

How to help your students become self-directed learners

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What do successful professional employees, researchers, and entrepreneurs do?



Clearly define problems that may be fuzzy



Make decisions based on logic and evidence



Think outside the box



Reflect on how they're doing and seek out resources

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What is self-directed learning?

Self-directed learning is the process of learning in which individuals organize and manage their own learning needs and activities.



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What do **self-directed learners** do?



Clearly define problems that may be fuzzy



Make decisions based on logic and evidence



Think outside the box



Reflect on how they're doing and seek out resources

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Activity: Write responses

What teaching techniques could we use to grow **self-directed learners**?



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How do we grow **self-directed learners**?

Teach them to



clearly define problems that may be fuzzy

Inductive teaching and learning



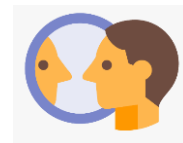
think outside the box

Creative thinking



make decisions based on logic and evidence

Critical thinking

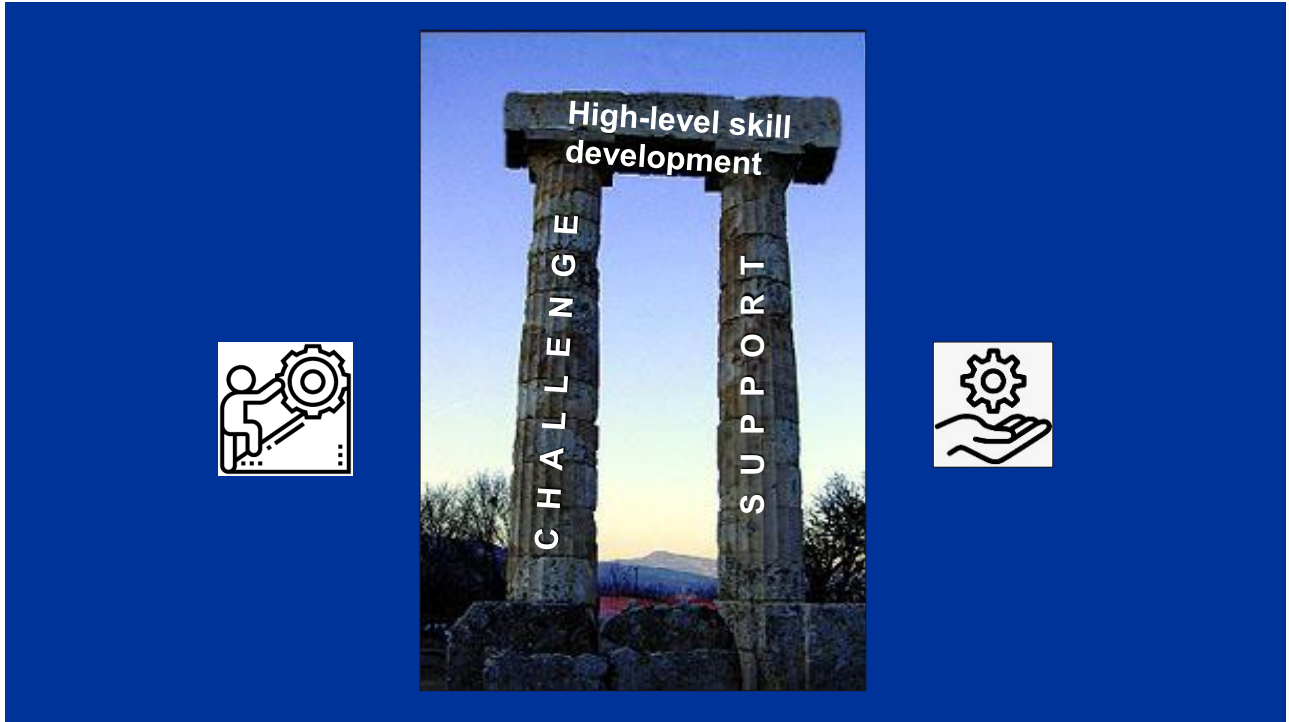


reflect on how they're doing and seek out resources

Metacognition

PLUS

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Activity: Respond to poll

Which do you do more in teaching your classes?

