Writing Questions to Help Students Learn

GOAL
• To develop a repertoire of types of questions to use in guiding a discussion and in writing homework or test problems and to generate questions that require students to use a variety of cognitive skills.

KEY CONCEPTS
• Asking students questions is an effective way to stimulate them to think at various cognitive levels about the course content.
• Questions that may be posed about course material vary range along a spectrum from rote regurgitation to critical thinking. There is an established taxonomy in the educational literature that is used for evaluating the cognitive level of questions.
• It is important to be aware of the cognitive style and level of homework and test questions and to match them to the level of class discussions and student ability.
• Asking and answering questions forms the foundation of learning, but classroom research reports that university instructors in science classes use questions only 2.5% of the class time (on average) and that 80% of the questions asked by instructors and students are at the lowest cognitive levels.
• The instructor who has mastered the use of a variety of question types can guide a discussion both to include basic material and to engage student interest.

PROCEDURE
1. On the following two pages are short excerpts for reading: 1) a list of cognitive skills required to answer questions, and a list of kinds of questions to ask; and 2) a paragraph describing some types of questions to avoid if you want to encourage discussion.
2. After reading the material, the facilitator will divide you into groups of about 4 trainees each. Each group will be assigned to study one of the two scientific diagrams included below.
3. Study and discuss the information displayed on the diagram your group was assigned. In your group, write questions about this material at low-, medium-, and high-skill cognitive levels (as modified in the reading from Davis and Bloom below). Try to generate examples of both multiple-choice and short-answer questions (with answers). Enter your work on the work sheet and onto the blank transparencies provided. Example questions are provided below.
4. Groups will share and compare their questions at the cognitive skill levels with the whole class. Use the blank work sheets to record sample questions of other groups.

TIPS
• The cognitive levels are flexible and meant only as guidelines. Do not expect to understand them fully before you begin. The goal is to get to a feel for them by working with them.
• Introduce your question with a context/scenario.
• Vary your use of words. Don’t just use what, where, who or why, but rather describe, examine, compare and contrast, pros and cons.
• Ask yourself: what do I want the students to tell me, or what answer am I looking for? Then write the question as clearly and precisely as you can to try to elicit that answer.
ATTACHED READING

ADDITIONAL REFERENCE

Levels and Types of Questions (Davis, 1993)
(Grouped in pairs for purposes of this workshop)

“Vary the cognitive skills your questions call for.” Different questions require different levels of thinking. Lower-level questions are appropriate for assessing students’ preparation and comprehension or for reviewing and summarizing content. Higher-level questions encourage students to think critically and to solve problems. Various researchers have developed cognitive schemes for classifying questions. Bloom’s (1956) system of ordering thinking skills from lower to higher has become a classic:

**Low-Skill Questions**
- Knowledge skills (remembering previously learned material such as definitions, principles, formulas): “Define shared governance.” “What are Piaget’s stages of development?”
- Comprehension skills (understanding the meaning of remembered material, usually demonstrated by restating or giving examples): “Explain the process of mitosis?” “Give some examples of alliteration.”

**Moderate-Skill Questions**
- Application skills (using information in a new context to solve a problem, answer a question, perform a task): “How does the concept of price elasticity explain the cost of oat bran?” “Given the smallness of the sample, how would you analyze these data?”
- Analysis skills (breaking a concept into its parts and explaining their interrelationships; distinguishing relevant from extraneous material): “What factors affect the price of gasoline?” “Point our the major arguments Shelby Steele uses to develop his thesis about affirmative action.”

