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K. PATRICIA CROSS

CLASSROOM
ASSESSMENT
TECHNIQUES

A Handbook for College Teachers

SECOND EDITION
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Background Knowledge Probe

Estimated Levels of Time and Energy Required for:

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**DESCRIPTION**

At the first class meeting, many college teachers ask students for general information on their level of preparation, often requesting that students list courses they have already taken in the relevant field. This CAT is designed to collect much more specific, and more useful, feedback on students’ prior learning. Background Knowledge Probes are short, simple questionnaires prepared by instructors for use at the beginning of a course, at the start of a new unit or lesson, or prior to introducing an important new topic. A given Background Knowledge Probe may require students to write short answers, to circle the correct responses to multiple-choice questions, or both.

**PURPOSE**

Background Knowledge Probes are meant to help teachers determine the most effective starting point for a given lesson and the most appropriate level at which to begin instruction. By sampling the students’ background knowledge before formal instruction on that topic begins, these probes also provide feedback on the range of preparation among students in a particular class.

For students, the Background Knowledge Probe focuses attention on the most important material to be studied, providing both a preview of what is to come and a review of what they already know about that topic. Background Knowledge Probes can also be used as pre- and post-assessments: before instruction, to find out the students’ "baseline" knowledge level; and immediately after, to get a rough sense of how much and how well they have learned the material. This CAT elicits more detailed information about what students know than Focused Listing (CAT 2) can.

**RELATED TEACHING GOALS**

- Improve memory skills (TGI Goal 11)
- Develop appropriate study skills, strategies, and habits (TGI Goal 16)
- Learn terms and facts of this subject (TGI Goal 18)
- Learn concepts and theories in this subject (TGI Goal 19)
- Develop an informed historical perspective (TGI Goal 32)
SUGGESTIONS FOR USE

You can use this technique as early as the first class meeting; it works well in classes of any size. Focus the questions in your probe on specific information or concepts that students will need to know to succeed in subsequent assignments, rather than on their personal histories or general knowledge. Make sure to ask at least one question that you are certain most students will be able to answer correctly, and at least one other that you judge to be more difficult. At the next class meeting, individual students can find out how the class as a whole did, and can gauge their level of preparation in relation to that of the group. To assess changes in students' knowledge and concision in responding, you can use the same or similar questions at the midpoint and at the end of the lesson, unit, or term. The probe can also be used to introduce important concepts that will subsequently be developed through a number of lessons, or throughout the entire course.

EXAMPLES

From a Survey of English Literature (English/Literature)

On the first day of class, to get an idea of how much exposure her students had had to Shakespeare's plays, this professor prepared a Background Knowledge Probe. The form asked students in her lower-level English literature course to list the plays that they were familiar with. For each work listed, they were to check off whether they had read it, seen it performed in a theater, or seen it in the movies or on television. Most of the lists she got back were predictably short; and Romeo and Juliet, Hamlet, and Macbeth were the titles most frequently named. A handful of students turned in quite long lists, however, while a few turned in blank forms. Several other students included works on their lists that were not by Shakespeare. More students had seen Shakespeare's works on television or in the movies than had read them, and only a quarter had seen a live performance. As a result, most of the students were familiar with abridged and sometimes drastically altered versions of the original plays.

At the next class meeting, the English literature professor shared a summary of this information with the class, letting some of them know that they would be encountering a play for the second time and explaining that she had substituted King Lear for Macbeth because many already had seen or read the latter. She complimented the students who had already read and/or seen a work of Shakespeare and asked them to assist those in class to whom it would be totally new. She also alerted the class to major differences between the texts they would read and some of the filmed versions they had seen. She then passed out a handout summarizing the feedback gathered and giving the names of the authors of the works listed that were not by Shakespeare.

From Fundamentals of Electric Circuits (Electrical Engineering)

Before their first lecture-demonstration-lab session, this electrical engineering instructor wanted to determine what his students might already have learned—whether through course work or on-the-job expe-
rience—about measuring current, voltage, and resistance. To find out, he prepared a Background Knowledge Probe that contained five illustrations representing the displays of the following instruments: voltmeter, ammeter, ohmmeter, deflection multimeter, and digital multimeter. Each illustration clearly indicated a different reading or readings through the pointer positions and switch settings, or digital readouts shown. Near the end of the first class session, he presented students with these illustrations, reproduced on two pages, and asked them to determine, and write out, the readings for the five instruments shown.

The responses to his probe indicated that most students were more familiar with digital instrument displays and that most of them had some idea what the readings on at least one of the instruments meant. But he also saw that most students did not use standard electrical engineering notation and vocabulary in their responses and that there was quite a range of prior knowledge. A few students had no idea how to respond; a few others got everything correct.

To capitalize on the diversity in preparation, he decided to start the next class with a small-group warm-up exercise. He randomly assigned students to groups of four and then handed out clean copies of the same Background Knowledge Probe. He gave the groups fifteen minutes to come up with correct readings for all five instruments. They were told that each person in each group was expected to learn the correct answers. This, of course, meant that the more experienced students had to explain and teach their responses to the novices.

After the instructor had asked questions of each group, he commented on the diversity of the earlier, individual responses to the probe. To respond to this diversity, he told the class, he had to include material that would be totally new to some of them but would be review to others. He asked the more advanced students to consolidate their knowledge by helping their less experienced classmates. And he asked the beginners to recognize their responsibility to invest relatively more time and effort.

1. Before introducing an important new concept, subject, or topic in the course syllabus, consider what the students may already know about it. Recognizing that their knowledge may be partial, fragmentary, simplistic, or even incorrect, try to find at least one point that most students are likely to know, and use that point to lead into other, less familiar points.

2. Prepare two or three open-ended questions, a handful of short-answer questions, or ten to twenty multiple-choice questions that will probe the students’ existing knowledge of that concept, subject, or topic. These questions need to be carefully phrased, since a vocabulary that may not be familiar to the students can obscure your assessment of how well they know the facts or concepts.

3. Write your open-ended questions on the chalkboard, or hand out short questionnaires. Direct students to answer open-ended questions succinctly, in two or three sentences if possible. Make a point of announcing that these Background Knowledge Probes are not tests or quizzes...
and will not be graded. Encourage students to give thoughtful answers that will help you make effective instructional decisions.

4. At the next class meeting, or as soon as possible, let students know the results, and tell them how that information will affect what you do as the teacher and how it should affect what they do as learners.

TURNING THE DATA YOU COLLECT INTO USEFUL INFORMATION

After you have collected the responses, try dividing them into three or four piles, according to degree of preparation for the upcoming learning tasks. You can, for example, quickly rate both written answers and multiple-choice responses, classifying them into the following four categories: 

[ — 1] = erroneous background knowledge; [0] = no relevant background knowledge; [+ 1] = some relevant background knowledge; [+ 2] = significant background knowledge. By summing the individual numerical ratings for each question, you can find out whether the class as a whole has more knowledge about some topics than about others. For an even faster analysis, you can simply sort responses into "prepared" and "not prepared" piles.

IDEAS FOR ADAPTING AND EXTENDING THIS CAT

After students have responded individually to the probes, ask them to work in pairs or small groups to come up with mutually acceptable, correct answers.

Divide the class into small groups of students and ask them to rate and sort responses from other groups.

If you have a small number of students in an upper-level course, consider having the students interview each other, taking notes on the responses to probe questions.

Use Background Knowledge Probes as a higher-level follow-up or alternative to Focused Listing (CAT 2).

PROS

Background Knowledge Probes can provide useful data not only about students' knowledge of the topic but also about their skills in communicating what they know.

They provide baseline data that teachers can use to make critical instructional decisions before instruction begins.

By building on specific background knowledge that students do have, the instructor can give students a familiar starting point, a "hook to hang new information on."

Like Focused Listing, this technique can "prime the pump" of recall, encouraging students to connect the lesson or course topic to their own past experiences and prior knowledge and prodding students to begin constructing their own "bridges" between old and new knowledge.
If student responses are at odds with the teacher’s expectations, the feedback can sometimes be overwhelming and even demoralizing to the instructor.

In a similar fashion, trying to respond to the probe can be a difficult and frustrating experience for students who are underprepared.

In the process of reading and classifying responses, a teacher may form hard-to-change first impressions, which can affect his or her expectations of the students for the remainder of the term.

**CAVEATS**

Feedback from this technique can throw even the best-planned lesson or syllabus into serious question by demonstrating the need for quick and sometimes major revisions in instructional plans. Therefore, Background Knowledge Probes should be used only if you have the time, energy, and willingness to analyze and respond to the information they generate.

Do not generalize too much from the responses to a single administration of this CAT.

Although you will naturally be concerned with the underprepared students that a Background Knowledge Probe is likely to identify, you will also need to plan a response for those students who are adequately to extremely well prepared.