- A. Provide challenges**
- B. Provide support**
- C. About the same of each**

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Challenge



Skills develop only through **practice** and **feedback!**

- **Identify the skills** you want students to acquire.
- **Assign tasks that require the skills** in and out of class and then on tests
- **Integrate** the skills throughout the curriculum

Support



- Make **expectations clear** (learning objectives)
- Show good & bad responses to difficult challenges
- **Model** the kind of thinking required (give good and bad examples)
- Provide **practice & feedback** in activities and on assignments. Then, and only then, put challenges on tests and projects
- **Scaffold**: Start with lots of support and gradually put more responsibility on the students.

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How do we grow **self-directed learners**?



**Inductive teaching
and learning**



Creative thinking



Critical thinking



Metacognition

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*Two ways
to teach*

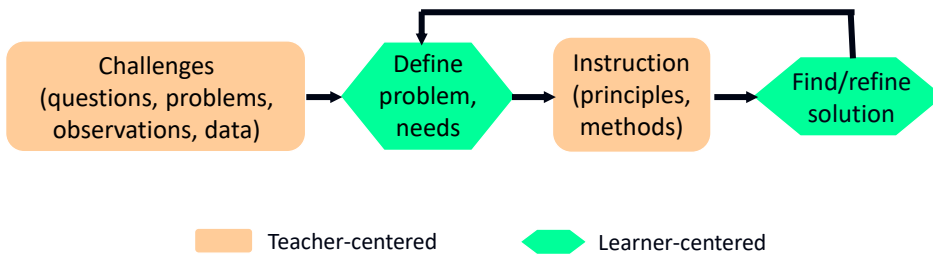


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Deductive Teaching (traditional)



Inductive Teaching (guided inquiry, problem/project-based learning, just-in-time teaching,...)



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Which one works better—**deduction** or **induction**?



→ Deduction

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→ Induction

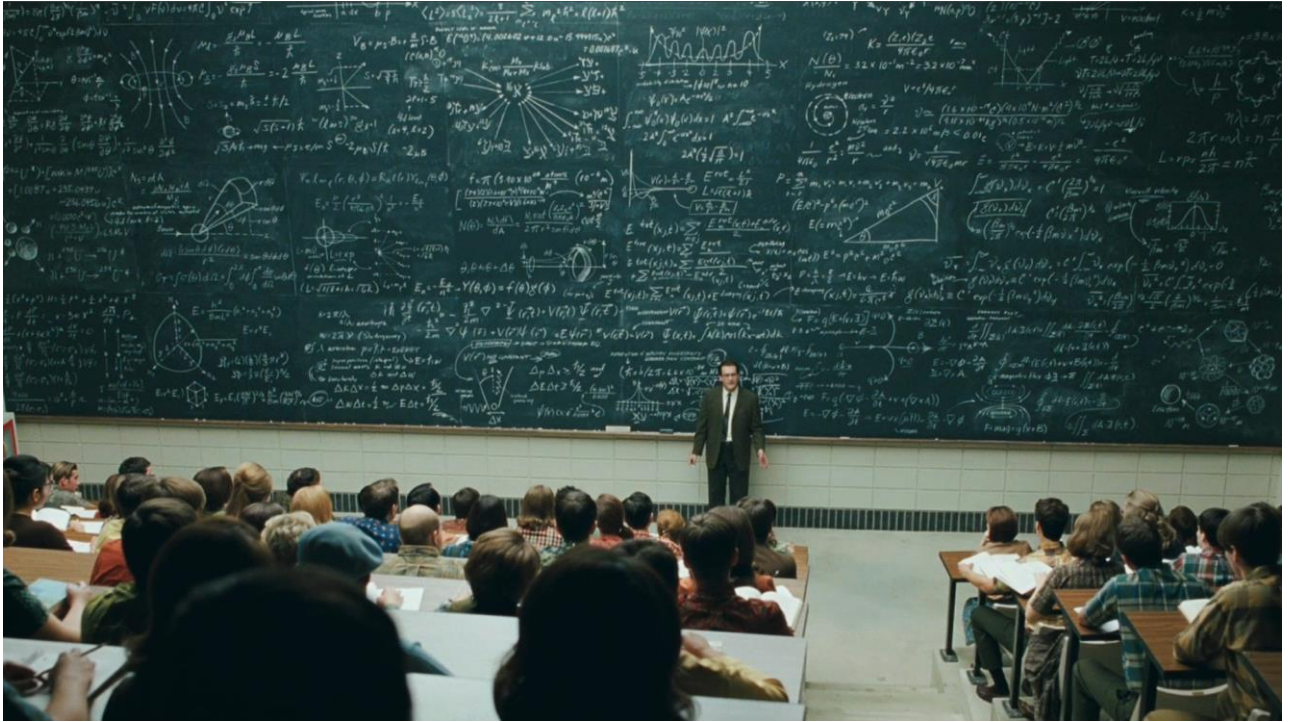
- Use to help establish relevance of course content to students' interests, goals, and prior knowledge
- Desirable difficulty
- Research-proven

