ESSENTIALS OF LEARNER-CENTERED TEACHING

ACTIVE LEARNING

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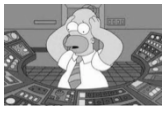
Scenario 1

- You are about ½ way through a reaction engineering lecture. The class is quiet, as usual. Many students struggled with the last exam, yet they do not ask questions in class, even when prompted. Nick is asleep again. Occasionally he will wake up and ask a question, but it is usually something that he missed a few minutes ago during his nap. You ask again, "any questions", and the students respond with blank stares.

- What is going on?

Scenario 2

- You decide to try something different. After discussing exothermic reactions in class, you suddenly say, "A reactor has been operating normally for an extended time. The reaction is exothermic, and the reactor is cooled with cooling water. Suddenly the temperature begins to rise rapidly."
  - What will happen if you do nothing?
  - What should you do?



Scenario 2

- You say "get into groups of two or three, pick a recorder, and figure out what is going on. List all your ideas for what you should do. At the end, I will call on a few of you."
- The students go right to work. The noise level is up. After a minute, when you call on people, you get even more responses from volunteers.
- You spent 2-3 minutes on this activity, during which students were awake and engaged. This is *active learning*.

Traditional (Passive) Learning

- Traditional learning positions students as passive receptors into which teachers deposit information
  - Emphasizes delivery of course content
  - Rewards students for regurgitating content on exams
  - Students with good short-term memories succeed

Passive Learning

- Lecture
- Ask questions that the same few students answer
- Conduct discussions that engage only a small fraction of the class

Active Learning

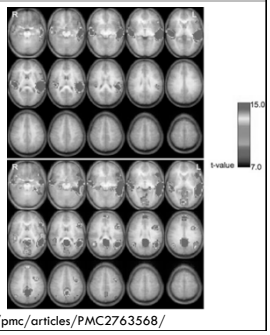
- Active learning is anything course-related that all students in a class session are required to do, other than simply watching, listening and taking notes.
  - Shifts focus from what the instructor should deliver to what the students should be able to *do*
  - Motivates students to be *prepared* for class, having assimilated material and being ready to use it

Active Learning

- Ask a question, pose a problem, or present a challenge
- Tell students to work individually or in small groups to formulate and share responses
- Call on students or groups to share responses

Evidence in favor of Active Learning

- fMRI Images
- Brain activity showing active response during passive (top) and active (bottom) story listening
- Passive: 30s story, 10 sentences
- Active: 5s, 2 sentence segment followed by a Q&A



Vannest et al., J Magn Reson Imaging 29(4), 2009, 971–976. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2763568/

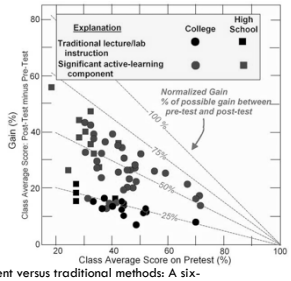
A few facts on lectures*

- Students are not attentive to lectures 40% of the time
- Students retain 70% of the information in the first 10 min
- Students retain 20% of the information in the last 10 min
- 4 months after an introductory psychology course, students knew only 8% more than students who did not take the course

*C. Meyer and T.B. Jones, Promoting active learning: Strategies for the college classroom, San Francisco, Jossey-Bass, 1993.

Active vs. Passive Learning Results

- Class averages on pre- and post-tests of fundamental conceptual knowledge in first-semester physics.
- Learning gains in active-learning classes 2-3 times higher in comparison to lecture courses.
- The data set includes more than 6500 students in 62 classes.



R. Hake, 1998, Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses, Am. J. Phys. 66: 64-74

What about my lecture content?

- Lecture content is still valuable. You must share your expertise on the subject.
- Lecture should not be the only thing you do
- 30s – a couple minutes of activity here and there
  - Wakes up and engages students
  - Results in better retention
  - Results in dramatically better high-level learning

What can you ask?

- Active Learning worksheet #1
- What kind of activities or questions can be used to engage students for 30s-3 min?
- With your group, make a list of generic questions
  - Draw a graph to predict…
  - Troubleshoot a system..,

What can you ask?

- Explain a concept in terms a high school student would understand
- Sketch a diagram
- Solve a short problem
- Outline the solution of a longer problem
- Perform the next step of a derivation
- Predict the outcome of an experiment
- Critique a design
- Troubleshoot a system
- Brainstorm a list
- Formulate a question related to lecture

- Focus on the hard stuff, not the easy obvious stuff.

Active Learning Structure

1. Tell students to form groups of 2-4 and appoint a recorder (if needed)
   - Team can pick a recorder, or
   - Pick recorder born closest to classroom, who woke up earliest that morning, etc.
2. Pose a challenging question or problem
   - Allow enough time for progress toward finishing. Not all groups will finish
   - Time should be 15 s – 3 min
   - If problem requires more time, break it into small steps

Active Learning Structure

3. Call on individuals or groups to share responses
   - If they don't hit on what you are looking for, call on volunteers
   - Discuss and/or move on with lecture

Structure 1: Think-Pair-Share

1. Pose the problem and have students work individually for a short time
2. Have them form pairs and reconcile/improve solutions
3. Call on several individuals or pairs to share responses

- Requires a little more time
- Individual thinking leads to greater learning

Structure 2: Think aloud pair problem solving (TAPPS)*

1. Have students pair up and designate one "explainer" and one "questioner"
2. Explainers have 1-2 min to explain the problem solution to partner
3. Questioners ask questions when explanations are unclear
4. Stop and call on students for explanations
5. Switch roles and continue with next part of solution

Lockhead, J. and Whimbey, A., Teaching analytical reasoning through thinking aloud pair problem solving, in J.E. Stice (Ed.), Developing creitcal thinking and problem solving abilities: New directions for teaching and learning, No. 30, San Francisco, Jossey-Bass, 1987.

