Active Learning Problem Solving Activity Guide

Center for Teaching Excellence
DEAN OF FACULTIES

General Overview:

This guide contains 25 problem solving activities that focus on students either being an active learner or a reflective learner depending on how the activity is utilized…in either case, students will be minds-on which is the goal. Active learners are inclined to experience things to better understand them, while reflective learners want to understand something before experiencing. The goal to using this guide shouldn't be to teach a student in the way they prefer, but rather to teach in a way that is balanced and not in favor of one method over the other (Felder & Brent, 2016).

Using the techniques in this guide allows students to think about and engage with content in a more authentic and practical way - by relating content to real life, gaining an appreciation for processes, and/or developing a natural curiosity for the world. Research indicates that learning does not come from students passively listening to explanations, but from students actively constructing their own knowledge through "effortful study" of the material (Weiman, 2017, p. 9).

How to use the guide:

The problem solving activities in this guide are targeted for success in the science, technology, engineering, and mathematics (STEM) classroom, but are adaptable for a variety of disciplines, class sizes, room formats, etc. Review the "I want to" column and select a statement describing a goal for an activity in a course you teach. Then, review the corresponding items in the "Activity Examples" column. Note that many of the activities contain a hyperlink leading to more information and/or example(s). Determine if there is an example that is a good fit for your course.

The "I want to:" column focuses on:

• Draw or Sketch…	• Think of a question…	• Figure out why…
• Real-world application…	• Answer a question…	• Brainstorm…
• Recall prior knowledge about…	• Diagnose…	• Summarize…
• Start a …or take the next step	• Predict…	• Critique…

For assistance with selecting, modifying, or implementing an activity, please contact The Center at cte@tamu.edu.

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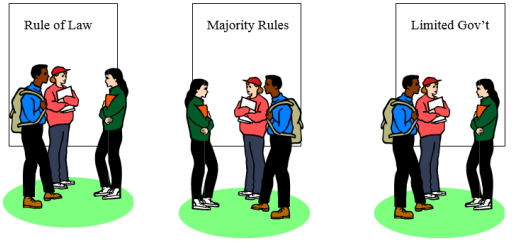
I want to:	Activity Examples
Draw a [free body diagram, plot, flow chart, or product life cycle] **OR** **Sketch** the form of [a mathematical function, the solution of a differential equation] without doing any calculations	**1. Poster Sessions:** Students create a visual work (formally or informally) that demonstrates their application of key course topics. Half of the class walks around and hears presentation while the other half of the class presents. After a set amount of time, groups switch roles with the presenters now becoming the listeners and the listeners now becoming the presenters.
	2. Carousel Approach: The instructor posts various "stations" around the room (on white boards, large stick notes, etc.) for groups to work through. Small groups of students rotate around the room, participating in each station for a set amount of time (usually 1 to 5 min. per station), posting their ideas at each station for other groups to read and elaborate on. The last group at each station then reports out to the whole group, synthesizing and summarizing what all the groups had contributed.  https://socialstudiestoolbox.pbworks.com/w/page/108679090/Carousel%20Brainstorming
Think of a question about material just covered in class	**3. Guided Reciprocal Peer Questioning:** Students formulate questions about assigned readings, using question stems that promote high-level thinking, and quiz one another in class.
	4. Muddiest Point: Can be used at any time during a class session. Students are asked to write down on an index card or half sheet of paper what they found least clear or most confusing in a teaching presentation or activity: "What was the muddiest point in the (lecture, assignment, discussion, play, film, video etc.)?"
Figure out why a calculated quantity may be wrong or different	**5. Peer Problem Review:** Each student individually solves a problem and then passes their problem and solution to a partner, who then analyzes the solution.