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Deduction is **misleading**



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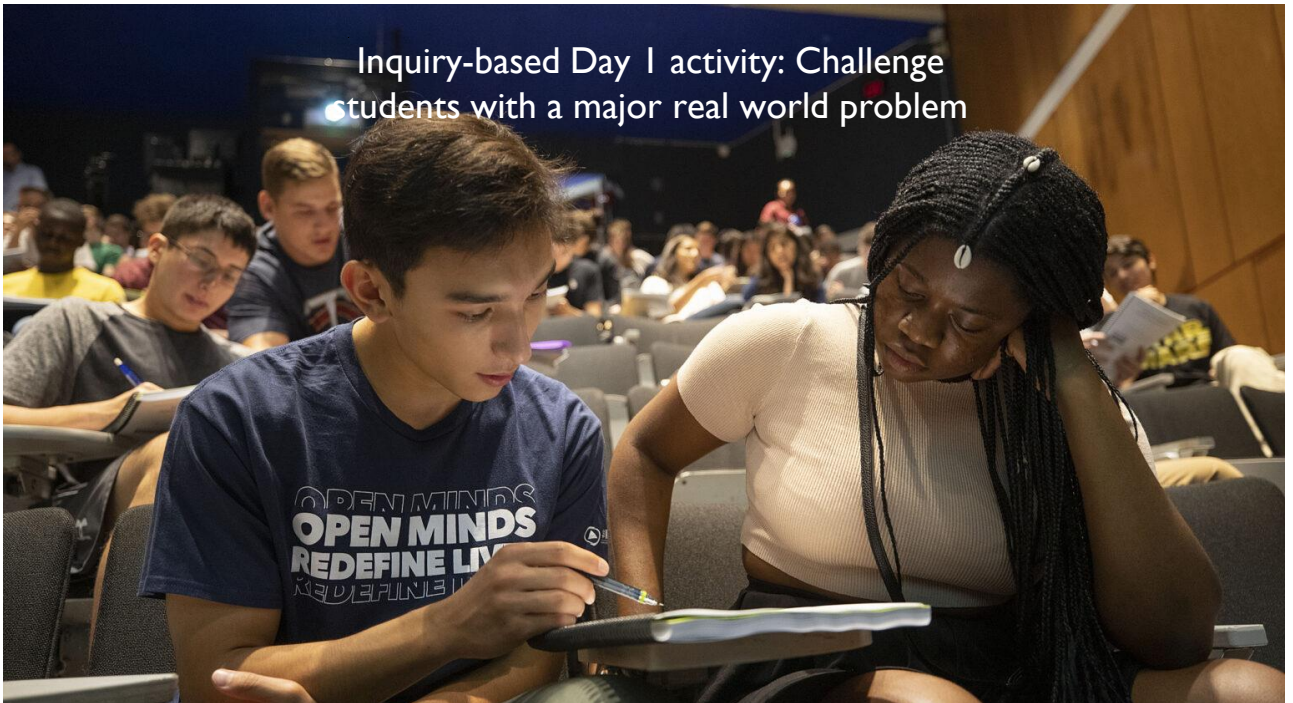
**Inductive teaching
and learning**

Challenges



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Inquiry-based Day 1 activity: Challenge students with a major real world problem



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Make predictions. Outcomes of an experiment or procedure. Responses of a system to input changes. "What if..."



