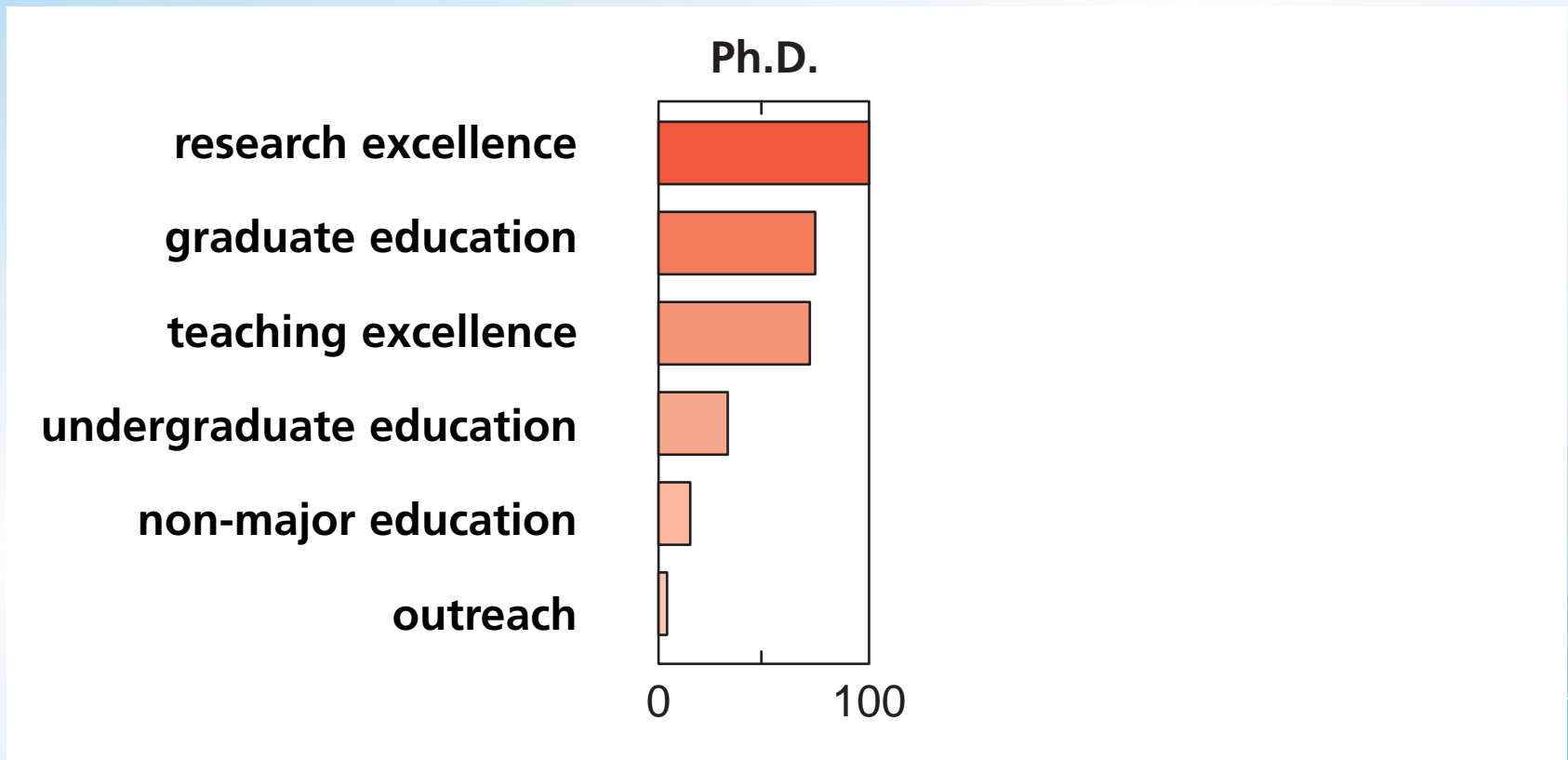
Why do we have this problem?

What are our three most important objectives?

- ▶ **excellence in research**
- ▶ **excellence in teaching**
- ▶ **education of graduate students**
- ▶ **education of undergraduates**
- ▶ **education of non-majors**
- ▶ **outreach**