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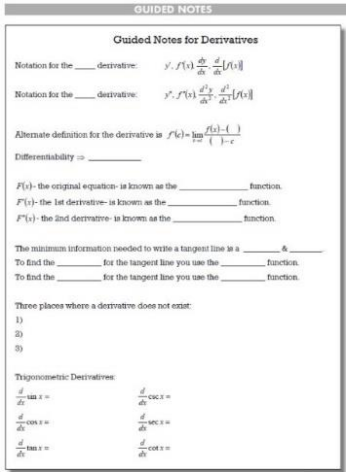
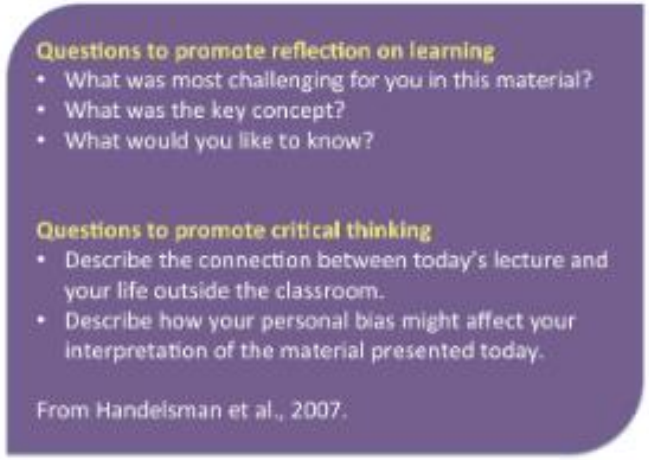
I want to:	Activity Examples
Summarize a lecture or part of a lecture	**6. Handouts with Gaps/Guided Notes:** Lecture notes are placed in a class handout format, but not the complete notes. Straightforward parts like definitions, facts, simple math, and diagrams are left with interspersed blanks (gaps) for students to insert answers, missing pieces to problem solutions or derivations, and visuals such as molecular, physical, and biological structures and diagrams or flow-charts. In class, give students brief periods of time to read the straightforward parts themselves and then use lecturing to fill in the gaps. The students can copy in the missing information during the lecture, but will need to pay close attention to listen for what goes in the gaps.  GUIDED NOTES Guided Notes for Derivatives https://jewilson01.wordpress.com/2013/04/07/guided-notes/
	7. Minute Paper: During last 5 minutes of class, instructor asks students to answer one or two questions on an index card or half sheet of paper. Questions can include: "What was the most important thing you learned during the class?" "What important questions remain unanswered?" Cards/papers are handed in as students leave classroom.  Questions to promote reflection on learning • What was most challenging for you in this material? • What was the key concept? • What would you like to know? Questions to promote critical thinking • Describe the connection between today's lecture and your life outside the classroom. • Describe how your personal bias might affect your interpretation of the material presented today. From Handelsman et al., 2007. https://cft.vanderbilt.edu/guides-sub-pages/active-learning/#tech

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I want to:	Activity Examples
Start a [problem solution, derivation] or take the next step	**8. Chunked Analysis:** Instead of simply presenting a fully worked-out solution or derivation in one continuous block, break it up into small chunks. Some chunks will be straightforward calculations and other chunks will be conceptually difficult. Quickly lecture through the straightforward parts or have students read through them on the handout, and then have the students work through the difficult chunks in class with the instructor there to answer questions or go over after some student worktime has passed.
	9. Think-Aloud Problem Solving Protocols (TAPPs): Students work in pairs, assuming the role of either problem solver or listener, to solve problems. As they work through the problems, the problem solvers talk through the problem out loud as they go through the steps to solve it and the listener attempts to understand the reasons behind the steps and records the process as they heard it. The pairs then switch roles and repeat the process for the next problem. This process can be audio or video taped for skills analysis.
Predict [an experimental outcome, a system response to a change in input]	**10. Prediction Guide:** Students are given a series of questions that they must use to make predictions prior to a learning activity. They then complete the activity and after, revisit their original predictions to evaluate their responses and look for misconceptions.
	11. Perform a Demonstration or Show a Video of One: Helps spark student interest…Describe what you are going to do or show, have the students predict what will happen, and then do or show it. Afterwards, discuss what the outcome was and where those who predicted it incorrectly went wrong.

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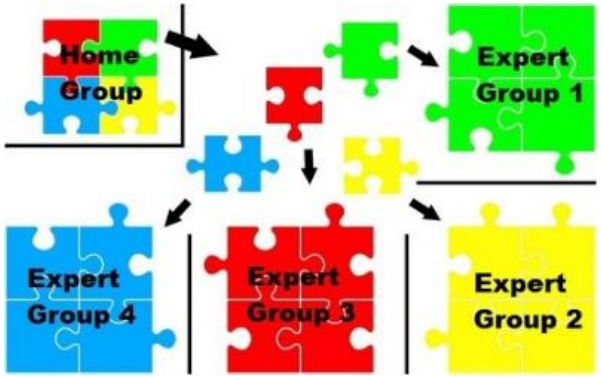
I want to:	Activity Examples
Critique a [writing sample, oral presentation, data interpretation, computer code, clinical procedure, process design, product design]	**12. What's the Problem?:** Students are given examples of common problems found within a context. They then name each type of problem.
	13. What's the Principle?: Students must identify type of problem they have been presented in a handout and the principle (s) to apply in order to solve the problem; or the principles that have been violated to create the problem.
Group discussion or activity	**14. Pair Programming:** Students work at computers in pairs alternating roles of pilot (keyboarding, tactile thinking) and navigator (checking, strategic thinking).
	15. Jigsaw: Students are assigned different areas of expertise and given supplemental training in those areas, which they then teach to their small group.  https://strategiesforspecialinterventions.weebly.com/jigsaw1.html