Structure 3: In-Class Teams

- Form teams of 2-4 and choose recorders
- Give 15 s – 3 min to
  - Summarize prior material
  - Answer a question
  - Start solving the problem
  - Think of an example
  - Explain a concept
  - Think why a result might be wrong
  - Brainstorm a list…

Structure 4: Note Check*

- Students work in pairs
- Summarize notes and locate misconceptions
- Fill in gaps in their notes
- Approx 3 min

*Johnson, D.W., Johnson, R.T. and Smith, K.A., 1998. Active Learning: Cooperation in the college classroom (2nd ed.). Edina, MN, Interaction Book Co.

Structure 5: Reciprocal Peer Questioning

- Work in groups of 3-4
- Provide generic question templates
  - How does X relate to prior knowledge?
  - What conclusions can I draw about X?
  - What is the main idea of X?
  - What is a new example of X?
- Each student prepares 2-3 questions on topic
- Questions are discussed in small groups, then groups choose especially interesting ones to share

King, A., From sage on the stage to guide on the side. College Teaching, 41 (1), 30-35, 1993.

Structure 6: Concept Tests

1. Ask a multiple-choice question about a concept, with distractors (wrong answers) that reflect common misconceptions.
2. Have students respond using "clickers" and display a histogram of responses. Or have them hold up cards indicating their chosen responses; scan the room for response distribution
3. Have the students pair up, reconcile responses, vote again.
4. Call on someone to explain their response; discuss the correct answer and why the distractors are incorrect

Structure 7: Writing Assignments

- Write about a topic before the lecture, to make connections with prior knowledge
- Summarize main idea of the lecture
- Generate a list of applications or examples
- Make a list of questions about the new material

Brent, R. and Felder, R.M., Writing assignments – Pathways to connections, clarity, creativity. College Teaching, 40(2), 1992, 43-47.
http://www.ncsu.edu/felder-public/Papers/Writing_Paper.pdf
Young, A., Teaching writing across the curriculum (3rd ed.), Prentice Hall, Upper Saddle River, 1999.

Mistakes with Active Learning

1. Making exercises too long (>3 min)
   - Some students will finish quickly and then waste time
   - Others will use whole time, become frustrated and waste class time
2. Calling on *volunteers* after every activity
   - Students learn that they don't have to think
   - Students will talk about sports, parties, etc., and someone else will supply the answer

Your Turn! In-class Groups

- Worksheet Activity #2
- Form groups of 3 and choose a recorder (person who woke up earliest today)
- Brainstorm: What problems or obstacles do you see with active learning?
- 2 min – Go!

Myth: Active Learning Takes Too Much Time

- A few minutes of activity in each class makes a substantial difference in learning outcomes
- Provide handouts for time consuming content such as derivations and diagrams.
  - Allow them to read quickly through the straightforward material
  - Leave gaps for active learning questions related to conceptual material. Spend time on this.
  - You will cover more material and the learning will be enhanced.

Myth: It takes too much time to plan

- Adding activities to lesson plans does not require much time
- Glance at lecture notes before class, use sticky notes to designate active learning opportunities

What if some students don't like to work in class?

- There might be some resistance, especially at first.
  - Some students want instructors to tell them what they need to know for the exam. No more, no less.
- Tell students about the benefits of active learning
  - They will do better on homework and exams

What if some students refuse to join groups?

- Some students may stare straight ahead…
  - Encourage them personally to work with each other
  - After a few times, almost everyone should get the hang of it.
  - If there are a few holdouts, don't worry about it.

Myth: My class size is too large for active learning!

- This video will bust that myth!

Active Learning with Dr. Richard Felder,
http://www.youtube.com/watch?v=1J1URbdisYE

Active Learning Practical Resources

R.M. Felder & R. Brent. (2003). "Learning by Doing." *Chem. Engr. Education, 37(4), 282–283. <www.ncsu.edu/felder-public/Columns/Active.pdf>. The philosophy and strategies of active learning.*

R.M. Felder. (1994). "Any Questions?" *Chem. Engr. Education, 28(3), 174–175. <www.ncsu.edu/felder-public/Columns/Questions.pdf>. Illustrative questions for engineering and* science courses that can serve as the basis of active learning exercises.

R.M. Felder & R. Brent. (1999). "FAQs-2." *Chem. Engr. Education, 33(4), 276–277. <www.ncsu.edu/felder-public/Columns/FAQs-2.html>. Responses to the questions "Can I use active learning exercises in my classes and still cover the syllabus?" and "Do active learning methods work in large classes?"*

R.M. Felder. (2007). "Sermons for Grumpy Campers." *Chem. Engr. Education, 41(3), 183–184. <www.ncsu.edu/felder-public/Columns/Sermons.pdf>. Short speeches to persuade students that* active and cooperative learning are not violations of their civil rights but instructional methods likely to improve their learning and grades.

M.J. Prince. (2004). "Does Active Learning Work? A Review of the Research." *J. Engr. Education, 93(3), 223-231. <www.ncsu.edu/felder-public/Papers/Prince_AL.pdf>. A summary of research* evidence for the effectiveness of active learning.

Active Learning Activity

- ☐ Worksheet #3
- ☐ Introduce 3 active learning strategies into a lecture
  - Use a variety of activities from the list of 7
  - Specify the question you will ask
  - Indicate specific activity (e.g., think-pair-share, TAPPS, etc.)