

MEMORIZATION OR UNDERSTANDING: ARE WE TEACHING THE RIGHT THING?

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Harvard University**

**1999 CSSP Awards Banquet
Washington, DC
5 December 1999**



Executive Summary

Education must adapt to a changing world

Executive Summary

The goals of education remain the same:

Executive Summary

**The goals of education remain the same:
transfer knowledge and develop skills...**

Executive Summary

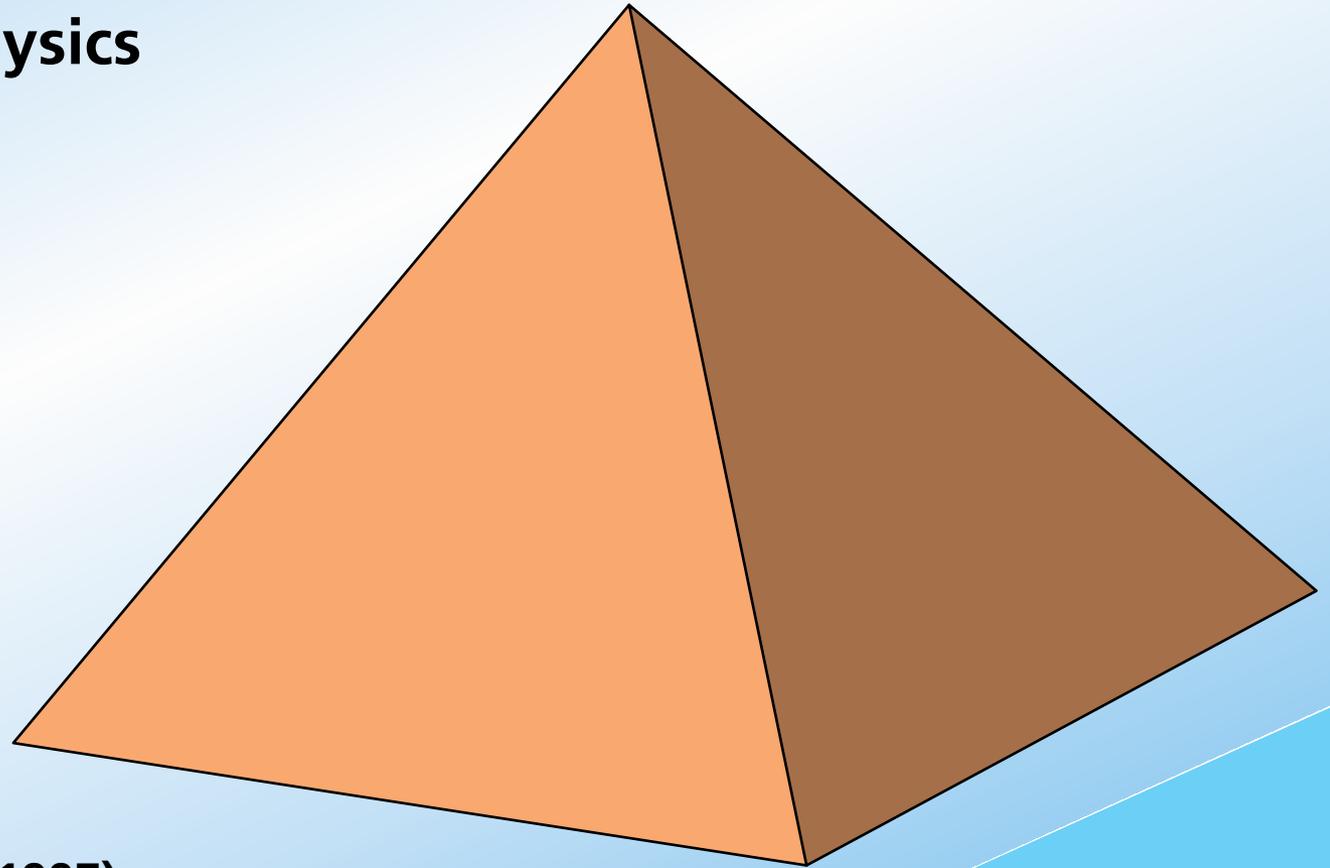
...but the modern workplace requires new skills

Executive Summary

- ▶ **thinking skills**
- ▶ **complex problem solving skills**
- ▶ **lifelong learning skills**
- ▶ **interpersonal and teamwork skills**

