Student-Centered Learning:

Inquiry, Interactive Lecture, & Authentic Assessment

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How do we view "instruction"?

"The previously dominant view of instruction as direct transfer of knowledge from teacher to student does not fit the current perspective.

The present view places the learner's constructive mental activity at the heart of all instructional exchanges…"

Structured Discovery

"…This does not mean that students are left to discover everything for themselves, nor that what they discover and how they choose to describe and account for it are left solely to them…

Valid and powerful knowledge

"…Instruction must provide experiences and information from which learners can build new knowledge. Instruction helps to focus those processes so that the resulting knowledge is both **valid and powerful**. Valid in the sense of describing the world well…and powerful in the sense of being useful and reliable for those students in many diverse settings."

J. W. Layman,
Natl. Center for Cross Disciplinary
Teaching and Learning

Dispenser of knowledge vs. facilitator of learning

THINK/PAIR/SHARE

Ideally, what percentage of your total contact time with student each year would you like to spend as…

_____ Dispenser of knowledge

_____ Facilitator of discovery learning

What actual percentage of your total contact time with student this year was spent as…

_____ Dispenser of knowledge

_____ Facilitator of discovery learning

How do we get there?

- **Incrementally…**
  - Small changes
  - Practice is essential
  - Expect resistance
- **Experimentally…**
  - A learning process for all
  - Some things work well in your setting
  - Most things need "tweaking"

Teaching and Learning:
Three Strategies Toward a Student-Centered Classroom

Incorporating Inquiry-Based Lessons

Building Interactive Lectures

Utilizing Authentic Assessment

Inquiry-Based Teaching and Learning

What is it?

Why do it?

How do you do it?

"Cookbook Labs"

Why do it?

Why do YOU use cookbook labs?

Write down at least one purpose they serve in your course(s)

"Cookbook Labs"

Why do it?

Goal: Follow the written procedure as carefully as possible in order to produce the expected result and answer the questions correctly

What is it?

Inquire (verb)

- *To ask about*
- *To search into especially by asking questions*
- *To make investigation*

Inquiry approach places the student in the role of the investigator

- Asking questions
- Structuring investigations
- Confronting ambiguous findings
- Constructing relationships and creating metaphors

Learners…

- Are **engaged** by scientifically oriented questions.
- Give priority to **evidence** which allows them to develop and evaluate explanations that address scientifically oriented questions
- **Formulate explanations** from evidence
- **Evaluate their explanations** in light of alternative explanations, especially those reflecting scientific understanding; and
- **Communicate and justify** their proposed explanation.

National Research Council (NRC). (2000). *Inquiry and the National Science Education Standards.* Washington, DC: National Academy Press.

Inquiry-based Learning & Scientific Research: Parallels

Laboratory Researchers	Classroom Students
Focus on particular topics. Topics may change over time.	Topics of study are defined and are addressed at particular points in the curriculum.
Guided by previous research.	Based on student's previous knowledge AND research on previous findings on the topic.
Researchers and students propose questions they would like to answer.	
Researchers and students design experiments based on their questions AND on the materials available. Experimental designs must be approved.	

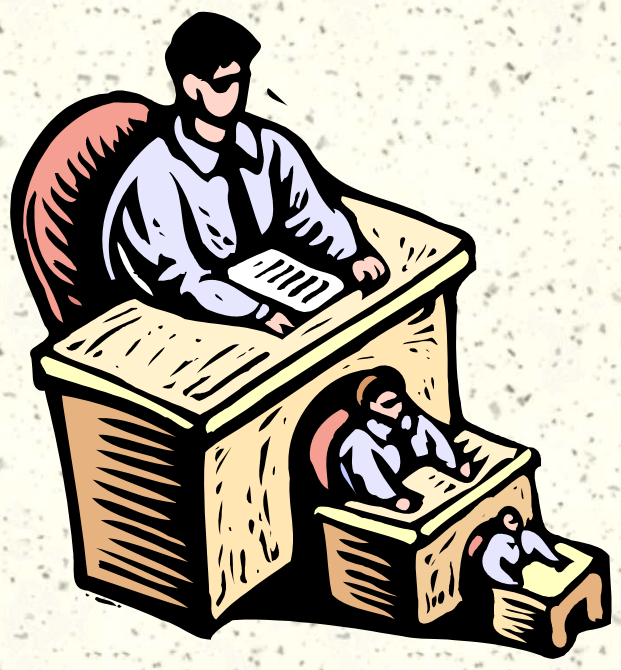
Parallels…continued

Laboratory Researchers	Classroom Students
Both carry out approved experiments, gather data, analyze results, and draw conclusions.	
Both share results with colleagues and, often, revise and retry their experiments based on their findings and the suggestions of colleagues.	
Both pose follow-up questions: What would I do next? What other questions do my findings raise?	
Both share their findings with others.	

