Active Learning Practice
Assignment

Purpose: This session offers a safe environment for instructors to: 1) practice engaging students in active learning, 2) observe peers using active learning strategies, and 3) exchange constructive feedback for improving the implementation of such strategies.

Registration: Choose one of four sessions at http://crlte.engin.umich.edu/aptregistration/

Assignment: Plan and lead a 10-minute lesson using one of the 6 active learning strategies listed below. Your audience will be a small group of GSIs/IAs and one trained facilitator (about 4 other people), who will both act as students during your session, and provide feedback after the session. Note that:

- The other GSIs/IAs may not be in your field, so select a topic accessible to multiple engineering disciplines to ensure they can engage.
- The rooms will have markers/chalk, whiteboard/blackboard, and pens. Some rooms may have a data projector, but you will need to bring your own laptop.

Details: Successful active learning takes careful planning. Here are some steps to take:

- Determine the learning objectives for the lesson – what do you want students to know or be able to do? Write on the board.
- Plan a short (1-2 min) introduction to stimulate interest and thinking, and make connections to students’ prior knowledge, the big picture and/or the real world. You are encouraged to prepare a handout or any other relevant visuals to help clarify concepts or instructions.
- Plan an activity to get students to use or think about the material you’re teaching in a meaningful way. Decide precisely what you want them to do, and plan clear instructions for the task. Select ONE of the following six teaching strategies (more information on these techniques is attached):
  - Minute paper
  - Think-Pair-Share
  - Thinking Aloud Paired Problem Solving
  - Brainstorming
  - Case Studies
  - Cooperative Groups
- Design meaningful checking questions you will ask students. Write down precisely how you can state them, and then paraphrase them, so that you are prepared with more than one way to ask the questions. Try to predict the answers your questions will generate.
- Plan how you will conclude the lesson, using students’ work.

Resources: To speak with an engineering teaching consultant for ideas or questions go to https://crlte.engin.umich.edu/services/consult-service/
For information on lesson planning, see GSI Guidebook pp. 37-39 or go to: http://www.crtt.umich.edu/gsis/p2_5
For more information about active learning, see GSI Guidebook pp. 86-87 or go to: http://www.crtt.umich.edu/tstrategies/tsal
http://crlte.engin.umich.edu/aptregistration/apt_podcasts/
For videos of GSIs teaching using active learning, go to: http://crlte.engin.umich.edu/resources/gsi-videos/

Afterwards: Reflect on your lesson, make improvements, and implement active learning in your classroom! Keep in mind that Engineering Teaching Consultants and CRLT-Engin staff will be ready to assist you with any teaching question you have during the term.
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<thead>
<tr>
<th>Learning Objectives (Direct the lesson and practice)</th>
<th>Classroom Assessment (Are students getting it?)</th>
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<tbody>
<tr>
<td>At the end of the lesson students will be able to ...</td>
<td>Questions to check for student understanding.</td>
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<th>Connections (How does the lesson connect to prior knowledge, to the big picture, to student interests and concerns?)</th>
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<th>Learning Activities (What are you teaching? How will the students engage with the content as you teach?)</th>
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<th>Conclusion</th>
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<td>Recap the objectives in different words, preview what’s to come</td>
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CRLT-Engin
Active Learning in the Engineering Classroom

What is active learning?
Active learning is a process whereby students engage in activities, such as reading, writing, discussion, or problem solving that promote analysis, synthesis, and evaluation of class content. We learn best by doing.

“Active Learning’ is, in short, anything that students do in a classroom other than merely passively listening to an instructor’s lecture. This includes everything from… short writing exercises in which students react to lecture material, to complex group exercises in which students apply course material to ‘real life’ situations and/or to new problems.” (Paulson & Faust, n.d.)

Why use active learning?
Research studies have shown that active learning practices (like the six options on back) boost student engagement with course material, enhancing learning and increasing performance on assessments. Integrating active learning practices into the classroom also helps to personalize learning and build a learning community among students and instructors.

“As we have seen, a major problem with the lecture is that students assume a passive, non-thinking, information-receiving role. Yet, if they are to remember and use the information, they need to be actively engaged in thinking about the content presented.” (McKeachie, 2005)

How can you incorporate active learning into engineering classroom?
There are many ways to use active learning in the classroom. The table on back summarizes some simple approaches described by others (Active learning, n.d.; Felder & Brent, 1994; Felder & Brent, Fall 2003; Felder & Brent, Summer 1994; Paulson & Faust, n.d.). More examples of active learning teaching methods can be found in the GSI guidebook (pp. 86-87), or at http://www.crlt.umich.edu/tstrategies/tsal

Does active learning work?
Some examples of research findings on the impact of active learning include:

- Freeman et al. (2014) conducted a meta-analysis involving high enrollment lectures and found that active learning increased student performance on exams by an average of 6%, and decreased failure rates for these courses from 34% to 22%.
- Reimer et al. (2016) found active learning to be particularly beneficial to first-generation college students in STEM courses, boosting both retention and passing rates.
- Gray et al. (2010) found students who used ‘hands-on’ active learning outperformed the control group, who passively received a lecture, on a concept test by a mean of 68%.

