DE05: AAPT Summer Meeting 2001, Rochester, NY

Instructor's Ideas About Problem Solving:

Setting Goals*

Preliminary Results and Hypothesis Generation

Charles Henderson

Ken Heller, Patricia Heller,
Vince Kuo, Edit Yerushalmi

University of Minnesota

http://www.physics.umn.edu/groups/physed/

*Supported in part by NSF grant #DUE-9972470

Goals Survey

Highest Rated Goals

Goal	RU (N=6)	CC (N=7)	PC (N=9)	SU (N=8)
Know the basic principles behind all physics (e.g. forces, conservation of energy,…).	4.5	4.7	4.7	5.0
Solve problems using general quantitative problem solving skills within the context of physics.	4.5	3.9	4.6	4.6
Solve problems using general qualitative logical reasoning within the context of physics.	4.5	4.1	4.4	4.4
Know the range of applicability of the principles of physics (e.g. conservation of energy applied to fluid flow, heat transfer, plasmas, …).	3.8	4.1	4.1	3.9

Ratings are on a scale of 1="Not at all Important to 5="Very Important".

Goals Survey

Lowest Rated Goals

Goal	RU (N=6)	CC (N=7)	PC (N=9)	SU (N=8)
Understand and appreciate "modern physics" (e.g. solid state, quantum optics, cosmology, quantum mechanics, nuclei, particles,…).	2.5	2.0	2.2	2.8
Use modern measurement tools for physical measurements (e.g. oscilloscopes, computer data acquisition, timing techniques,…).	2.3	2.9	3.4	3.3
Understand and appreciate the historical development and intellectual organization of physics.	2.3	2.1	2.9	2.9
Program computers to solve problems within the context of physics.	2.0	2.0	2.3	1.6

Ratings are on a scale of 1="Not at all Important to 5="Very Important".

What are Course Outcomes?

RU Faculty

Category (Problem solving skills)	Students who accomplish
Procedural Techniques (e.g. Draw vector diagrams)	55-80%
Understand Physics Concepts and How to Use Them (e.g. Know that tension in string in this problem does no work)	45-70%
Decide on General Approach (e.g. Develop a strategy to arrange principles)	45-70%
Signs of Maturity (e.g. Recognize when something is missing)	20-45%