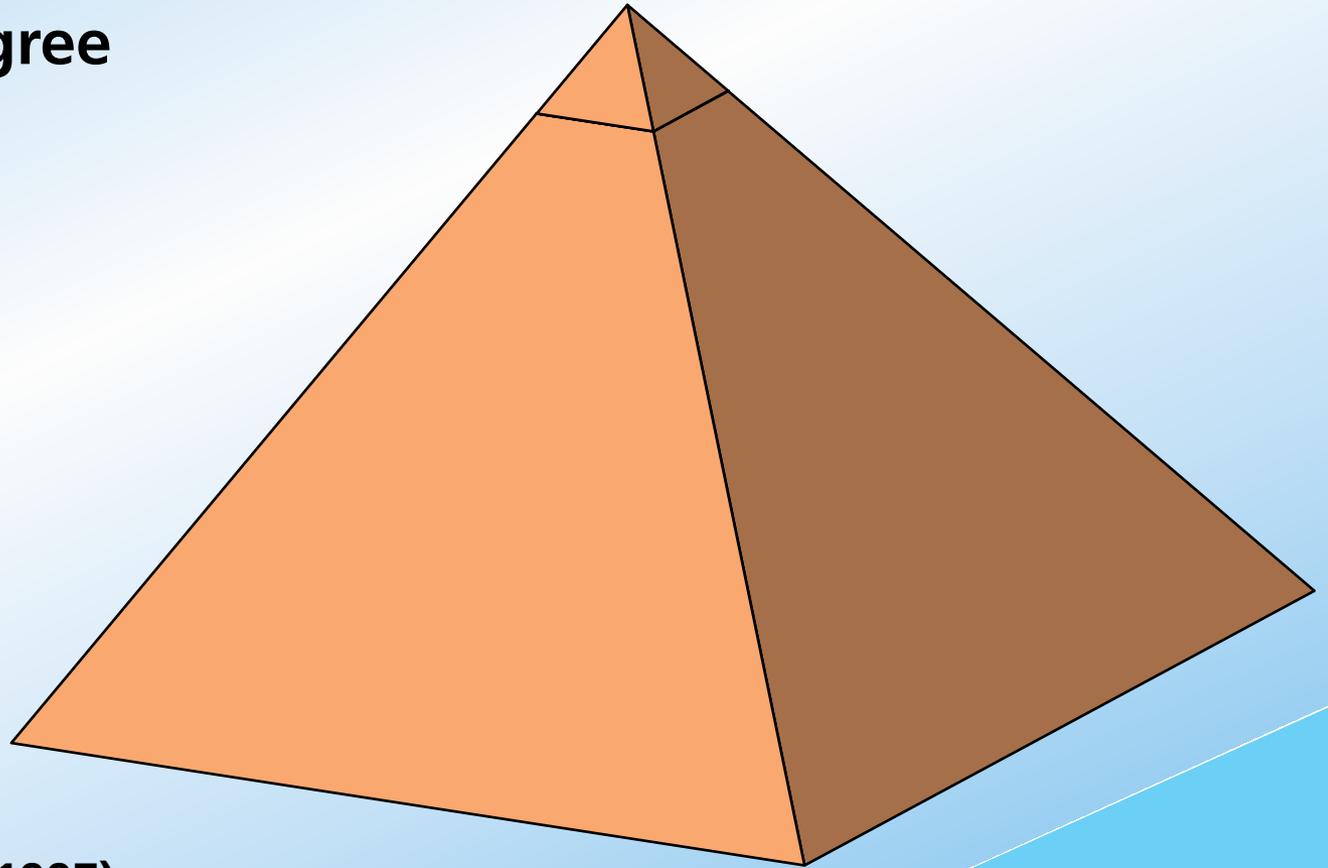
We have a problem

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



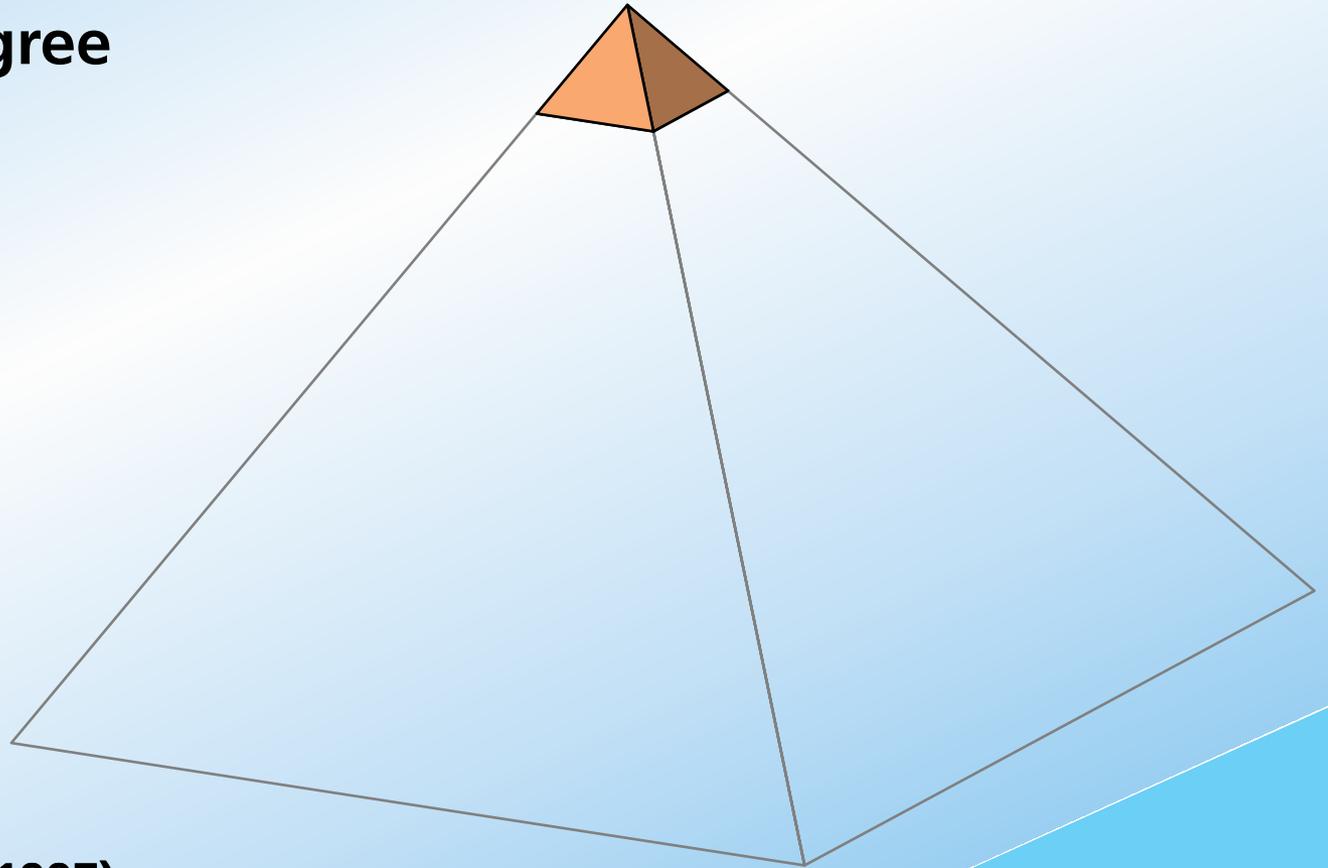
We have a problem

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