“In short, if you start using active learning in your classes, you can expect to see some initial hesitation among the students followed by a rapidly increasing comfort level, much higher levels of energy and participation, and above all, greater learning. Check it out.” (Felder & Brent, Fall 2003)

References
http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/Prince_AL.pdf
### Examples of Active Learning in the Engineering Classroom

Watch short online videos for more info: [https://crlte.engin.umich.edu/aptregistration/apt_podcasts/](https://crlte.engin.umich.edu/aptregistration/apt_podcasts/)

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<th>Type</th>
<th>Description</th>
<th>Example</th>
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<td>Minute Paper</td>
<td>At an appropriate point in the lecture, ask the students to take out a blank sheet of paper. Then, ask the topic or question you want students to address; for example, “Today, we discussed conductive heat transfer. List as many of the principal features of this process as you can remember. You have two minutes – go!”</td>
<td>In AE 550, Linear Systems, the instructor says, “Today, we discussed the controllability of linear time-invariant (LTI) systems. Without looking at your notes, list all of the equivalent ways to test for the controllability of an LTI system. You have two minutes.”—Amor Menezes (Former EGSM)</td>
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<td>Think-Pair-Share</td>
<td>Have students first work on a given problem individually, then compare their answers with a partner and share ideas with the class.</td>
<td>In IOE 310, Introduction to Optimization, the professor puts an optimization problem on the projector and asks the students to come up with the objective function and the constraints. When they have written down their answers, the students are asked to compare their solution to their neighbors. Then the instructor goes over the example for the entire class. —Arleigh Waring (Former EGSM)</td>
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<td>Think-Aloud Paired Problem Solving</td>
<td>In pairs, students describe in detail how they would solve a problem, approach a case study, or interpret data. Taking turns, one student would serve as the “explainer,” while the other student listens and asks clarifying questions. After a while, the students switch roles.</td>
<td>A computer programming instructor could show a code on the board and asks the one of the students in the pair to describe aloud what the code will do. The task would be repeated with another example code for the second student to describe. Afterwards the code is implemented and the results are observed. The instructor then asks why the program behaved in the expected or unexpected way.—Adapted from Fernando Tavares (Former EGSM)</td>
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<td>Brainstorming</td>
<td>Introduce a topic or problem and then ask for student input. Give students a minute to write down their ideas, and then record them on the board. For example, “What are possible safety (environmental, quality control) problems we might encounter with the process unit we just designed?” could be a brainstorm topic in an engineering class.</td>
<td>During a biomedical design course, the students are presented with a problem how to help patients with severe tremors (e.g. from Parkinson’s disease) be able to do common tasks, such as eating and writing. The students break up into groups of 4-5 and write down ideas on a board, and then follow-up by further developing those ideas on a CTools wiki. —Matt Gibson (Former EGSM)</td>
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<td>Case Studies</td>
<td>Use real-life stories that describe what happened to a community, family, school, industry or individual to prompt students to integrate their classroom knowledge with their knowledge of real-world situations, actions, and consequences. (See <a href="http://sciencecases.lib.buffalo.edu/cs/">http://sciencecases.lib.buffalo.edu/cs/</a> for sample cases)</td>
<td>In ChE 466 (Process Dynamics and Control) the instructor provides the students with a news-piece about an explosion in a chemical plant and asks students to brainstorm reasons for the accident using the concepts learned from this course. He further asks them act as investigators and to make a list of questions they would like to ask the plant operators to find out the actual cause of the accident. —Tabish Maqbool (Former EGSM)</td>
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<td>Cooperative Groups</td>
<td>Pose a question on which each cooperative group will work while you circulate around the room answering questions, asking further questions, keeping the groups on task, and so forth. After an appropriate time for group discussion, ask students to share their discussion points with the rest of the class.</td>
<td>Vehicle Dynamics: Provide each group with a toy car whose front and rear wheels are selectively lockable. Ask them to experimentally investigate the stability differences between rear wheel brake lockup and front wheel brake lockup.—Mark Hoffman (Former EGSM)</td>
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EGSM-Engineering GSI Mentor (Former title for the Engineering Teaching Consultants)

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