Bridging Studies of Physics and Education

Physics 180: Teaching and Learning Physics

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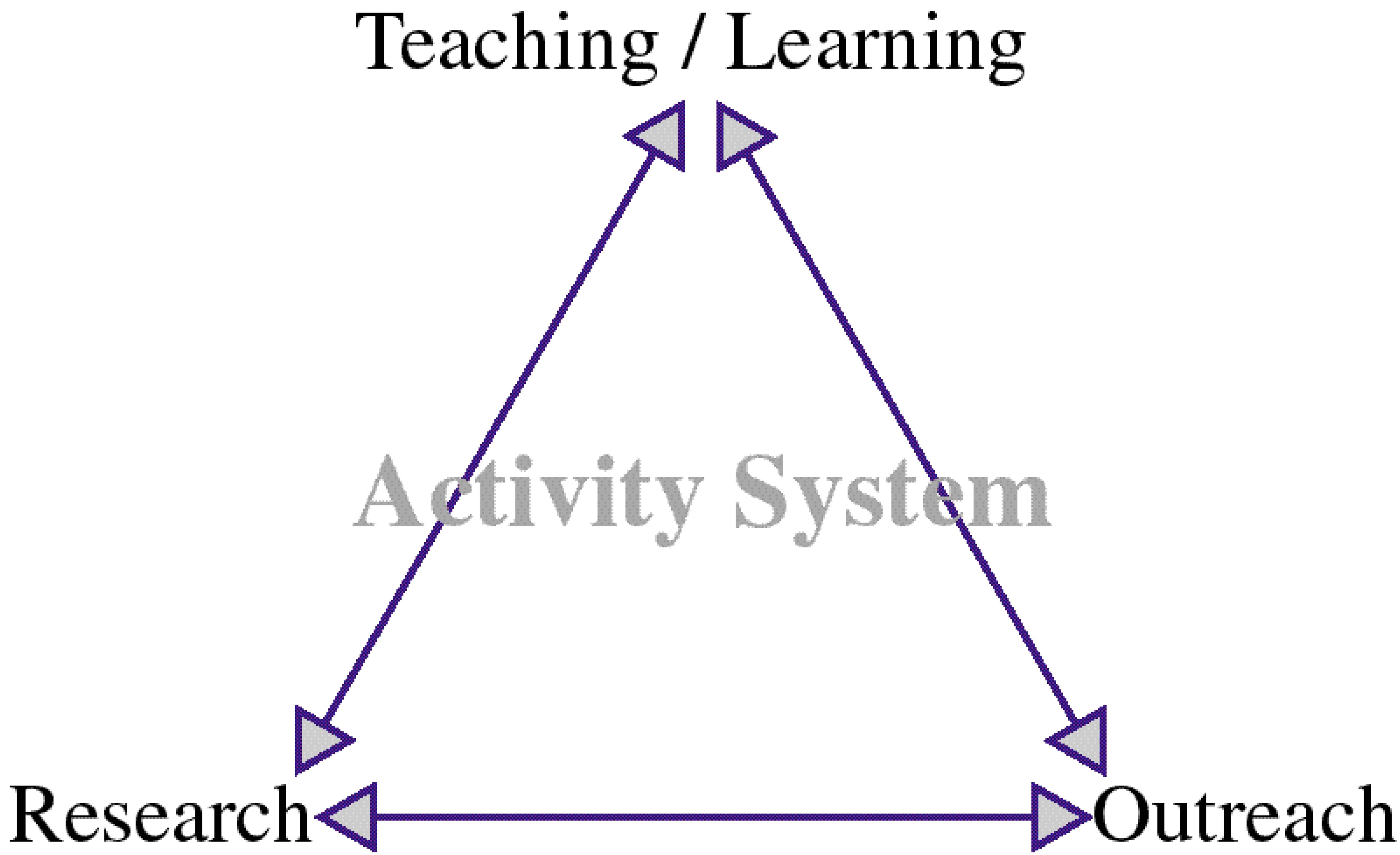
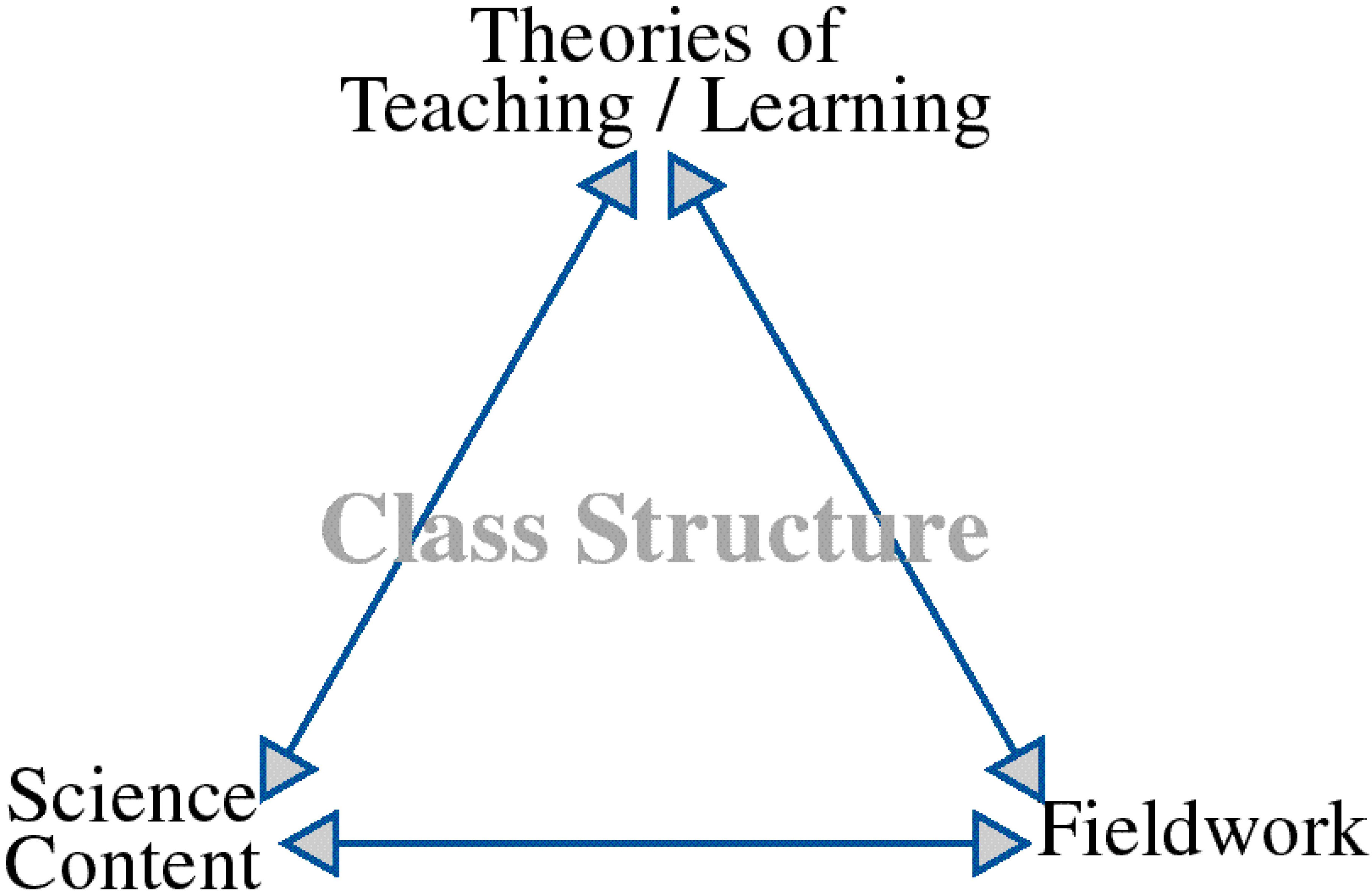
DEPARTMENT OF PHYSICS AND

