Effective Classroom Teaching

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A Question

- Who are the three or four best teachers that you have ever had?

What made them the “best?”

Is this the same as “most liked?”

Is this the same as “favorite?”

Is this the same as “most inspirational?”
My Best Teachers

- Mr. John Layman (high school physics)
- Mr. Edward Allard (college physics)
- Dr. Harold Fuller (modern physics)
- Mr. Charles Gross (circuits)
50 Year Reunion of Physics Class
The Key Attribute:

“Caring Genuine Engagement”
Consistent Concept

Teach with Your Strengths: How Great Teachers Inspire their Students
“Mountains of research point to the this remarkable fact: While their styles and approaches may differ, all great teachers make the most of their natural talents.”

“Here’s something else: Great teachers don’t strive to be well rounded. They know that ‘fixing their weaknesses’ doesn’t work – it only produces mediocrity. Worse, it diverts time and attention from what they naturally do well.”
Outline

- Introduction
- Formal Educational Structure
- Teaching Styles
- Course Software
- Grades
- Classroom Teaching Tips
- Assessment
New Teacher Questions

- Will they give me a hard time?
- Why am I so nervous?
- Do I look O.K.?
- How friendly should I be?
- How can I get their attention?
- Should I use a seating chart?
- Who can help me?
- What if I don’t know the answers to their questions?
- What should I do first?
- How much of this stuff do they expect me to know?
The three most important things in classroom teaching are

- Attitude
- Attitude
- Attitude

*ATTITUDE IS EVERYTHING*
Which is more important in your classroom?

- Effective Teaching
- Effective Learning
The goals of a classroom teacher should **NOT** be
- to present material flawlessly from start to finish.
- to present material in the most elegant way.
- to cover every page of the text.
- to cover every possible type of problem.
Goals of Classroom Teacher

- The goals of a classroom teacher SHOULD be
  - to try to help the students learn what they should know about the subject.
  - to view the teacher’s role as a tutor
    - to get the students through the hard parts
    - as a friend to help students
  - to emphasize the applications of the material.
  - to make homework that reviews the material.
  - to make homework that extends the material to practical applications.
Formal Educational Structure
Educational Goal of Course

- Concise statement. “The goal of the course is to … ”
- For ECE 6530 “Modulation, Diffractive, and Crystal Optics”
  “to provide a working knowledge of temporal and spatial optical modulation, diffractive optical devices, and crystal optics.”
Educational Objectives of Course

- Statements of specific things that the student should be able to do. “The student should be able to …”

- For ECE 6530 “Modulation, Diffractive, and Crystal Optics”
  - “to describe the origin and characteristics of material dispersion.”
  - “to describe the dipolar origin of crystalline birefringence.”
  - “to describe the relationships between E, D, B, and H fields of an electromagnetic wave in a birefringent crystal.”
  - “to solve the wave equation for plane waves in a birefringent crystal.”
  - “to calculate the phase velocity refractive indices for a given wavevector direction in a birefringent crystal.”
  - “to use allowed wavevector surfaces to calculate refraction and reflection characteristics at an interface between birefringent crystals.”
Syllabus

ECE 4500
OPTICAL ENGINEERING
Course Syllabus

- Light Sources and Light Measurement (Chapter 2, Pedrotti and Pedrotti)
- Radiometry / Photometry
- Blackbody Radiation
- Light Emitting Diodes (LED)
- Lasers
- Coherence (Spatial and Temporal)
- Photodetection
Information Sheet

- Instructor’s Name and Contact Information
- Time and Place of Class
- Office Hours
- Required and Optional Texts and Materials
- Course Organization
- Course Software (WebCT, T-Square, Blackboard)
- Grade Distribution (homework, tests, written project, oral presentation)
- Dates of Tests, Project, Presentations
- Rules of Homework, Tests, and Projects
Teaching Styles
Using the Board and a Marker

I. LEVELS AND TYPES OF QUESTIONS
   1. LOWER AND HIGHER LEVEL QUESTIONS
   2. OPEN AND CLOSED QUESTIONS

II. PLANNING QUESTIONS
    INTERACTION SKILLS
    1. PHYSICAL SETTING
    2. INSTRUCTOR ATTITUDE

III. PLANNING QUESTIONS
Using Overhead Projector or Document Camera and a Pointer

DIFFERENTIAL - INTERFERENCE - CONTRAST
(NOMARSKI) MICROSCOPY

RAY PATHS
OBJECTIVE PATH VARIATIONS

Differential-Interference-Contrast Image of a Binary Lens
DEVIATION BY PRISM

A ray of light in air is incident at an angle $\alpha$ upon a prism of index of refraction $n$. The two refracting surfaces of the prism are inclined by an angle $\phi$. The medium surrounding all sides of the prism is air. Show that the deviation, $\delta$, of the light ray upon passing through the prism is

$$\delta = \alpha - \phi + \sin^{-1}\{n \sin[\phi - \sin^{-1}(\sin\alpha/n)]\}.$$
Using PowerPoint and Animation

