DE03: AAPT Summer 2001 Conference, Rochester, NY

Instructor's Ideas about Problem Solving

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***Supported in part by NSF grant #DUE-9972470**

Focus of Our Group

Learning of physics through problem solving

focus of this study

Instructors' beliefs and values about the teaching and learning of problem solving in physics

There are three talks on preliminary results and the hypotheses generated

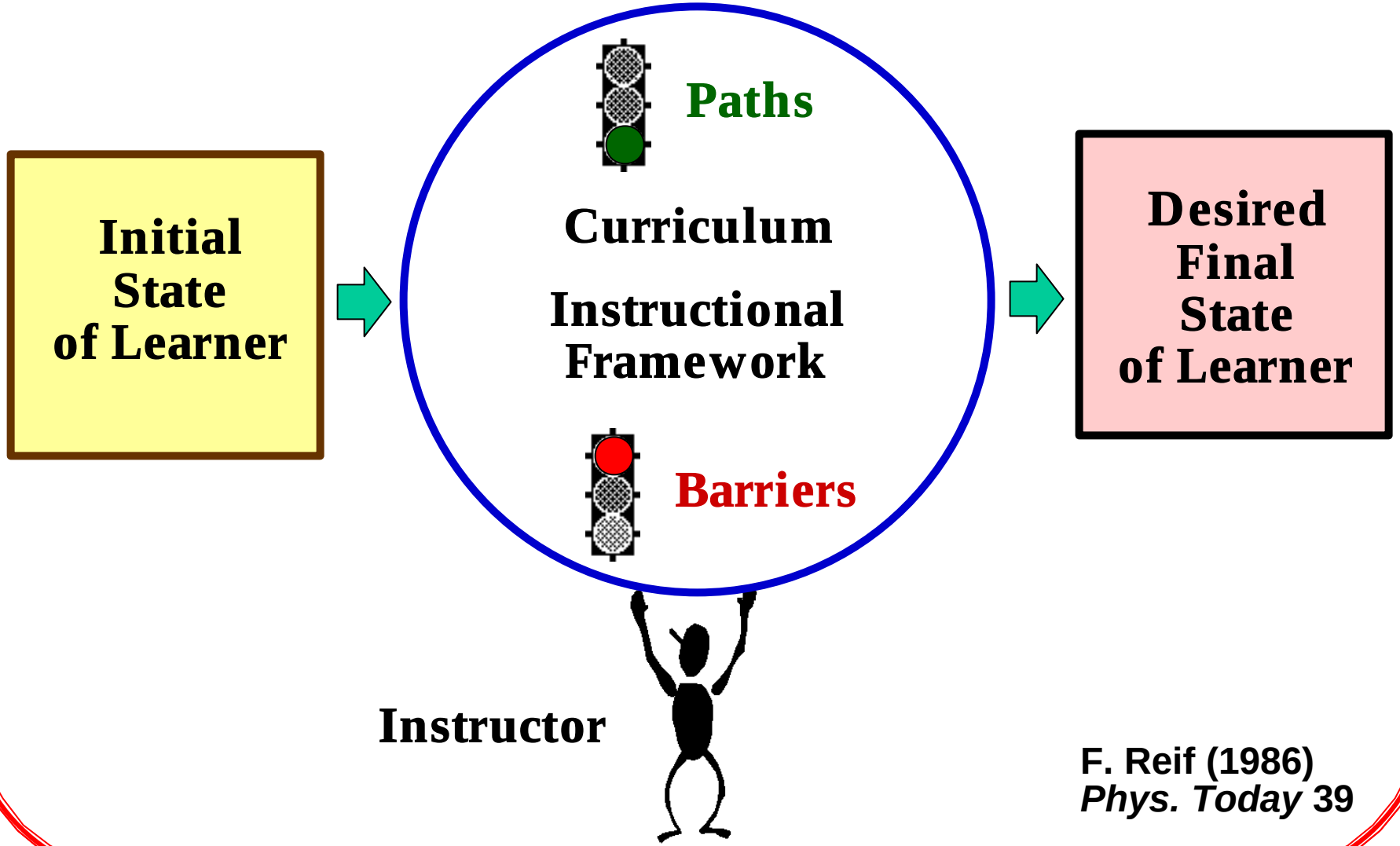
Talk 1: grading of student solutions

Talk 2: instructors' beliefs and values about student learning of problem solving in physics

Talk 3: relationships between instructors' beliefs and values about student learning, and their goals and expectations for their students

Why Faculty?