**REFERENCES AND RESOURCES**

A description of this technique, along with many other useful ideas on teaching and learning, can be found in an in-house publication of Roxbury Community College (1986, especially pp. 8 and 9). For an example of the Background Knowledge Probe used in a political science course, see *Early Lessons* (Angelo, 1991, pp. 20-21).
Focused Listing

Estimated Levels of Time and Energy Required for:

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**DESCRIPTION**
As the name implies, this Classroom Assessment Technique focuses students’ attention on a single important term, name, or concept from a particular lesson or class session and directs them to list several ideas that are closely related to that "focus point."

**PURPOSE**
Focused Listing is a tool for quickly determining what learners recall as the most important points related to a particular topic. It can help faculty assess how well students can describe or define a central point in a lesson, and it can begin to illuminate the web of concepts students connect with that point. Practicing this technique can help students learn to focus attention and improve recall.

**RELATED TEACHING GOALS**
- Improve skill at paying attention (TGI Goal 9)
- Develop ability to concentrate (TGI Goal 10)
- Improve memory skills (TGI Goal 11)
- Improve listening skills (TGI Goal 12)
- Develop appropriate study skills, strategies, and habits (TGI Goal 16)
- Learn terms and facts of this subject (TGI Goal 18)
- Learn concepts and theories in this subject (TGI Goal 19)

**SUGGESTIONS FOR USE**
Focused Listing can be used before, during, or after the relevant lesson. As a result, teachers can use this technique to gauge the best starting point, make midpoint corrections, and measure the class's progress in learning one specific element of the course content. Because of its simplicity, Focused Listing works well in classes of all sizes. It can be used relatively frequently in courses where a large amount of new information is regularly introduced. Perhaps for this reason, Focused Listing has been particularly popular with instructors in undergraduate survey courses and those who teach courses in vocational and preprofessional education.
From Introductory Physics for Nonscience Majors (Physics)

Over the years, this physics professor has found that, for many first-year students, the specialized vocabulary of her field is almost as great a barrier to learning as the level of mathematical sophistication that most such courses assume. For that reason, she and her colleagues developed a challenging introductory physics course that focuses on conceptual understanding and teaches students the necessary terminology and mathematics as they go.

She often uses Focused Listing to assess her students' knowledge of critical physical science terminology and to raise their awareness of the important information and concepts represented by those terms. On the first day of class, for example, she hands out half-sheets of scrap paper and asks students to write a list of five or so words or phrases that define work in physics. After about two minutes, she collects their responses.

Once she has read them through quickly, the physics professor sorts the responses into three piles: those that do at least a fairly good job of defining work in physics; those that confuse work in physics with work in everyday life; and all the rest. As she prepares for the second class meeting, the professor works the results of the Focused Listing and several quotes from student responses into her lecture notes. In the next class, using concepts and words that the students provided in their Focused Listings, she explains and differentiates the two distinct but easily confusable meanings of work: the everyday and the scientific. Throughout the semester, she uses Focused Listing to assess and help students learn other key concepts, such as mass, velocity, energy, impulse, and momentum.

From Investments (Finance/Management)

After an initial lecture on stocks in this core management course, the finance professor asked his fifty students to list and quickly define five to seven fundamental concepts related to stocks. Since they were writing brief definitions in addition to listing concepts they recalled, he allowed the class ten minutes for this assessment. Reading quickly through student responses afterward, he found that more than half of the class had listed and adequately defined at least three of the six concepts on his Focused List; some of the students had included other important and valid concepts that were not on his list (seven such concepts were included).

At the following class meeting, the finance professor gave out a printed list of some of the best definitions and reviewed the three fundamental concepts from his list that had not been included by most students. This experience led him to begin each class session by writing on the chalkboard a list of several key concepts and terms that students should focus on throughout the lecture.

From an Introduction to Non-Western Art and Music (Art/Humanities)

With no introduction except directions to listen and watch attentively, the instructor in this general education survey course showed a twenty-
minute slide and audiotape presentation on classical Persian art and music. After turning the lights back up, she asked the students to make a Focused Listing of terms they would use to describe classical Persian culture, based on what they had seen and heard. She allowed students a couple of minutes to make individual lists. Then, rather than collecting the Focused Lists and analyzing them out of class, the instructor asked students to share what they had written.

By eliciting responses from around the room, she made a composite list of a dozen terms on the chalkboard and used that list as a starting point for her lecture on the topic. Now that she knew the students’ vocabulary of concepts, she could help them connect her new, very specific set of terms and concepts to their general impressions and previous knowledge. She also used the class’s Focused List to demonstrate to the students that although most of them had never encountered Persian culture before, they could begin to appreciate it with the cultural vocabularies they already possessed.

From United States Government and Politics (Political Science)

(This last example is a somewhat more complicated one, in which Focused Listing was used as a pre- and post-assessment of students’ learning in the course of a single class session.)

At the beginning of the ninety-minute session, before leading a lecture/discussion on basic concepts of United States government, this political science professor handed out 3-by-5-inch index cards to his thirty first-year students, telling them to label one side of the card "Before." He then gave them two minutes to make a Focused List of a half-dozen words and short phrases they would use to define or describe Federalism. When two minutes had passed, the professor asked them to turn over the index cards, but to keep them handy.

At the conclusion of the lecture/discussion on Federalism, but about ten minutes before the end of class, the instructor asked students to write another half-dozen or so terms defining or describing Federalism on the blank side of their index cards, and to label the second list "After." He then directed them to circle the three most important terms and hand in the index cards.

Even a quick scan of the cards highlighted the students’ inclusion of more specific and more appropriate terms in their "After" lists. This was, of course, the kind of learning the professor was hoping his lesson would provoke. As he compiled a list of the terms that students had circled as the three most important, however, he noticed a great deal of variation. In fact, his thirty students had come up with twenty-three different terms as "most important." The five fundamental terms that the instructor had emphasized in his lecture were there on the composite list, but not on every individual list. He saw that many of the class’s eighteen remaining terms could be subordinated to his five big ideas but that some clearly did not relate to Federalism.

The political science instructor decided to use the students’ list as a starting point for the next class session. He created three overhead transparencies. The first overhead contained the twenty-three terms from the composite list; the second consisted of the same items organized into six subgroups, headed by his five topics and one other; and the third transparency was his own Concept Map (see CAT 16) showing
the relationships between Federalism and those items from the class list that he could connect. In the next class, those three transparencies served as launching points for a lively twenty-minute discussion focusing on why and how particular concepts from their lists did or did not relate to Federalism.

**STEP-BY-STEP PROCEDURE**

1. Select an important topic or concept that the class has just studied or is about to study and describe it in a word or brief phrase.

2. Write that word or phrase at the top of a sheet of paper as the heading for a Focused List of related terms important to understanding that topic.

3. Set a time limit or a limit on the number of items you will write, or set both time and item-number limits. Two or three minutes and five to ten items are usually sufficient.

4. Adhering to your own limits, make a list of important words and phrases you can recall that are related to and subsumed by your heading.

5. Look over your list quickly, adding any important items you may have left out.

6. If you are still convinced that the topic is important and well defined—worth class time to assess and respond to—give your students the same focus topic, tell them the time and/or length limits, and ask them to make Focused Lists. (You will probably need to allow students somewhat more time than you gave yourself to carry out this task.)

**TURNING THE DATA YOU COLLECT INTO USEFUL INFORMATION**

In analyzing responses to the Focused Listing, as with any other CAT, organize the data to highlight the information, categories, or relationships you want students to pay attention to and learn from. You may find it useful to compare the number of items (quantity) and the identity of those items (quality) on the students’ lists with the content of your own lists. While your own Focused List should serve as the "master list" — the criterion against which to compare the students’ lists — you might want to read at least a sample of the students’ lists to see whether they have come up with any acceptable items that you missed.

The simplest way to categorize students’ responses is to sort them into groupings of "related" and "unrelated" or "appropriate" and "inappropriate" items. A second level of analysis is to categorize responses according to the type or degree of relationship they have to the focus topic. For instance, you might sort students’ responses into groups of definitions, examples, descriptions, and illustrations; or into those that have primary, secondary, and tertiary relationships to the focus term.

**IDEAS FOR ADAPTING AND EXTENDING THIS CAT**

Provide students with the focus topic along with their homework assignment and ask them to complete the Focused List before class. Allow students to work in small groups to develop collective Focused Lists. Make your Focused List available to the students for comparison and, if possible, for questions and discussion in class.
Make—or have students working in small groups make — a follow-up list that combines the best of the students' lists with your own. This activity provides students with an opportunity to think about what is most important to learn, know, and remember about that topic.

Encourage students to keep a notebook or journal of their Focused Lists and to use the technique whenever they find it useful.

Ask students to write definitions for each of the key terms on their Focused Lists.

Have students turn their lists into expository prose, clearly explaining the relationships between the focus point and the items and / or the relationships among the items.

Use Focused Listing again at intervals after the first administration. It then becomes a technique not only for assessing longer-term recall but also for reinforcing and deepening learning and encouraging restructuring.

Build on this CAT by assessing students' knowledge of the same focus point with Concept Maps (CAT 16), the One-Sentence Summary (CAT 13), Directed Paraphrasing (CAT 23), or the Memory Matrix (CAT 5).