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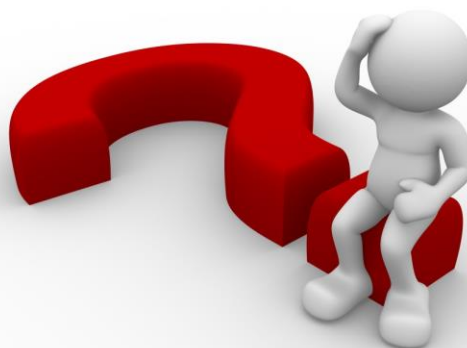


Design and carry out experiments

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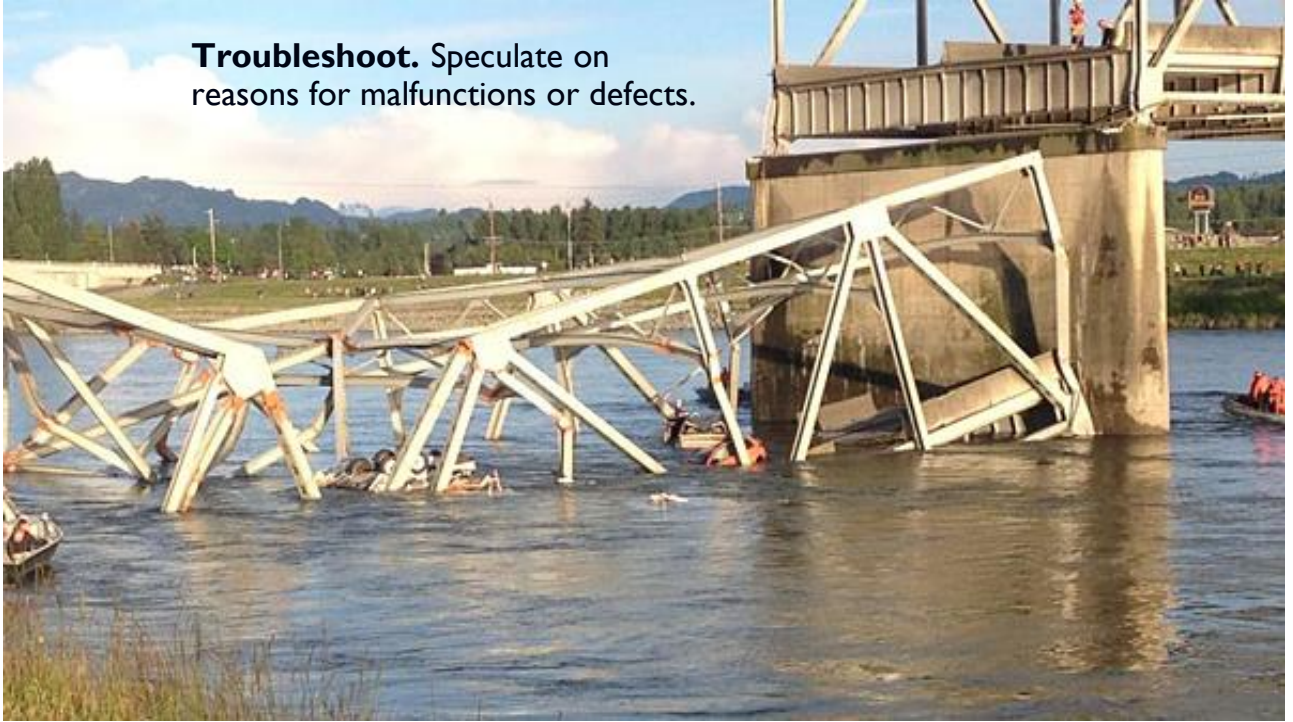
Define problems

- Present different types of “fuzzy” real-world problems
- What’s the problem we need to solve?
- What’s the relevant information we know and what we need to know to solve the problem?
- Where can we get the information we need?



