GOOD TEACHING: THE TOP TEN REQUIREMENTS

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1. ***Good teaching is as much about passion as it is about reason***. It's about **not only *motivating students to learn*, but *teaching them how to learn*, and doing so in a manner that is *relevant, meaningful, and memorable*. It's about *caring for your craft, having a passion for it, and conveying that passion to everyone, most importantly to your students***.

2. Good teaching is about substance and treating students as consumers of knowledge. It's about doing your best to keep on top of your field, reading sources, inside and outside of your areas of expertise, and being at the leading edge as often as possible. But knowledge is not confined to scholarly journals. Good teaching is also about bridging the gap between theory and practice. It's about leaving the ivory tower and immersing oneself in the field, talking to, consulting with, and assisting practitioners, and liaisoning with their communities.

3. Good teaching is about ***listening, questioning, being responsive, and remembering that each student and class is different. It's about eliciting responses and developing the oral communication skills of the quiet students. It's about pushing students to excel; at the same time, it's about being human, respecting others, and being professional at all times***.

4. Good teaching is about not always having a fixed agenda and being rigid, but ***being flexible, fluid, experimenting, and having the confidence to react and adjust to changing circumstances***. **It's about *getting only 10 percent of what you wanted to do in a class done and still feeling good*. It's about *deviating from the course syllabus or lecture schedule easily when there is more and better learning elsewhere***. Good teaching is about the creative balance between being an authoritarian dictator on the one hand and a pushover on the other.

5. ***Good teaching is also about style***. Should good teaching be entertaining? You bet! Does this mean that it lacks in substance? Not a chance! Effective teaching is not about being locked with both hands glued to a podium or having your eyes fixated on a slide projector while you drone on. ***Good teachers work the room and every student in it. They realize that they are the conductors and the class is the orchestra. All students play different instruments and at varying proficiencies***.

6. This is very important -- ***good teaching is about humor***. It's about being self-deprecating and not taking yourself too seriously. It's often about making innocuous jokes, mostly at your own expense, so that the ***ice breaks and students learn in a more relaxed atmosphere*** where you, like them, are human with your own share of faults and shortcomings.

7. Good teaching is about ***caring, nurturing, and developing minds and talents*. It's about devoting *time, often invisible, to every student. It's also about the thankless hours of grading, designing or redesigning courses, and preparing materials to still further enhance instruction***.

8. Good teaching is ***supported by strong and visionary leadership***, and very tangible institutional support -- resources, personnel, and funds. *Good teaching is continually reinforced by an overarching vision that transcends the entire organization -- from full professors to part-time instructors -- and* ***is reflected in what is said, but more importantly by what is done***.

9. Good teaching is about mentoring between senior and junior faculty, teamwork, and being recognized and promoted by one's peers. ***Effective teaching should also be rewarded, and poor teaching needs to be remediated through training and development programs***.

10. At the end of the day, ***good teaching is about having fun, experiencing pleasure and intrinsic rewards ... like locking eyes with a student in the back row and seeing the synapses and neurons connecting, thoughts being formed, the person becoming better, and a smile cracking across a face as learning all of a sudden happens***. Good teachers practice their craft not for the money or because they have to, but because ***they truly enjoy it and because they want to***. Good teachers couldn't imagine doing anything else.

SEVEN QUALITIES OF HIGHLY EFFECTIVE TEACHER

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By themselves, these seven qualities may not be sufficient conditions for teaching excellence, but they may be pretty close to essential.
The number seven seems to have magical properties that attract people to it.

The universe was created in seven days, according to Genesis, and we now have seven days in a week. There are seven theological and cardinal virtues (faith, hope, charity, prudence, justice, fortitude, temperance). Likewise, there are seven deadly sins (pride, covetousness, lust, anger, gluttony, envy, sloth). The liberal arts of the Middle Ages numbered seven, chunked into a quadrivium (arithmetic, geometry, astronomy, music) and a trivium (grammar, rhetoric, logic). And today, fortunate faculty members may be granted sabbatical leaves.

On a more mundane plane, seven is the most probably sum when rolling two dice. Seven digits (such as a telephone number) are generally all that most people can store in short-term memory. And if you want your slide or overhead projector transparency to be readable, don't put more than seven lines on it, with each line no longer than seven words.

So it's not unexpected that an American Association for Higher Education commission focused on "Seven Principles of Good Practice in Undergraduate Education," and Steven Covey wrote a best seller Seven Habits of Highly Effective People. I even read a recent journal article by an off-beat writer: "Seven Principles of Teaching Seldom Taught in Grad School" (see Chalkdust, J. Staff, Prog, & Org Dev., Vol. 10, No. 4, Winter 1992, pp. 217-218).

1. Highly effective teachers ***care***. ***They care about their students, their work, and themselves. They treat others with dignity; they respect others' integrity. They give high priority to benefiting others. They affirm others' strengths and beings; it's a kind of love***.
2. Highly effective teachers ***share. They share their knowledge, insights, and viewpoints with others. Their willingness to share is a way of life for them. They don't withhold information for personal gain***.

3. Highly effective teachers learn. They continually seek truth and meaning. They seek to discover new ideas and insights. They reflect on their experiences and incorporate the learning into their lives. They are willing to upgrade their skills. They continue growing and developing throughout their lives.

4. Highly effective teachers ***create***. ***They are willing to try the new and untested, to take risks for worthy educational outcomes. Anything worth doing is worth failing at. They are not discouraged by an occasional failure; they reframe the error as an opportunity to do better as a result of the experience***.