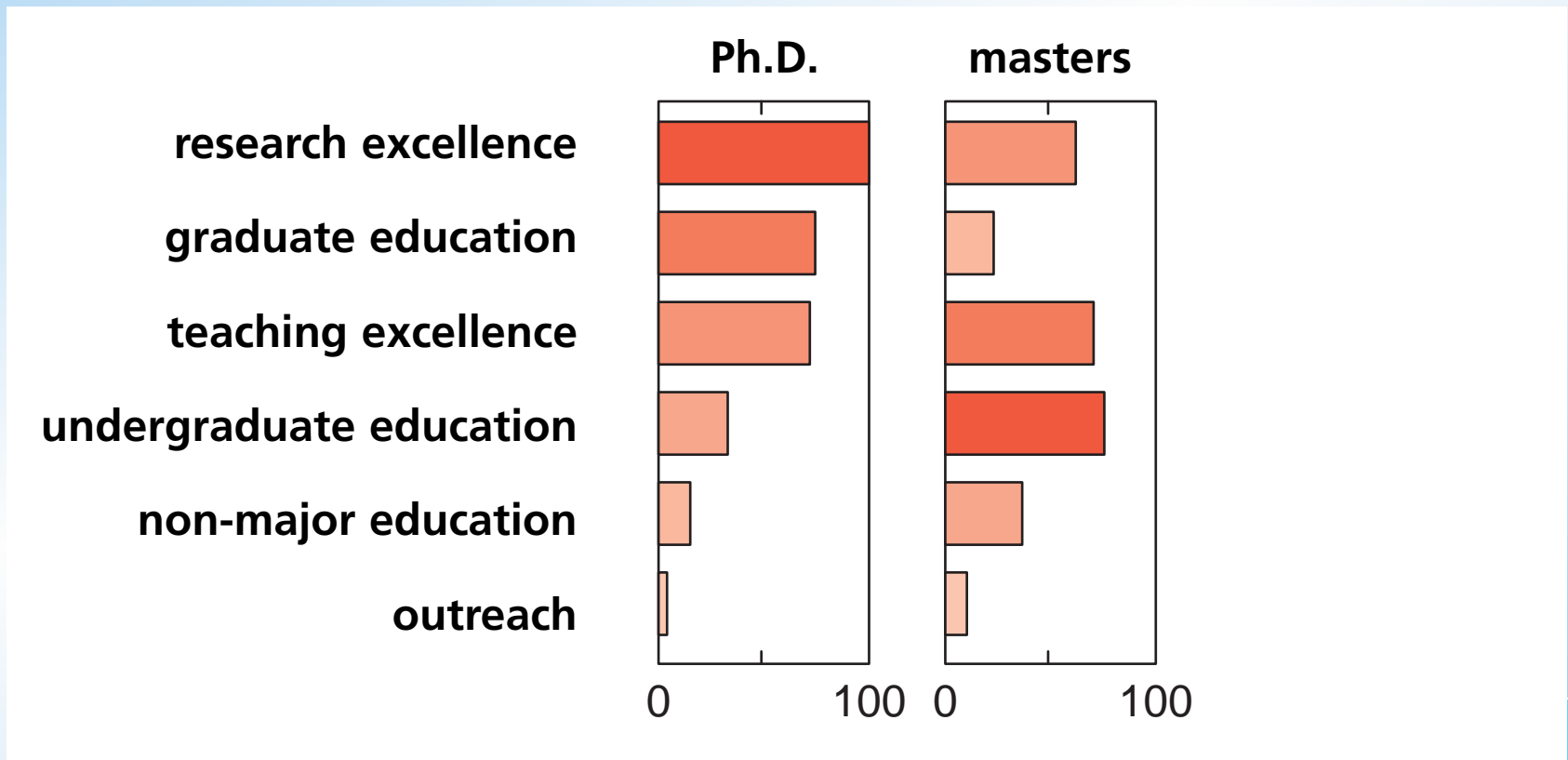
Why do we have this problem?

What are our three most important objectives?



