Let Data Drive Student Inquiry

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How do we move from talking about critical thinking to doing it in the classroom? The answer lies in a “data-intensive” instructional approach, which transforms mundane textbook content into student learning activities that foster an “attitude of inquiry.” During this session participants will experience and analyze critical thinking tasks that place students into activities common among university faculty inquiry, discovery, interpretation, invention, scholarship, and application of research.

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“Critical Thinking is... self-directed, self-disciplined, self-monitored, and self-corrective thinking.”

(Richard Paul and Linda Elder)
It’s easy to change what people know.

It’s much harder to change how people think.
Some data collected from several university professors

“No, I will not share my lecture notes with colleagues—I spent years developing these.”

“I have to lecture because students won’t be able to understand these concepts on their own when they read.”

“If I post my lectures on the web, students won’t have a reason to come to class anymore.”

“___(my specialization here)___ is so complex and difficult that students have to learn all the basics first, before they can even begin to…”

“If I post all my notes on the web, the students will have all the answers for the test.”
You are anthropologists doing an ethnographic study of university culture.

Work with the other anthropologists at your table. Together, create a single hypothesis about university culture to explain how all of these data are related to key cultural characteristics.

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Meta-cognitive moment:

You have just experienced a “Data Splash”

Raw data = basis for activity design

- Compare and contrast individual data points (analysis)
- Construct hypothesis (synthesis, abstraction, prediction)
- Imagine, speculate, guess (attitudinal development)
The professors’ statements reflect a broadly accepted view of university practices

- Information transfer drives teaching
  (knowledge is power and authority)

- Information reception drives “learning”
  (students expected to wait for teacher to disseminate the “correct” information)

*How did we get here?*
One root of the problem is medieval

In Europe of 1200 AD...

- Not many books
- Not many readers
- Not much “information”
- Information is “sacred” & owned by a few
- Professor-priest = guardian of knowledge
...plus, a modern source of the problem

The enormous amount of available information leads to...

“the panic of teaching content”
Higher Ed’s “Perfect Storm”

The medieval **sacredness** of information confronts the modern **deluge** of information.
Higher Ed’s “Perfect Storm”

Consequence: the “insanity” of the modern university course:

We press harder and harder to teach more and more information, while students seem to achieve less and less.
One professor’s personal insanity:

“Since my students only remember 10% of what I tell them, I have to tell them 10 times the amount that I want to tell them, so that the 10% they remember is 100% of what I really want them to learn.”
Every professor’s dilemma
and every student’s nightmare:

EVERYTHINGMUSTBETAUGHTANDE
EVERYTHINGMUSTBEREMEMBEREDB
ECAUSEEVE
RYTHINGIS
ESSENTIAL.
EVERYTHING MUST BE TAUGHT AND EVERYTHING MUST BE REMEMBERED BECAUSE EVERYTHING IS ESSENTIAL.

So, why wouldn't students continually ask,

“Hey, Professor, can you tell us what’s going to be on the test?”?
Frustrated Student:

“You want me to try to guess the answer? How can I? You haven’t even covered that chapter yet!”
How do we escape the insanity?
One assumption and one strategy

Assumption:
The goal of instruction is to create dynamic conditions that promote student inquiry.

Strategy:
Dynamic conditions are created by subverting the traditional “academic model” for teaching and learning.
What is the Academic model?

1. Instructors think: my students need to know a lot before they can be expected to think for themselves

2. Students think: I need to know a lot before I can be expected to think for myself

(Dominant operational value: students should not be expected to ask questions until they know lots of answers!!)
General effects of the academic model

- **Non-dynamic relationship** with information: students have *nothing to discover* as beginners

- **No connectivity** between data and concepts or theories (analytical thinking—see PIT Case from Session I)

- **Students’ lack of independence, and lack of a sense of responsibility** for their own learning and thinking skills
How do we subvert the academic model?

(re-) “problematize” the knowledge of the discipline...

...to inhibit easy consumption

...to reveal the originating questions of the discipline
Work in groups to complete the following 3 tasks.

In the envelope you will see several small texts. Each text is a test question.

1. Identify a “reader” for your group, to read each statement out loud. Listen, and as a group, order these questions from most difficult to least difficult. Do not sort according to discipline...the sorting criterion is the level of intellectual challenge.