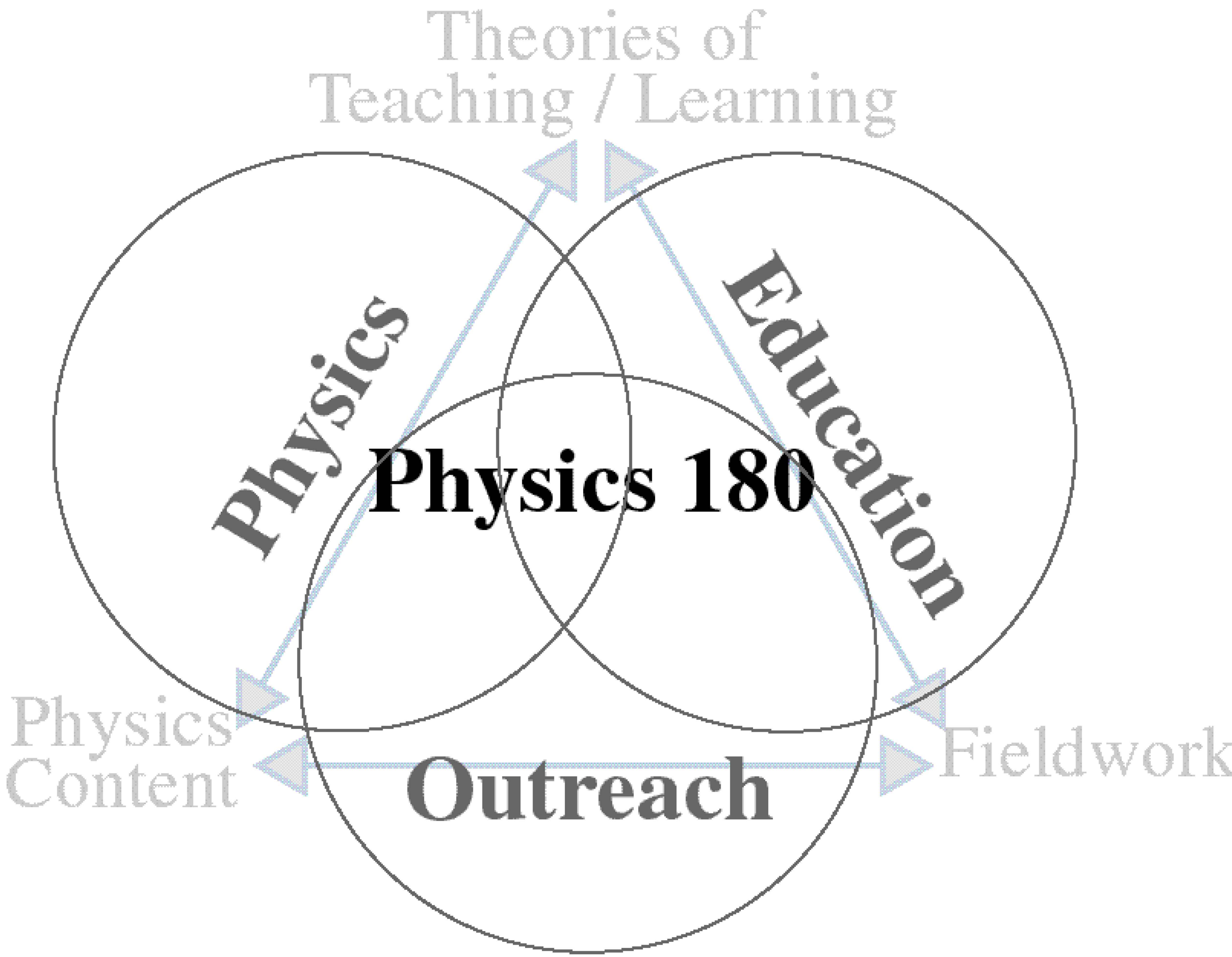
LAB. OF COMPARATIVE HUMAN COGNITION

LCHC

University of California San Diego


Teaching / Learning
Activity System
Research
Outreach


Theories of
Teaching / Learning
Class Structure
Science
Content
Fieldwork


Theories of
Teaching / Learning
Physics
Education
Physics 180
Physics
Content
Outreach
Fieldwork

Combining Research, Learning, Teaching, and Outreach

Physics Content

- **heavily conceptual**
- **based on intro classes and text (covering 2/3rds of a traditional course)**
- **dramatically shift emphasis from equation solving/ memorization to reflection and analysis of concepts, text and problems**
- **classes project oriented -- host of activities from teaching to lab dvmt**

Meta-physics (theories of teaching and learning)

- **readings and discussion in seminar format**
- **both pragmatic / process oriented approach (e.g. McDermott) and theories of cognition (e.g. diSessa)**
- **designed to pair with study of science, and fieldwork**

Fieldwork

- **teaching / tutoring / researching content (physics & meta-physics)**
- **5 sites from elementary, middle, high school, and university**

PHYSICS 180 / TEP 105: THE DETAILS

***Physics 180 / Teacher Education Preparation 105*: A course on how people learn and understand key concepts in introductory electricity and magnetism. Readings in physics and cognitive science plus fieldwork teaching and evaluating pre-college students. For students interested in teaching science at any level. -- 4 Units**

CREDIT FOR UPPER DIVISION PHYSICS / T.E.P. CERTIFICATE AND MINOR:

- 1.5 hrs - readings in theories of learning physics
- 1.5 hrs - electricity and magnetism
- 2 hrs fieldwork teaching

