

# What a great teaching idea!

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### Encouraging critical thinking with scientific sketching activities

#### You utilize active learning strategies in your courses to engage students during class. Can you describe an active learning strategy that you’ve found particularly effective?

Incorporating active learning strategies into your course can significantly enhance student learning (Freeman et al., 2014). For instance, in a preparatory course for incoming Ph.D. students, I use an active learning sketching exercise to help students probe their own understanding of important concepts and processes I teach in my course. These scientific sketches are visual representations of a specimen, experiment, or phenomenon that includes illustration, labels, arrows, diagrams, and even questions or explanations. Sketching requires students to focus on details and make observations. Scientific sketches, illustrations, and diagrams are tools used in many STEM fields, but can also be used in other disciplines to deepen students’ understanding of a concept or process. For example, in a course in the humanities, you might use sketching to create a concept map of the relationships between philosophies, or to diagram factors influencing a historical event.

The specific learning objective for this activity is for students to identify what might have gone wrong in an experiment by careful analysis of each step. Sketching can provide greater clarity and facilitate troubleshooting than discussion alone. Students are first given a brief description of the failed experiment and asked to list all possible reasons for the failure by working in groups of four for 10 minutes. We then reconvene and a designated member of each group shares one reason for the experiment’s failure. I then have a student come to the whiteboard in a live class (or use the whiteboard feature in Zoom) and ask the student to sketch the steps of the experiment (draw a tube, a petri dish, etc.). After each step of the experiment is sketched, I pause and ask students to consider any possibilities that have not been considered. Invariably, new reasons as to why the experiment failed and possible controls to consider in future experiments emerge because visualization through sketching triggers the critical thinking process in a way that words alone may not.

#### How do you know when it is working?

I know that the sketching activity is working when students can think of additional reasons for the experiment’s failure as the steps are sketched. An even stronger indication is when students come up with additional controls or considerations for future experiments. This shows that the technique is stimulating critical thought. Generating a sketch is an experiential learning process that allows students to observe and apply course concepts in order to process information at a deep level (Tippett, 2016).

#### What advice do you have for instructors in other disciplines who are interested in doing something similar?

Studies show that both interpreting existing sketches and constructing new visual representations can lead to better understanding of concepts (Tippett, 2016). My advice to other instructors is to try it once and then collect student feedback on their experience. Because instructors are experts and students are typically at the novice or intermediate level, it can be easy to forget that students may not yet have a full working understanding of basic concepts. Sketching can help students solidify their understanding by making the process they are learning more concrete. It can help students conceptualize the “how” and “why” of each step in the process.

### Tips from CET

#### Steps to implement a sketching activity:

1. Explain the purpose and process of making a sketch. Make a point to students that the artfulness of the sketch is not the main focus, rather it is the information contained in the sketch that is important.
2. Provide them with a model and identify the key elements of a successful sketch.
3. Ask students to complete their sketches individually or in small groups.
4. Ask students to either reflect on their individual sketches, switch sketches with a peer and review, or discuss as a class.
5. Lead a class debrief or provide group or individual feedback to tie the activity back to course content and your objectives for the activity.
6. After the activity, students may submit their sketches or keep them as a study guide. Sketches could also be posted in the classroom or shared with the class virtually on a discussion board for follow-up activities.

### References

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). [*Active learning increases student performance in science, engineering, and mathematics*](https://doi.org/10.1073/pnas.1319030111). Proceedings of the National Academy of Sciences, 111(23), 8410–8415.

Tippett, C. (2016). What recent research on diagrams suggests about learning with rather than learning from visual representations in science, *International Journal of Science Education, 38*(5), 725-746.