2. If possible, identify categories of questions according to difficulty. (group 1, group 2, etc.)

3. Invent a descriptive name/label for each category
Reflection I

What difficulties did you have in trying to categorize these questions? (where did you find reason to debate or discuss?)
Reflection II

The question-sorting exercise is loosely based on common education concepts that inform course and assessment design (Bloom)

- recall
- comprehension
- application
- analysis
- synthesis
- evaluation

Why is it possible for experienced educators (experts!) to disagree and have a “new” discussion about concepts and theories that are very familiar?
Revisiting data upon which our theories/concepts/principles are based reveals the “problems” that created the need for the theory to begin with.
What did Socrates do to make his students think?

Problematize the familiar by looking at familiar concepts as represented through specifics

What is love?
What’s an example of love?
Is this an example of love?
Is that an example of love?
Why this one and not that one?
If this one, then define love as you really mean it (create a concept)
One way to problematize the familiar: “inductivize”

1. **Identify key concepts** (my example: Bloom’s Taxonomy)

2. **Find or invent “data” or representations of data that concretize the concepts** (e.g. the test questions)

3. **Ask students to work backward from examples to concepts** (inductive reasoning)
   i.e. discover/uncover the original question(s) that made the data relevant
Bloom’s Research

- Collected thousands of questions and assignments to compare and sort
- Created categories according to cognitive principles

The question exercise is a staged *retracing* of Bloom’s familiar research.
Another example of staging an inquiry: the case of the missing causality
This task is from Environmental Chemistry

Note: if you have a strong background in atmospheric or related sciences, please take the role of “silent observer” while your group carries out the following activity.
The graph represents the relationship between

- altitude
- atmospheric pressure
- atmospheric temperature
Work in groups at your tables to prepare answers to the following:

- Which of the lines indicates changes in pressure?
- Which of the lines indicates changes in temperature?
- How do you explain the contrasting shapes of these two lines?
Meta-cognitive moment

How did you (and your group) go about answering the question? What was your process?
What this exercise does...

- Asks students to use their rudimentary knowledge, intuition, imagination, personal experience, and analytical skills to explain data related to phenomena.

- Forces students to speculate (think conceptually) without complete information.
  - (Lack of determinant framework and details forces conversation to be conceptual rather than “calculational”)

What all good experts do a lot of...

Attempt to predict the data that will be collected, given the research question (hypothesis)

Make “educated guesses” based on limited, minimal or even no data

Speculate, estimate, “guesstimate” and imagine....
Reflection

This graph was lifted directly from a textbook for Environmental Chemistry.

At your tables, take a minute and speculate on the probable function of this graph in the textbook chapter on the chemical composition of the atmosphere.
How the textbook presented the graph...

- After a detailed description of atmospheric composition and information about variation of pressure and density with altitude.
  - Telling the students stuff

- After instructions on how to write it as an equation.
  - Telling the students stuff

- As a non-active visualization after loads of information
  - Visual aid repeating what they’ve been told
Beware the "learning style trap":

Providing students with multiple representations of material (visual, verbal, kinesthetic, etc.) to appeal to multiple learning styles does not, by itself, foster more advanced thinking nor a critical thinking attitude.
College textbooks =

Expensive books that provide long answers to questions that students never asked
The function of a textbook within the academic model:

provide flawless, complete information

Assumption:

*if you can memorize a biology textbook, you will be a biologist (or a good candidate for medical school!!!)*
Why textbooks often fail our students and undermine instruction

Illusion of comprehensiveness

Illusion of seamless continuity

Illusion of knowledge as “finished” (i.e. not worthy of further inquiry) rather than “under construction”
Our challenge going forward:

We need to change students’ relationship with the information of our discipline

We need to take the stuff of textbooks and lectures and turn them into objects of inquiry
Let Data Drive Inquiry

1. Start with the raw materials and common representations of the discipline (images, charts, graphs, paragraphs)

2. Isolate the material from its context ("stage it") so students have no access to an explanation
   
   Lift it from the book/article and make a photocopy
   Delete context
   Delete introduction (literature, art)
   Use "similar" or parallel cases not in the textbook

3. Require students to make a specific judgment about the meaning/importance of the material/object (force a "guess") BEFORE readings or lectures on the same information.
In a classroom that targets fundamental change in how students see themselves in the learning process...

...students navigate encounters with what is new, unfiltered, unfamiliar, and untidy...BEFORE they learn all the procedures and conceptual tools that show the way
Examples:

Make a judgment about this art object (before I’ve lectured on it)

Explain how X theorem or concept could be used in this situation (which you have never seen before)

Read this historical document (that you have never seen before), and explain who might have written it, and why.

*(small groups help offset the student anxiety that comes with this)*
Next up...

The Courage to Think