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Troubleshoot. Speculate on reasons for malfunctions or defects.



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Design (or design and build) a ____ to ____ under these conditions: ____



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Activity: Respond to poll

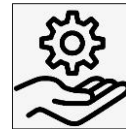
If you tried one or two of the challenges we just described, how would more of your students react?

- A. They would love it!
- B. They would not know where to start.
- C. They would be angry that I was expecting so much of them.

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Supporting inductive learning



- Remember inductive learning is new to most students and they are fearful so...
- **Start small** and do most activities in class with immediate feedback
- Make your expectations clear
- Gradually **encourage** students to practice the skills independently

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How do we grow **self-directed learners**?



Inductive teaching and learning



Critical thinking



Creative thinking



Metacognition

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Creative thinking challenges

- Brainstorm/brainwrite
- Explain unexpected results
- Make up a problem
- Create something



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Creative thinking challenges

- **Brainstorm/brainwrite**
- Explain unexpected results
- Make up a problem
- Create something



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Activity: Write responses

What could your students brainstorm (generate a long list of ideas for)?



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What could STEM students **brainstorm**?



- Ways to measure a physical property or variable
- Use for something that would normally go to waste
- Ways to improve a process, device, product, or code
- Real-world applications of a theory or formula
- Safety & environmental concerns in an experiment or process
- Potential flaws or hazards in a proposed design
- Possible reasons for differences between predicted and observed results (troubleshooting)
- ...

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Activity: Reflect on your own

What are one or two brainstorming activities you could have your students do in a course you teach?



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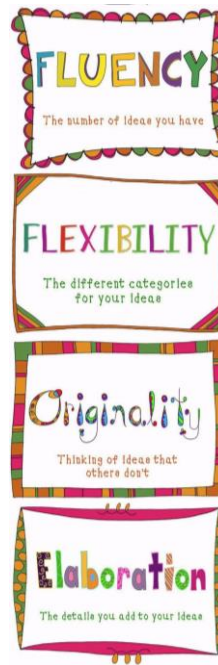
Brainstorming & Brainwriting

- Brainwriting (write list of ideas individually, then group brainstorm)
- Broader participation, greater diversity of ideas, works in **online classes**



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Evaluating brainstorms



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Encouraging **Creativity** in Brainstorming

Focus on **quantity**, not quality of ideas



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Welcome unusual ideas



37

Build on the ideas of others



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Withhold criticism



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Creative thinking challenges

- Brainstorm/brainwrite
- Explain unexpected results
- Make up a problem
- Create something



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Explaining unexpected results



Why did THAT happen?

Why aren't we meeting the design specs?

What's that stuff on the bottom of the beaker?

Who ordered THIS???

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Creative thinking challenges

- Brainstorm/brainwrite
- Explain unexpected results
- **Make up a problem**
- Create something



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Make up a problem



Make up (or make up and solve) a challenging problem

- based on material covered in this class
- based on material covered in this class and in one other class you're taking this semester
- that requires creative thinking
- that I could ask on next week's midterm exam related to the system described below:

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Creative thinking challenges

- Brainstorm/brainwrite
- Explain unexpected results
- Make up a problem
- Create something



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Create something



- Sketch plans for a bridge, an intersection, a device, an app, a playground
- Outline steps needed to realize the plans
- Build a prototype
- Complete a full-scale capstone design

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Activity: Reflect on your own

What could you have your students **create** in a course you teach?