Plane Perpendicular to Surface Containing Grating Vector

(Normal to Surface)

Plane Perpendicular to Surface Containing Grating Surface Fringes

Plane Containing Grating Surface Fringes and Incident Wavevector

Plane of Incidence

Plane Perpendicular to Wavevector

$\theta'$

$\phi$

$\psi$

$\alpha$

$\delta$

$E$

$K$

$\xi$
Using a Personal Response System

Interwrite
Using a Personal Response System

- Two-Line Display
  - Displays multiple questions/answers
  - Scroll through questions/answers
  - Receive visual notification/feedback

- Dedicated keys
  - True/False
  - Multiple Choice
  - Rank ordering
  - Numerical values
Using a Personal Response System

- Transmitter
  - 915 MHz
  - 3 LED’s
  - Power
  - Low Battery
  - Vote Status

- Receiver
  - USB
  - Power
  - Signal
  - LCD Display
  - Total Votes
  - Percentages of A through F

i-clicker
Course Software
Course Management Software

• Blackboard, WebCT
• Buzzport
• College, School Web Sites
• Mastering Physics
• Horizon Wimba
• Sakai
  • T-Square (Georgia Tech)
  • Stellar (MIT)
ECE 4500: Optical Engineering
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<th>Problem Title</th>
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T-Square Homework Problems (Modules)

Homework Problems

The content sections of this module are as follows:

5.1 Aluminum Gallium Arsenide Slab Waveguide
5.2 Angular-Division-Multiplexed Holographic Storage
5.3 Arrayed Waveguide Grating Router 1
5.4 Arrayed Waveguide Grating Router 2
5.5 Arrayed Waveguide Grating Router 3
5.6 Arrayed Waveguide Grating Router 4
5.7 Arrayed Waveguide Grating Router 5
5.8 Arrayed Waveguide Grating Router 6
5.9 Biconvex Lens - Circle of Least Confusion
5.10 Biconvex Lens - Thin-Lens Paraxial-Ray Focal Len
5.11 Biological Microscope Components
5.12 Birefringent Filter
5.13 Borosilicate Crown Glass Properties
5.14 Brightness Comparison
5.15 Carbon Dioxide Absorption Peak
5.16 Chromatic Aberration in Micro-Sphere Lens
5.17 Circle of Least Confusion
5.18 Close-Up Attachment Lenses
Grades
# Grades Spreadsheet Format (Excel)
(any course management software)

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Challenge: “Students are Leaving Engineering”

- Survey of 713 engineering students

- Research universities, in particular, often make a **half-hearted** attempt to encourage faculty to be more effective teachers.”

- “The way a teacher **interacts** with students is seldom accorded the importance it deserves.”

- “Expression, intonation, and body language that might convey a **condescending attitude** need to be modified.”
Challenge: “Students are Leaving Engineering”

- “One effective way of building rapport is for a professor to let students know that he or she had to struggle at times.”

- “Measuring teaching along the two dimensions of 1) interpersonal rapport and 2) teaching skills suggests that a professor’s approachability is perhaps more important than his or her teaching abilities.”

- “While learning to teach well takes time, being personable can be implemented immediately.”
Set the Right Tone.

Two Approaches to the Same Issue:

“If you do not turn in your homework by the beginning of class, I will grade you down or possibly not accept it at all.”

(Threat)

“Please turn in your homework by the beginning of class, so that you can avoid any possible late penalties.”

(Polite Helpful Request)
Know Your Students’ Names.

YOU IN THE FRONT ROW... ARE THESE RESULTS STATISTICALLY SIGNIFICANT?
Learning Students’ Names

- By calling on them in class
  pick names in advance

- By calling their names when returning papers

- By supplying name cards to use in class
Encourage Open Discussion.

HOW IN THE WORLD DID YOU COME UP WITH THAT ANSWER?

