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Epistemological Gains in a Large Lecture Class

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Explicating the hidden curriculum

- In our teaching of physics to college students in science and engineering, we often focus on the content to be covered.
- In practice, we hope (and expect) that our students will learn more than just memorizing certain rules and pattern matching certain problems.
- We hope (and expect) that they will learn to think, using physics appropriately.

Student Expectations

- What ever we hope (or expect), it is what our students expect that controls what they do in our class.
- Students (even in college) often think
  - learning science means memorizing isolated facts.
  - "plug-&-chug" = problem solving
  - professional scientists worry about concepts and coherence — but they don't have to.

The MPEX

- In the mid-90s we developed a survey to probe student expectations in calculus-based physics for engineers.
- The Maryland Physics Expectations (MPEX) survey is a Likert-style agree-disagree survey of 34 items.
- The MPEX probes students' declared views (not their functional behavior) about what they will be important to their learning in the class.

MPEX Results: Engineers

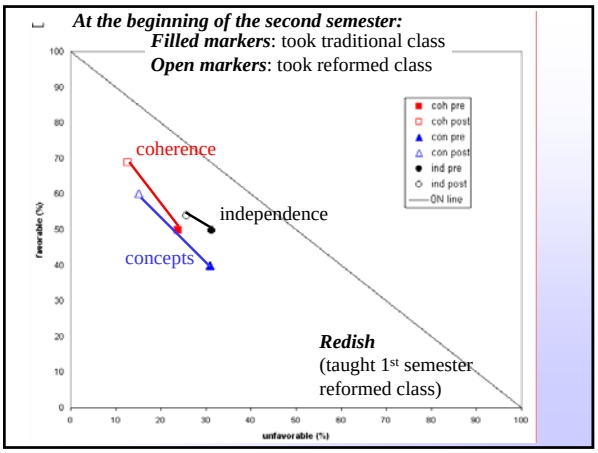
- Incoming engineering students only agree with expert orientations of the MPEX items about 2/3 of the time.
- One semester of traditional instruction results in a slight deterioration of student agreement.
- Active-learning reforms that substantially improve concept learning do not change this result.
- This result is very robust and has been repeated at many colleges and universities.

Can we improve MPEX results?

- In 2000, the UMd PERG started a project to try to improve the learning of bioscience students in algebra-based physics.
- A variation of the expectations survey (MPEX-II) adjusted and validated for the population was developed.
- New instructional methods were adopted to make students more explicitly aware of the value of conceptual thinking, looking for coherence, and making the link to their intuitive real-world knowledge.

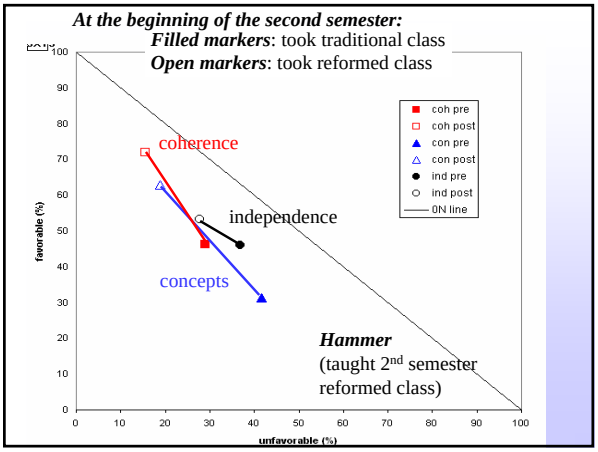
Does it work?

- Results (reported at previous meetings) were good, showing substantial MPEX-II gains in the first semester while maintaining the strong conceptual gains we attained with the engineers.
- But — we lost our control group.
  - We had a new population, not = engineers.
  - We had modified the survey.
  - Other instructors were unwilling to take time to give MPEX-II pre-post in their classes.



A "behind the back" control

- During the second semester, members of the UMd PERG were the instructors of record for all of algebra-based physics II.
- This allowed us to give MPEX-II at the beginning of the second semester, and to sort students into those who had our epistemologically-reformed class and those who hadn't.