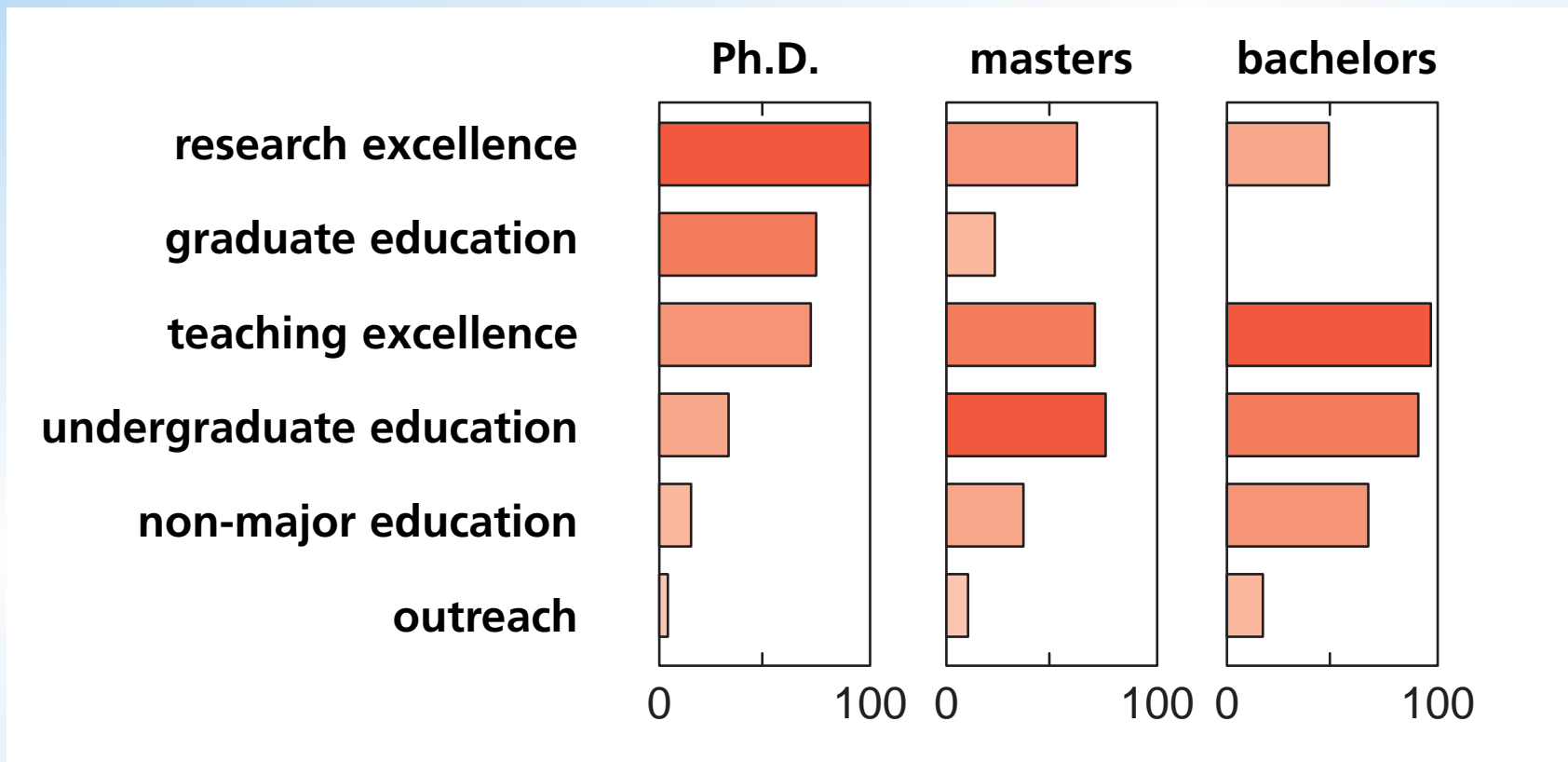
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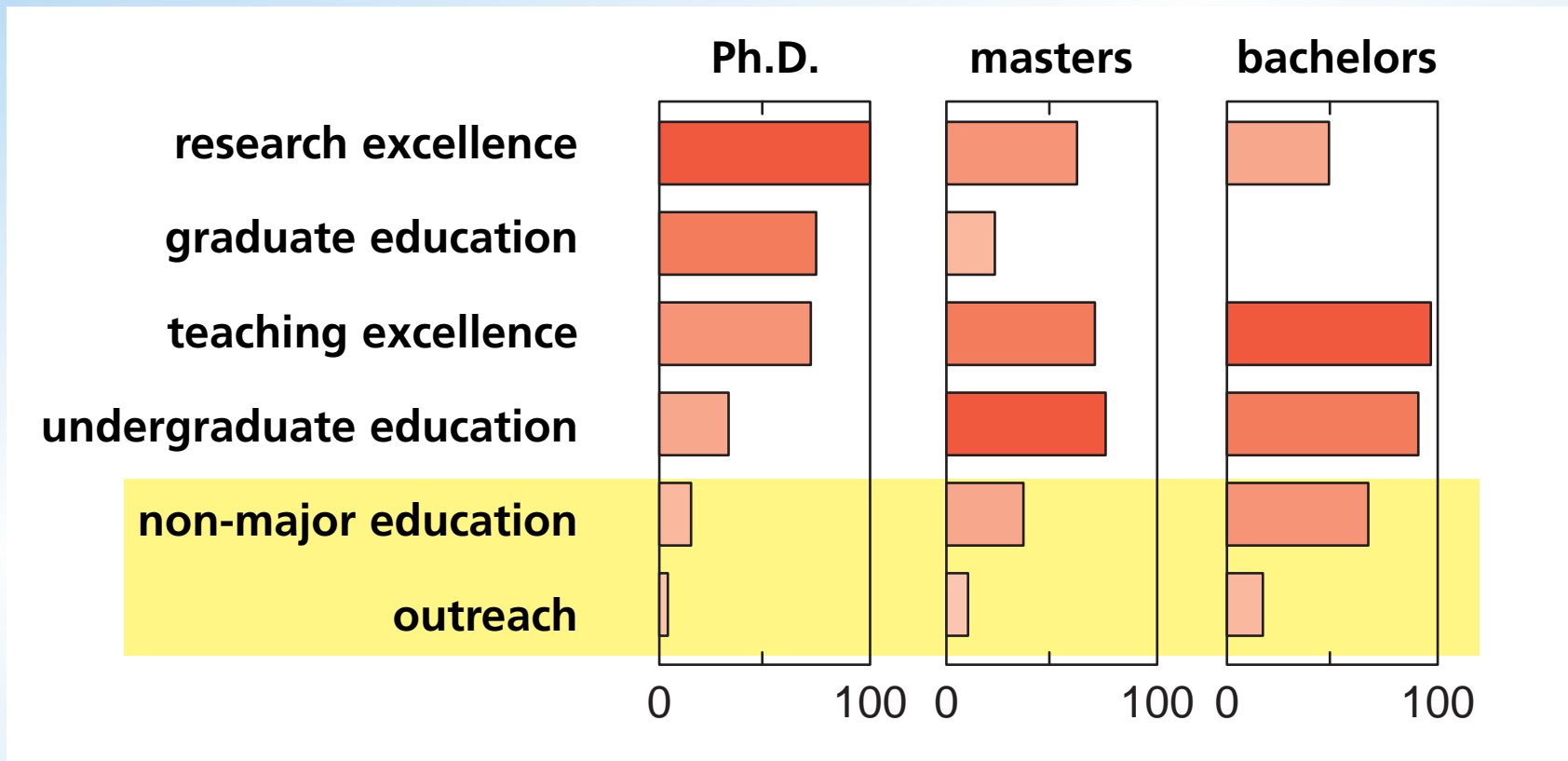
Why do we have this problem?