To assess students' understanding of two related concepts, try the Defining Features Matrix (CAT 9).

**PROS**

Focused Listing is an extremely simple, quick, and flexible way to collect information on student knowledge about a particular topic.

It gives the teacher a clear idea of which specific terms and concepts the students recall and which they don't, allowing for more focused and effective review.

When the amount of time allotted for list making is very limited, the resulting responses often indicate what the most salient information is from the learner's point of view, rather than what the students think the teacher wants to hear.

If Focused Listing is used before instruction, it can "prime the pump," stimulating students to recall anything they may know about a topic before reading or hearing about it. They will therefore be more likely to connect and remember the new information they encounter.

**CONS**

In its basic form, Focused Listing requires only recall, and so makes no demands, or very limited ones, on higher-level cognitive skills.

Some students may be able to produce a list of relevant terms without necessarily understanding their meanings or interrelationships.

This technique focuses on one idea at a time, but many of the most difficult learning problems have to do with students' difficulty in understanding the relationships between and among ideas.
Caveats

Always work through this technique yourself before using it in class. Make sure you have your own Focused List ready.

Focus on a term or concept so important that you want students to remember it three years after the class is over.

Choose a focus topic that is neither too broad nor too narrow. A topic that is too broad will lead to hopelessly divergent lists, while too narrow a focus can lead to extremely limited and trivial lists.

Make sure that both the task and the limits are clear and that students know if you expect them to apply any particular criteria in generating their lists, such as listing only defining words, synonyms, or examples.

References and Resources

See Obler, Arnold, Sigala, and Umbdenstock (1991, pp. 111-112) for an example of Focused Listing used in a U.S. history class.
Misconception /Preconception Check

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**DESCRIPTION**
Focused Listing and Background Knowledge Probes are simple techniques for gathering information on what students already know in order to determine effective starting points for instruction. The Misconception /Preconception Check also assesses students' prior knowledge, but with a twist. Its focus is on uncovering prior knowledge or beliefs that may hinder or block further learning.

**PURPOSE**
The greatest obstacle to new learning often is not the student’s lack of prior knowledge but, rather, the existence of prior knowledge. Most college teachers know from experience that it’s much harder for students to unlearn incorrect or incomplete knowledge than to master new knowledge in an unfamiliar field. Consequently, teachers can benefit from discovering early in the term which common misconceptions and preconceptions students have that are likely to interfere with their learning in a given course. This CAT is designed to uncover specific instances of incorrect or incomplete knowledge, attitudes, or values that represent likely barriers to new learning. Because assessment activities such as this CAT identify misconceptions and preconceptions early on and help students explicitly recognize and understand them, students stand a much greater chance of learning new material correctly and integrating it into their "revised" and often "transformed" knowledge structures.

**RELATED TEACHING GOALS**
- Develop ability to distinguish between fact and opinion (TGI Goal 8)
- Learn terms and facts of this subject (TGI Goal 18)
- Learn concepts and theories in this subject (TGI Goal 19)
- Develop an openness to new ideas (TGI Goal 27)
- Cultivate an active commitment to honesty (TGI Goal 50)

**SUGGESTIONS FOR USE**
Although there are common misperceptions or preconceptions about every field, they seem to be most pernicious and common in those areas of the curriculum that have the greatest overlap with life outside the university.
classroom. For instance, virtually all incoming first-year college students have knowledge, beliefs, and attitudes about the phenomena they will study in political science, economics, anthropology, sociology, history, and psychology courses. While these same students are likely to have fewer strongly held preconceptions and misconceptions about mathematics, the natural sciences, and related fields, some of the wrongheaded, implicit "common-sense" notions that they cling to can still effectively derail learning.

Thus, this CAT can be particularly useful in social and behavioral science courses, especially those dealing with controversial or sensitive issues. In the natural sciences and mathematics, the Misconception /Preconception Check can help faculty uncover naive and sometimes magical beliefs that can act like filters: allowing disconnected facts and principles through but blocking out a deeper understanding of method or worldview. Although two of the three examples below concern beginning-of-term applications, this technique can be used at any point in a course when students encounter new information or interpretations that they may find counterintuitive or disturbing.

**EXAMPLES**

*From the Americas Before Columbus (History)*

On the first day of class, after initial introductions, the instructor in this upper-division course on pre-Columbian history administered a Misconception /Preconception Check. She explained to the twenty-five or so students that she was gathering information on what the class as a whole already knew about the Americas and Native Americans before 1492, so that she could better tailor her teaching to fit them. She then passed out sheets of lined paper and asked the students to write their best answers to three questions, but not their names. She told them they would have five minutes to write. The three questions she wrote on the chalkboard were:

1. About how many people lived in North America in 1491?
2. About how long had they been on this continent by 1491?
3. What significant achievements had they made in that time?

After five minutes, she collected the papers, shuffled them, and handed them back, asking anyone who got his or her own paper back to trade with someone else. Once everyone had someone else’s paper, she asked the students to share those responses. First, she elicited the lowest and highest numerical answers for questions 1 and 2, establishing the ranges. The ranges were quite spectacular, and there wasn’t much agreement between the poles. For question 3, she simply listed answers on the board until they began to repeat. The list was not particularly long.

Having finished the list, the history professor stood quietly. Finally, one of the students asked her what the right answers were. She allowed that his was an important question, but one that would have to wait until they had explored an even more critical question. She collected their responses again, so that she could read them at home, and then wrote her fourth question on the board: "Where did you get those first three
answers?" The students spent the rest of that session trying to answer question 4. Most of them soon realized that their impressions of pre-
Columbian America were based on shaky ground. Then the professor
gave them their first library research assignment. They were to work in
pairs to double-check the accuracy of their first three answers and, in
the process, to find the "right" answers. The students found, of course,
that there are no generally accepted right answers but that some
answers are more plausible and better supported than others.

From Human Sexuality (Health Science/Biology)

Several weeks into the semester, before students in his large general
education course began the unit on sexually transmitted diseases and
AIDS, this biology professor constructed a Misconception/Preconcep-
tion Check focusing on these related topics. He developed a simple
questionnaire containing ten prompts designed to uncover commonly
held, incorrect ideas and beliefs about how diseases such as gonorrhea,
syphilis, hepatitis, and AIDS are transmitted; how prevalent these dis-
eases are among college students; and how individuals can avoid ex-
posure entirely or greatly reduce the risks of infection. Each prompt was
a statement, such as "Most of those now infected with the AIDS virus
became infected through homosexual activities or intravenous drug
use." In response to each statement, the student was to circle one of
the answers below.

I'm absolutely certain this is true
I'm pretty sure it is true
I have no idea whether it's true or false
I'm pretty sure it is false
I'm absolutely certain it is false

He asked students to circle the one most appropriate answer for
each question, but not to put their names on the questionnaires. After
class, he quickly tallied the responses and found that a majority of his
students were either operating under dangerously incorrect notions or
simply unsure about nine out of the ten issues. The Misconception/
Preconception Check also revealed that his students felt more certain
about some wrong answers than others. Knowing what the common
misconceptions were, and just how common they were in that class, the
biology professor could tailor his teaching plan to respond to the partic-
ular needs of that group. And knowing that some incorrect notions were
more deeply ingrained than others, he could prepare more effectively to
meet different degrees of resistance.

At the beginning of the first class meeting on this topic, he dis-
played a series of ten overhead transparencies, each illustrating the
range of responses to each statement. In the lecture and discussion
that followed, he explained why the incorrect answers were incorrect
and what implications the general "true" information he presented
might have for specific individuals. He also talked with students about
the evolution of knowledge about these diseases over time, and ways in
which the media sometimes encourage or reinforce misconceptions.

From Introduction to the Structure of the Universe (Astronomy)

Ten minutes before the end of the first meeting of a large undergradu-
ate science course, the professor handed out half-sheets of paper and
asked students to write their best answers to the following question: "What makes the seasons change on Earth?" She told them that any sincere answer was acceptable except "I don't know." She explained why she was asking them this question and what she would do with their responses. She also directed the students not to write their names on the papers and assured them that, on the first day of class, she certainly could not yet identify them by their handwriting.

The professor stood by the exit as class ended, holding a small cardboard box for students to drop their answers in, thereby encouraging a high response rate. Later that day, she looked through the student responses very quickly, dividing them into the following four piles, based on the type of explanations given: the "correct" pile, the "distance" pile, the "weather" pile, and the "others" pile. The pile of correct answers was fairly small, representing less than one-tenth of the class. The pile of answers that explained seasons as the result of distance from the sun was the largest, with over 50 percent of the responses. Those who thought that weather somehow caused seasonal change represented almost 20 percent, and the rest came up with a bewildering variety of other explanations, including references to the moon's gravitational pull!