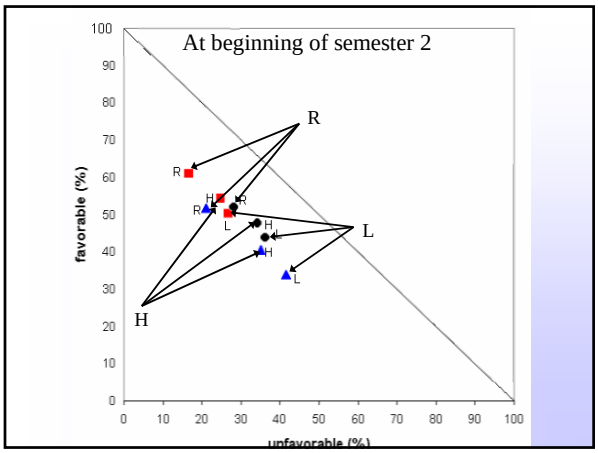
Classes

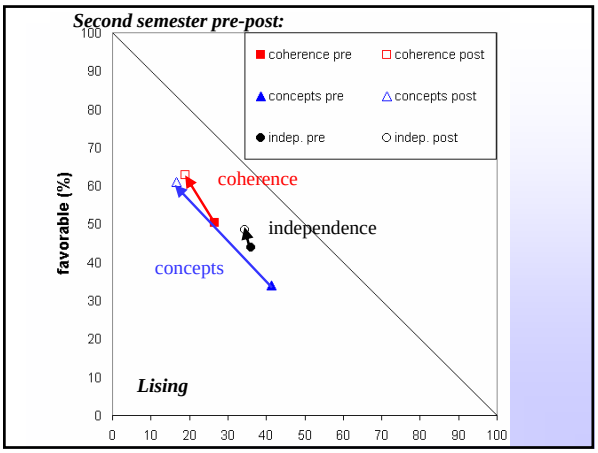
- Semester 1
  - Reformed class: Redish
  - Traditional class: Two others (non PERG)
- Semester 2
  - Reformed class: Hammer (N=122)
  - Reformed evening class: Lising (N=64)*
  - Partly reformed class: Redish (N=168)

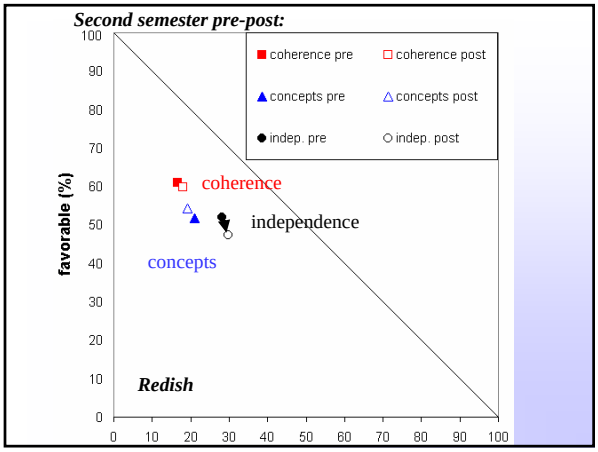
* Contained few students from reformed semester 1

Results: Pre-semester 2 comparison

- There is a substantial difference between students who had the reformed class and those who had the traditional on all 3 clusters.
  - $\Delta F \sim +(10\text{-}20\%)$.
  - $\Delta U \sim -(10\text{-}20\%)$.
- Overall score higher in Redish class at beginning of semester 2.


At beginning of semester 2
favorable (%)
unfavorable (%)
R
L
H


Second semester pre-post:
coherence pre
coherence post
concepts pre
concepts post
indep. pre
indep. post
coherence
independence
concepts
Lising
favorable (%)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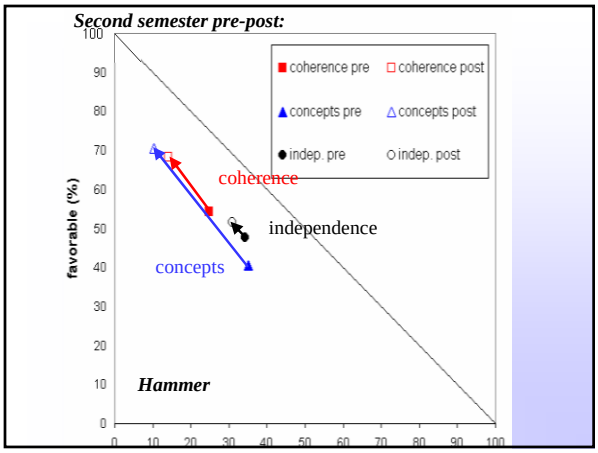
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