What are our three most important objectives?



Why do we have this problem?

What are our three most important objectives?



Why do we have this problem?

- ▶ **Lectures focus on transfer of information...**

Why do we have this problem?

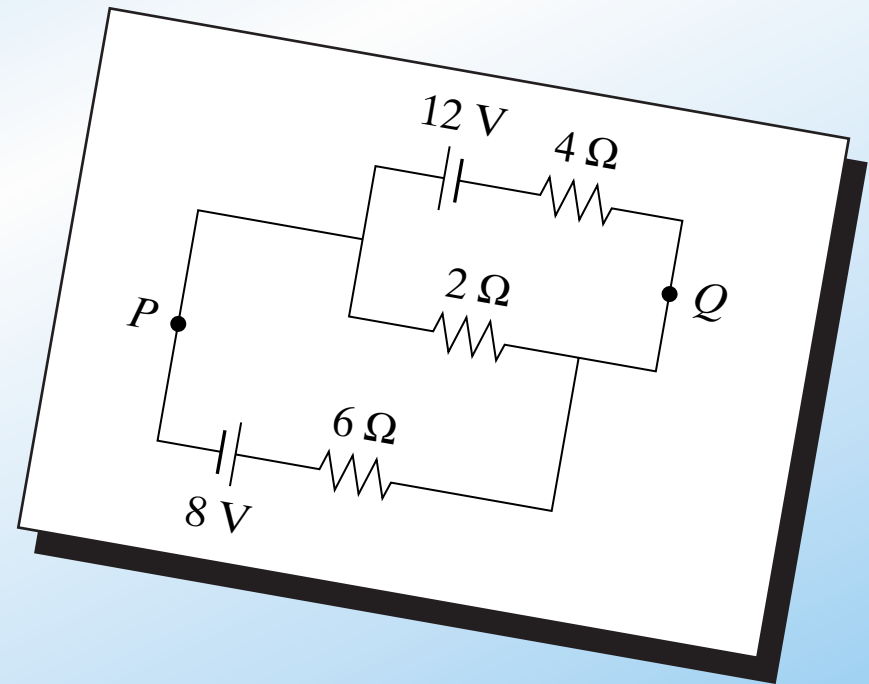
- ▶ **Lectures focus on transfer of information...**
(but education is more than information)

Why do we have this problem?

- ▶ **Lectures focus on transfer of information...
(but education is more than information)**
- ▶ **Conventional problems reinforce bad study habits**

Why do we have this problem?

Conventional problems reinforce bad study habits

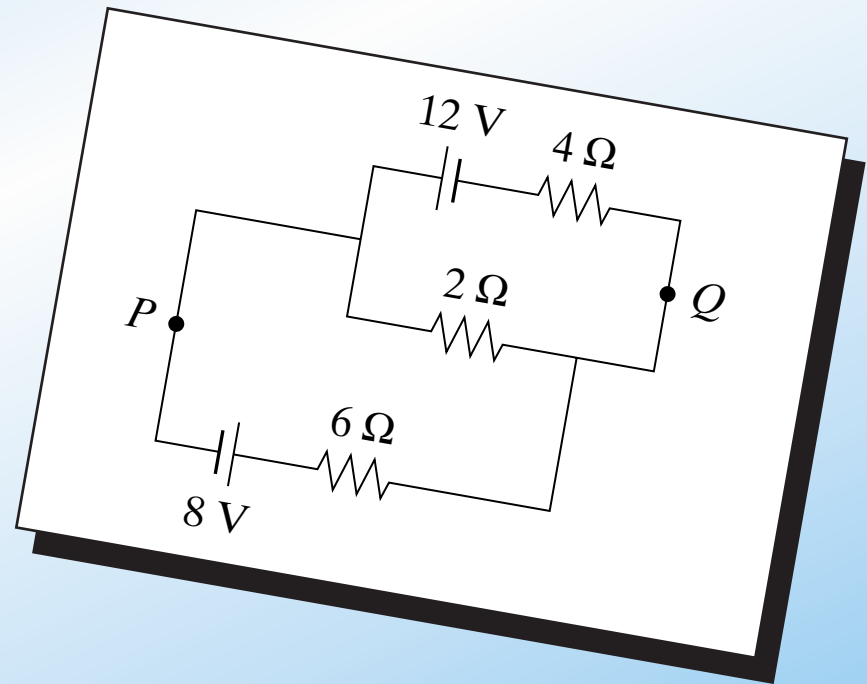


Why do we have this problem?