**High-Skill Questions**
- Synthesis skills (putting parts together to form a new whole; solving a problem requiring creativity or originality): How would you design an experiment to show the effect of receiving the Distinguished Teaching Award on a faculty member’s subsequent career progress?” “How would you reorganize Bloom’s taxonomy in light of new research in cognitive science?”
- Evaluation skills (using a set of criteria to arrive at a reasoned judgment of the value of something): “To what extent does the proposed package of tax increases resolve the budget deficit?” “If cocaine were legalized, what would be the implications for public health services?”
“Balance the kinds of questions you ask.” Move from simple questions to those that require more thought. Experienced discussion leaders have found it helpful to develop a typology or inventory of questions such as these:

- **Exploratory questions** probe facts and basic knowledge: “What research evidence supports the theory of a cancer-prone personality?”
- **Challenge questions** examine assumptions, conclusions, and interpretations: “How else might we account for the findings of this experiment?”
- **Relational questions** ask for comparisons or themes, ideas, or issues: “What premises of *Plessy v. Ferguson* did the Supreme Court throw out in deciding *Brown v. Board of Education*?”
- **Diagnostic questions** probe motives or causes: “Why did Jo assume a new identity?”
- **Action questions** call for a conclusion or action: “In response to a sit-in at California Hall, what should the chancellor do?”
- **Cause and effect questions** ask for causal relationships between ideas, actions, or events: “If the government stopped farm subsidies for wheat, what would happen to the price of bread?”
- **Extension questions** expand the discussion: “How does this comment relate to what we have previously said?”
- **Hypothetical questions** pose a change in the facts or issues: “Suppose Greg had been rich instead of poor; would the outcome have been the same?”
- **Priority questions** seek to identify the most important issue: “From all that we have talked about, what is the most important cause of the decline of American competitiveness?”
- **Summary questions** elicit syntheses: “What themes or lessons have emerged from today’s class?”

Also include questions that ask for hunches, intuitive leaps, and educated guesses. Stimulate students’ thinking by varying the intellectual approach of your questions.”

**Some types of Questions NOT to Ask (Christensen, 1991)**

I avoid, “Don’t you think?” because it is an answer disguised as a question. The authority implicit in this phrase implies that any disagreement must be mistaken—hardly a message to stimulate free inquiry. I have also forbidden myself the use of, “Who doesn’t understand this?” and its close cousin, “Does everyone see how I reached that conclusion?” It takes a brave or foolish student to accept these noninvitations.”

[Other types of questions to avoid include: “Isn’t that right?” “Are there any questions?” (Try “Now, let me have your questions?” instead), and questions with added hints that dumb-down the question such as “Where is the thermocline on this temperature profile? Is the change in slope of the profile significant?”]
Sample Questions Using Bloom's (1956) Taxonomy

**Topic:** The “Greenhouse Effect”

<table>
<thead>
<tr>
<th>Cognitive Level</th>
<th>Sample question</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low-Skill Questions</strong></td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>Define the greenhouse effect.</td>
</tr>
<tr>
<td>Comprehension</td>
<td>What human activities are believed to enhance the greenhouse effect, and how do they do this?</td>
</tr>
<tr>
<td><strong>Moderate-Skill Questions</strong></td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td>How and why is an enhanced greenhouse effect predicted to alter global precipitation and hurricane activity?</td>
</tr>
<tr>
<td>Analysis</td>
<td>Explain several examples of positive feedback intensification that are believed to result from an enhanced greenhouse effect.</td>
</tr>
<tr>
<td><strong>High-Skill Questions</strong></td>
<td></td>
</tr>
<tr>
<td>Synthesis</td>
<td>Which human activities are believed to make the greatest contributions to enhancing the greenhouse effect, and why?</td>
</tr>
<tr>
<td>Evaluation</td>
<td>What efforts to reduce human enhancement of the greenhouse effect are likely to be most effective, and why?</td>
</tr>
</tbody>
</table>
Figure 1.17
The hydrologic cycle and annual transfer rates (thousands of cubic kilometers per year). Snow and rain together equal precipitation. Sublimation, the direct transfer of ice to water vapor is included under evaporation. Surface flow and groundwater flow are considered as land runoff.
A trophic pyramid. Trophic levels are numbered from base to top. The first trophic level requires nutrients and energy. Nutrients are recycled at each level; energy is lost as heat at each level.