Tips for Teachers

Tweaking questions and tasks to deepen critical thinking in science

Invite students to think more deeply about science topics by tweaking the questions and tasks you use.

Critical thinking is a methodology that helps students develop a deep understanding of science as well as the competencies required to succeed in science. The key to improved critical thinking in science is nurturing a student's ability to make thoughtful and defensible judgments. We can do this by framing stronger questions and tasks, and inviting students to use more thoughtful reasoning to arrive at their conclusions. Teachers can enhance student thinking in science by:

- ensuring questions and tasks regularly invite students to make reasoned judgments rather than simply recall or restate information
- including an evaluative term in the task or question (e.g., What would be the *best* way to represent your findings?)
- articulating or co-constructing the criteria students should consider in reaching judgments about:
    - science concepts and issues (e.g., Which conservation approach is most consistent with known facts, most feasible and least damaging to other species?)
    - their own understanding and performance (e.g., Which way of representing your findings is the most clear, precise and efficient?)
- requiring students to support conclusions with accurate, relevant and clearly explained evidence (e.g., Explain, with evidence, your recommended way of representing your findings.)

The following examples illustrate how common tasks and questions in science can be enriched using these strategies:

Common questions and tasks	Tweaked for deeper scientific thinking *(with sample criteria)*
Generating ideas • What are different ways you can think of to do this task?	• Which of the brainstormed list of factors that may have affected the growth of our bean plants is the most easily testable? • Rank-order the top three approaches for determining the components of various soils. *(e.g., feasible, efficient)*
Predicting and hypothesizing • What do you think will happen? • Create a hypothesis.	• Develop a reasonable prediction for what will happen when we shift the location of the load on the lever. (*e.g., based on available evidence and what is known, logical*) • Develop a reasonable hypothesis about a factor that affects the rate of rusting. (e.g., *based on evidence and/or previous knowledge, logical relationship between variables*)

Common questions and tasks	Tweaked for deeper scientific thinking
Demonstrating understanding of a concept • Describe the concept.	• What are the five most important adaptations for an organism in a wetland environment? Justify your answer. • Create a powerful analogy to describe the phenomenon of alternating electric current. • Design a device to keep an organ system healthy for an astronaut settling on Mars. • Design a board game highlighting the most important concepts in our unit on optics. *(e.g., creative, engaging, addresses key concepts, provides accurate feedback to answers)*
Comparing • How are these ideas/concepts/ solutions different?	• Do acids or bases have the bigger impact on your life? • Which is my most important sense? • What is the biggest similarity and biggest difference between the two proposed solutions? • Which is the best class of lever to do the Mars Rover task you have chosen?
Interpreting information • What can you infer from your experiment?	• Explain why the inferences you have made about the identity of the provided gases are plausible? (*e.g., consistent with evidence, based on an adequate number of tests, few sources of experimental error, strong experimental design)*
Choosing among possible solutions • What is the correct solution/ answer?	• Determine which simple machine is most efficient and rank order the remaining options according to their efficiency. • Which elements will allow for the greatest diversity of energy transfer in your Rube-Goldberg device? (e.g., *number of energy transfers, variety of transfers from one form to another, least loss of energy during the transfers*)
Considering impact • How did A affect or contribute to B? • How might A affect B?	• What was the most significant impact of logging on the salmon population? • Rank the pollution threat of a poultry farm, a textiles plant and landfill for the local water supply. • Which solution to the declining caribou population might have the least desirable effect upon the environment? How might undesirable effects be lessened?
Communicating science ideas • Present your scientific ideas/ conjectures/conclusions.	• Develop a thoughtful presentation outlining the most important impacts of soil pollution. (e.g., *catchy/appealing, clear/well-organized, concise, accurate, comprehensive, appropriate for audience and purpose*)
Proposing a practical course of action • Develop a plan of action.	• What are the three most important things we can do at school to help the environment? • Propose an effective action plan for the conservation team responding to a flood from a burst power dam, identifying which species need immediate help and which situations are less urgent. *(e.g., connects new information from the site to what is already known, feasible, safe for animals and humans, raises new questions for ongoing research)*