Conventional problems reinforce bad study habits

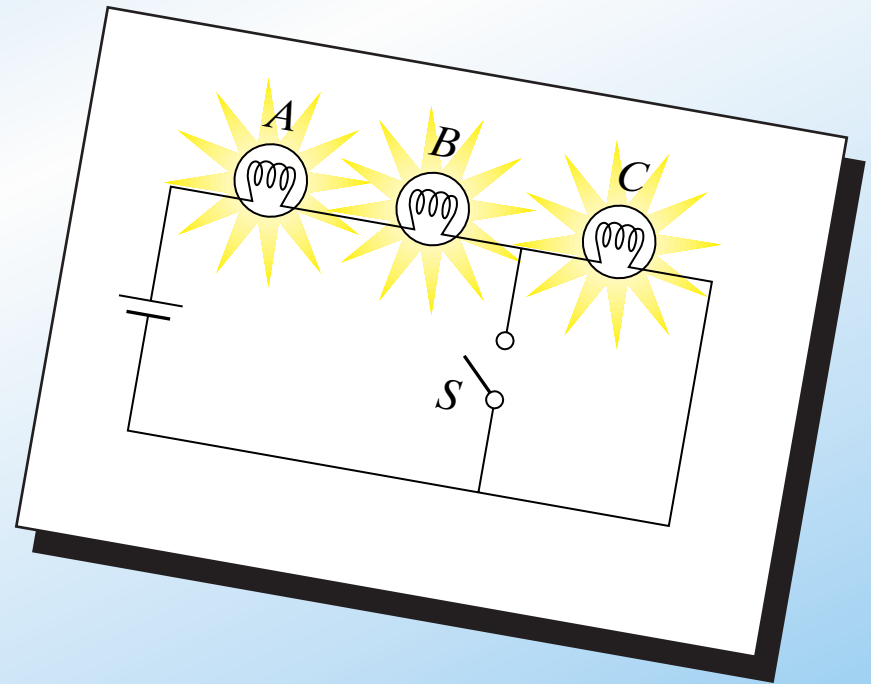
Calculate:

- (a) the current in the $2\text{-}\Omega$ resistor, and
- (b) the potential difference between points P and Q



Why do we have this problem?

Are basic principles understood?

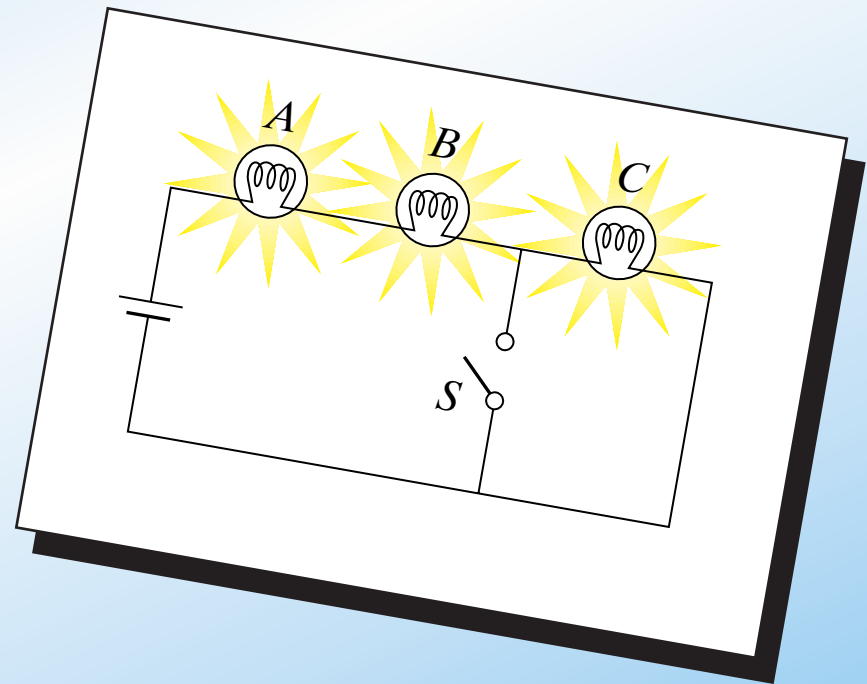


Why do we have this problem?

Are basic principles understood?

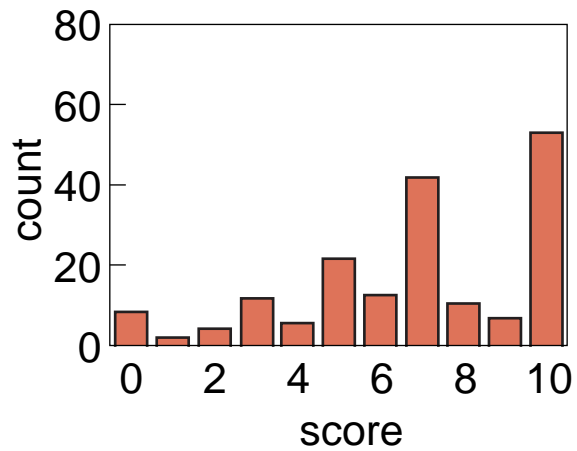
When S is closed, what happens to the:

- (a) intensities of A and B ?
- (b) intensity of C ?
- (c) current through battery?
- (d) voltage drop across A , B , and C ?
- (e) total power dissipated?