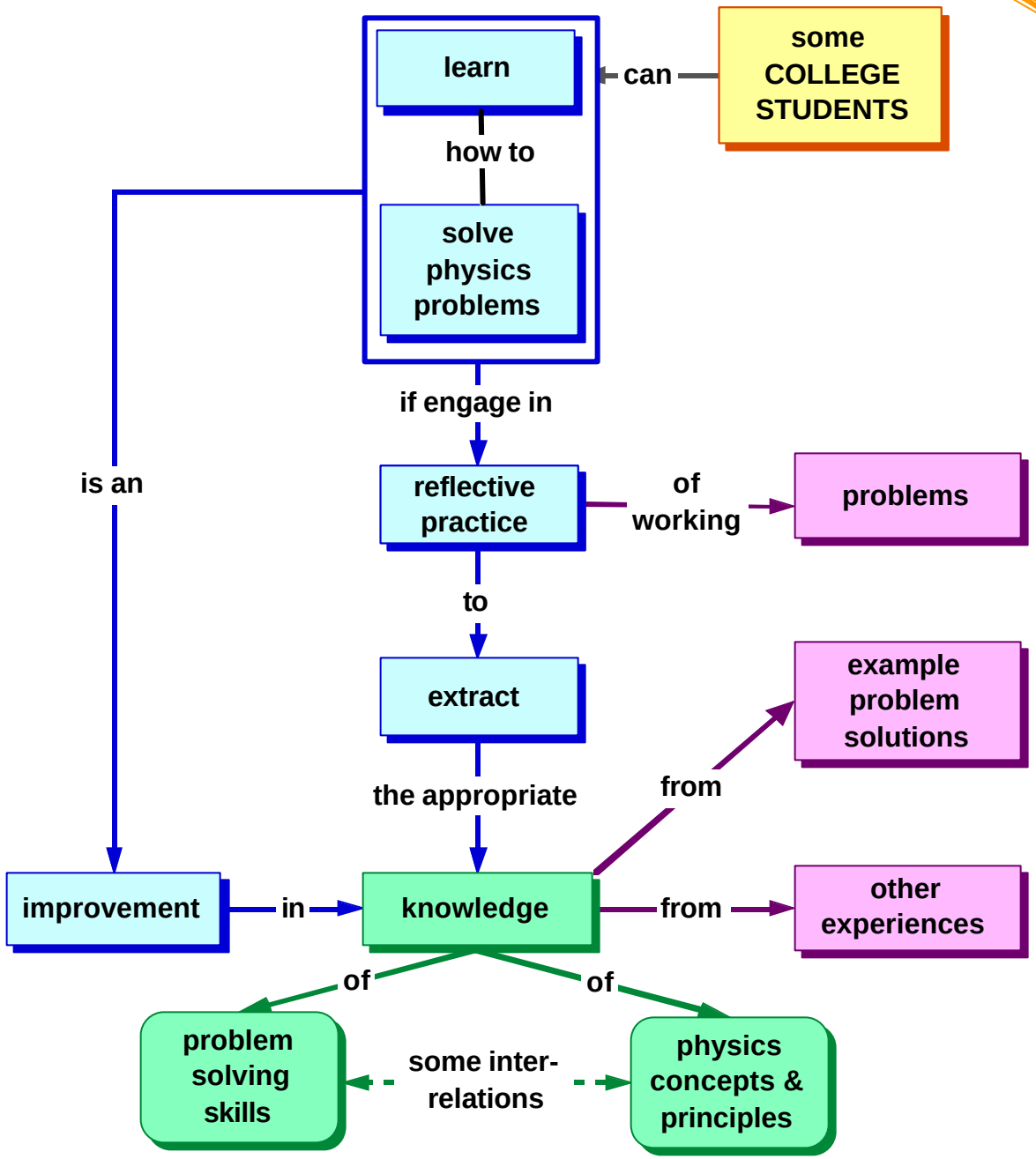
Why Don't Some Students Learn

- **Some students are not capable of learning problem solving.**
- **Other students choose not to learn problem solving.**

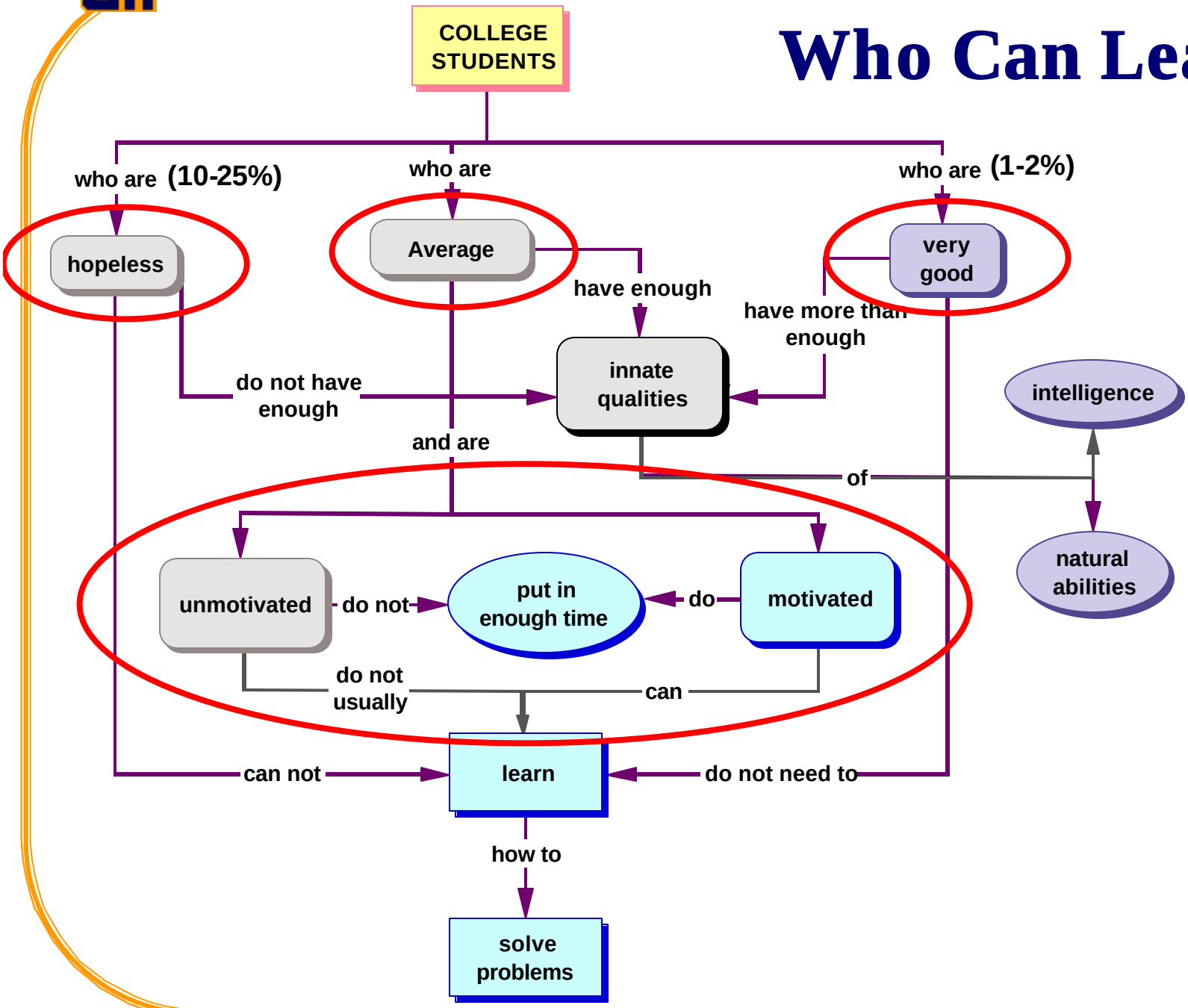
  ("Most of the success in physics depends on how hard students work.")
- **It's hard to learn problem solving and some problem solving skills take a long time to develop (~4 years).**