EMPHASIS ON TEACHING PHYSICS / EDUCATION

GROUP WORK / SEMINAR STYLE

STUDENT RUN / CENTERED

CONSTRUCTIONIST

GOALS FOR STUDENTS IN PHYSICS 180

BETTER UNDERSTANDING OF PHYSICS:

- Conceptual
- Problem solving
- Meta-cognitive (Schoenfeld's: self assessment, control, beliefs)
- Epistemology (Hammer: structure, content, learning)

BETTER UNDERSTANDING OF TEACHING (THEORY AND PRACTICE)

PRACTICAL EXPERIENCE (IN PHYSICS AND TEACHING)

DATA (EVALUATION OF STUDENT ACHIEVEMENT)

PHYSICS:

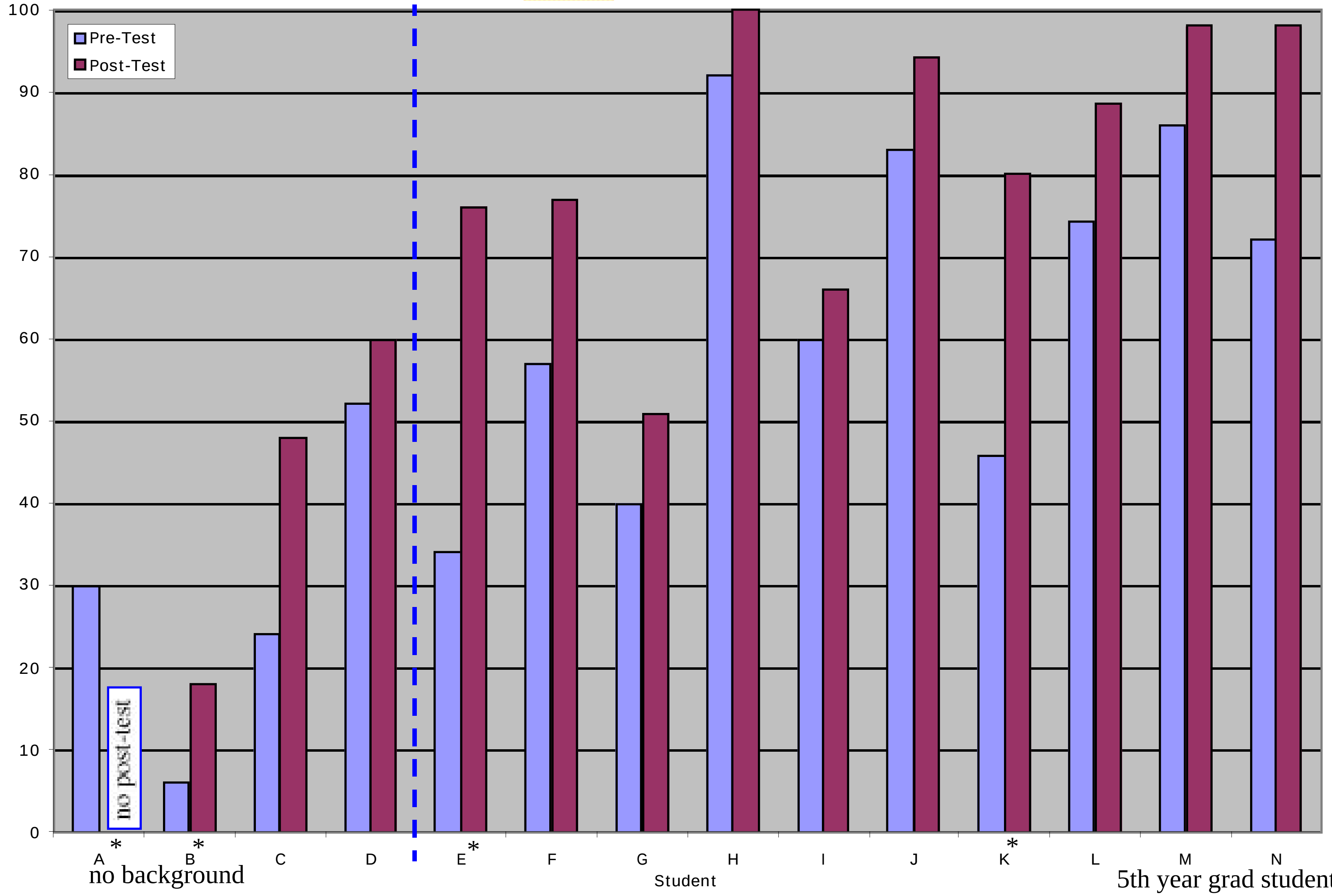
- pre-test / post-test - CSEM / ECCE
- homework (problem sets - analysis of problem and strategies used solving)
- fieldnotes (mainly on in-class physics activities)
- video/ audio tapes