Transformation Process



F. Reif (1986)
Phys. Today 39

To understand instructors' beliefs and values

with respect to problem solving

We have developed and administered a 1½ - 2 hour interview to physics faculty based on instructional artifacts:

1st) 3 Instructor solutions: varied in the details of their explanation, physics approach, and presentation structure

2nd) 5 Student solutions: based on actual final examination solutions at the University of Minnesota to represent features of student practice

3rd) 4 Problem types: represent a range of the types of problems used in introductory physics courses

All artifacts were based on one problem -- instructors were given the problem and asked to solve it on their own before the interview.

Sample

Physics faculty in Minnesota:

taught introductory calculus-based physics course in the last 5 years, could be visited and interviewed in a single day (~107 possible).

Sample Randomly Selected:
30 faculty members
(From 35 contacted, 5 declined to be interviewed)

Roughly evenly divided among:

1) Community College (CC) N = 7
2) Private College (PC) N = 9
3) Research University (RU) N = 6
4) State University (SU) N=8

Why Grading?

- **Concrete task to focus the faculty and elicit their values**
- **Important because it sends messages to students**

Analysis technique:

- **Looked at grades that all 30 faculty gave to 2 student solutions**

To generate hypotheses:

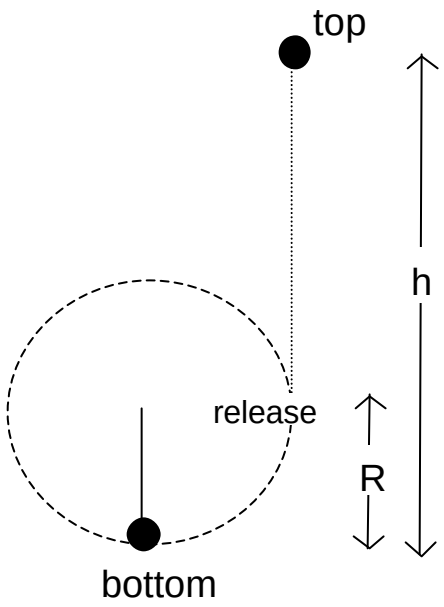
- **Use a sub-sample of 6 RU faculty**
- **Looked back at the interview to find their reasoning for the grades**

Problem Used in the Interview

You are whirling a stone tied to the end of a string around in a vertical circle having a radius of 65 cm. You wish to whirl the stone fast enough so that when it is released at the point where the stone is moving directly upward it will rise to a **maximum height of 23 meters** above the lowest point in the circle. In order to do this, **what force will you have to exert on the string** when the stone passes through its lowest point one-quarter turn before release? Assume that by the time that you have gotten the stone going and it makes its final turn around the circle, you are holding the end of the string at a fixed position. **Assume also that air resistance can be neglected.** The stone weighs 18 N.

Final examination question (Fall, 1997)

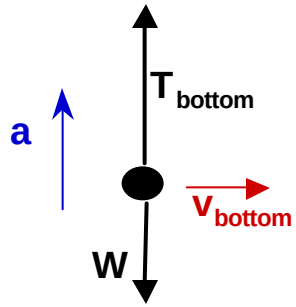
An Expert Solution



No work is done by string (since $T \perp u$), so all work is done by gravity. Using conservation of energy between bottom and top:

$$\frac{1}{2}mv_{bottom}^2 = mgh$$

Using Newton's 2nd Law at the bottom.