Before the next class, she picked out the clearest, most articulate example from each of the four piles and transcribed those four answers onto a one-page handout, which she then distributed to the students at the beginning of the next class. After they had read all four explanations, she asked them simply to circle the one correct answer and to turn in the handouts. While she went on with her lecture, her teaching assistant quickly tallied the responses. The assistant then wrote the percentages of the various answers from the first assessment and those from the second assessment side by side on the board. The second time around, the proportion of correct responses was much higher, nearly 40 percent. This is a common effect, occurring because students can more often recognize the correct answer when it is presented to them than they can independently produce that same answer.

At that point, the professor stopped her lecture and invited several students to explain their choices to the class. Proponents of each of the four major positions explained their models of seasonal change. That weekend, each student's assignment was to find out which of the answers really was correct and to explain, in less than a page, how he or she could be certain that it was indeed the correct explanation. Students then provided the explanations during the next class, with the professor offering minor corrections and qualifications. The class then discussed the adequacy of the arguments and evidence for each position. The instructor concluded the lesson on seasons by explaining why several other models, though incorrect, were reasonable. She also reminded the class that it had taken humans, as a species, quite a long time to figure out what caused the seasons.

### STEP-BY-STEP PROCEDURE

1. Start by identifying some of the most troublesome common misconceptions or preconceptions students bring to your course. Brainstorming this question with colleagues in your department or field can be a very effective way to generate such a list.
2. Select a handful of these troublesome ideas and beliefs — ones that are likely to interfere most with learning in your course—and focus your Misconception / Preconception Check on them.

3. Create a simple questionnaire to elicit information about students' ideas and beliefs in these areas. You may want to use a multiple-choice format or a short-answer format. Short-answer questions can uncover more useful information, but they compromise anonymity. Multiple-choice questionnaires are therefore safer, and the responses are easier to analyze. If you need to know how strongly held the beliefs or ideas are, consider providing Likert-scale responses such as those used by the biology instructor in the example above.

4. Have another faculty member read your questions to make sure they do not seem patronizing, threatening, or obvious.

5. Before giving the questionnaire to your students, think through how you will respond to several likely outcomes. Strike any questions or topics you do not feel prepared to deal with.

6. Explain your reasons for using this CAT to the students, make sure the anonymity of their responses is ensured, and announce when and how you plan to respond to their feedback.

**Turning the data you collect into useful information**

Depending on the way the questionnaire is designed, analyzing the feedback from this CAT can answer one or more of the following three questions: What specific misperceptions or preconceptions do my students have about the course material that might interfere with their learning? How many of the students have them? How deeply embedded are these "problematic" ideas or beliefs?

To answer the first two questions, you can quickly organize the responses into rough categories by type of misconception or preconception, and then tally them, as in the example above from the physics course. You can best answer the third question if you have constructed the Misconception / Preconception Check to provide information on the students' degree of certainty or strength of beliefs, as in the example from the Human Sexuality course. As you read through and tally responses to this type of question, look for patterns within and across items. For example, watch for questions or topics on which the students' responses are clearly divided. Looking across items, group the topics into four categories: those that elicit strong reactions at both the "correct" and the "incorrect" ends of the scale, those that elicit mostly incorrect or mostly correct responses, and those that most students are unsure of or that elicit thoroughly mixed results.

**Ideas for adapting and extending this CAT**

To encourage candid responses to sensitive topics, begin by asking students to identify common misconceptions and preconceptions that they think other people have about the topic or field.

Have students work in teams to come up with "reasonable" explanations or justifications for the misconceptions uncovered through this assessment.
Readminister the same questionnaire later in the term — after your instructional response — to see what, if anything, has changed and how.

**PROS**

The Misconception / Preconception Check gives teachers a quick way to uncover likely barriers to learning and thus to prepare to meet and overcome them.

Since this CAT is carried out anonymously, individual students are likely to reveal their own ideas and beliefs, rather than providing "safe" answers.

Many students are both surprised and relieved to learn that they are not alone in being mistaken or unclear about a given topic. The feedback session can provide that reassurance.

When students do explicitly recognize and question their own knowledge, beliefs, and attitudes, they gain a measure of control over their own thinking. This technique can help students take one small step in the direction of self-knowledge and self-awareness.

**CONS**

The first and most obvious disadvantage of using this technique is that virtually no one enjoys having his or her certainties questioned. As noted above, unlearning—though often necessary—can be very difficult and even painful.

A related problem is time. Changes in fundamental ideas, beliefs, and attitudes take time and rarely occur in a linear fashion. For many students, the developmental changes involved in moving from a "magical," prescientific view of the universe to an empirical approach will take much more than a semester to solidify.

**CAVEATS**

One person’s unquestioned fact is often another’s questionable theory — or pernicious falsehood. Tread lightly when dealing with potentially sensitive issues if you want students to open up enough to risk having their assumptions challenged. In general, do not use this technique to focus on issues that students may find personally threatening until a climate of trust and civility has been established in the class.

**REFERENCES AND RESOURCES**

For an example of this CAT applied to a chemistry course, see *Early Lessons* (Angelo, 1991, pp. 21-22).

*A Private Universe* is a fascinating videotape that explores high school and college students’ (mis)understandings of the causes of seasons and the difficulty one student faces in unlearning her incorrect, though highly original, explanation. This videotape illustrates the importance and difficulty of uncovering powerful misperceptions and helping students unlearn them. (Videotape distributed by Pyramid Film and Video, Box 1048, Santa Monica, Calif. 90406.)
Empty Outlines

**Estimated Levels of Time and Energy Required for:**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty to prepare to use this CAT</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>Students to respond to the assessment</td>
<td>LOW</td>
</tr>
<tr>
<td>Faculty to analyze the data collected</td>
<td>MEDIUM</td>
</tr>
</tbody>
</table>

**DESCRIPTION**
The name of this technique is self-explanatory. The instructor provides students with an empty or partially completed outline of an in-class presentation or homework assignment and gives them a limited amount of time to fill in the blank spaces. To help students better organize and learn course content, many instructors already provide outlines of their lectures at the beginning or end of class sessions. In our experience, however, fewer teachers use the outline format to assess students' learning of that same content.

**PURPOSE**
The Empty Outline technique helps faculty find out how well students have "caught" the important points of a lecture, reading, or audiovisual presentation. It also helps learners recall and organize the main points of a lesson within an appropriate knowledge structure, making retention more likely and aiding understanding.

**RELATED TEACHING GOALS**
- Improve skill at paying attention (TGI Goal 9)
- Develop ability to concentrate (TGI Goal 10)
- Improve listening skills (TGI Goal 12)
- Develop appropriate study skills, strategies, and habits (TGI Goal 16)
- Learn terms and facts of this subject (TGI Goal 18)

**SUGGESTIONS FOR USE**
This technique works best in courses where a large amount of content—facts and principles—is presented regularly in a highly structured manner. For example, Empty Outlines have been used with success in introductory courses in physical and life sciences, nursing, law, art history, and music history. The technique can be used at the conclusion of a class session or at the beginning of the next one. Because it generates quite a bit of feedback, the instructor usually can read every response only in small classes. In large courses, the instructor can collect only group responses, or read and respond to only a sample of student outlines.
**EXAMPLES**

**From Pathophysiology (Nursing)**

Experience and examination results had convinced this nursing professor that her students had difficulty recognizing, organizing, and recalling the most important points in her lectures. To gain specific insights into how students were managing the heavy information load of her lectures, she handed out copies of an Empty Outline form ten minutes before the end of class. The outline contained four main headings, representing the four main topics she had just lectured on. Each main heading was followed by empty lines for three to five subheadings. She directed the students to fill in the subheadings quickly, making use of their class notes. At the end of the session, she collected the forms.

The Empty Outline form was based on her lecture outline, of course; so she could easily compare the students' subheadings with her own. A quick reading showed her that most of the students placed their responses under the correct headings. However, they often made their subheadings too specific, or they mixed items of different levels of specificity. The responses demonstrated that students were missing at least some important subtopics because they were distracted by facts.

Armed with examples from the Empty Outlines, the instructor was better able to illustrate the level on which she wanted students to focus their attention during the lectures. By the third application of this CAT, most students had located that level and were therefore more successful at "seeing the forest for the trees."

**From Child Language Acquisition (Child Development)**

Before he showed a videotape of an educational television program on the stages of language acquisition from birth to five years, the instructor watched the video himself and sketched a simple outline of its topics and major points. The major topics in his outline were the developmental stages of language acquisition; the subheadings were the developmental milestones that characterize each stage. To create an Empty Outline assessment form, he simply deleted the content of his subheadings, leaving the main headings intact.

After the class had viewed the hour-long videotape, the instructor passed out the one-page Empty Outline forms and asked students to work in pairs to fill them in. He allowed five minutes for the work and then collected the completed forms. A quick analysis of the results showed him that his students most clearly recalled the milestones from the first and last stages presented in the video. Their responses to the intermediate stages were much sketchier. This information gave the teacher clear directions on where to begin the follow-up discussion and what to focus on. It also convinced him of the need to stop in the middle of the videotape to allow students time to take notes and review what they had seen and heard to that point.