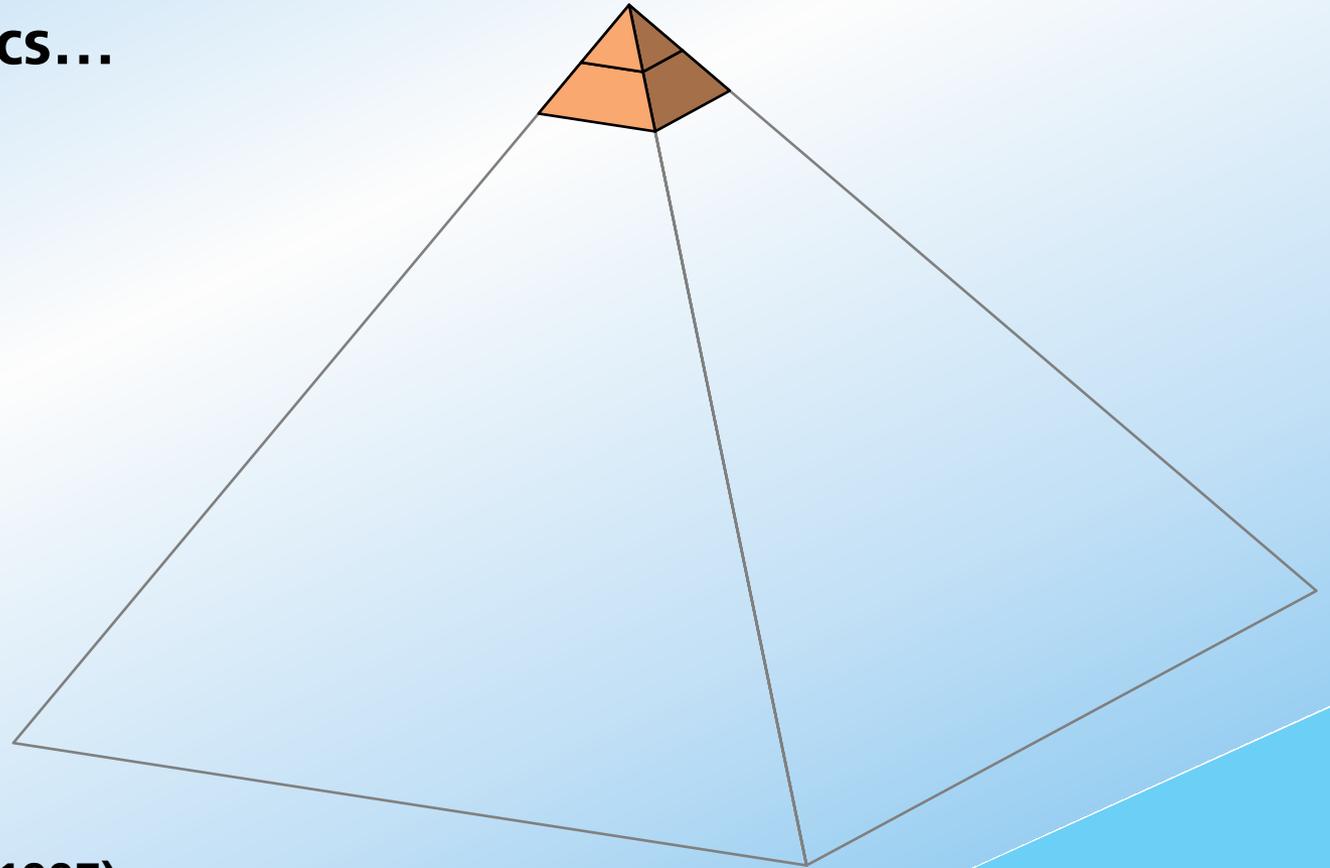
We have a problem

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



We have a problem

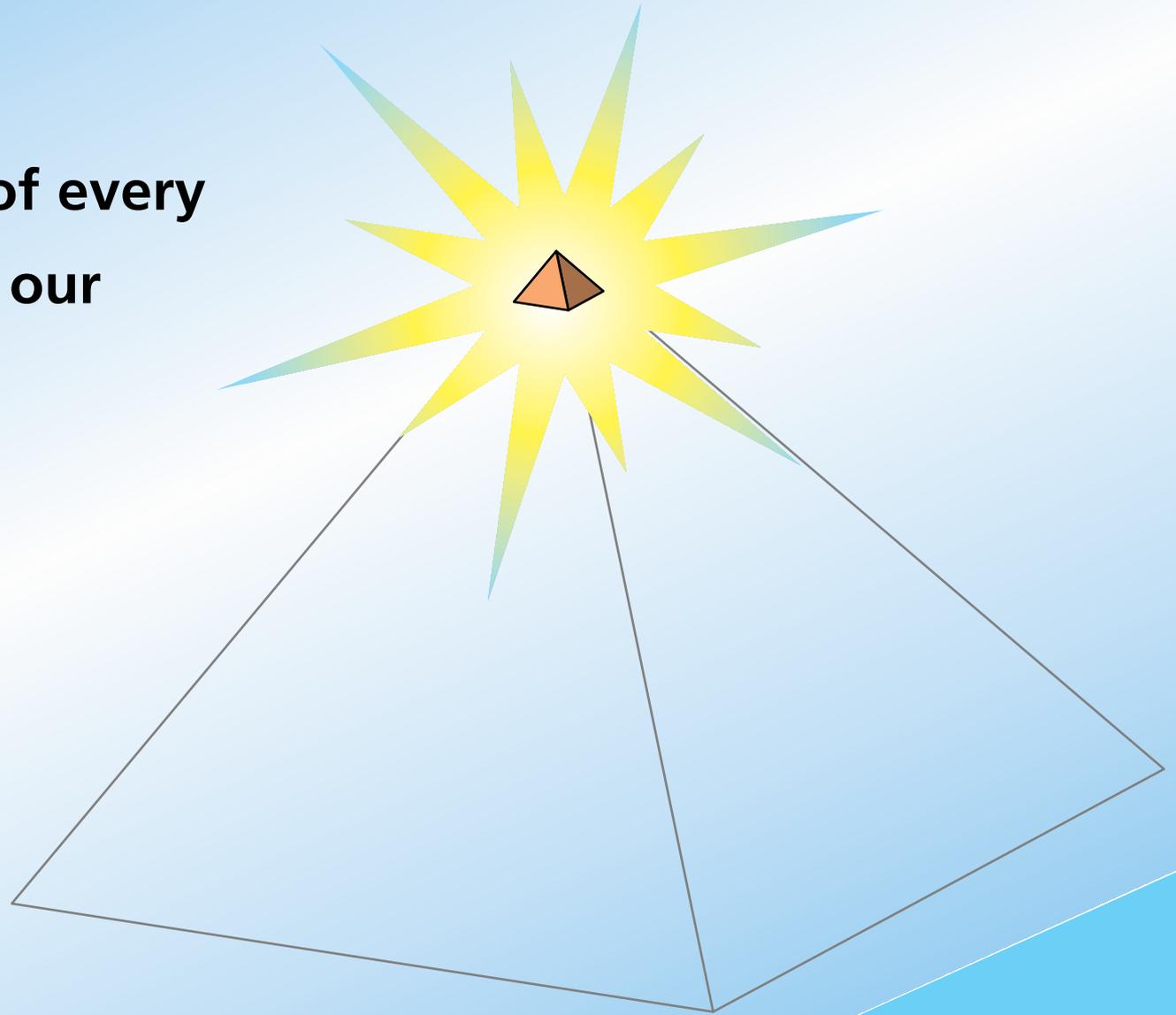
**about 35% go on to get a graduate
degree in physics...**



AIP Report R-151.33 (1997)