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Supporting **creative** thinking



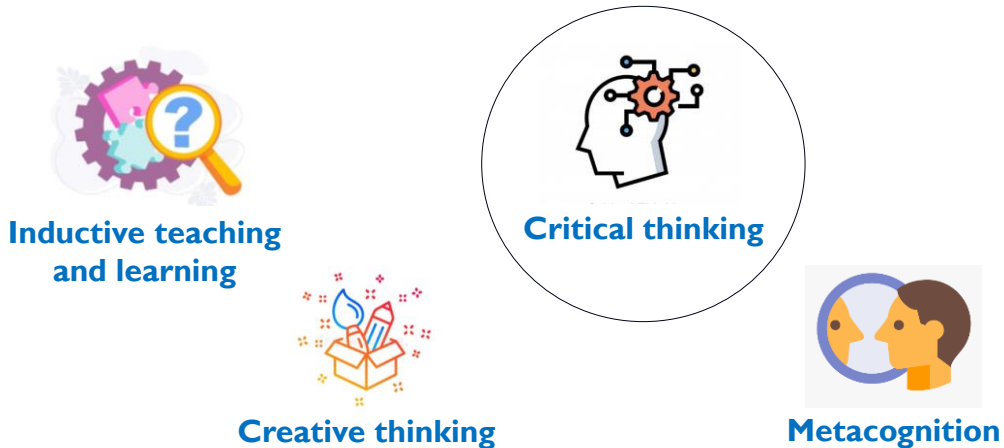
- Regularly include creative challenges in in-class activities and assignments
- Do creative activities in small groups where students can build on ideas of others
- Show examples of fluent creative thinking (lots of ideas)
- Discuss why all ideas (especially the crazy ones) are important in brainstorming

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How do we grow **self-directed learners**?



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What is critical thinking?



Judging the quality, value, or validity of something (e.g., a product, process, or procedure) or the superiority of one alternative over others, and justifying the judgment using evidence and logic.

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Critical thinking

Challenges

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Select from among alternative (designs, plans, programs, derivations, interpretations of data) and justify your selection.



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Analyze a case study or ethical dilemma, recommend a course of action for the protagonist, and justify the recommendation.



53

Assign a grade to a lab or project report and justify the grade.



54

Critique an article or editorial (evaluate accuracy & persuasiveness, identify stated and hidden assumptions)



55

Activity: Reflect on your own

What is one critical thinking activity could you ask your students to do?



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Supporting critical thinking



- Imbed critical thinking exercises in assignments and exams.
- Use a **rubric** (grading form) to evaluate critical thinking assignments. (Search *critical thinking rubric* to see samples.)
- In class before you give critical thinking assignments, **show examples** of good and bad critical thinking, and have students evaluate them using your rubric.
- **Model** steps in your own critical thinking to help students better understand what is involved.

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How do we grow **self-directed learners**?



**Inductive teaching
and learning**



Critical thinking

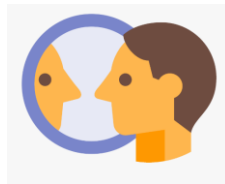


Creative thinking



Metacognition

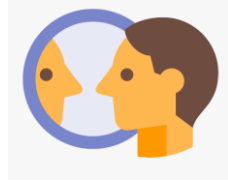
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What is **metacognition**?