**From International Marketing (Business/Management)**

In this upper-division course, taught primarily through the case method, the instructor wanted to determine whether her students were noting the major points brought out during case discussions. She drew up her
Outline before the discussion and then revised it as the case discussion took place. Ten minutes before the end of the two-hour class meeting, the marketing professor sketched a simple Empty Outline on the board. It consisted of four Roman numerals, each followed by three capital letters. She directed the students to copy the outline on a blank sheet of paper, to fill in the main points illustrated by the case discussion, and to follow each with at least three supporting comments made by class members.

While she had expected some range of responses, the width of that range surprised her. There was general agreement on only two major points, and very little consistency in the supporting comments cited. Many students had difficulty coming up with supporting comments. Her outline and the students’ were often far apart, and not in ways that simply reflected reasonable differences in focus or interests.

The marketing professor summarized these differences broadly and reported back to the students, letting them know what she saw as the main points and strong supporting comments, and why. She invited discussion of her outline content—and got it. Several students were able to explain their responses persuasively.

At the suggestion of members of the class, she repeated the Empty Outlines exercise halfway through the next case discussion, and made time for small-group discussion of responses and revision of responses before they were handed in. Over several class sessions, the use of this technique led to much greater consensus on the important points and much more careful listening and questioning during the case discussions.

**STEP-BY-STEP PROCEDURE**

1. Create an outline of the lecture, presentation, discussion, or reading you want to focus on.

2. Make conscious decisions about the level on which you will focus the Empty Outline and, thus, the students' attention. Do you want students to supply the main topics, the main subtopics, or the supporting details? These decisions will determine what information you supply in the form and what you leave out.

3. When students are to complete the form from memory—that is, without any notes or other information — limit the number of items the Empty Outline elicits to fewer than ten.

4. If your Empty Outline focuses on a live presentation or a discussion, make sure that your own notes reflect any important changes that may have occurred between what was scripted and what actually happened.

5. Let students know how much time they will have to complete the outlines and the kinds of responses you prefer — words, short phrases, or brief sentences.

6. Be sure to announce the purpose of the assessment and the time when the students will receive feedback on their responses.

**TURNING THE DATA YOU COLLECT INTO USEFUL INFORMATION**

As with the responses from many other CATs, you can take your analysis in two useful directions. You may wish simply to compare the actual responses to those you expected, counting the number of students who agreed or disagreed with your responses for each item. As an alternative, or as a second
IDEAS FOR ADAPTING AND EXTENDING THIS CAT

If students have a great deal of difficulty completing the Empty Outline, try providing the class with a jumbled list of headings and subheadings and letting them structure the outline by using that content. Provide main headings but not subheadings; at other times, list the subheadings or details and ask students to fill in the main points. For more advanced learners, provide nothing more than guidelines. Simply ask them to create outlines of the focus lesson and indicate how much detail you expect.

Use the technique to assess student expectations of the lesson by having them fill in the Empty Outline before the presentation or reading. Allow students a few minutes to work in pairs or small groups to fill in the outlines. Use Focused Listing (CAT 2) as a warm-up or step-up to Empty Outlines. Consider using Concept Maps (CAT 16) as an alternate or next step.

PROS

Repeated use of this CAT can promote more careful listening and note-taking.

Feedback on responses gives important direction and useful models to less experienced students.

Empty Outlines can help students better organize and more effectively reorganize their memories of the material they are learning.

The Empty Outline can be used to demonstrate the basic organizing schemes of the discipline and to give students practice in using these schemes.

CONS

Once you have decided to use the Empty Outline at the end of a session, you may feel more constrained to follow your own outline than you otherwise would.

Not all information is best organized or best remembered in the hierarchical, linear fashion commonly associated with outlines.

Unless students are creating their own outlines from "scratch," little if any higher-order thinking is required.

CAVEATS

Because learners start at different points and process information differently, there will always be some variation in the way students complete the Empty Outlines.

Don't try to assess too much at any one time. If there are twenty main points in your lecture or in the chapter you are focusing on, for example, use the Empty Outline to assess understanding of only one-third or half of that material.
Memory Matrix

<table>
<thead>
<tr>
<th>Estimated Levels of Time and Energy Required for:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty to prepare to use this CAT</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>Students to respond to the assessment</td>
<td>LOW</td>
</tr>
<tr>
<td>Faculty to analyze the data collected</td>
<td>MEDIUM</td>
</tr>
</tbody>
</table>

**DESCRIPTION**
The Memory Matrix is simply a two-dimensional diagram, a rectangle divided into rows and columns used to organize information and illustrate relationships. In a Memory Matrix, the row and column headings are given, but the cells, the boxes within, are left empty. When students fill in the blank cells of the Memory Matrix, they provide feedback that can be quickly scanned and easily analyzed.

**PURPOSE**
The Memory Matrix assesses students' recall of important course content and their skill at quickly organizing that information into categories provided by the instructor. By using this technique, teachers can quickly see not only whether their students have memorized the basic information but also how well they have organized that information in their memories.

**RELATED TEACHING GOALS**
- Improve memory skills (TGI Goal 11)
- Improve reading skills (TGI 14)
- Develop appropriate study skills, strategies, and habits (TGI Goal 16)
- Learn terms and facts of this subject (TGI Goal 18)
- Learn concepts and theories in this subject (TGI Goal 19)

**SUGGESTIONS FOR USE**
The Memory Matrix is useful for assessing student recall and basic comprehension of facts and principles in courses with a high informational content. It works particularly well, for example, in introductory courses in the natural sciences, foreign languages, music theory, history, and law. This assessment technique is often used after lectures, reading assignments, films, or videotapes that present a substantial amount of clearly categorizable information. Like the other CATs in this section, however, the Memory Matrix also can be used as a preinstructional assessment.

**EXAMPLES**
*From Elementary Spanish I (Foreign Languages)*

Several classes after teaching the introductory lessons on verb endings, this Romance languages instructor wondered how well students in...
her first-semester Spanish class had internalized the organizing logic of "families" of verbs. Specifically, she wanted to find out whether they could quickly and easily categorize common verbs they had recently learned. She handed out the matrix shown as Exhibit 7.1 and gave students ten minutes to fill the blank cells with as many different "base form" verbs as they could recall.

**Exhibit 7.1. A Sample Memory Matrix for Spanish Verb Endings.**

<table>
<thead>
<tr>
<th></th>
<th>-ar</th>
<th>-er</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irregular</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

By quickly looking over the students' completed matrices, the Spanish teacher identified two problem areas. First, students almost never misclassified irregular verbs as regular, but they did mistakenly categorize regular verbs as irregular ones fairly frequently. Second, students confused the -er and -ir verbs—something she often noted during conversational practice. This feedback gave the instructor a clearer picture of what to review in the next class meeting. It also helped students decide how to focus their study time before the first test.

From a Survey of Nineteenth- and Twentieth-Century Western Art (Art/Humanities)

This art history professor used a Memory Matrix to find out how well her students were connecting major artists, the countries they were associated with, and the important trends they exemplified, as well as to provide the class with a foreshadowing of the midterm examination. She allowed students in her large survey course ten minutes to fill in the matrix shown as Exhibit 7.2 by placing the names of major artists they had studied in the appropriate cells.

**Exhibit 7.2. A Memory Matrix for Major Artists and Styles.**

<table>
<thead>
<tr>
<th></th>
<th>France</th>
<th>United States</th>
<th>Britain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neoclassicism</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impressionism</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postimpressionism</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expressionism</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The instructor then divided the students into groups of five and directed each group to work together for ten minutes and come up with the most complete, correct matrices possible. Each of the seven groups was given a larger, blank copy of the matrix to write the group response on. At the end of ten minutes, the groups were still so enthusiastically engaged that she decided to give them five more minutes to work. Finally, after fifteen minutes of group work, she convinced the students to hand in their individual and group matrices.
Just by flipping through the responses, she could see that the group memory was much better than almost any individual student's recall. She also noted that categorizing artists by nationality was easy for most students. But even the groups had some trouble distinguishing Impressionists from Postimpressionists or Postimpressionists from Expressionists. That feedback gave her the starting point for a lecture/discussion on how and why art historians categorize artists in this fashion, and how and why they sometimes disagree on who belongs where.

From Anatomy and Physiology I (Nursing/Biology)

One of this biology instructor’s primary teaching goals was to help students make the connections between structures, processes, and functions. To assess how well his first-year nursing students understood these connections in relation to the digestive system, he drew the Memory Matrix shown as Exhibit 7.3. He decided to use the assessment after the students had read a chapter on that system but before he had lectured on it.

Exhibit 7.3. A Memory Matrix for Biology: The Digestive System.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Functions</th>
<th>Enzymes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Esophagus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stomach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small intestine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large intestine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pancreas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gall bladder</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Since this particular biology instructor was a firm believer in the value of cooperative learning, he organized the forty or so nursing students into eight more or less equal groups. Then he gave a piece of newsprint to each group, projected the Memory Matrix on a screen, and asked one person from each group to draw the diagram on the newsprint. After the empty matrices were sketched out, he allowed the groups fifteen minutes to fill in the missing information. A remarkable flurry of activity followed as the groups scrambled to complete their matrices.