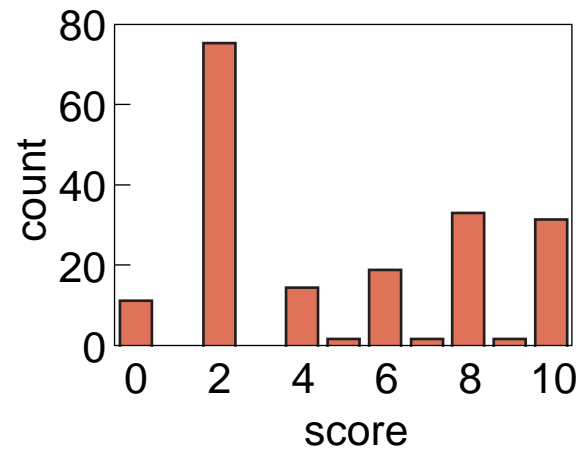


Why do we have this problem?

conventional

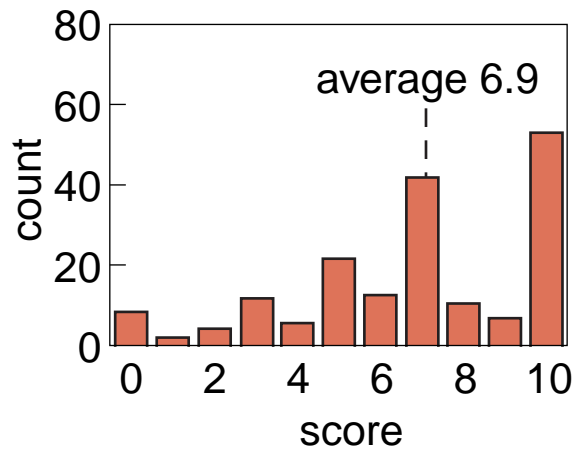


conceptual

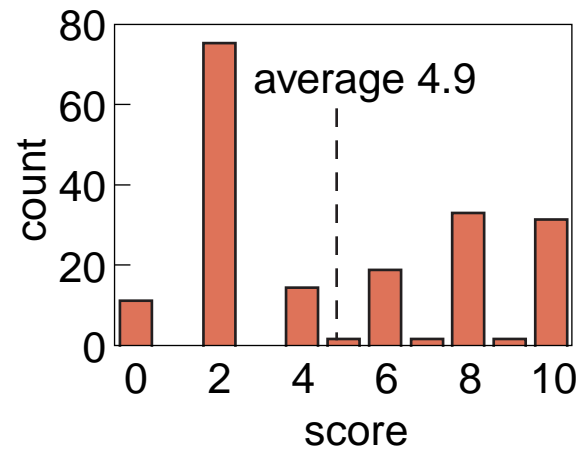


Why do we have this problem?