Why do it?

- Impact on content knowledge
- Impact on skills that are applicable in diverse situations
- Addresses multiple learning styles
- Science content and complexity increases…knowledge overload
- Scientific literacy for all citizens

How do you do it?



- Inquiry immersion versus inquiry infusion
- Faculty AND students must learn how
- Progressive! NOT all at once!

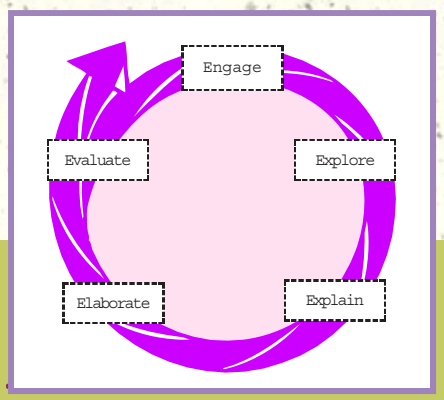
How do you do it?

- Consider ways to facilitate learning rather than dispensing knowledge
- Expand & hone your questioning skills
- Inquiry is NOT a "free for all"
  - Educator sets the focus and parameters
  - Students generate questions within this framework
  - Students design investigations given basic methods and materials

Traditional Approach

- Introduce content verbally and via readings
- Use "cookbook" labs to illustrate and "verify" what was presented
- Complete chapter problems and/or structured activity to practice using new content
- Evaluate -> primarily content acquisition

Learning Cycle



Engage student interest.

Mini-lab, demo, KWL, concept map, video or podcast

Explore content & learn lab skills via concrete experiences

Inquiry or cookbook labs, hands-on explorations, generate questions

Explain questions generated by introducing content

Readings, lecture/discussion, experts, webquest, info sources

Elaborate by applying concepts and lab skills to new inquiry situations

Inquiry labs or activities

Evaluate content, process, and communication skills

Redo KWL or concept map, lab reports, posters, test/quiz, reflection, peer or self-ratings, homework, etc.

Hints on change…

- Use cookbook labs as a starting point…not an end point.
- Do the "cookbook" lab first to generate interest and questions.
- Discuss the lab before verbally introducing content, noting all questions raised
- Use the methods learned in the cookbook lab in a student-centered inquiry that extends the concept exploration.

How do your labs "rate?"

Inquiry Rating Scale

Sutman, 1998

Inquiry Rating	Prelab		Lab	Postlab	
	Proposes the problem or issue to be explored	Plans the procedure to be used	Carries out the procedure	Supplies answers or conclusions	Lab outcomes determine applications, implications, or further exploration/ instruction.
0	Teacher	Teacher	Teacher	Teacher	Teacher
1 - demo	Teacher	Teacher	Teacher	Teacher	Teacher/ Student
2 - demo	Teacher	Teacher	Teacher	Student	Student
3 - cookbook	Teacher	Teacher	Student	Student	Student
4 - guided	Teacher/ Student	Student	Student	Student	Student
5 - full	Student	Student	Student	Student	Student

Rate Your Recent Labs

Write down the title or description of the last 3 labs your students did (can be from one or more than one course).

Now rate each one using Sutman's inquiry rating scale on the previous slide.

BEN provides resources for...

- Guided Inquiry
- Open Inquiry
- Inquiry online
- Inquiry as part of a learning cycle unit
- Transforming "Cookbook" labs into guided/open inquiries

Interactive Lectures

How can a didactic lecture be "student-centered?"

Interactive Lecture

- Breaks the lecture at least once per class
- Students participate in an activity that lets them work directly with material.
- Allows students to:
  - Apply what they have learned earlier; or
  - Gain a context for upcoming lecture material.