I DON’T FEEL SO GOOD

POOR TOM
Encouraging Discussion

- Ask questions.
- Give credit for “participation.”
- Call on particular students - pick names in advance
- If they don’t know the answer
  - Lead them step-by-step to correct answer.
  - Twist their incorrect words and make them correct.
  - Call on someone who is likely to know answer.
Appreciate the Student’s Viewpoint

Solve:

\[
\frac{\sin x}{n} = 6
\]
Appreciate the Student’s Viewpoint

Solve:

\[
\frac{\sin x}{n} = 6
\]

Student Solution:

\[
\frac{\sin \pi x}{\pi} = \sin x = 6
\]
Appreciate the Student’s Viewpoint

Solve:

\[ \frac{\sin x}{n} = 6 \]

Student Solution:

\[ \frac{\sin \pi x}{\pi} = \sin x = 6 \]

Teaching Tip:
Be explicit. “Solve for x in the following equation.”
Appreciate the Student’s Viewpoint

Instructor’s Example:

\[ \lim_{{x \to 8}} \frac{1}{{8 - x}} = \infty \]
Appreciate the Student’s Viewpoint

Instructor’s Example:

$$\lim_{x \to 8} \frac{1}{8 - x} = \infty$$

Test Question:

$$\lim_{x \to 5} \frac{1}{5 - x} = \text{[Blank]}$$
Appreciate the Student’s Viewpoint

Instructor’s Example:

\[
\lim_{{x \to 8}} \frac{1}{8 - x} = \infty
\]

Test Question:

\[
\lim_{{x \to 5}} \frac{1}{5 - x} =
\]

Student Response:

\[
\lim_{{x \to 5}} \frac{1}{5 - x} = \infty
\]
Appreciate the Student’s Viewpoint

Instructor’s Example:

\[
\lim_{x \to 8} \frac{1}{8 - x} = \infty
\]

Teaching Tip:
Avoid examples that
1) have unintended symmetries,
2) produce oversimplified answers,
3) produce answers that may be misinterpreted.
Check your examples before using them in class!
Example Question and Answer

What did Mahatma Ghandi and Genghis Khan have in common?

Teaching Tip:
Be explicit and complete in your questions.
Example Question and Answer

Name six animals which live specifically in the Arctic.

Teaching Tip: Be explicit!
Example Question and Answer

Name one of the early Romans’ greatest achievements.

Teaching Tip: Be explicit!
Example Question and Answer

Name the wife of Orpheus, whom he attempted to save from the underworld.

Teaching Tip: Be explicit!
Example Question and Answer

Where was the American Declaration of Independence signed?

At the bottom.

Teaching Tip: Be explicit!
How Difficult Should Your Tests Be?

FOXTROT

THAT ECE TEST WAS IMPOSSIBLE!

TOTALLY IMPOSSIBLE!

IT WAS RIDICULOUS!

COMPLETELY RIDICULOUS!

THERE WASN'T A SINGLE QUESTION THAT WAS EVEN REMOTELY DOABLE.

NOT A ONE.

GOOD THING WE DIDN'T WASTE A LOT OF TIME STUDYING FOR IT.

NO KIDDING.
# Semantics

<table>
<thead>
<tr>
<th>Professor’s Description</th>
<th>Student’s Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trivial problem</td>
<td>Reasonable problem</td>
</tr>
<tr>
<td>Drill problem</td>
<td>Possible problem</td>
</tr>
<tr>
<td>Useful problem</td>
<td>Difficult problem</td>
</tr>
<tr>
<td>Interesting problem</td>
<td>Extremely difficult problem</td>
</tr>
<tr>
<td>Challenging problem</td>
<td>Essentially impossible, can only be worked by Nobel laureate</td>
</tr>
<tr>
<td>Difficult problem</td>
<td>No solution exists</td>
</tr>
<tr>
<td>Typical problem</td>
<td>Only problem that the professor can work</td>
</tr>
</tbody>
</table>
Decide Your Policy on Re-grading Exams.

FOXTROT

A "79"? But... but... that's a "C"! I can't go home with a "C"!
I gave you the grade you earned, Peter.
One more point and I'd have a "B"! Please, sir, please! Couldn't you at least double-check everything?
I mean, take problem four — shouldn't I at least get a little partial credit?
I suppose writing "I haven't a clue how to do this" does take some effort.

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Historical Examples

Michael Faraday
Enforce a Strict but Tasteful Dress Code.
Taboos (Not to be Discussed)

- Appearance (Dress, Hair, Weight, etc.)
- Child Raising
- Personal Finances
- Politics
- Race
- Religion
- Sex
Call on Students to Show Their Work.