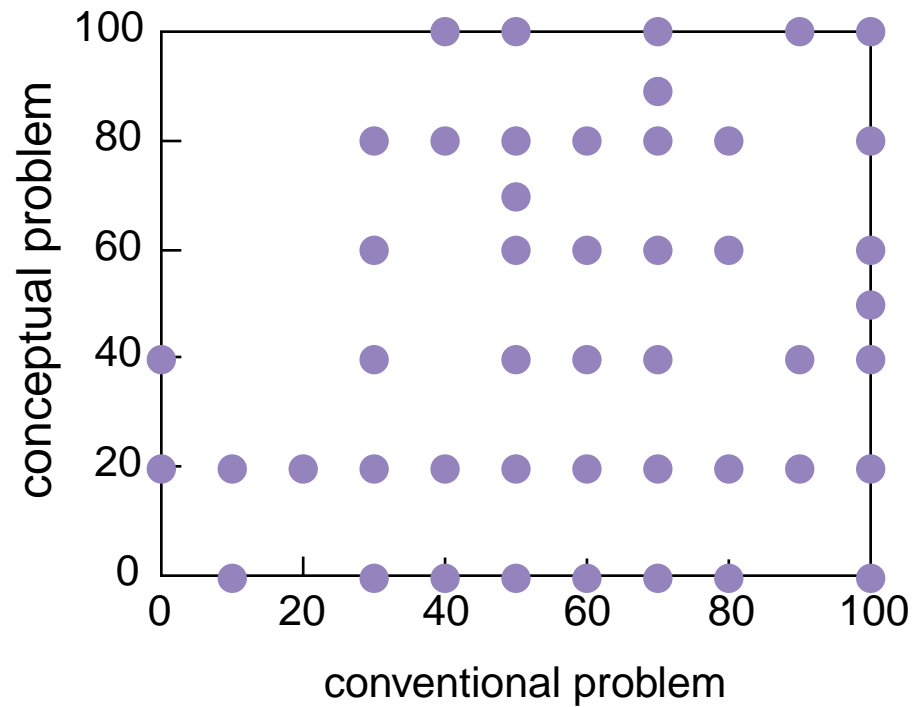
conventional



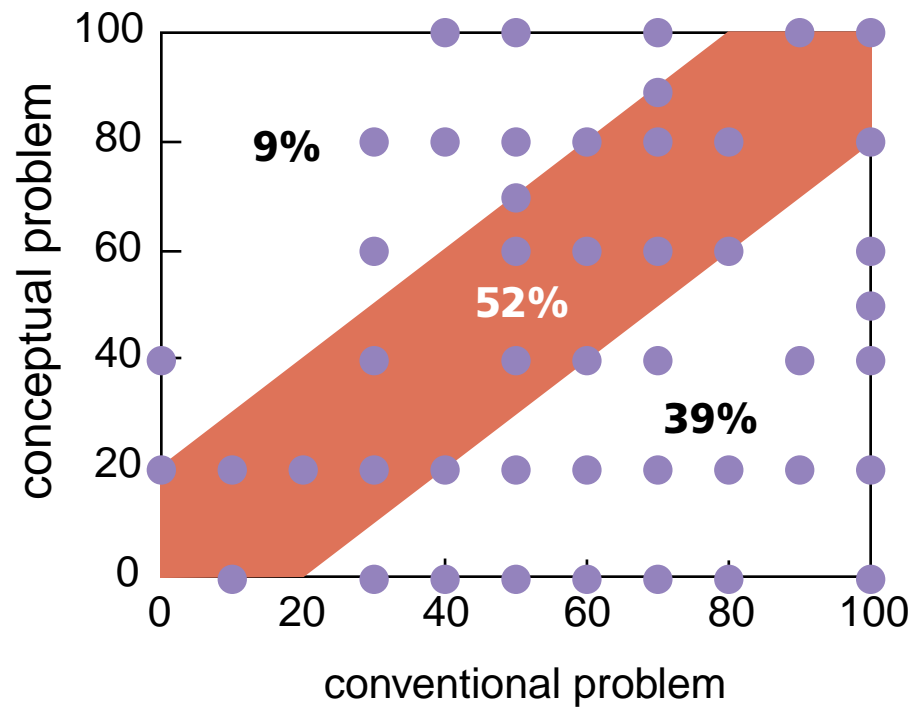
conceptual



Why do we have this problem?



Why do we have this problem?