When the time was up, the instructor collected the eight sheets. During the next twenty minutes, while the students watched an instructional videotape on enzyme functioning in the digestive system, he quickly scanned their group matrices for misplaced and missing information. The professor made quick notes on his own master version of the matrix, tallying up the number of groups that included critical
information and jotting down errors. As he had expected, remembering all the enzymes and associating them with the correct structures were the most difficult tasks.

By the time the videotape ended, the instructor was ready to lead a short, very focused discussion on the digestive system. He first pointed out some of the more common errors that the groups had made; then, using his "model" transparency of the matrix, he reinforced those points that most groups had gotten right. After the students had asked clarifying questions, he handed out individual copies of the same Memory Matrix, giving the students the last five minutes of class to fill them in. Their responses, which he looked over after class, indicated that all but a handful of students had successfully integrated the information.

STEP-BY-STEP

1. Draw a simple Memory Matrix in which row and column headings represent useful categorizing variables for important information covered in the lesson.

2. Fill in the blank cells yourself with the appropriate facts. Use the same vocabulary as that used in the relevant lectures, discussions, readings, or other instructional material.

3. Check to see that there is a good "fit" between row and column headings and the facts in the cells. Revise the Memory Matrix if necessary.

4. When you are satisfied with your matrix, draw a new one with only the row and column headings and spacious but empty cells. To encourage high achievers, provide enough space in the cells for a larger number of items than you expect students to come up with. Duplicate this matrix on scrap paper and hand out copies, or draw it on an overhead transparency or the chalkboard and have students copy it.

5. Direct students to provide the information needed to fill in the cells. Ask them to write only words or brief phrases. Set a realistic lower limit for the number of items you expect them to insert in each cell. Asking students to provide at least three items, for example, can keep them from stalling and blocking in search of the one best answer.

6. Collect the matrices and assess the correctness and completeness of the information given.

TURNING THE DATA YOU COLLECT INTO USEFUL INFORMATION

One way to analyze the data in the cells of the matrices is first to tally the number of instances (frequencies) of correct items in each cell and then to look for noticeable differences, both in total and in average numbers of correct responses, between and among the cells. This analysis will quickly show you what the students know well. A second useful approach is to focus on the incorrect or marginal items, once again by tallying them and looking for patterns. After you have tallied responses either way, you can look for patterns in the kinds of errors made. If there are clear imbalances in numbers of correct items in cells, they may indicate a failure to recall or correctly categorize specific types of information; or they may simply indicate that less
teaching or study time was devoted to certain categories of information than to others.

Use the Memory Matrix as a whole-class assessment by drawing the diagram on the chalkboard, eliciting the missing information from the class, and filling it in as you go. Ask a student or students to take notes, or write the elicited information on the chalkboard or on an overhead projector transparency.

Allow students to work in pairs or small groups to fill in the matrix, providing a bit more time for the task than you would for individuals.

Provide students with a Memory Matrix that is missing elements other than the contents of the cells. Leave out one column heading, for example. Then fill in one cell to serve as a clue to the identity of the missing column heading.

Break the class into small groups, giving each group a list of facts or terms that can be categorized into a Memory Matrix. The groups' task will be to decide how many and which categories to use as the row and column headings for their matrices. Responses from the various groups can then be compared and discussed.

**PROS**

The Memory Matrix allows you to assess not only how many facts the students can recall about a lesson but whether they can correctly categorize those facts and understand relationships among them.

It produces a bare minimum of written information displayed in a simple graphic framework, so the information can be read and assessed quickly.

Because of its graphic qualities, students who are strong visual learners may find this technique particularly helpful.

The Memory Matrix helps students manage, organize, and learn large amounts of information, making retrieval from memory easier and more efficient.

**CONS**

By providing row and column headings, the matrix precludes the students from using their own categorizing schemes. Therefore, the teacher may not find out whether some students have alternate ways of organizing and storing the information covered in the course.

Because the matrix provides very basic categories and information, the teacher may not be able to determine whether the students' answers represent what they have learned in the course or what they knew before they took the course.

The matrix format can make complex, dynamic systems appear static and lifeless.
Caveats

If your students have had little experience with this format, start out with simple matrices, preferably no larger than two by two (rows by columns), or three by three. Limiting the number of categories initially will help students master the technique more quickly.

Not all data can be neatly arranged in matrix cells; hence the distinction between categorical and sequential data so familiar to statisticians. If categories do overlap or blend, make sure those blurred lines get illuminated and clarified in subsequent feedback sessions. When distinctions are of degree rather than kind, the Defining Features Matrix (CAT 9) may be a more appropriate and useful assessment tool.

While it is a useful way to assess and organize information of many kinds, the Memory Matrix needs to be acknowledged as a convenient simplification of a more complex reality.

References and Resources

See Walker (1991, pp. 70-71) for an example of the Memory Matrix used in a large undergraduate psychology class.
Minute Paper

**DESCRIPTION**
To the best of our knowledge, no other Classroom Assessment Technique has been used more often or by more college teachers than the Minute Paper. This versatile technique—also known as the One-Minute Paper and the Half-Sheet Response — provides a quick and extremely simple way to collect written feedback on student learning. To use the Minute Paper, an instructor stops class two or three minutes early and asks students to respond briefly to some variation on the following two questions: "What was the most important thing you learned during this class?" and "What important question remains unanswered?" Students then write their responses on index cards or half-sheets of scrap paper — hence the "Half-Sheet Response" — and hand them in.

**PURPOSE**
The great advantage of Minute Papers is that they provide manageable amounts of timely and useful feedback for a minimal investment of time and energy. By asking students what they see as the most significant things they are learning, and what their major questions are, faculty can quickly check how well those students are learning what they are teaching. That feedback can help teachers decide whether any mid-course corrections or changes are needed and, if so, what kinds of instructional adjustments to make. Getting the instructor's feedback on their Minute Papers helps students learn how experts in a given discipline distinguish the major points from the details. The Minute Paper also ensures that students' questions will be raised, and in many cases answered, in time to facilitate further learning.

Despite its simplicity, the Minute Paper assesses more than mere recall. To select the most important or significant information, learners must first evaluate what they recall. Then, to come up with a question, students must self-assess — asking themselves how well they understand what they have just heard or studied.

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**Estimated Levels of Time and Energy Required for:**

<table>
<thead>
<tr>
<th>Task</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>Faculty to analyze the data collected</td>
<td>LOW</td>
</tr>
</tbody>
</table>
**RELATED TEACHING GOALS**

Develop ability to synthesize and integrate information and ideas (TGI Goal 5)

Develop ability to think holistically: to see the whole as well as the parts (TGI Goal 6)

Improve skill at paying attention (TGI Goal 9)

Develop ability to concentrate (TGI Goal 10)

Improve listening skills (TGI Goal 12)

Develop appropriate study skills, strategies, and habits (TGI Goal 16)

Learn terms and facts of this subject (TGI Goal 18)

Learn concepts and theories in this subject (TGI Goal 19)

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**SUGGESTIONS FOR USE**

Minute Papers are probably most useful in lecture or lecture/discussion courses, although the technique can be easily adapted to other settings. For example, the Minute Paper can also be used to assess what students have learned from a lab session, study-group meeting, field trip, homework assignment, videotape, or exam. Minute Papers work well at the end or the beginning of class sessions, serving either as warm-up or wrap-up activities. Like other simple techniques in this section, Minute Papers can be used frequently in courses that regularly present students with a great deal of new information. Because it is quick to administer and easy to analyze, the Minute Paper is well suited for use in large classes.

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**EXAMPLES**

*From European History: Renaissance to Modern Times (History)*

At the end of an exquisitely prepared, well-illustrated lecture on the Renaissance entitled "Why Italy?" the veteran history professor decided to use a new feedback technique she had heard about from a younger colleague. She passed out small, blank index cards and then raised the projection screen to reveal two questions, which she had written on the chalkboard before class. She told the students that she wanted thoughtful, brief, and legible answers, but no names. Then she read the two questions aloud: "What is the single most significant reason Italy became a—if not the—center of the Renaissance?" "What one question puzzles you most about Italy's role in the Renaissance?"

After five minutes, the history professor collected the index cards, told the students that she would respond to them at the next meeting, and dismissed the class. Reading through the forty-plus cards in her office, she was pleased that many of the students offered reasons she had underlined in her lecture. For this professor, acceptable reasons for Italy's central role in the Renaissance included its geographical proximity to Asia and Africa, its political organization into city-states, its historical links to Greece and Rome, and its highly developed mercantile economies.

