Disciplinary Knowledge & Skill

Implications for undergraduate learning within and across majors

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Introduction

- We want to discuss some issues and do some work as a group today--so this is a working session rather than a presentation--despite this misleading start!
- Our starting assumption is that different disciplines represent and structure knowledge differently, and develop different skills, and that this may present challenges & opportunities for students' educational experiences.

Background

This started for me in my own experience as a cognitive psychologist who:

- --does research on problem solving and the importance of problem representation
- --teaches a large introductory course where we confront these issues all the time
- --and has taught some history of psych and encountered some of its historic foibles.
- --and along with Jarrod Moss, a cognitive graduate student works in a cross disciplinary collaboration with a mechanical engineer on both AI and cognitive approaches to engineering design.

Today's Process

We see today's work as a two stage process where

a) We mutually develop some perspectives on how disciplines represent knowledge and skill and

b) We then move to consider what implications this has for student learning and involvement both within and perhaps also, across disciplines.

Process

- We'll first try to develop some understanding of the knowledge representations that a number of disciplines strive for..
- Depending on how things are going, we'll take a very brief look at a couple of studies of representation changes in engineering students acquiring early expertise
- Finally, we'll try to explore possible implications for student research and learning within and possibly across disciplines.

Psychology

A few thoughts about psychology to get the ball rolling…

- Diverse discipline with social/natural science span (in fact, all disciplines cited large diversity/range)
- Knowledge representation is in terms of empirical findings rather than deep theoretical reductionist principles
- Skill is of critical empiricism--a finely honed set of critical skills for dealing with noisy conflicting data

Psychology teaching implications

Knowledge representation somewhat paradoxical; hard to assimilate but easy for students to engage in research

- Skill at disentangling/validating empirical results has great range of application-psych grads do well at this during their graduate training
- Knowledge representation doesn’t lend itself to point predictions in complex environments
- Knowledge rep. “sheds light” on phenomena (relation between variables, and sometimes mechanisms) but doesn’t offer strong prediction
- Knowledge rep. isn’t deeply & powerfully reductionist

Conversation: Physics

- Physics: The goal is essentially reductionist--to move from experimental/observational results to a small set of very general theories or, in lieu of that, a set of effective theories--intermediate level theories.
- The foundation is firm--and we build on it.
- Reductionist vs. emergentist approaches.

Physics teaching challenge

- Focusing on standard theories/findings limits feel for methodology-- “how are discoveries made?”
- Solution is involvement in research and “teaching the struggle” -how did we come to believe this?
- Sometimes experiments focus too much on looking for a particular thing vs. hypothesis, but they get data that is meaningful.

Physics teaching limitations

- Tension between teaching method and getting the material out.
- Avoidance of contention--leads to too much suppression of unorthodox views (tendency to get to “the” answer.
- Complexity prevents describing point predictions (weather, ping pong ball, etc.).

Conversation: Biology

- Strongly reductionist: explain phenomena via genes and proteins
- A purist central dogma--develop a molecular understanding of cell cooperation to perform at a tissue level
- But biology operates at many levels, organism to atomic, and not everyone is reductionist in orientation

Biology: teaching implications

- Involving students in this kind of bio-molecular research results in bimodal distribution, some get it immediately and some not at all.
- Everyone can do the mechanics but not everyone visualizes and makes sense of it.