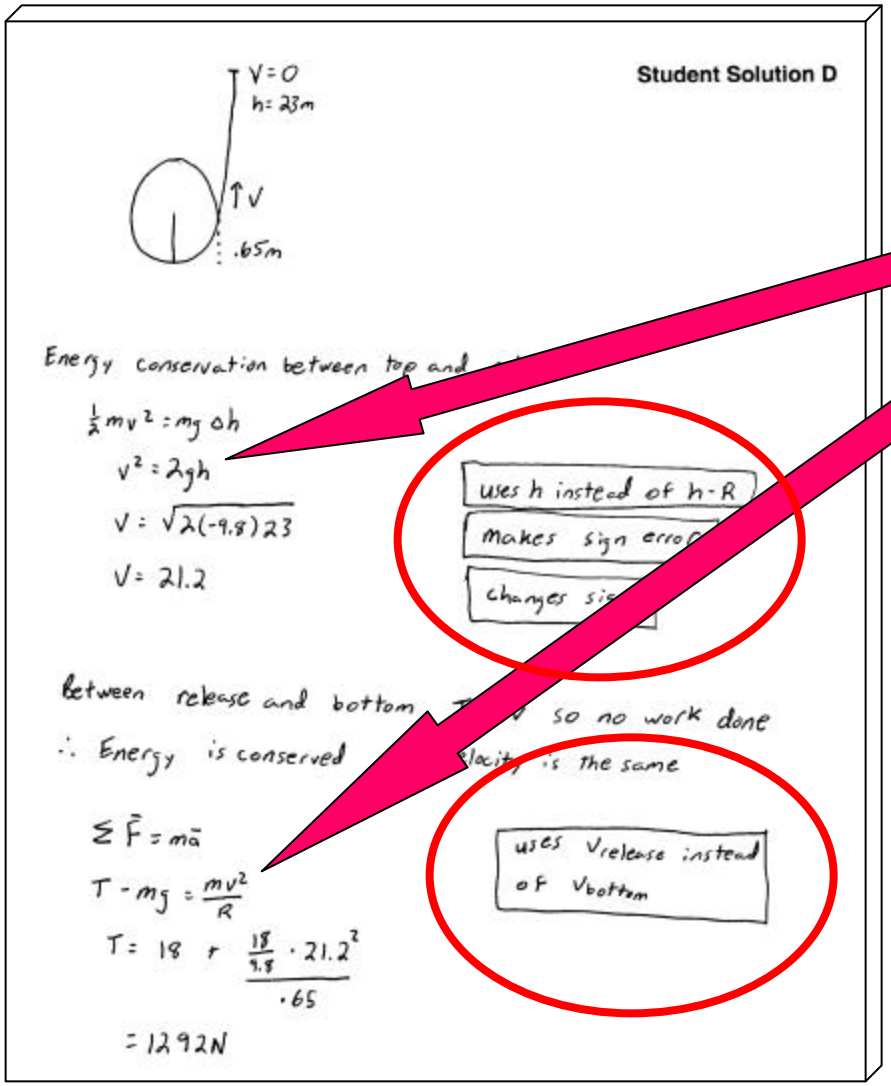


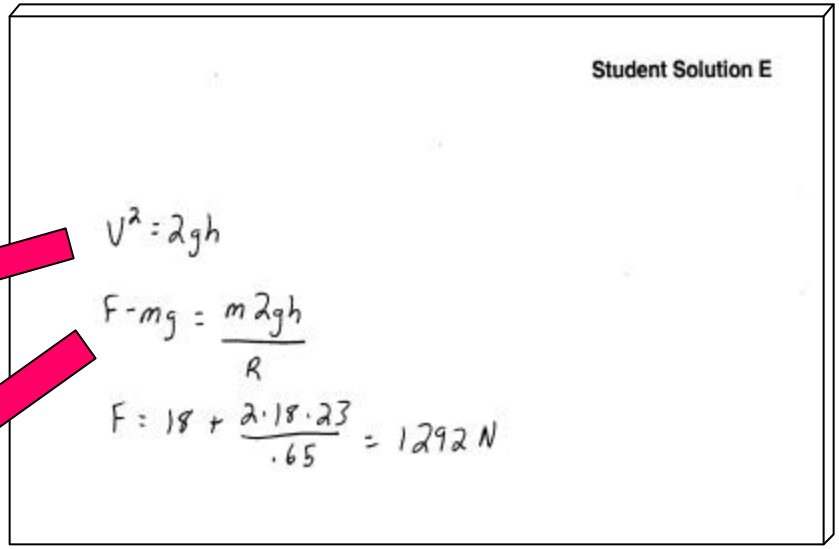
Free body diagram at bottom

$$T_{bottom} - mg = m\frac{v_{bottom}^2}{R}$$

$$T_{bottom} = 1292 \text{ N}$$

Student Solutions D and E



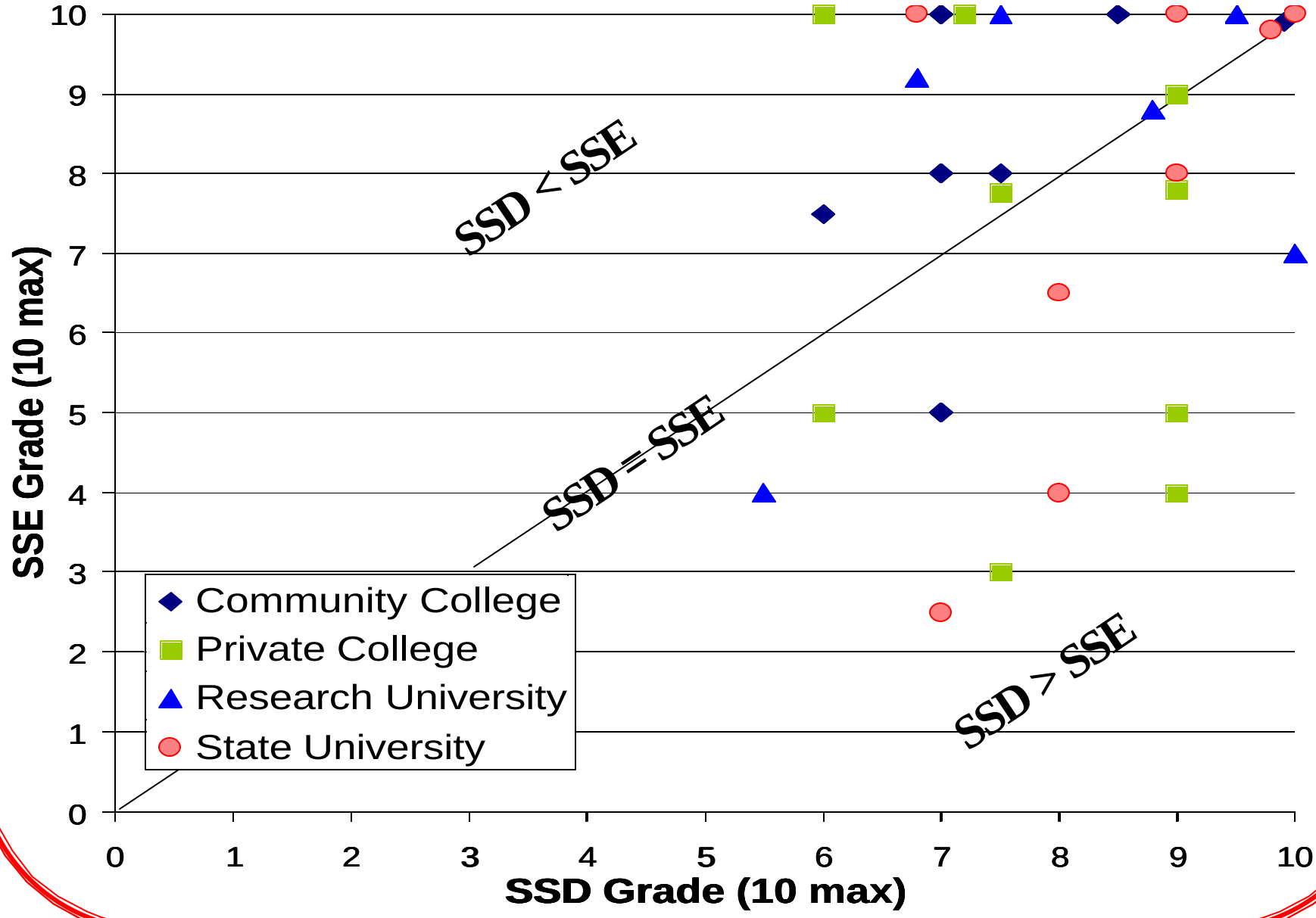


could have made the same mistakes as SSD

Instructors were asked to grade these solutions on a 10-point scale

comments made by interviewers

How did Interviewees Grade?



Looking at faculty from RU

Preliminary results of sub-sample, we decided to analyze the 6 RU faculty!

5 (out of 6) of the instructors expressed conflicting values when grading Student Solution E (short solution).

- **Value 1: Instructors want to see student reasoning so they can know if a student really understands.**

  - **"There's not a single word to tell you that he put these things down and didn't guess." (Instructor 4)**

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  - ❖ **Burden of Proof on Students**
- **Value 2: Instructors are reluctant to penalize a student who *might* be correct.**
  - ❖ **Burden of Proof on Instructors**
    - ➢ **"There's nothing in here that's wrong. Yeah, it's not clear what v is in $v^2=2gh$, but in the end the equation would come out the same." (Instructor 5: 10 pts.)**

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  - ❖ **Burden of Proof on Instructors**
  - ❖ **Viewing solution in best possible light:**
    - ➢ **"He had to know the 3 principles involved in the problem perfectly. Just had to." (Instructor 4: 7 pts.)**

Resolving the Conflict

Value 1: Instructors want to see student reasoning so they can know if a student really understands.

Value 2: Instructors are reluctant to penalize a student who *might* be correct.