Georgia Tech Archives
Provide State-of-the-Art Demonstrations.

Georgia Tech Archives
Tour of State-of-the-Art Research Labs.
Assessment
Self-Assessment of Classroom Teaching

- Observation and written evaluation provided by the Georgia Tech Center for Enhanced Teaching and Learning (CETL).
- Videotaping provided and subsequent consultation by the CETL or by ECE or by self.
- Consultation, following the above, with CETL.
- Self-evaluation.
Student Assessment of Classroom Teaching

- Student evaluation requested by the instructor.
- Student evaluation by the Georgia Tech Course Instructor Opinion Survey.
Further Information 1

- **Active Learning**
  [http://www.cie.purdue.edu/teaching/view.cfm?TeachID=14&CatID=2](http://www.cie.purdue.edu/teaching/view.cfm?TeachID=14&CatID=2)
  Purdue University, Center for Instructional Excellence

- **Compendium of Suggestions for Teaching with Excellence**
  [http://teaching.berkeley.edu/compendium/](http://teaching.berkeley.edu/compendium/)
  UC-Berkeley, Office of Educational Development

- **Forum on Educational Innovation**
  MIT, Teaching and Learning Laboratory

- **Getting and Using Course Feedback**
  [http://ctl.stanford.edu/Handouts/web/SU/getting_feedback.html](http://ctl.stanford.edu/Handouts/web/SU/getting_feedback.html)
  Stanford University, Center for Teaching and Learning
Further Information 2

- **Humor in the Classroom**  
  [http://ase.tufts.edu/cae/occasional_papers/humor.htm](http://ase.tufts.edu/cae/occasional_papers/humor.htm)  
  Tufts University, Center for Academic Excellence

- **Making Lectures Interesting**  
  [http://www.ou.edu/idp/tips/ideas/lectures.html](http://www.ou.edu/idp/tips/ideas/lectures.html)  
  University of Oklahoma, Instructional Development Program

- **Plagiarism and the Web**  
  [http://www.cmu.edu/teaching/resources/plagiarism.html](http://www.cmu.edu/teaching/resources/plagiarism.html)  
  Carnegie Mellon, Eberly Center for Teaching Excellence

- **The Scholarship of Teaching and Learning**  
  [http://www.carnegiefoundation.org/elibrary/docs/bibliography.htm](http://www.carnegiefoundation.org/elibrary/docs/bibliography.htm)  
  The Carnegie Foundation for the Advancement of Teaching
Further Information 3

- The Teaching Resource Exchange
  [http://www.uiowa.edu/~centeach/tre](http://www.uiowa.edu/~centeach/tre)
  University of Iowa, Center for Teaching

- Teaching to Variation in Learning
  [http://www.brown.edu/Administration/Sheridan_Center/workshops/CognitionWorkshop/new_dev/index.shtml](http://www.brown.edu/Administration/Sheridan_Center/workshops/CognitionWorkshop/new_dev/index.shtml)
  Brown University, Sheridan Center for Teaching and Learning
Comments or Questions?
Back-Up Slides
Properties of Good Teaching

- A desire to share your love of the subject with students;
- An ability to make the material being taught stimulating and interesting;
- Facility for engaging with students at their level of understanding;
- A capacity to explain the material plainly;

Properties of Good Teaching

- Commitment to making it absolutely clear what has to be understood, at what level, and why;
- Showing concern and respect for students;
- Commitment to encouraging student independence;
- An ability to improvise and adapt to new demands;

Properties of Good Teaching

- Using teaching methods and academic tasks that require students to learn thoughtfully, responsibly, and cooperatively;

- Using valid assessment methods;

- A focus on key concepts, and students' misunderstandings of them, rather than on covering the ground;

- Giving the highest-quality feedback on student work;

Properties of Good Teaching

- A desire to learn from students and other sources about the effects of teaching and how it can be improved.

Concepts to Shape Teaching

- **Empathy.** Students will respond when they know that you genuinely care about them.
- **Active Learning.** Student participation will facilitate learning.
- **Judicious Interplay of Groups and Individuals.** Learning is a solitary activity, yet it can be enhanced by group work.
- **Empowerment.** Encourage students to feel that they are responsible for their own learning successes.

Classroom Issues

- Late arrivals to class
- Lack of motivation
- Confrontation in class
- Medical emergency in classroom
Statistics Display (Student View)