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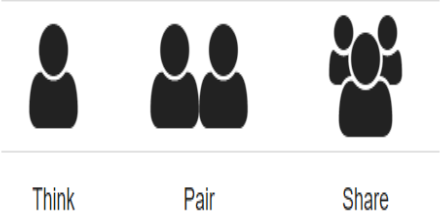
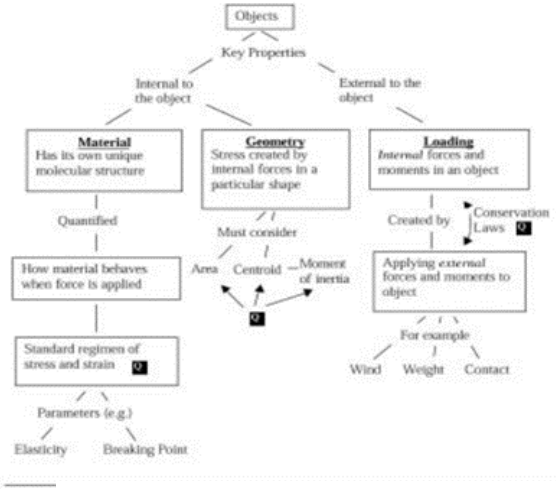
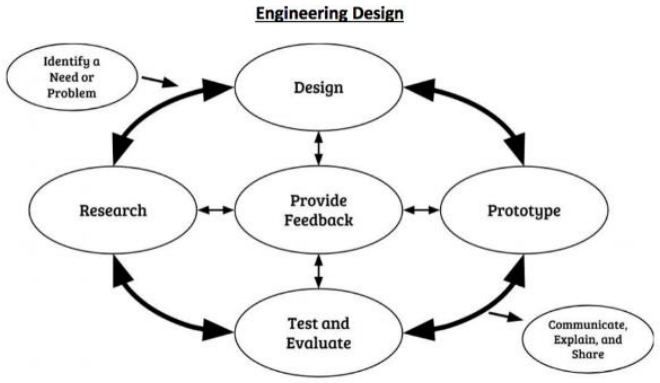
I want to:	Activity Examples
Answer a question	**16. Think-Pair-Share:** The instructor develops and poses a question to the students. The students have time to formulate their response before sharing their ideas with their partner. Once partners have had time to share, the instructor can decide to have pairs share with the whole class.  https://mcphs.libguides.com/centerteachinglearning/classroomstrategies
	17. Student Response System (iClicker): A question is asked using an online system, and students are asked to respond using an iClicker or other device. This allows them to both consider their response and make a public claim to their answer, allowing a deeper thought process when evaluating why their answer was correct or incorrect. A histogram of all student responses is displayed which gives the professor an idea of what percentage of the class understands the material and provides an opportunity to review if needed.  https://learn.iclicker.com/active-learning-
	18. Peer Instruction – A method popularized by Eric Mazur, a Harvard physics professor, which breaks lecture up into chunks, where each chunk is followed by a concept inventory (i.e., conceptual understanding) type question that gauges students learning of the content just presented. Peer instruction is a combination of think-pair-share and student response systems. Once the question is asked, students are given one to two minutes to answer individually and submit his/her answer. "Students then discuss their answers with others sitting around them; the instructor urges students to try to convince each other of the correctness of their own answer by explaining the underlying reasoning. During the discussion, which typically lasts two to four minutes, the instructor moves around the room listening. Finally, the instructor calls an end to the discussion, polls students for their answers again (which may have changed based on the discussion) explains the answer, and moves on to the next topic" (Crouch & Mazur, 2001, p. 970).

I want to:	Activity Examples
Recall prior knowledge (e.g. what was covered in the previous class section)	**19. Concept Map:** Students draw a diagram to demonstrate their ideas or understandings of a specific concept. These diagrams show relationships between concepts. This can be done individually or in teams.  https://www.ijee.ie/articles/Vol20-6/IJEE1544.pdf **20. Graphic Organizer:** Visual overview that helps students make connections between course topics and prior knowledge.  http://www.greengineers.org/engineering-design-process.html

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I want to:	Activity Examples
Real-world application for the [material just discussed, formula just derived]	**21. Pose an Open Ended Real World Problem:** Students work in groups to brainstorm what they would need to know to solve the problem and how they would begin. Have one group member record the group's responses to hand in.
Brainstorm a list of ways to do something	**22. Consider This:** Students must figure out a way to apply a theory or concept that they have been taught to a new context.
	23. Triple Jump: Students think through a real-world problem by: 1. Articulating a plan for solving it, 2. Gathering resources, and 3. Attempting to provide a solution.
Diagnose a [defective product, set of symptoms, computer error message]	**24. Crisis Clinics:** Students evaluate and address hypothetical team member behaviors and team dysfunctionalities.
	25. Case Study: Students are presented with a real-life scenario that they must analyze based upon a brief history of the situation and dilemmas faced by the key character. Students use this information to help the character develop a solution to their problem.

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