Active Learning in the Sciences

shifting the focus from teaching to learning

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Seminar overview

I. My teaching goals

II. Course design

III. Classroom approach

IV. Role of teaching technologies

V. Your ideas

My teaching goals

* Promote student interest in course topics

    to attract majors, summer researchers, grad students.

* Encourage working knowledge rather than recitation

    to prepare students to answer questions I want them to answer.

* Develop course frameworks which can be used year after year

    to help balance teaching with other responsibilities.

Influences

* "Five Easy Lessons: Strategies for successful physics teaching"
Randall Knight (California Polytechnic State University)
Addison Wesley (2002).

* Peer instruction (affiliated with Project Galileo)
Eric Mazur (Harvard University)
galileo.harvard.edu/home.html

10 minute mini-lectures, 5 minute questions

* Experiential learning
MUN Physics & Physical Oceanography
Mt. Allison Physics

integrated mini-lectures and lab activities

* Peer instruction in the lecture setting
Al Slavin, Trent University
www.mcmaster.ca/cll/posped/ (last article in Vol. 1, Issue 1)

mini-lectures among short and long questions

Course context

PHYS 4000 "Introduction to Solid State Physics"

4th year elective, historical enrollment 3-12 students

draws on many subdisciplines

closely associated with my research interests

Challenge: convey adequate breadth and depth

Course design

Follows "standard" progression of topics

One textbook

Supplemental information covered in class

Evaluation:

- Two midterm exams, one comprehensive final exam
- Two problem sets, one before each midterm
- Class presentations on special topics near term end

Classroom approach

Reading responses due weekly, prior to class

quiz over basic content & request for points to clarify

Class consists of answering questions

definitions, equations

key concepts

short quantitative problems

longer (problem set type) questions

comparisons and "big picture" contexts

discussing data from scientific literature

Reading responses

Reading response #1

Name: Kristin Poduska (Preview)
Start time: September 4, 2003 10:50
Number of questions: 4

Finish | Help

Question Status

- Unanswered
- Answered
- Answer not saved

1	2	3	4

Question 1 (1 point)

Crystal systems

Which of the following is NOT a type of crystal system?

a. Hexagonal
b. Trigonal
c. Tetragonal
d. Pyramidal

Save answer

Question 2 (1 point)

Miller indices

How many (unique) indices are required to specify an atomic plane in a 3D crystal?

a. 2
b. 3
c. 4
d. 5

Save answer

Question 3 (1 point)

Atomic packing

Which of the following terms relating to atomic packing are equivalent?

a. face-centered cubic and cubic close packed
b. cubic close packed and hexagonal close packed
c. hexagonal close packed and face-centered cubic

Save answer

Question 4 (1 point)

Points to clarify

What concepts, derivations, or explanations need the most clarification for you? (The more specific you are, the more directed the class meetings will be.)

Class exercises

* definitions, equations

Which of the following expressions for electrical conductivity are correct?

(a) j/E

(b) $1/\rho$

(c) l/RA

(d) $n e \mu$

(e) $n e^2 \tau/m$

* key concepts

* short quantitative problems

Using a cube,

* find the [100], [110], and [111] directions.

* find the (100), (110), and (111) planes.

What is the distance between (111) planes?

Class exercises

* Comparisons and "big picture" contexts

Which is the most likely cause of electron scattering in a metal at room temperature?

(a) electron-electron scattering

(b) electron-defect scattering

(c) electron-phonon scattering

*Longer (problem set type) questions

Elliott Question 4.4:

Calculate the vibrational density of states g(omega) for the periodic one-dimensional, monatomic chain and compare, by means of a sketch, its behaviour with that of the Debye density of states of an elastic continuum. How does the behaviour change for the linear di-atomic chain model?

Class exercises

Longer (problem set type) questions can benefit from parsing.

Calculate the vibrational density of states g(omega) for the periodic one-dimensional, monatomic chain.

Define relevant concepts, identify useful relations, derive equation and sketch result.