She was irritated, on the other hand, because some students insisted on confusing cause and effect, reasoning that Italy became a Renaissance center because it had so many great artists and learned men. A few students even seemed to think that the Renaissance was created by Marco Polo, Leonardo da Vinci, Michelangelo, or the Medicis—a "Great Man" view of history that annoyed her even more!
How on earth, she wondered, could these students have missed the main points of her excellent, crystal-clear lecture? She was so delighted with their questions, however, that she soon got over her irritation and began to reshape her outline for the next class meeting. On the whole, they were much more thoughtful questions than students asked in class. She prepared an overhead transparency that categorized the students’ responses as Major Causes, Minor Causes, Effects, Actors, or To Be Discussed, this last category for answers she could not fit in the other categories. She then listed five questions that had been asked by more than two students and tried to answer them by referring to information the class had provided. Although her response to the Minute Papers and the ensuing discussion devoured one-third of the following class, she considered it time well spent. The class’s excellent performance on the midterm essay question dealing with causes of the Renaissance was further evidence that her personalized Minute Paper had improved their learning.

From Introductory Statistics (Statistics)

Intrigued by a demonstration of the Minute Paper during a faculty development workshop at his college, this young mathematics instructor decided to adapt the technique for use in his intensive Introductory Statistics course. Although he liked the format, he felt that asking for only one significant point was too limiting, and decided to ask students to come up with several. Consequently, a few minutes before the end of each lecture, he asked students to list the five most important points from that session, along with one or two important questions they had. He then collected the responses and quickly read them after class, making a list of the “important points” and questions and tallying how often each item was repeated.

At first, the variety of points that students listed as important astounded the statistics instructor. He found that, as a group, his thirty-five students came up with as many as twenty different important points from the same lecture. Many of the points they listed were ones he considered details; others were distortions of things he had said; still others were points he was sure he had never mentioned at all! The bewildering variety of responses on Minute Papers from the first few class meetings convinced him of the need to teach students how to tell the “wheat from the chaff.”

He began by listing the ten or twelve most common responses on the board before class. He then took the first five to ten minutes of class to explain the relative importance of these points and their relationships to one another. He also let students know which points were definitely not related. In the course of these “feedback sessions,” he could often weave in responses to two or three commonly asked questions as well. The Minute Paper responses convinced him that his students needed a more explicit road map than he had been providing. Therefore, in addition to the list of responses to the preceding lecture, he wrote his own list of most important points for that day. With both lists on the board, he could make connections between one class and the next graphically clear.

After a month of following the Minute Paper at the end of one class with a feedback session at the beginning of the next, the average total
number of different "important points" had dropped from nearly twenty
to eight or nine. That was a level of variation he could live with. Repeated
use of the Minute Paper helped his students learn to listen more care-
fully and focus more effectively during lectures. The CAT helped the
instructor realize the importance of being explicit in teaching statistics
to students with very little or no previous knowledge of the subject.

From Writing for Magazines and Newspapers (Journalism)

As she neared the end of the hour, the journalism instructor suddenly
realized that she had spent far too much time on one topic, slighting two
other important themes she had planned to develop in her lecture on the
life cycle of magazines. She felt guilty of self-indulgence, since the topic
she had lingered on—the death of general-interest magazines—was
one she found particularly fascinating. It was clear to her that she had
been carried away in her enthusiasm and had pounded the same points
home too many times.

Although she was certain that she could predict their responses,
the journalism instructor went ahead with the Minute Paper anyway. She
had established the use of CATs as part of the classroom routine from
the first day of class and did not want to break the pattern. So she
handed out squares of scrap paper and asked students to write down
the three most important things they had learned from her lecture, and
one important question they would like to pursue further.

To her astonishment, very few of the Minute Papers even men-
tioned the topic to which she had devoted most of the lecture: the
demise of weekly magazines such as the Saturday Evening Post and
Life. Instead, most of the students had focused on the rise of the more
specialized, current magazines they were familiar with and on her few
comments about getting published. In essence, her students had paid
scant attention to information the instructor worried she had over-
stressed. When she asked why a major portion of the lecture was poorly
represented in their Minute Papers, the students explained that they
considered it background information—interesting but not very rele-
vant history. To them, the most important information was that which
they thought might help them succeed as professional writers. This
response made the journalism teacher realize that she should contin-
ually point out the connections between the content of her course and
the "real world" of journalism and the job market.

**STEP-BY-STEP PROCEDURE**

1. Decide first what you want to focus on and, as a consequence, when to
   administer the Minute Paper. If you want to focus on students’ under-
   standing of a lecture, the last few minutes of class may be the best time.
   If your focus is on a prior homework assignment, however, the first few
   minutes may be more appropriate.

2. Using the two basic questions from the "Description" above as starting
   points, write Minute Paper prompts that fit your course and students.
   Try out your Minute Paper on a colleague or teaching assistant before
   using it in class.

3. Plan to set aside five to ten minutes of your next class to use the
   technique, as well as time later to discuss the results.
4. Before class, write one or, at the most, two Minute Paper questions on
the chalkboard or prepare an overhead transparency.

5. At a convenient time, hand out index cards or half-sheets of scrap
paper.

6. Unless there is a very good reason to know who wrote what, direct
students to leave their names off the papers or cards.

7. Let the students know how much time they will have (two to five
minutes per question is usually enough), what kinds of answers you
want (words, phrases, or short sentences), and when they can expect
your feedback.

Simply tabulating the responses and making note of any useful comments is
often all the analysis needed. Consider saving Minute Papers from early in
the term to compare with responses at midterm and later. Comparing
responses over time can allow you to see changes and development in the
clarity of student writing and thoughtfulness of answers.

Use only half of the Minute Paper. That is, ask students either for the
most important point(s) or for their question(s). These "Half-
Minute Papers" are the most common adaptations because they
make the assessment process even simpler and quicker. The Mud-
diest Point (CAT 7) is a particularly creative example of such an
adaptation.

Change the wording to make the prompt more appropriate and spe-
cific. For example, instead of asking students to identify the most
significant point, ask them for one of the following: the most
illuminating example, the most powerful image, the most convinc-
ing argument or counterargument, the most surprising informa-
tion, the most memorable character, or the most disturbing idea.

Allow students a few extra minutes to compare and discuss their
Minute Paper responses with their classmates in pairs or small
groups.

Assign students to small groups. Give each group, in turn, the oppor-
tunity to suggest questions for the Minute Papers and let the mem-
bers of the group analyze and present the results to the whole class.

Minute Papers provide immediate mid-course feedback to teachers and
allow quick response to students.

This advantage is especially important in college classrooms, where
many issues and questions have limited life spans and time is always
in short supply.

The responses—even from a very large class—can be read, tabulated,
and analyzed quickly and with limited effort.
Faculty using the Minute Paper demonstrate respect for and interest in student feedback, thereby encouraging active listening and engagement, which are often lacking in large classes.

Feedback on the Minute Paper allows individual students to compare their responses with those of the class as a whole.

**CONS**

If Minute Papers are overused or poorly used, students will begin to view the technique as a gimmick or a pro forma exercise in polling.

It is more difficult than it may seem to prepare questions that can be immediately and clearly comprehended and quickly answered.

**CAVEATS**

Not all learning experiences can be meaningfully assessed by an instrument that asks learners to note significant points or remaining questions. In other words, this technique is flexible but not universally applicable.

When students seem to confuse trivial details with significant themes, or pose questions that you have already answered several times, remind yourself that they see the material through different eyes, hear it with different ears, and make sense of it differently than you do. Hold off responding until the irritation has faded. Accepting their starting points is often a necessary step in getting them to the desired learning goal.

Responding to Minute Papers often takes longer than planned, because questions lead to further questions. Build in some flexibility but set clear limits for the time you will spend on feedback.

To temper expectations and prevent individual disappointment, let the class know in advance that you may not be able to comment on every important point and question submitted. It is often wise to promise less feedback than you think you can deliver. Let students know in advance, for example, that you will respond to the three most commonly raised points and questions from their Minute Papers, even though you hope to do more.

**REFERENCES AND RESOURCES**

Wilson (1986) describes the Minute Paper in an article on using feedback from students and consultants to improve college teaching. The term *half sheet response* comes from an article on a similar technique by Weaver and Cotrell (1985). Of course, versions of the Minute Paper, and many other CATs, probably have been invented and reinvented time and again by instructors in various colleges at different times.
Muddiest Point

Estimated Levels of Time and Energy Required for:

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<tr>
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</table>

**DESCRIPTION**
The Muddiest Point is just about the simplest Classroom Assessment Technique imaginable. It is also remarkably efficient, since it provides a high information return for a very low investment of time and energy. The technique consists of asking students to jot down a quick response to one question: “What was the muddiest point in?” The focus of the Muddiest Point assessment might be a lecture, a discussion, a homework assignment, a play, or a film.

**PURPOSE**
As its name suggests, the Muddiest Point technique provides information on what students find least clear or most confusing about a particular lesson or topic. Faculty use that feedback to discover which points are most difficult for students to learn and to guide their teaching decisions about which topics to emphasize and how much time to spend on each. In response to this CAT, learners must quickly identify what they do not understand and articulate those muddy points. Consequently, even though the technique is extremely simple to administer, responding to it requires some higher-order thinking.

