Extraordinary Education from Ordinary Ideals

Adam Johnston
Weber State University

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My Qualifications:

• Officially, I advise about 2 graduates per year.

• Unofficially, I’m advising many more science teaching students . . .

• about one-third of whom move to Texas after graduation.

• The majority of my time is spent playing with toys.
Introduction

• First, a brief lesson on fluid dynamics and chaos . . .
• We’re often used to systems that can be defined by a few variables. Once those are determined, the rest of the system is predictable.
• Do we treat our classrooms, students, and learning in the same way we consider these systems?
Limits of control and the “variable” of learning

- **Learning** is the responsibility of
- **Students**, who are in the classes of
- **Faculty**, who are teaching a
- **Curriculum**, which is within the jurisdiction of a
- **Course**, which fits into a university
- **Program**, that students get directed to by

**Academic Advisors**

So, let’s step back and look at what this is all about.
The Zeroeth Law

• Why are you an educator?

• What we do is more important than just a “job”. This is our future. This is about my children, their society, their planet . . .

• We can’t afford to be ordinary.
Introduction to Poetry
Billy Collins

I ask them to take a poem 
and hold it up to the light 
like a color slide

or press an ear against its hive.

I say drop a mouse into a poem 
and watch him probe his way out,

or walk inside the poem's room 
and feel the walls for a light switch.

I want them to waterski 
across the surface of a poem 
waving at the author's name on the shore.

But all they want to do 
is tie the poem to a chair with rope 
and torture a confession out of it.

They begin beating it with a hose 
to find out what it really means.
The message from poetry

What do we expect to be the result of an education?
To write a poem? To understand literature? To recite a poem? To do physics? To understand some physics? To memorize some physics? To build a widget? To get a degree? To make more money? To be a doctor?
Goals: A great but subtle contrast

Students’ goals are concrete and immediate:

• What major should I declare?
• What class should I take?
• How do I get an ‘A’?
• How do I solve problem number 42, part b?

Educators’ goals are abstract and long term:

• What is an educated citizen?
• How do we educate students to be critical thinkers?
• What does an ‘A’ mean?
• Why do we assign #42?
Our goals:

One example

- “Students will develop a sense of self.”
- “Students will develop a sense of self in relation to families and community.”
- “Students will develop an understanding of their environment.”

These are taken from Utah’s Kindergarten core curriculum standards.
Our goals:
Lessons from Undergraduate Research

FACULTY GOALS:

• The “process of science”: “How do we come up with ideas in the first place, and what is the process for chasing them down.”

• Appreciation for science: “I want them to experience the joy of scientific discovery.”

• Valuable skills: “…learning how to design experiments or field work, working with groups when this occurs, developing oral and written communication skills.”

• Goals and future

STUDENT OUTCOMES:

• Problem solving and analysis

• New laboratory skills: “[A]fter isolating DNA from tissue, I performed molecular sequencing tests.”

• Using computers/programming

• Collecting data and doing statistics

• Reading journal articles and doing literature searches/review

• How to write

• Overarching focus on practicalities of doing research.
Our goals:
Lessons from 1000 problems

Students do not overcome conceptual difficulties after solving 1000 traditional problems

Eunsook Kim and Sung-Jae Pak
Physic Education Department, College of Education, Seoul National University, Seoul 151-742, Republic of Korea

(Received 28 March 1998; accepted 24 August 2001)

The relation between traditional physics textbook problem solving and conceptual understanding was investigated. The number of problems a student solved, as estimated by students themselves, ranged from 300 to 2900 with an average of about 1500. The students did not have much difficulty in using physics formulas and mathematics. However, we found that they still had many of the well-known conceptual difficulties with basic mechanics, and there was little correlation between the number of problems solved and conceptual understanding. This result suggests that traditional problem solving has a limited effect on conceptual understanding. © 2002 American Association of Physics Teachers.

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17. An elevator is being lifted up an elevator shaft at a constant speed by a steel cable as shown in the figure. All frictional effects are negligible. In this situation, forces on the elevator are such that:

- A. the upward force by the cable is greater than the downward force of gravity.
- B. the upward force by the cable is equal to the downward force of gravity.
- C. the upward force by the cable is smaller than the downward force of gravity.
- D. the upward force by the cable is greater than the sum of the downward force of gravity and a downward force due to the air.
- E. none of the above. (The elevator goes up because the cable is being shortened, not because an upward force is exerted on the elevator by the cable).
Our goals:

Our goals are relative . . .
Our goals:
Our goals are relative . . .

“For its part, science education . . . should help students to develop the understandings and habits of mind they need to become compassionate human beings able to think for themselves and to face life head on. It should equip them also to participate thoughtfully with fellow citizens in building and protecting a society that is open, decent, and vital. America's future . . . depends more than ever on the character and quality of the education that the nation provides for all of its children.”

from Project 2061: Science for All Americans
What is learning? Multiple models from multiple perspectives

- Stimulus & response: Behaviorism (switchboard model)
- Information processing & storage (computer model)
- Being able to do something (apprenticeship model)
- Conceptual change theory (philosophy model)
- Developing new appreciation and affect (psychological model)
- Developing a new sense of self versus culture (anthropological model)
- [and many others]
Models of learning:

An Educational Anthropologist’s View

• Learning as “identity transformation” -- much different than a physicist’s typical model

• High school students’ (girls in particular) views of learning, success, goals in “Active Physics” classroom (Carlone, 2004)

• Science students’ (women, minority) incorporation of self into science fields dominated by those of different cultures (Carlone & Johnson, 2007)
What is learning?

Conceptual Change Theory

Conditions for conceptual change:
• Understanding
• Plausibility
• Fruitfulness
• Dissatisfaction

Moreover, conditions for conceptual change are impacted by extrarational factors:
• Attitudes
• Engagement
• Beliefs
• Views of learning
What is learning?

The students’ views

Students ask questions with the following frequencies in an astronomy course:

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course logistics and miscellany</td>
<td>14%</td>
</tr>
<tr>
<td>Procedural</td>
<td>5%</td>
</tr>
<tr>
<td>Tourist</td>
<td>35%</td>
</tr>
<tr>
<td>Conceptual</td>
<td>22%</td>
</tr>
<tr>
<td>Epistemological</td>
<td>9%</td>
</tr>
<tr>
<td>Reflective</td>
<td>15%</td>
</tr>
</tbody>
</table>
What is learning?
The students’ views
What is learning?

Students’ perspectives

• A student is more likely to get this question right if taking the class in person vs. online.

• When answering *incorrectly*, a student is more likely to say “the professor will answer B” [correctly] if taking the class in person.

• *And*, the ability a traditional classroom student to predict the professor’s answer correctly better correlates with overall course performance than the student’s own answers.
The power of a person

To me, all of these data describe education not as a way to get information out of a text/computer/library, but instead something that requires:

• Mistakes
• Modeling
• Demonstration of the bigger picture
The personal invitation

A useful model for how this can be enacted is exemplified by a favorite musician of mine: Brandi Carlile (musician) = Sherry Southerland (my graduate advisor)
What do we learn from all of this?

“Education” does not happen accidentally or automatically, even with all the right conditions.

Our goals need to be clear, and if we can make these explicit to students, the more advantage they have.

Learning is not a simple accumulation of information or addition of lines on a transcript; it’s a personal endeavor that requires personal connections.

Conclusion