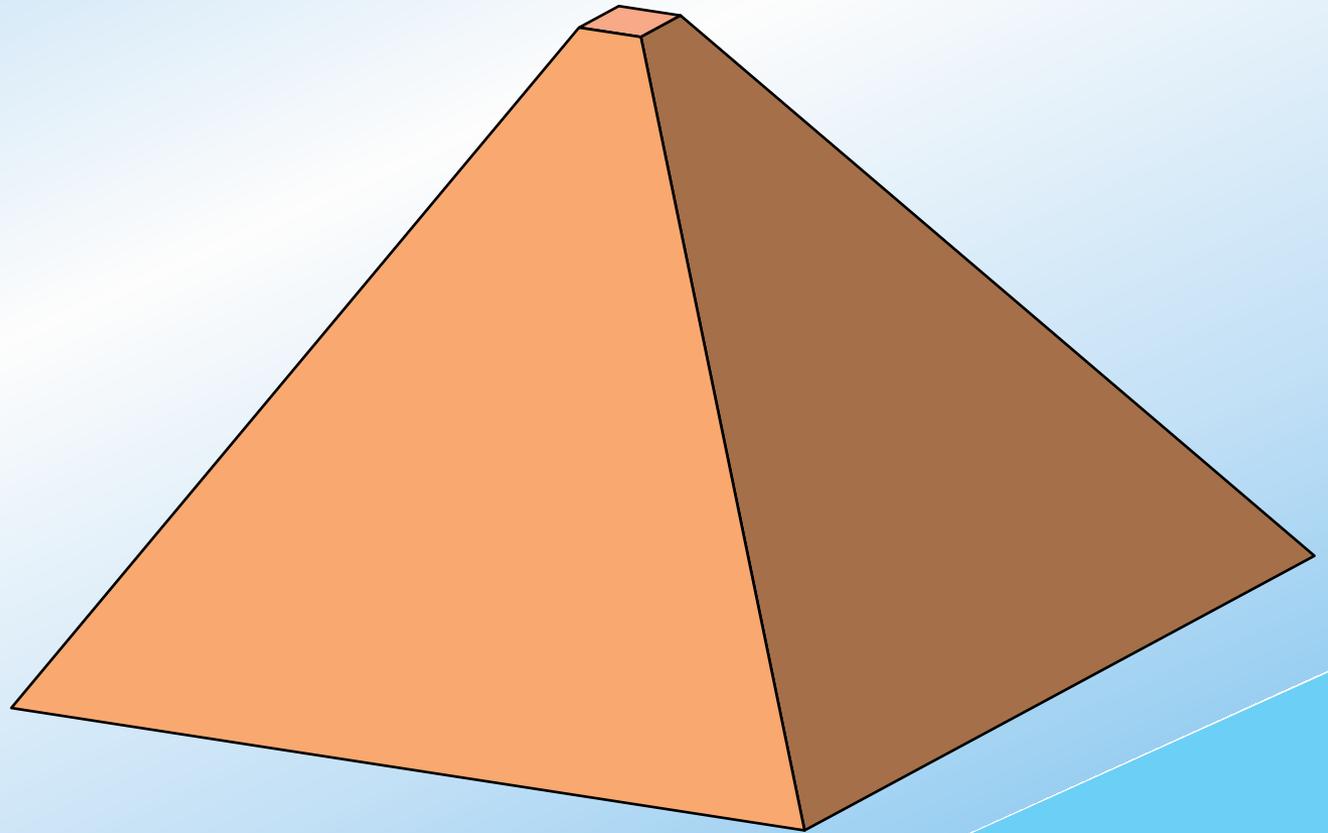
We have a problem

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



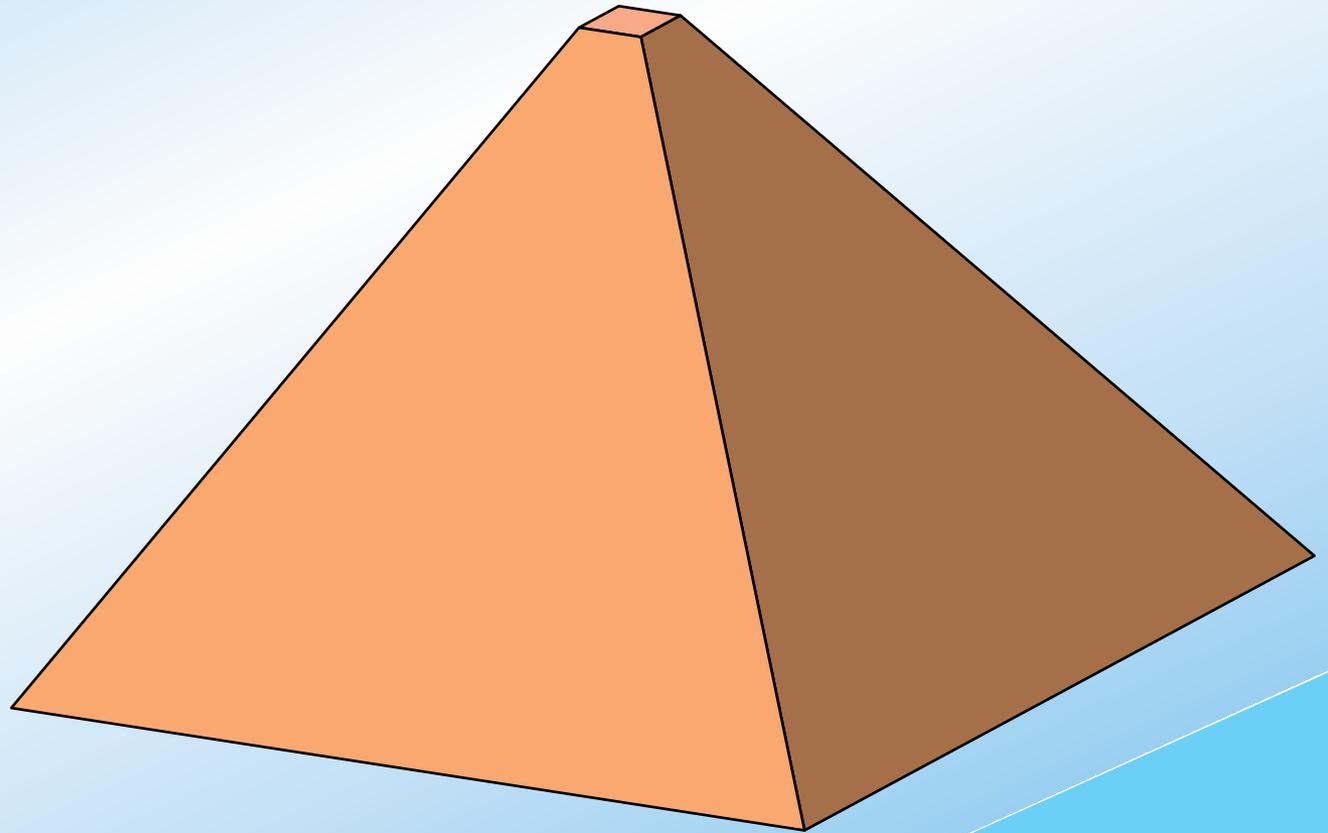
We have a problem

**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

Should we worry?

We have a problem

We'd better!