Thinking about one's thinking

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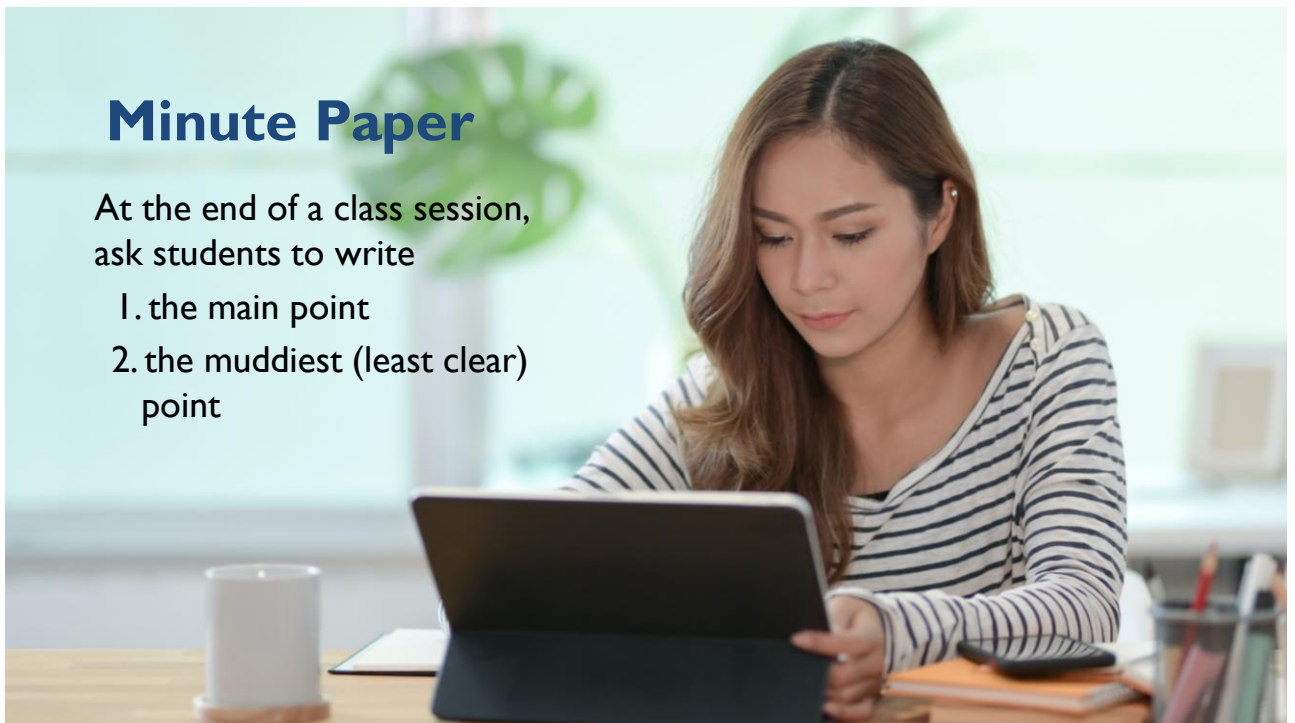
Metacognitive Challenges

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Minute Paper

At the end of a class session, ask students to write

1. the main point
2. the muddiest (least clear) point



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Asking themselves questions when problem-solving

- Does my solution make sense?
- How many different ways can I check this solution?
- What could go wrong in my design or my plan?
- What are my assumptions? Are they reasonable?
- Is there a better way I could do this?

Integrate questions into problems and projects



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Critical place for metacognition?

Preparation for quizzes and exams



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Activity: Respond to poll

What advice do you commonly give your students about studying for your tests? Select all that apply.

- A. Take practice tests.**
- B. Set up problem solutions from examples in class or your homework without looking at the answers.**
- C. Go over your graded homework solutions.**
- D. Reread your textbook and notes.**

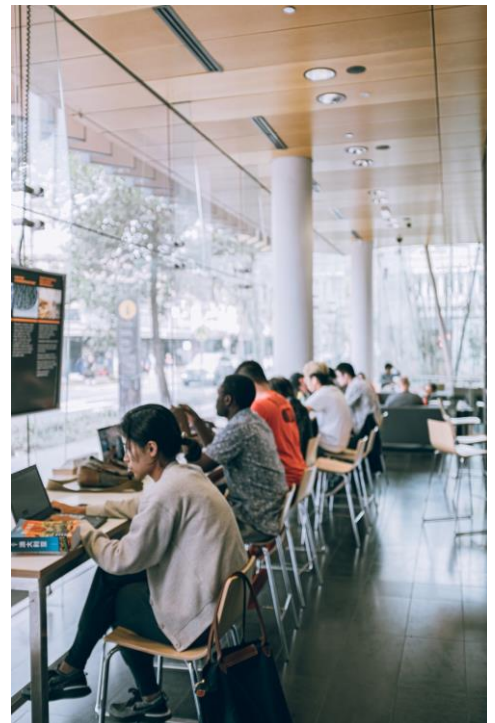
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~~Studying for exams (common method)~~

- ~~• Reread text~~
- ~~• Reread old problem solutions~~



Illusions of competence



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Studying for exams

- Self-test on important content
- *Reproduce* problem solutions
- If you can't remember something, look it up, put it aside for a few hours, try it again.