**RELATED TEACHING GOALS**
- Improve skill at paying attention (TGI Goal 9)
- Develop ability to concentrate (TGI Goal 10)
- Improve listening skills (TGI Goal 12)
- Develop appropriate study skills, strategies, and habits (TGI Goal 16)
- Learn terms and facts of this subject (TGI Goal 18)
- Learn concepts and theories in this subject (TGI Goal 19)

**SUGGESTIONS FOR USE**
While this technique can be used in virtually any setting, it is particularly well suited to large, lower-division classes. Since students' responses to the Muddiest Point question usually consist of a few words or phrases, a teacher can read and sort a great many in a few minutes. The Muddiest Point question should be posed at the end of a lecture, at the close of a discussion.
or presentation, or immediately after a reading assignment. This CAT can be used quite frequently in classes where a large amount of new information is presented each session—such as mathematics, statistics, economics, health sciences, and the natural sciences—probably because there is a steady stream of possible "muddy points." On the other hand, the Muddiest Point is best used sparingly in courses where the emphasis is on integrating, synthesizing, and evaluating information.

**EXAMPLES**

*From the Decline and Fall of the Soviet Union (International Relations/Political Science)*

This professor used the Muddiest Point in his senior-level honors course to assess students' understanding of a prerecorded videotape. The videotape was a recording of an hour-long speech on the reasons for the collapse of the Soviet Union. The speech had been delivered by one of the professor's eminent colleagues to foreign policy consultants and journalists in Washington, D.C. At the conclusion of the tape, the international relations professor asked his eighteen students to write the "muddiest point" they found in the videotape.

As the professor read through the responses, he noted that almost half of his students mentioned the same "muddy point": the videotaped speaker's thesis that "imported inflation" seriously undercut the Soviet economy in the 1980s. Since the instructor regarded that thesis as the most important and original element of his colleague's analysis, he was pleased to discover the students' confusion right away. To clear it up, he prepared a detailed explanation of that critical point, which he presented during the next class meeting.

*From Fundamentals of English (English as a Second Language)*

After two lectures and related homework assignments on English pronoun usage, the new ESL instructor decided to try the Muddiest Point technique. So, just before class ended, she asked students to write down the "muddiest point" in their minds about pronoun usage. When several students quickly raised their hands to ask what she meant by a "muddy point," she realized that even widely used colloquialisms can stymie nonnative English speakers. As soon as she explained that "muddy" in this phrase meant unclear, confusing, or hard to understand, they were able to carry out the assessment.

Later, shuffling through the index cards containing their responses, the instructor was dismayed and disappointed by what she read. Although she had worked hard to explain the pronominal system on a conceptual level, stressing what pronouns do in English and why it is important to use them correctly, the muddy points that students mentioned were virtually all about very specific, and sometimes rather minor, rules of usage—such as the difference between "who" and "whom."

Feeling that her class had failed to see the forest for the trees, the ESL instructor asked one of her veteran colleagues for advice. Her colleague assured her that the students' responses were quite normal, given their low level of experience with and knowledge of English. The
veteran teacher reminded the new faculty member to keep her audience in mind. Teaching the pronominal system conceptually makes sense if students are English-speaking linguistics majors or future English language teachers, but is less useful with beginning or intermediate language learners.

After that conversation, the new ESL teacher again looked at the muddy points. This time she realized that she had been teaching about pronouns as she had been taught in graduate linguistics courses, rather than thinking about what her ESL students needed to learn and how they could best learn it. That realization caused her to change her approach to the next few lessons. Specifically, she provided many more examples and much more practice, helping students move from the specifics to the more general concepts and back to specifics—and helping them see the connections.

From General Chemistry (Chemistry)

From the first week of class, students in this general education science course had been responding to the Muddiest Point. Now, several weeks into the course, the professor used this CAT to assess the students' understanding of a lecture on enthalpy and entropy. The most commonly mentioned muddy point concerned the difference between enthalpy of activation and entropy of activation. Other students mentioned the difference between enthalpy of formation and enthalpy of activation. These responses let the professor know that the students had not firmly grasped the differences between entropy and enthalpy and that many of them probably did not understand either principle in isolation. Looking back on her lecture, she realized it had probably contained too much detail and too little differentiation of concepts—resulting in highly "entropic" learning.

STEP-BY-STEP PROCEDURE

1. Determine what you want feedback on: the entire class session or one self-contained segment? A lecture, a discussion, a presentation?

2. If you are using the technique in class, reserve a few minutes at the end of the class session. Leave enough time to ask the question, to allow students to respond, and to collect their responses by the usual ending time.

3. Let students know beforehand how much time they will have to respond and what use you will make of their responses.

4. Pass out slips of paper or index cards for students to write on.

5. Collect the responses as or before students leave. Stationing yourself at the door and collecting "muddy points" as students file out is one way; leaving a "muddy points" collection box by the exit is another.

6. Respond to the students' feedback during the next class meeting or as soon as possible afterward.

As with everything else about this technique, data analysis can and should be kept very simple. Quickly read through at least half of the responses, looking for common types of muddy points. Then go back through all the responses and sort them into piles — several piles containing groups of
related muddy points, and one "catch-all" pile made up of one-of-a-kind responses. You may want to count the responses in each group before you decide which to deal with. Or you may want to group together the muddy points that concern facts and principles, those that concern concepts, and those that concern skills.

Ask students to identify the muddiest points in a homework assignment or an out-of-class reading and to turn in their responses at the next class meeting. For example, ask them to list the three muddiest points in a chapter or a case that they have been assigned to read.

Ask students to read each other's drafts of writing assignments and to point out the muddiest points in those drafts.

When students are familiar with the material and are relatively articulate, ask them to indicate the muddiest point and then to explain briefly what it was about that point that they found "muddy."

At each class meeting, ask a few different students to categorize and summarize the data and to present the results—and perhaps even their responses—at the beginning of the next class.

Use other CATs (such as Directed Paraphrasing, Memory Matrix, or Concept Maps) to check later on how much clearer the most critical muddy points have become since you responded to them.

Let students know that some of your exam questions will concern the muddy points that you have responded to in class.

The Muddiest Point is not only quick, simple, and easy to administer; it also requires very little preparation. This is one of the few CATs you can successfully use on the spur of the moment.

For students who are hesitant to ask questions in class, this technique is a safe alternative. For students who are lost, it can be a "lifeline."

This technique can give the instructor a "snapshot" diagnosis of what students are finding difficult to learn. As a result, the teacher can focus subsequent lessons and assignments much more accurately and effectively.

This technique enables teachers to see the material through their students' eyes and reminds them of the range of intellectual and perceptual diversity present in each classroom.

If students are regularly asked to identify the "muddiest point," they tend to pay more attention to how well they are understanding the relevant session or assignment because they expect to be asked about it. This expectancy can lead, on the simplest level, to more care in listening and studying. Because of the nature of the question, however, this technique also promotes introspection and self-assessment.
This is a simple technique that students can easily internalize, making self-assessment a regular part of their own classroom and study routines. Students can learn to habitually ask themselves, "What was the muddiest point in ?" whether or not other instructors ask them for such feedback.

**CONS**

As Mosteller (1989) points out, there are drawbacks to asking students to focus only on what they don't understand. Such an emphasis can undermine both the students' and the teacher's motivation and sense of self-efficacy. To restore some balance, teachers need to focus on what students do understand as well as on the muddy points.

It can be disconcerting to realize that even your best-prepared, most lucid lecture or lab will be misunderstood or poorly understood by some of your students.

Initially, a number of students may have difficulty explaining, or even naming, what it is that they don't understand. Becoming effective self-assessors takes time and practice, and you may not wish to develop that skill on class time.

As students become more adept at identifying and explaining the points they find "muddiest," they become more likely to raise difficult questions that you may be unable to answer on the spot.

**CAVEATS**

Don't become angry or disappointed when students identify something as a "muddy point" that you're positive you presented with absolute clarity. At least, don't respond to the class until you have dealt with those feelings. (Remember: don't ask if you don't really want to know.)

Don't spend so much class time responding to "muddy points" from past sessions that you risk losing the momentum of your course.

Don't give students the impression that all confusions and questions can be cleared up in a few minutes — or even a few days. Make it clear that some points are "muddier" than others and that a few are real landslides that will take a lot of digging out!

**REFERENCES AND RESOURCES**

In an informative and thoughtful journal article, Mosteller (1989) describes how he developed and used the Muddiest Point in his large undergraduate statistics course at Harvard. To request copies of the journal *(The Journal of the Harvard-Danforth Center)* or reprints of the Mosteller article, contact:

The Derek Bok Center for Teaching and Learning
318 Science Center
Harvard University
Cambridge, Mass. 02138

See also Cottell (1991, pp. 50-51) for a clear and humorous example of the Muddiest Point applied to accounting. In this example, the author refers to the CAT as an adaptation of the Minute Paper.