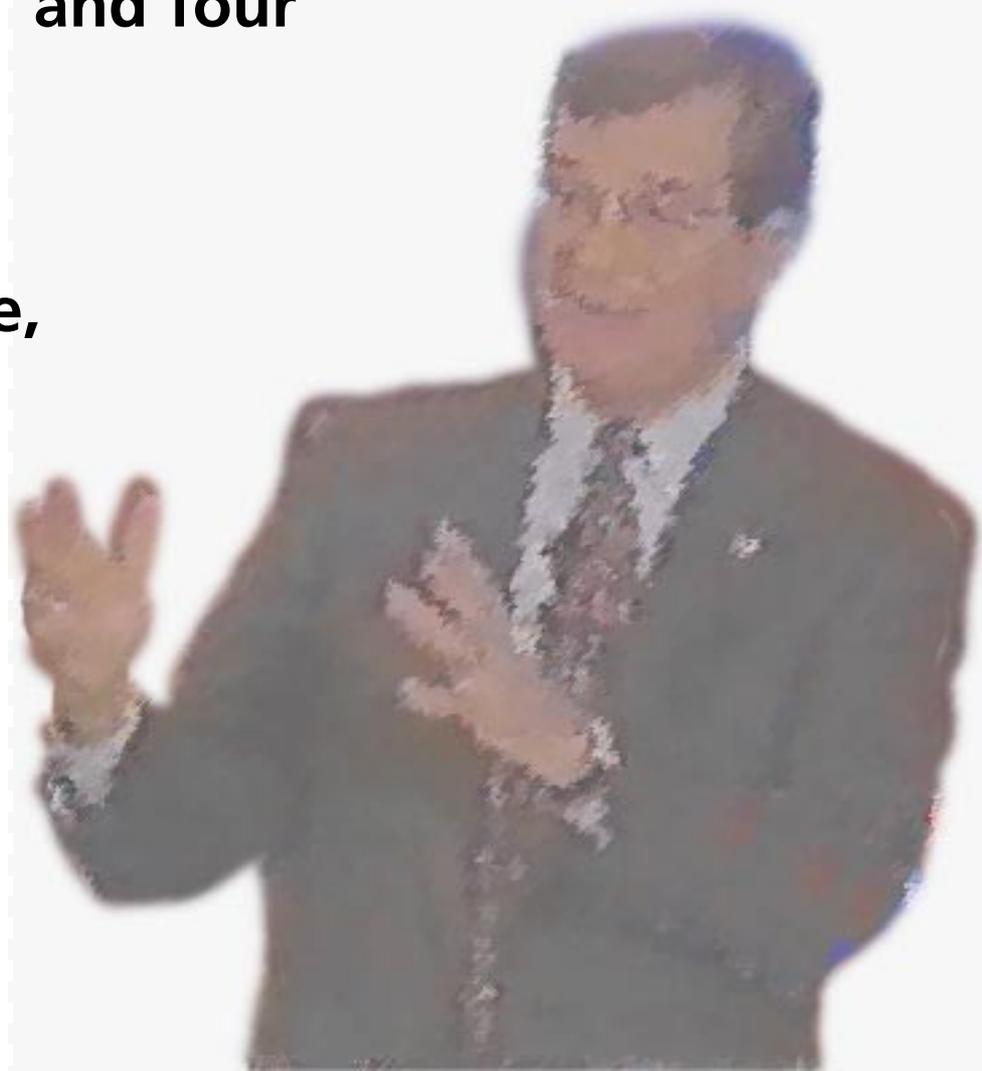
We have a problem

"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?*"





Why do we have this problem?

Why do we have this problem?

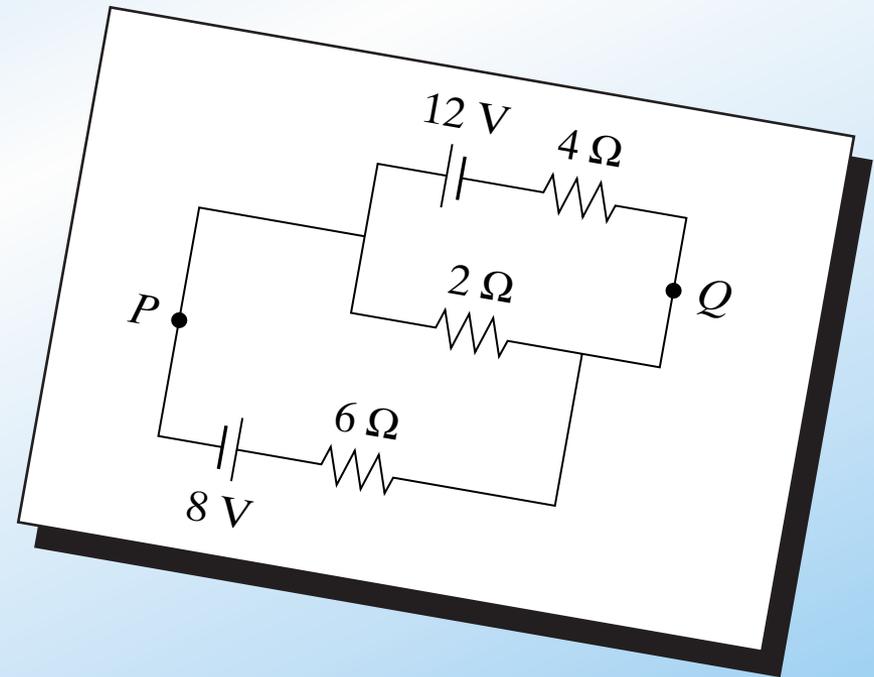
Lectures focus on transfer of information...

Why do we have this problem?

Conventional problems reinforce bad study habits

Why do we have this problem?

Conventional problems reinforce bad study habits

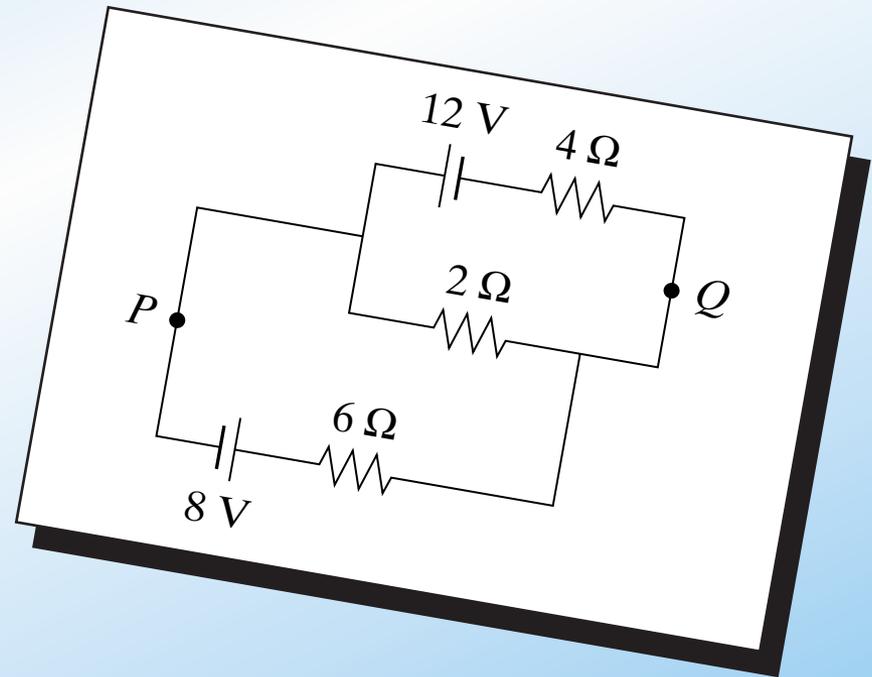


Why do we have this problem?