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Teach students to prepare for and take tests



Tips on test-taking



Exam wrapper

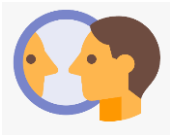
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Activity: Reflect on your own

What will you tell your students now about studying for tests and exams?



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Supporting **metacognitive** thinking



- Take minute paper responses seriously and use them to improve instruction
- **Model** your own metacognition as you solve example problems in class (verbalize what you're thinking)
- Talk about the importance of metacognition and study strategies (especially before and after tests)

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How do we grow **self-directed learners**?



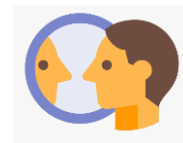
**Inductive teaching
and learning**



Critical thinking

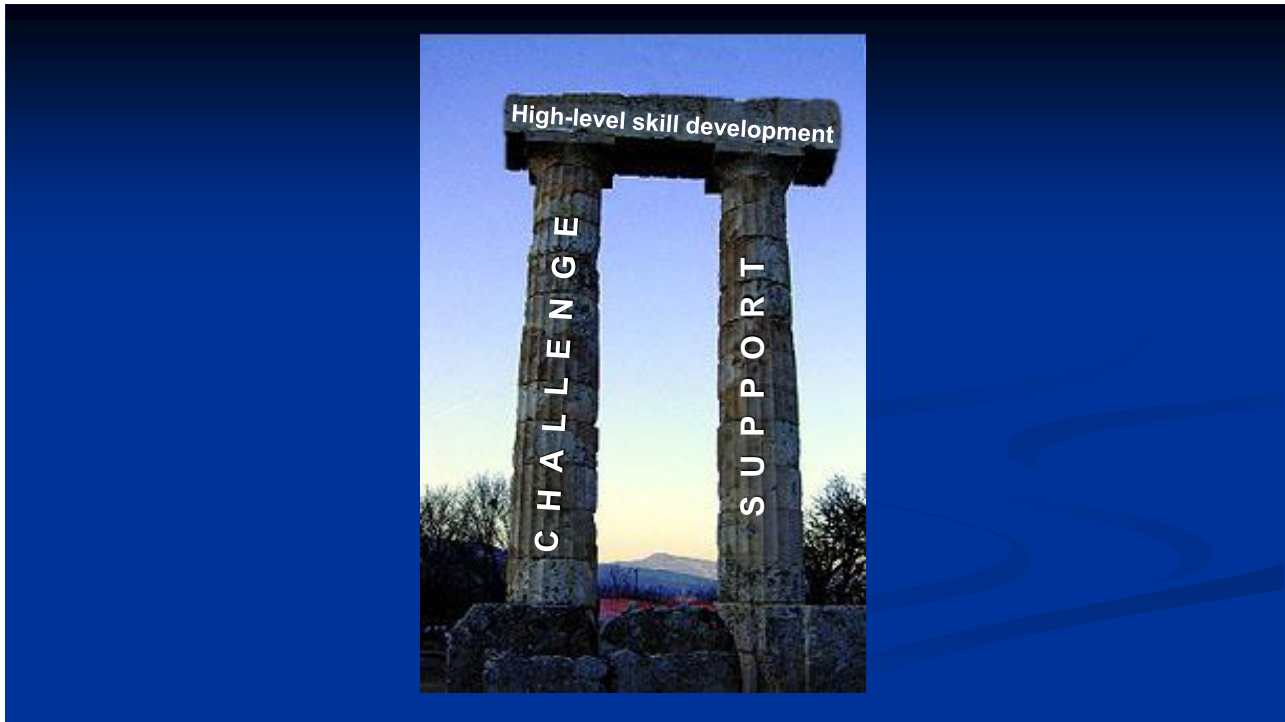


Creative thinking



Metacognition

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