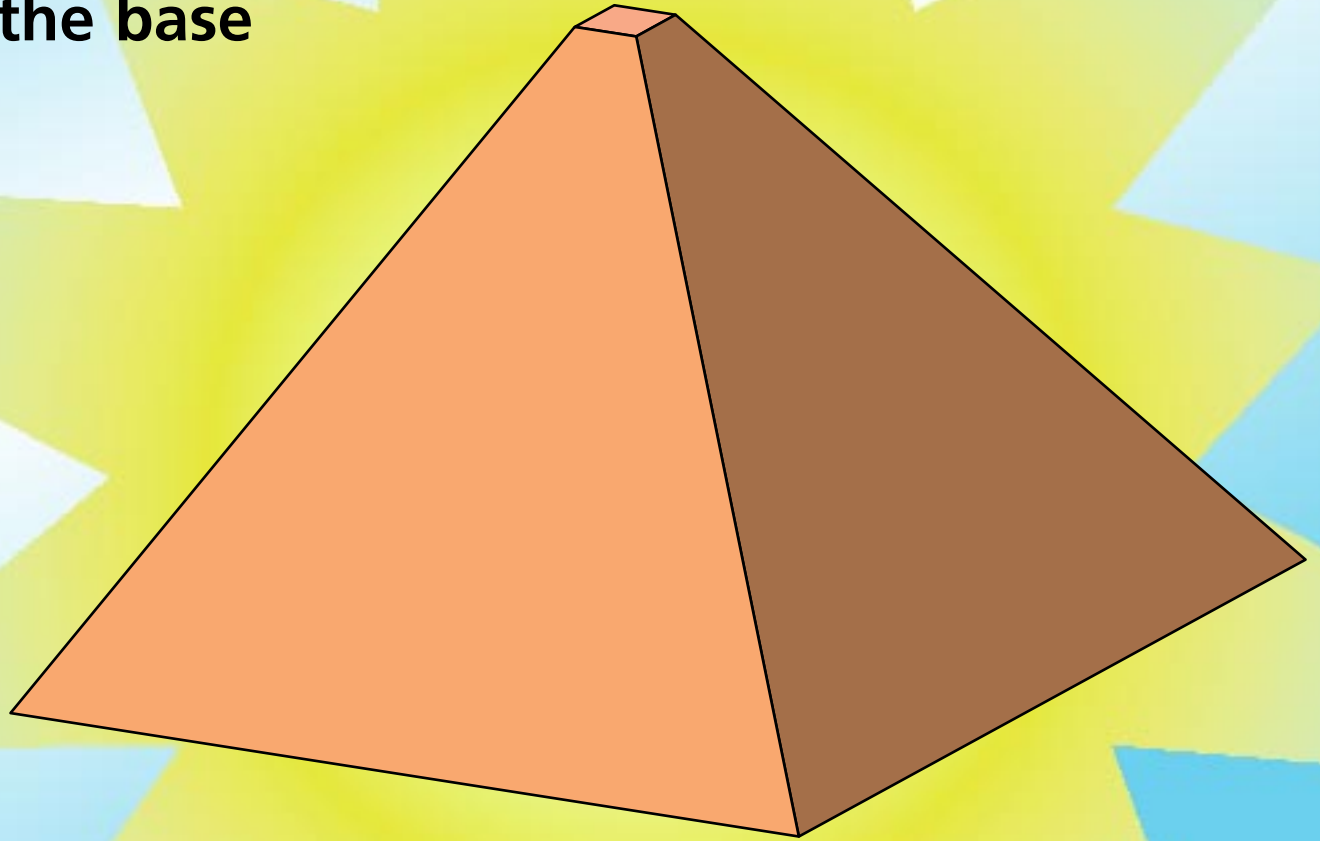




So what should we do?

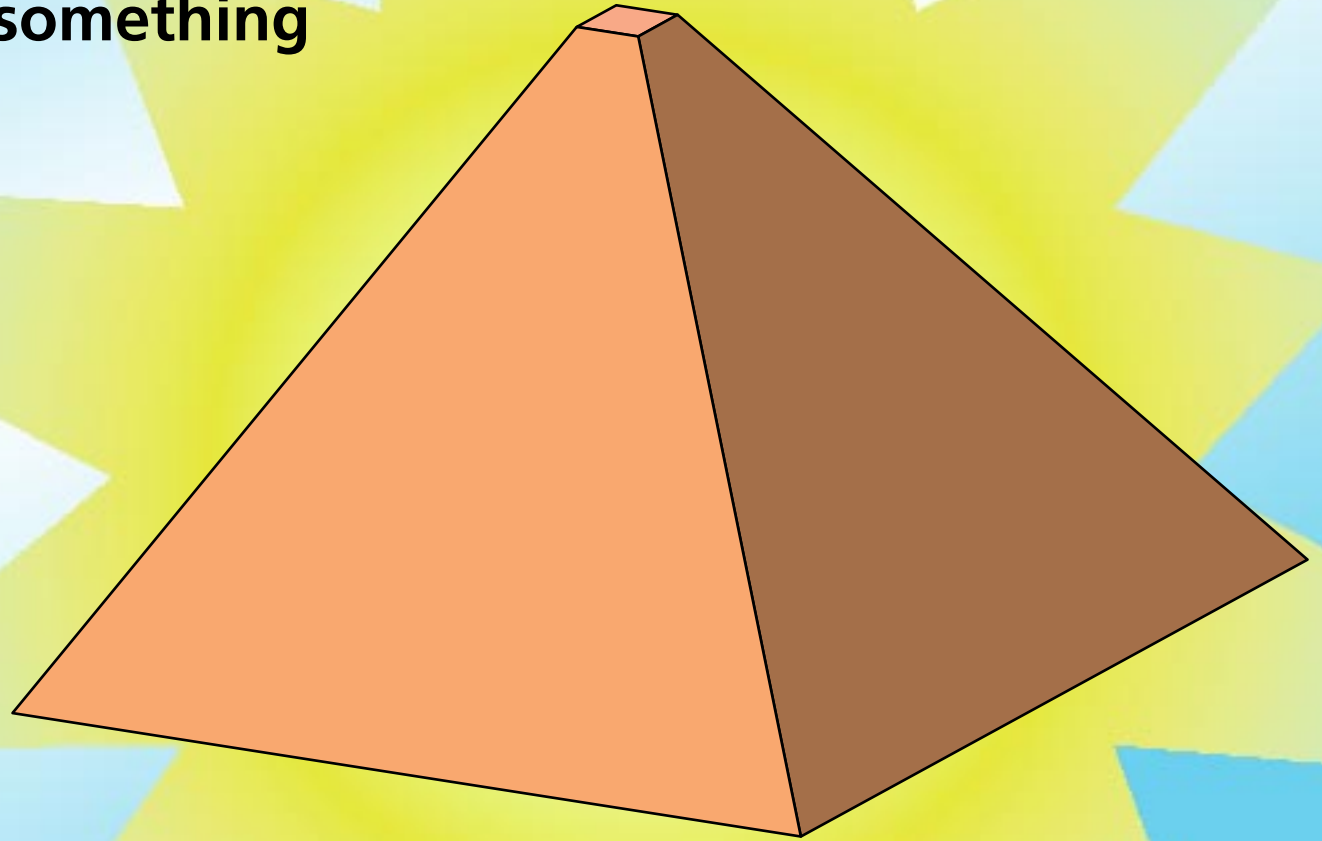
Conclusion

**Let's not forget the base
of the pyramid!**



Conclusion

**Let's give them something
of value!**



Conclusion

Rewards:

- ▶ **engagement**
- ▶ **improved understanding**
- ▶ **class is fun!**

Conclusion

**Let's integrate research and education for our
future scientists**

- **mentor UG in research**
- **involve all (GS and UG) in education**

Conclusion

Challenges:

- ▶ **internal skepticism**
- ▶ **growing pains**
- ▶ **limited circle of influence**

Funding

National Science Foundation

**For a copy of this talk and
additional information:**

<http://mazur-www.harvard.edu>