Compare, by means of a sketch, its behaviour with that of the Debye density of states of an elastic continuum.

Identify important aspects of alternative model and compare results.

How does the behaviour change for the linear di-atomic chain model?

Modify pertinent equations to accomodate the new situation and compare results.

Class exercises

* Data from scientific literature

The figure below shows the temperature dependence of electrical resistivity for CeSbTe. Is this material a metal, semiconductor, or insulator?

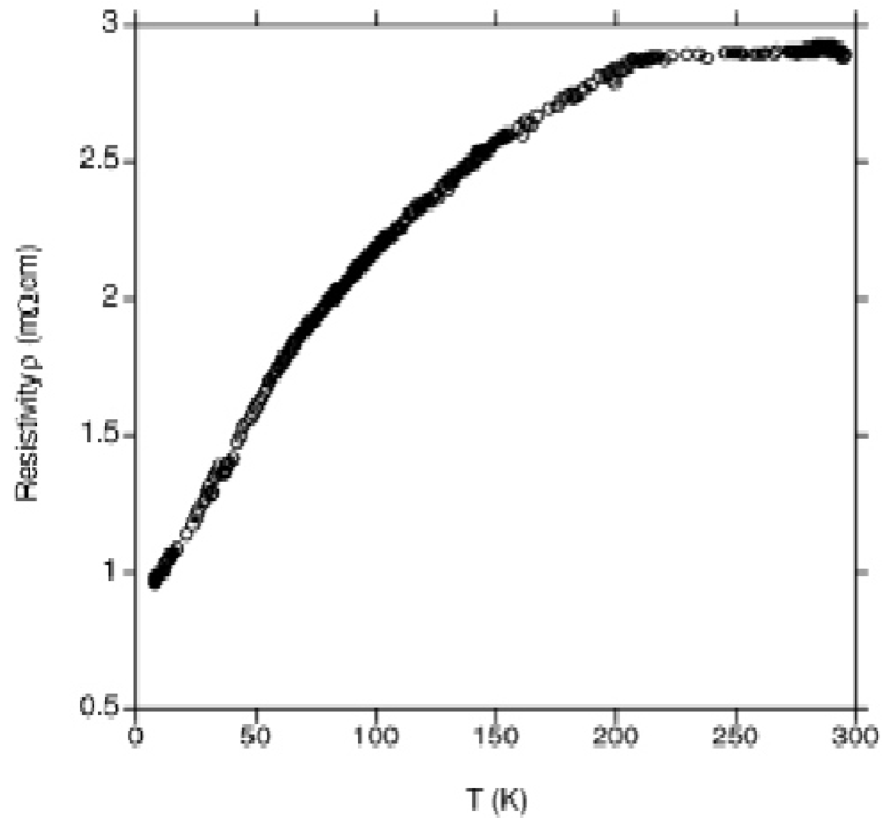

Fig. 6. Electrical resistivity as a function of T for CeSbTe.

Y.C. Wang et al. / Journal of Alloys and Compounds 314 (2001) 132–139

IV. Role of teaching technologies

* Computer-based lectures posted on web after class

* Occasional computer simulation exercises

* Reading responses facilitated with WebCT

Student feedback

What do you enjoy most about the course?

"the class structure"

"the class discussions"

"the lack of traditional lectures"

"the interaction in class"

"...a lot of information available"

What do you find most frustrating about the course?

"WebCT...seems overkill"

"lack of computational examples"

"It's hard to find time to sift through it all and find what we need."

"Certain (small) aspects of the course are best presented in a lecture."

"There is a lot of reading, with confusing math added in."

V. Your ideas

* Balancing conceptual and quantitative learning?

* Application to larger classes?

* Time commitments?

Summary

* Active learning strategies help me meet my teaching goals

Promote student interest in course topics
Encourage working knowledge rather than recitation
Develop course frameworks which can be used year after year

* Active learning can be implemented within a standard course framework

* Students appreciate the break from traditional lectures

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