Starting Point-Teaching Entry Level Geoscience. Science Education Resource Center - Carlton College, http://serc.carleton.edu/introgeo/interactive/whatis.html

Possible Activities

- Interpretation of graphs
- Making calculations and estimations
- Predictions of demonstrations
- Brainstorming
- Tying ideas together
- Applying what has just been learned in class or reading to solve a problem
- Collecting student responses

Starting Point-Teaching Entry Level Geoscience.
Science Education Resource Center - Carlton College,
http://serc.carleton.edu/introgeo/interactive/whatis.html

Classroom Response Systems

- "Software/hardware system that allows instructors to easily get instant feedback from their students, using remote control devices and a portable receiver…"
  (DIIA Instructional Technologies, U of TX-Austin)

- Impacts
  - Improve attentiveness
  - Increase knowledge retention
  - Poll anonymously
  - Track individual responses
  - Display polling results immediately
  - Create an interactive and fun learning environment
  - Confirm audience understanding of key points immediately
  - Gather data for reporting and analysis
    (Wikipedia – "Audience response")

Classroom Response Systems

- "Software/hardware system that allows instructors to easily get instant feedback from their students, using remote control devices and a portable receiver..." (DIIA Instructional Technologies, U of TX-Austin)
- E-Instruction, Renaissance Classroom Response System, Qwizdom, Turning Point, H-ITT ,PRS , iClicker
- Some comparative info can be found at https://sharepoint.cisat.jmu.edu/tsec/jim/CRS/default.htm
- FAQs:

  http://www.utexas.edu/academic/cit/howto/labinstructions/cpsfaqs.html

A Quick Archive Search (vs. Google)

- Think-pair-share (several sources)
- Case studies during lecture (Goodman, et al., 2005)
- "Rapid response test" – 10 T/F in 5 min (Rao, 2006)
- Role playing by students (van Loon, 1993)
- "Pause" midway through lecture (Trautwein, 2000)
- Classroom Assessment Techniques (CATs) (Angelo & Cross, 1993)
  - High Tech & Low Tech
- Interaction "scoreboard" promoted readiness (Kumar, 2003)
- Colored letter cards (DiCarlo & Collins, 2001)
- Lecture sketchbook (Smoes, 1993)
- Five Bits of Information Learned Today (VanDeGraff, 1992)
- Blunder Lecture (Nayak, et al., 2005)
- Broken Lecture (Nayak, 2006)

Impact?

O'Loughlin used 4 methods regularly:

- Memory matrices
- Learning exercises (e.g., make an ordered list of the pathway of blood through CV system)
- Sample exam questions
- "Muddiest point" survey

Result:

- Consistently higher exam scores
- Higher instructor evaluations
- Positive student comments

O'Loughlin, V.D., 2002

Pros and Cons…

Pro's…

- Increased ability to spot student misconceptions
- More focused lectures
- Increased enjoyment for the instructor due to more interaction with students
- Increased student understanding of the content

Con's…

- Believing that the actively-learned material was always the most important
- Students not participating with group reports
- Not incorporating outside readings into in-class problems
- Active learning tasks not always matched to current abilities of students

His decision…pro's outweighed the con's!
Carroll, R., 1993

Egg timer discussion…

Share with the Group…
What's Your Experience?

- Clickers
- Other Methods

Authentic Assessment

What does assessment look like in a "student-centered" classroom?

Assessment is…

"…an ongoing process aimed at understanding and improving student learning" (AAHE, Angelo, 1995)

- Make expectations public and explicit
- Set appropriate criteria & standards for learning
- Gather, analyze, and interpret evidence to determine how well performance matches expectations & standards
- Use resulting info to document, explain, and improve performance

Angelo, 1995

Assessment & Intended Purpose

"Assessments must be consistent with the decisions they are designed to inform" (NRC, 1996)

- **Examinations, papers, reports, & projects**
  - Product-based, but no information on how they were constructed
- **Periodic sampling of intermediate materials**
  - "Do you understand what I'm saying?"
  - "Can you tell me how you know?"
  - "Do you understand how to do this?"

Angelo, 1995

Assessment & Intended Purpose

Angelo, 1995

- **Peer-based Editing/Feedback/Grading**
  - Learner as teacher, e.g., "poster session"
- **Performance-based assessment**
  - "Solve this problem/Describe how you would solve this problem"
- **Large-scale survey work**
  - Pre & post tests
- **Interviews, observations, & focus groups**
  - Rich information but time consuming

Tap into different learning styles, levels of knowledge & skill.
If you use only one type…may want to diversify your strategies.

Final notes…

- Student-centered instruction (e.g., inquiry-based lessons & interactive lectures) provide a much richer set of assessment evidence that taps into:
  - Multiple learning styles
  - Process skills as well as content knowledge
  - Multiple levels of knowledge & skills

Final notes…

- Good source of information and examples on authentic assessment:
  - *College Pathways to the Science Education Standards* by Siebert & McIntosh, 2001
  - *Classroom Assessment and the National Science Education Standards* by Atkin, Black, & Coffey, 2001.

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