

# Starting Small with Active Learning

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**Outcomes:** This document is intended to help readers:

- identify active learning techniques that are relatively easy to begin using
- experience active learning techniques and reflect on what makes them work
- make a plan for incorporating active learning into their upcoming teaching

## Introduction

Active learning – defined as educational methods in which ALL STUDENTS are asked to engage in the learning process WHILE IN CLASS – has been shown to improve student learning and retention in STEM fields. These materials will help you get started!

### *Categories of Active Learning used in this Document*

In this document, we divide the active learning techniques presented into three categories: simplest, medium, and next level techniques. These categories are based on a combination of group characteristics (e.g. size, dynamics, member roles) and level of instructor interaction (e.g. circulating around the room, checking in with students). These categories are independent of what technologies they incorporate.

## Simplest active learning techniques

Implementing active learning in your classroom doesn't have to be a complicated endeavor! In this section, we present several methods of active learning that are the most accessible to start with and that require relatively low preparation. These methods can also be implemented easily in any classroom setting, from recitation sections and office hours to lecture and labs. The simplest methods also typically have little instructor interaction with students beyond initially framing the question and managing the time for the given activity. These techniques have an expedited learning curve for most people.

### *Socratic questioning*

Perhaps the simplest way to implement active learning is through socratic questioning, which consists of asking questions in a systematic, disciplined way that focuses on fundamental concepts within a topic. Socratic questioning often asks students to successively answer the question “why?,” prompting them to go deeper in their reasoning and understanding. For example, an instructor going over a derivation might

ask students to provide the next steps and reasoning for those steps rather than write up the entire derivation at once without engaging the class. However, it should be noted that socratic questioning does not necessarily involve *everyone* in the class; the following methods are more effective ways of getting all students engaged with the material.

### *Think-Pair-Share*

Think-Pair-Share is a relatively simple active learning technique that involves brief discussion among students. As the name of this technique implies, there are three stages to this type of discussion. First, students are asked to think independently about a question about the course material. Second, they pair up with a neighboring classmate to discuss their individual thoughts on the question. Finally, the class is asked to share what they discussed and debriefs the question as a whole. Think-Pair-Share is most effective when the debrief elucidates a few key points. Unlike socratic questioning, this technique gets virtually all students involved; even if they don't share what they discussed, they still will have discussed in their pair and have engaged with the material.

In all of these stages, it is advised that the instructor set timing guidelines, such as think for 30 seconds, pair for two minutes, and three people share what they discussed in their respective pairs. In addition to being a planned component of class time, Think-Pair-Share can also be used to mitigate extended silence after the instructor asks a question to which students don't seem to have an answer. A question previously met with crickets often prompts lively discussion once students are asked to talk amongst themselves rather than directly to the instructor.

### *Minute Papers*

Minute papers are a type of classroom assessment technique (CAT) that test how students are gaining knowledge, or not, and are usually administered at the end of class. In this active learning technique, the instructor asks students to write a brief response to questions such as "What was the most important thing you learned during this class?" and "What important question remains unanswered?" Minute papers engage students by requiring that they take a few moments to reflect on the day's material and think about what directions the class might be going. They also serve as a type of feedback for the instructor by showing how well instructor-set learning outcomes align with what students are getting out of the class as well as highlight areas of confusion for students.

A similar CAT is having students list the muddiest<sup>1</sup> point(s) in lecture, discussion, homework, or other components of class. These responses are even quicker than a standard minute paper and help the instructor identify where students are having difficulty understanding the course material. Muddiest points can be used for setting a starting point for the following class meeting or for planning the agenda for recitation sections.

## **Medium active learning techniques**

Medium active learning techniques require slightly more preparation and perhaps more time to implement than the simplest techniques. These often take the form of peer instruction, perhaps most commonly executed as “clicker questions.”

### *One-stage clicker questions*

Clicker questions are used to assess prior knowledge, misconceptions, or student understanding of material presented so far in class. After students commit to an answer, the instructor can simply go over the responses, providing further explanation for why certain answers are incorrect as they feel necessary before moving on. Students are required to get involved thus have at least minimal engagement with the material that is absent in a lecture-only setting, and the instructor gets immediate feedback about how well students understand course material. However, clicker-type questions are more effective when they go beyond and into a second stage that involves peer instruction.

### *Two-stage clicker questions, a type of peer instruction*

While asking students to answer clicker questions is a start to implementing active learning in your classroom, you can take this further by including peer instruction. Using peer instruction, students answer a clicker question as they do in the one-stage method. However, in the two-stage method, the instructor doesn't provide explanations before continuing with the class. Instead, they ask students to engage in peer discussion in pairs or small groups. In these discussions, peers can discuss why they think a certain answer is correct, re-affirming their reasoning behind the answer. If peers do not agree, peer discussion is used to try to convince the other parties to change their answers. After students have had time to discuss, the question is posed again, often with a different trend in responses.

Peer instruction has been shown to more effectively correct students's misconceptions than explanations from the instructor alone (Mazur 2001). In this approach to learning, students are required to take action in correcting their own wrong answers and thus are

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<sup>1</sup> “Muddiest” refers to “most unclear” or “most confusing.”

less able to zone out. Furthermore, students are more convincing to each other because they understand why their peers don't understand a given concept. This method is recommended when 30-70% of responses are correct; lower correct response rates may require revisiting the concepts, but higher correct response rates might see diminishing returns on using peer instruction.