Conventional problems reinforce bad study habits

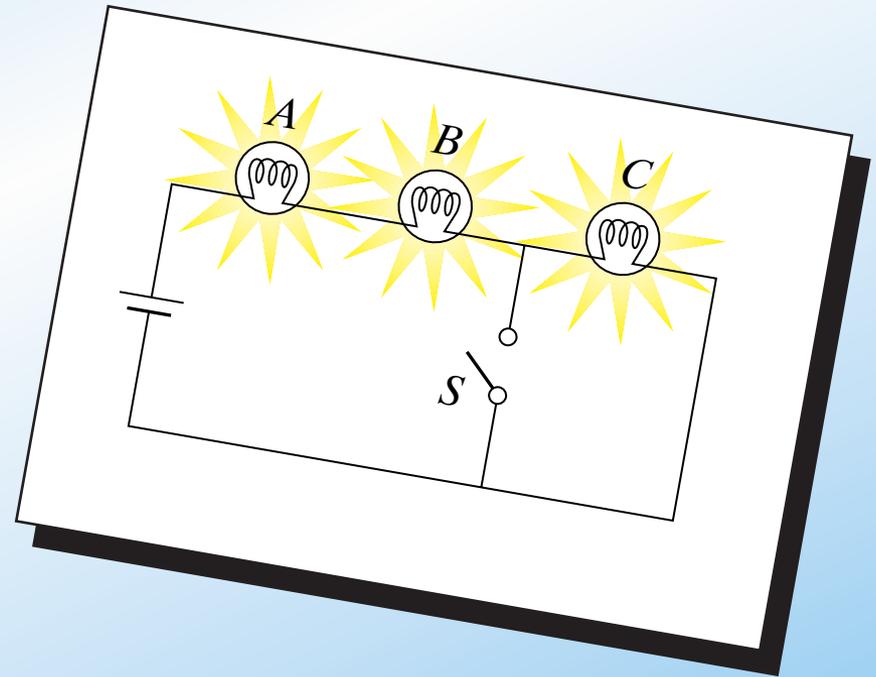
Calculate:

- (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?

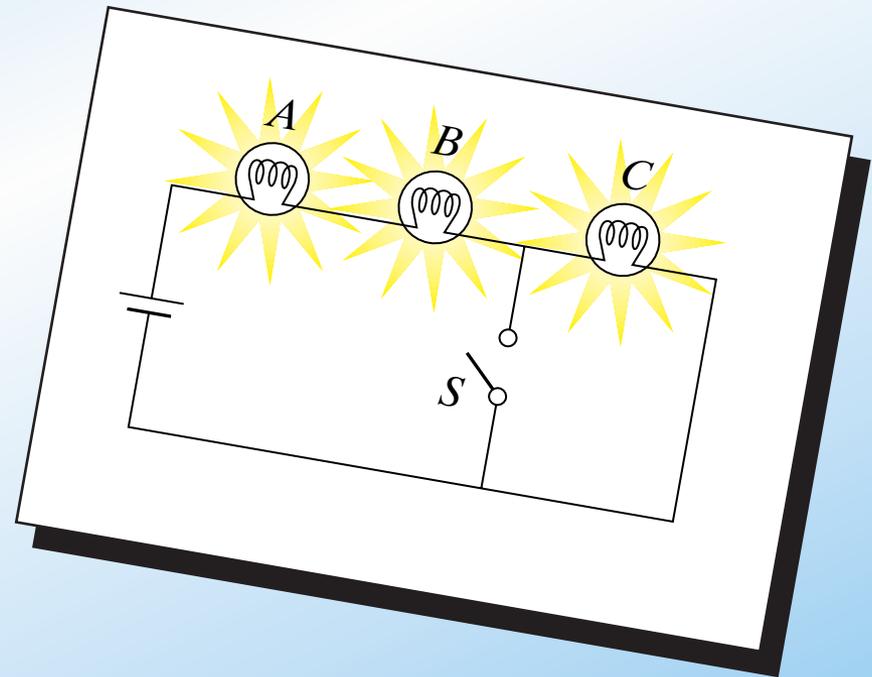


Why do we have this problem?

Are basic principles understood?

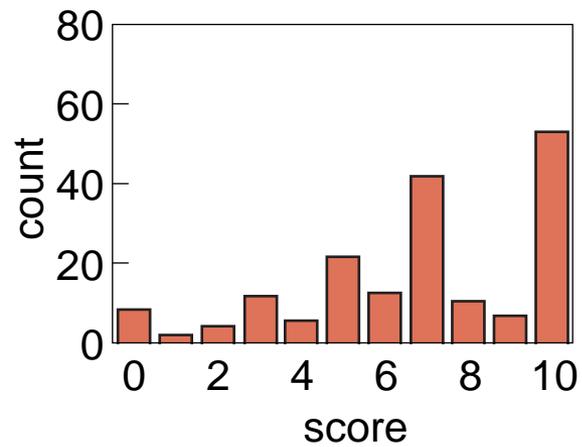
When S is closed, what happens to the:

- (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?

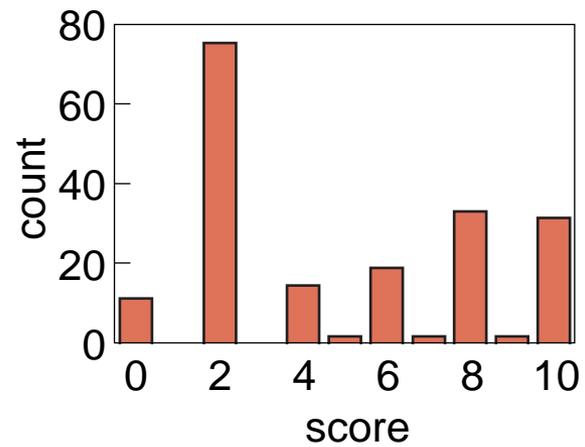


Why do we have this problem?