TEACHING:

- interviews (following modified Hewson protocol)
- pre- / post- written statements of approach to teaching
- fieldnotes (student / instructor)
- site data (other notes, journals, pre-college student performance)
- audio tape (class discussion of readings) and some video (of students teaching)
- final projects / papers

STUDENT EVALUATION OF CLASS: WEEKS 5, 9,10

STUDENT PERFORMANCE IN PHYSICS 180



Average of Student Gains: 51% **Pre-Test Ave: 54 %** **Post-Test Average: 74%**

Significance: p< 0.001 **s.d.: 25 %** **s.d.: 24 %**

Student performance (cont)

Fieldnote observations:

During a discussion of a course reading on the use of analogies to teach how batteries and light bulbs behave in series and parallel:

Student F made a very interesting revelation, with which Student J also identified: Total lack of conceptual understanding of series and parallel batteries and bulbs. Student F made the comment that he had thought batteries worked differently until he had read the article. Still, throughout the class he and Student J would make little mistakes about relative brightness, voltage etc. When asked to think about it in terms of the article and the analogies presented, [however,] they would get the right answer. It required conscious effort and though

Student self-reporting:

I'm finally enjoying this material [E/M ...] Overall, I've learned (understand finally) so much about E & M and I'm learning about techniques to teach it -Student E

I learned a lot about teaching, and even found a new interest in the subject of physics through this course - Student B

[The best part of the class was] discovering that I didn't know what I thought I knew about physics- Student D

I'm not good at [discussion]. This is really the first class where I have really had to talk about what I think - Student G

Student comments during class:

Of a discussion about current conservation, Student F reveals:

I don't know some of these things. I have the same misconceptions that kids and undergraduates that we're reading about. I'm a physics major, and I don't know these things. I can do the advanced stuff... but not the conceptual side.

STUDENT PERFORMANCE (TEACHING)

STUDENT SELF-REPORTING:

I got so excited [about teaching]

I thought I had a pretty good grasp on how to teach physics, but I've learned enough to revamp my whole style

I loved fieldwork b/c I actually was able to observe the teaching theories involved in class and even put them into practice

This [fieldwork] really drove home some of the points made in our discussions and readings

INFLUENCE OF CLASS READINGS:

Student H writes of pre-college students' failure to grasp a lesson:
This might be a consequence of the fact that they were not forced to confront many of their pre-conceptions, come upon a conflict, and resolve it. - parallels Posner's theory of accommodation.
The fieldnote continues: *knowledge ... never really became integrated as a system* - in this context, alludes to diSessa's knowledge in pieces and Reif's knowledge structures

PRE AND POST - STATEMENTS OF TEACHING:

Student L, Pre: "... there seems to be two ways of going about [getting people to learn]. One school of thought is that repetition is how one learns, and the teacher should focus on the most important ideas and go over them repeatedly. The other methods is to saturate the students with information... I have no opinion on which method works better..." - *week 1*

Post: "I believe that teaching is less telling and more leading through interactive experiences. It is important for a teacher to know the subject material and be able to convey it clearly, but it is equally important for a teacher to be able to prompt students into learning experiences through which students learn on their own, and in the process own the knowledge themselves....Another important duty of a teacher is to provide an environment for the student that is conducive to learning. This may include ... providing groups of students for interaction and making sure the students are learning and not just memorizing by getting involved in the learning process." - *week 10*

Physics Education Research in Physics 180

Under what conditions are students willing to revisit what they believe they already know?

How does context / culture influence meta-cognition and epistemology (and hence learning)?

One answer to these questions: TEACHING

- (given the right context (resources, time, motivation and feedback))
- forces making content knowledge overt, and public
- can spur both metacognitive skills (a la Schoenfeld),
- and can foster development of beliefs about the structure, content, teaching and learning of physics (epistemology a la Hammer)

RECAP

A COORDINATED ACTIVITY SYSTEM:

- **A good place to train teachers**
- **Results in a better understanding of physics (broadly defined)**
- **Places context as a central feature (from individual development to the development of broad-scale systems)**
- **Produces an environment well suited for PER**

MORE INFORMATION IS AVAILABLE AT:

http://lchc.ucsd.edu/nfinkels

SUPPORT

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