Insist on Reasoning — **Compromise** — **Give Full Credit**

Instructor 1
6 point penalty

Instructor 4
3 point penalty

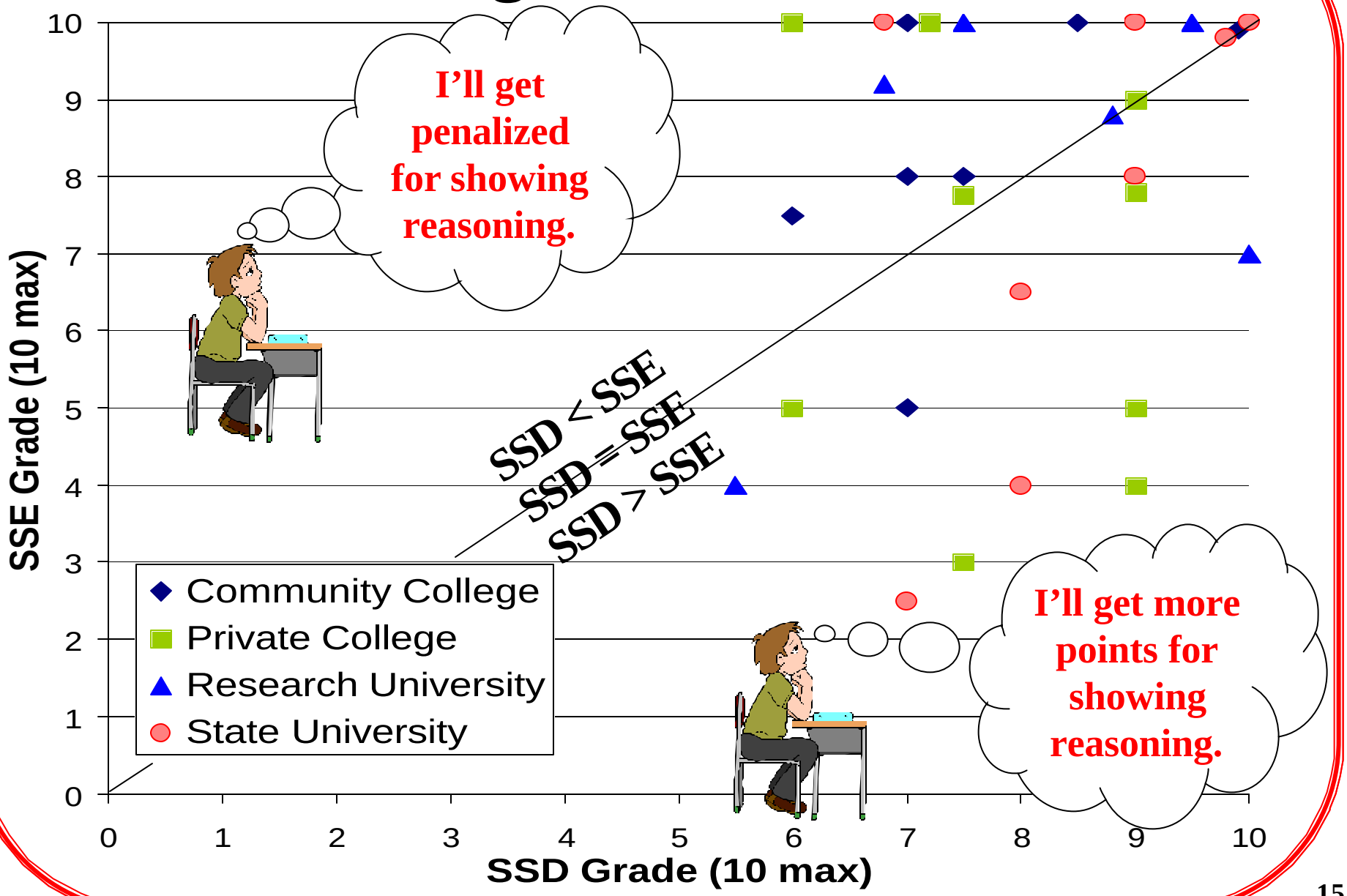
Instructor 3
~1 point penalty

Instructor 6
1 point penalty

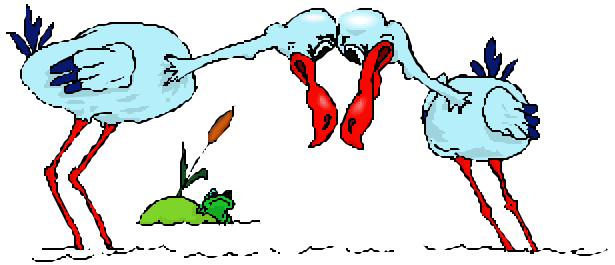
Instructor 5
No Penalty

Instructor 2
No Conflict
No Penalty

What Message Is Sent to Students?



What can we say about the preliminary results?



Do physics instructors hold conflicting values when grading?

Physics professors :

- **value seeing student reasoning in problem solutions**

- **yet many actually penalize students for showing reasoning**

We intend to test this hypothesis by examining the values expressed in the other 24 faculty interviews.

The End

For more information,
visit our web site at:

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