conventional

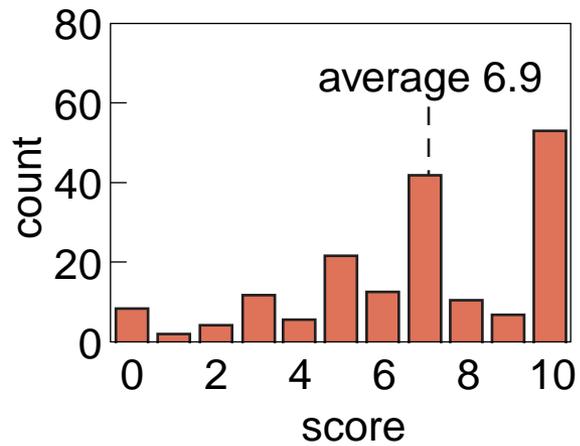


conceptual

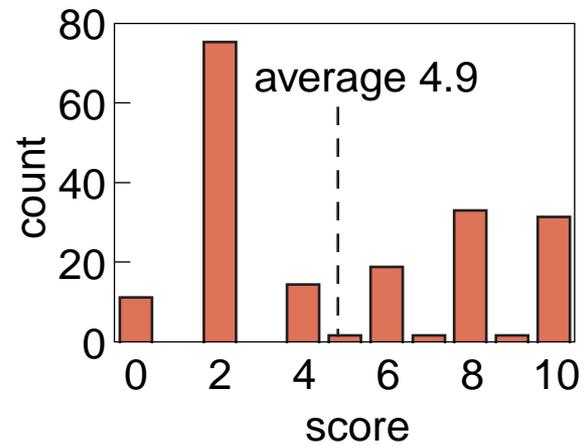


Why do we have this problem?

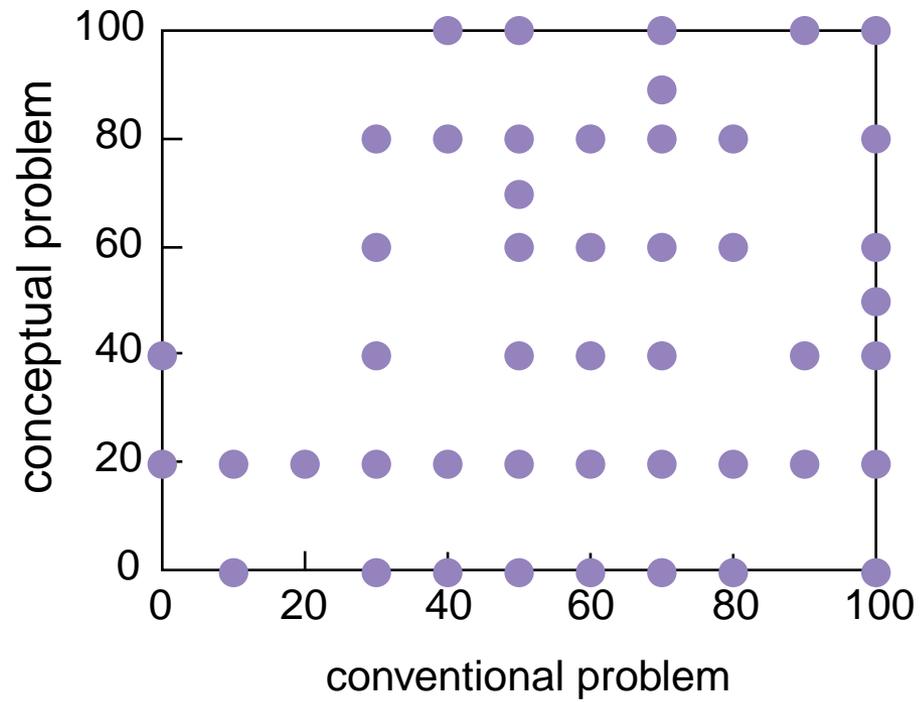
conventional



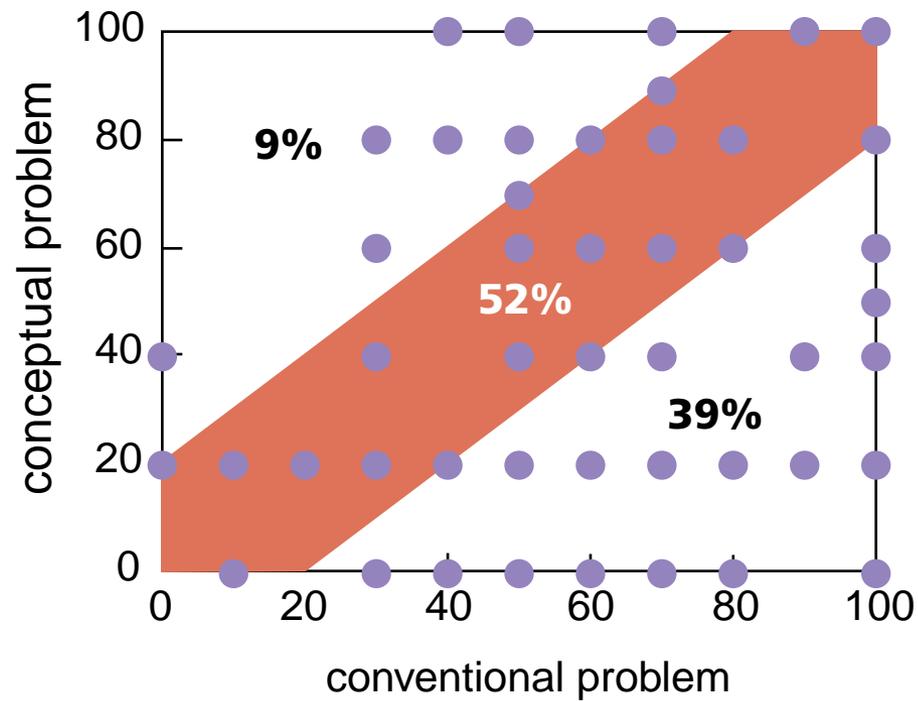
conceptual



Why do we have this problem?



Why do we have this problem?