  (The one-year course is just the beginning. If students don't accomplish it now they will in later courses.)

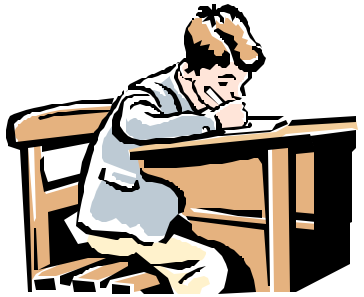
Faculty Beliefs and Values About Student Learning



Who Can Learn?



Why Don't Students Engage in Reflective Practice?



"Reflective Practice"

Three Possibilities:

- ~~Students might not know how.~~

- Students might know how, but not believe that it is necessary in order to learn.

- Students might know how and know that it is necessary, but choose not to do it.

What are possible/actual outcomes?

RU Faculty

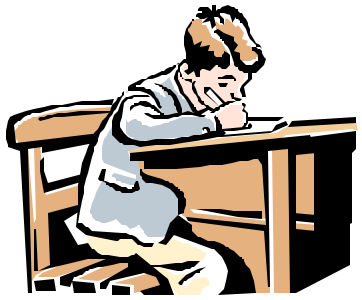
Category (Problem solving skills)		Can be accomplished	Students who accomplish
Procedural Techniques (e.g. Draw vector diagrams)	easiest	Yes	55-80%
Understand Physics Concepts and How to Use Them (e.g. Know that tension in string in a circular path does no work)		Yes	45-70%
Decide on General Approach (e.g. Develop a strategy to arrange principles)		Yes	45-70%
Signs of Maturity (e.g. Recognize when something is missing)	hardest	No	20-45%

Signs of Maturity

For most faculty (4 of 6), "Signs of Maturity" includes:

- **"Realizing the final result is too large"**
- **"Playing around to see what approaches might be valuable"**

Metacognitive skills similar to those needed for "reflective practice".



?

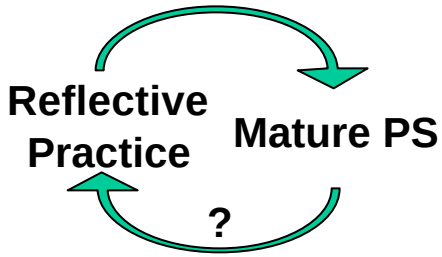
"Reflective Practice"

"Mature" Problem Solving

Is "Mature" Problem Solving the same as "Reflective Practice"?

Similarities

- **Both involve metacognition.**
- **Faculty do not (can not?) describe the mental processes that go along with either.**
- **Faculty make no attempt to teach either of these.**



Yet

- **"Reflective Practice" is a prerequisite to learning "Mature" problem solving.**
- **Students are capable of "Reflective Practice" during the intro physics course, but most are not "Mature" problem solvers by the end.**

Preliminary Hypotheses

- **Faculty have very similar course goals:**
  - **Students will learn the basic physics principles**
  - **Students will develop problem solving skills within the context of physics**
- **Why do faculty believe that some students don't learn physics problem solving:**
  - **Some students *cannot* learn physics problem solving.**
  - **Most students are capable of learning physics problem solving, but many do not put in the necessary time – doing "reflective practice".**
  - **"Mature" problem solving skills take a long time to develop.**
- **Faculty believe that students are capable of "reflective practice", but not the very similar "Signs of Maturity"**

Next Steps

- [x] **Use 6 RU interviews to generate hypotheses**

Use remaining 24 interviews to test/refine hypotheses

Use written questionnaire to expand to a larger national sample

Contact us if with comments or questions:

- **Web page: http://www.physics.umn.edu/groups/physed/**

- **Email: chenders@physics.spa.umn.edu**