### *Clicker question technologies*

There are several types of clicker question technologies, ranging from low tech (i.e. without electronics) to high tech:

- **Voting by hand** – Students either raise their hands (for questions with two possible answers) or, for a more anonymous response, hold their hands up to their chest with one, two, three, etc. fingers up.
- **Folded paper cards** – Each student has a sheet of paper folded into quarters such that each quarter has a different response (e.g. A, B, C, D). To respond to a question, students hold up their folded paper such that their response is visible. For easier visibility for the instructor, each quadrant can be printed to have a different color background.
- **Plickers** – Plickers (<https://www.plickers.com/>) allow up to 64 students to individually respond to a question by holding up a piece of paper with a bar code in one of four orientations. The only electronics required are that the instructor have the Plickers app downloaded, which allows them to scan the room with their smartphone camera and compile summaries of their students' answers.
- **Clickers** – The conventional clicker technique requires that all students have their own remote-control-type device which they use to respond to questions. Their answers are compiled by software and can be displayed after responses are recorded.
- **Poll Everywhere** – Poll Everywhere (<https://www.polleverywhere.com/>) is a versatile application that can be used to collect responses for multiple choice questions, record short answers, and collect instantaneous feedback (e.g. muddiest points) anonymously. However, this technology requires that all students have a smartphone, tablet, or laptop computer with internet access and may not be usable in classrooms where not all students have access to these devices or that have poor wireless internet connection.

### **Next level active learning techniques**

This group of methods involve some additional considerations, often because students are collaborating for longer periods of time and need clear instructions to make their work productive. The following methods (three of the many available) are still very accessible with a little bit of planning.

### *Whiteboard (or chalkboard) tasks*

Using either wall-mounted or desk/lap-sized whiteboards or chalkboards, small groups (usually pairs; groups of three at most) carry out learning-related tasks and record their answer or process on their erasable board. The questions they work on could be similar to clicker or peer instruction questions discussed above, but instead of voting or using clickers, groups record their thinking, reasoning, steps, or ideas on the board.

This technique has the advantage of being more open-ended, but requires planning to have erasable boards available, and clear instructions for what students will write down.

It is also important to have a plan for following up on their whiteboard work. For example, will you as instructor or TA circulate and choose one or two boards to show and discuss with the class? Will groups check and discuss their own work?

Lap/desk-sized erasable boards have been shown to be an impactful, yet low-tech, addition to classroom designs when used in this way.

### *Extended problem solving in groups*

In this method, groups of approximately three (no more than four) students actively work through example problems with one another—usually on a space of wall-mounted chalk or whiteboard. Inexpensive “cling sheets” of temporarily, plastic whiteboard material are available for rooms with smooth walls where more whiteboard space is needed.

Often, the instructor or teaching assistant provides a brief introduction to the key concepts of the day or week at the beginning to get everyone on the same page. Then, groups work together on the problems – either all on the same problems, or on different problems

With this method, the instructor or TA needs to circulate and monitor groups to make sure that everyone is involved, different students get a chance to hold the marker or chalk and write the group’s progress, and that all of the students in the group can answer questions about how and why the group is choosing to solve the problems.

If all students are working on the same problem, when the first one or two groups are nearly finished, it’s time to bring everyone back together and talk through it together. It’s ok if not everyone finished the problem as you will discuss it. In this case, as you discuss the problem with the whole class, call on the groups that didn’t quite finish for early steps, and the groups that finished to supply later steps.

If students are working on different problems, you can have them share with one another how they started or approached the different problems.

## *Jigsaw*

In this collaborative learning technique, students work together to build expertise on a question or topic (expert group), and then redistribute themselves to teach that material to other students (jigsaw group). This method takes advantage of the age-old (and now well-documented) wisdom that the best way to learn something well is to teach it. Numerous websites give examples and explain the process in detail.

Because it is a two stage process, and requires the number of topics or questions and number of students/groups be planned carefully, this one requires some preparation before class. But it is a great way to get everyone engaged in learning multiple ideas, problems, or concepts in an efficient way. It also build collaboration and cooperation.

## *Group guidance for next level methods*

For the three methods discussed in this section, it's helpful to keep in mind that college students may not all be experts in collaboration and group work. You can help them be effective in groups by giving them guidance:

- **Optimize group size for participation** – Unless you have a lot of very specific roles or tasks within a group, more than three or four people per group often means that one or more of them will not be active or engaged in the work.
- **Give guidance on roles** – The POGIL (Process Oriented Guided Inquiry Learning) technique, another more extended active learning method, has developed the following student roles to help groups work well: Manager, Presenter, Reflector, Recorder ([www.pogil.org/educators/resources](http://www.pogil.org/educators/resources), see “Role Cards” link for definitions). Make sure students each have a role when groups get started, especially on extended tasks, and give students opportunities to have different roles throughout the term.
- **Let students know that groups will change** – Whether you assign groups or let students form their own (and there is no single answer to which is better), in many instances it is helpful to let them know you'll be switching things up at some point. This allows you to intervene if certain groups really do not get along (even with the above ideas in place), and to give students experience collaborating with a wider variety of peers (an important skill to practice).  
*NOTE: If students are working on an extended project together, or when collaboration skills are a main course learning outcomes, keeping groups together for longer periods or an entire term may be important; in that case, make sure you pay special attention to group roles, accountability, and put in place a process for groups members to give and receive feedback to improve group functioning over the course of the project or term.*

## **Making a plan for your upcoming teaching roles**

Here are some questions to ask yourself in order to help you choose among the methods above.

- How much time are you willing to devote to active learning per class?
- How comfortable are you now with student discussion and interaction?
- How many students would you be engaging in active learning?
- What is your purpose (e.g. real-time feedback, peer teaching) in implementing active learning?
- Do you have access to the resources necessary to make this activity successful?

## **Additional Resources**

Classroom Assessment Techniques (CATs)

<https://cft.vanderbilt.edu/guides-sub-pages/cats/>

Peer Instruction

<https://www.uq.edu.au/teach/flipped-classroom/docs/FAB/FABPeerInstructionTipsheet.pdf>