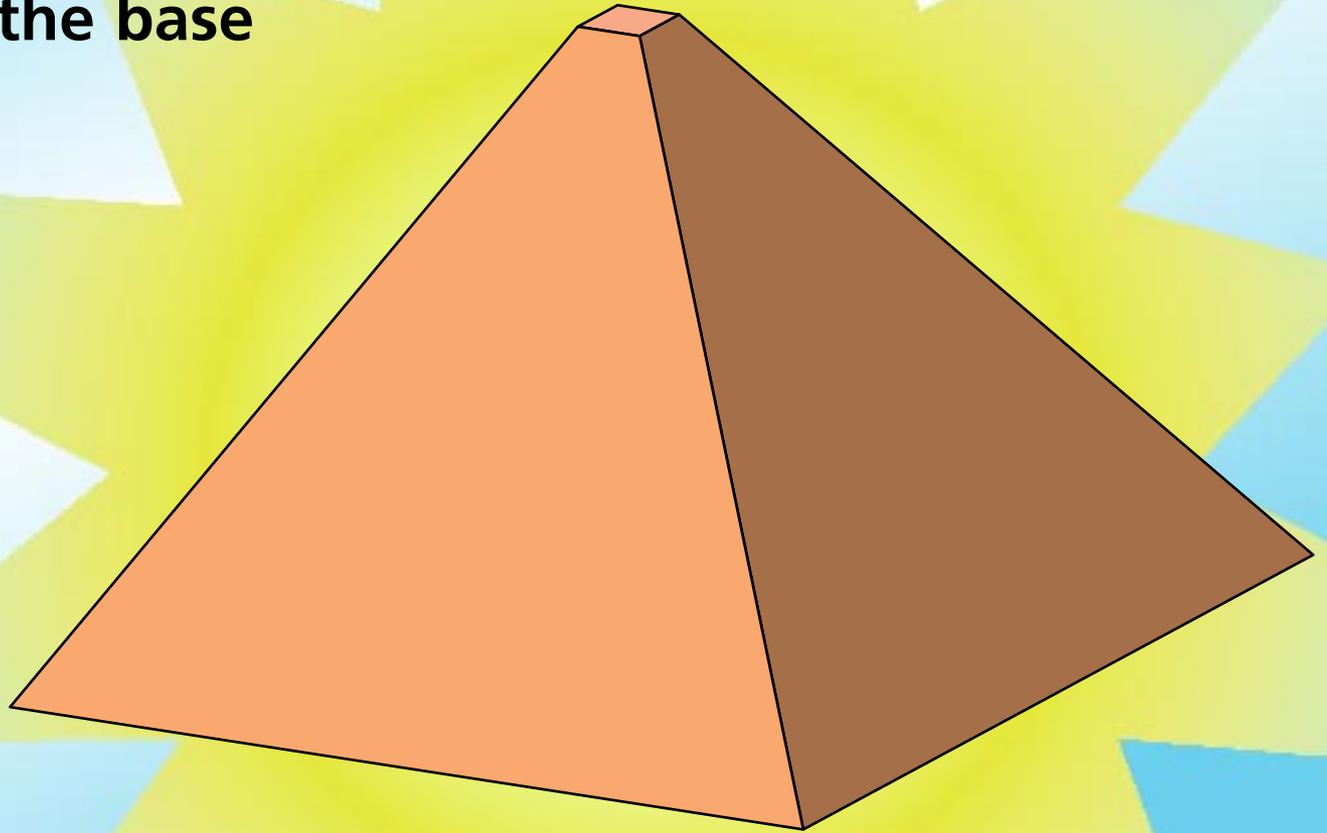


A wide-angle photograph of a large lecture hall. The room is filled with students seated at desks, viewed from behind. At the front of the room, a lecturer stands behind a podium on a stage. A large projection screen displays text, and a smaller screen to the right shows a list. The text on the main screen is partially legible and includes the words "So what should we do?".

So what should we do?

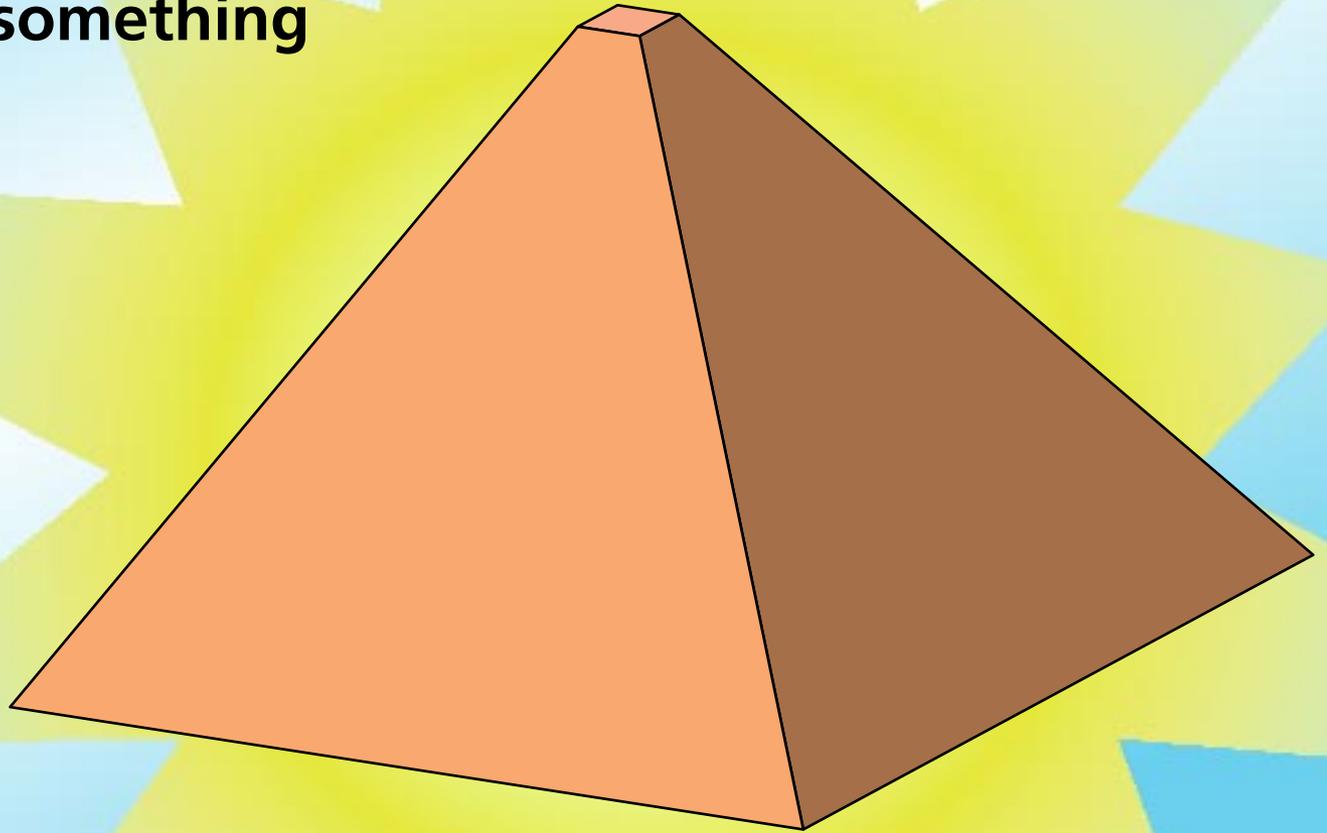
Conclusion

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



Conclusion

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



Conclusion

Challenges:

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

Conclusion

Rewards:

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

Funding

National Science Foundation

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

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