5. Highly effective teachers ***believe***. ***They have faith in students. They trust students and are willing to grant them freedom and responsibility. They hold high expectations for their students, as well as for themselves***.

6. Highly effective teachers ***dream***. ***They have a vision of success. They are driven by an image of excellence, the best that their innate abilities allow. They always seek to improve, never being content with just "gettingby" in teaching or in any other endeavor***.

7. Highly effective teachers ***enjoy***. Teaching is not just employment to them; it is their Work. ***They throw themselves into it with vigor. They gain major satisfaction and joy from it. And that joy often infects their students***.

"The task of the modern educator is not to cut down jungles, but to irrigate deserts."
- C. S. Lewis

Annex Box 1-1. Seven Principles of Learning

Research in the cognitive, learning, and brain sciences has provided many new insights about how humans organize knowledge, how experience shapes understanding, how individuals differ in learning strategies, and how people acquire expertise. From this emerging body of research, scientists and others have been able to synthesize a number of underlying principles of human learning. That knowledge can be synthesized into the following seven principles of learning:

1. Learning with understanding is facilitated when new and existing knowledge is structured around the major concepts and principles of the discipline.

Proficient performance in any discipline requires knowledge that is both accessible and usable. Experts' content knowledge is structured around the major organizing principles, core concepts, and "big ideas" of the discipline. Their strategies for thinking and solving problems are closely linked to their understanding of such core concepts. Therefore, knowing many disconnected facts is not sufficient for developing expertise. Understanding the big ideas also allows disciplinary experts to discern the deeper structure and nature of problems and to recognize similarities between new problems and those previously encountered. Curricula that emphasize breadth of coverage and simple recall of facts may hinder students' abilities to organize knowledge effectively

because they do not learn anything in depth, and thus are not able to structure what they are learning around the major organizing principles and core concepts of the discipline.

2. Learners use what they already know to construct new understandings.

College students already possess knowledge, skills, beliefs, concepts, conceptions, and misconceptions that can significantly influence how they think about the world, approach new learning, and go about solving unfamiliar problems. They often attempt to learn a new idea or process by relating it to ideas or processes they already understand. This prior knowledge can produce mistakes as well as new insights. How these links are made may vary in different subject areas and among students with varying talents, interests, and abilities. Learners are likely to construct interpretations of newly encountered problems and phenomena in ways that agree with their own prior knowledge even when those interpretations conflict with what a teacher has attempted to teach. Therefore, effective teaching involves gauging what learners already know about a subject and finding ways to build on that knowledge. When prior knowledge contains misconceptions, effective instruction entails detecting those misconceptions and addressing them, sometimes by challenging them directly.

3. Learning is facilitated through the use of metacognitive strategies that identify, monitor, and regulate cognitive processes.

Metacognition is the ability of people to predict and monitor their current level of understanding and mastery of a subject or performance on a particular task and decide when it is not adequate (NRC, 2000e). Metacognitive strategies include (1) connecting new information to former knowledge; (2) selecting thinking strategies deliberately; and (3) planning, monitoring, and evaluating thinking processes. To be effective problem solvers and learners, students need to reflect on what they already know and what else they need to know for any given situation. They must consider both factual knowledge—about the task, their goals, and their abilities—and strategic knowledge about how and when to use a specific procedure to solve the problem at hand. Research indicates that instructors can facilitate the development of metacognitive abilities by providing explicit instruction focused on such skills, by providing opportunities for students to observe teachers or other content experts as they solve problems, and by making their thinking visible to those observing.

4. Learners have different strategies, approaches, patterns of abilities, and learning styles that are a function of the interaction between their heredity and their prior experiences.

Individuals are born with a potential to learn that develops through their interaction with their environment to produce their current capabilities and talents. Among learners of the same age, there are important differences in cognitive abilities (such as linguistic and spatial aptitudes or the ability to work with symbolic representations of the natural world), as well as in emotional, cultural, and motivational characteristics. Thus, some students will respond favorably to one kind of instruction, whereas others will benefit more from a different approach. Educators need to be sensitive to such differences so that instruction and curricular materials will be suitably matched to students' developing abilities, knowledge base, preferences, and styles. Students with different learning styles also need a range of opportunities and ways to demonstrate their knowledge and skills. Using one form of assessment will work to the advantage of some students and to the disadvantage of others; multiple measures of learning and understanding will provide a better picture of how well individual students are learning what is expected of them.

5. Learners' motivation to learn and sense of self affect what is learned, how much is learned, and how much effort will be put into the learning process.

Both internal and external factors motivate people to learn and develop competence. Regardless of the source, learners' level of motivation strongly affects their willingness to persist in the face of difficulty or challenge. Intrinsic motivation is enhanced when students perceive learning tasks as

interesting and personally meaningful, and presented at an appropriate level of difficulty. Tasks that are too difficult can frustrate; those that are too easy can lead to boredom. Research also has revealed strong connections between learners' beliefs about their own abilities in a subject area and their success in learning that subject. For example, some students believe their ability to learn a particular subject or skill is predetermined, whereas others believe their ability to learn is substantially a function of effort. The use of instructional strategies that encourage conceptual understanding is an effective way to increase students' interest and enhance their confidence about their abilities to learn a particular subject.

6. The practices and activities in which people engage while learning shape what is learned.

Research indicates that the way people learn a particular area of knowledge and skills and the context in which they learn it become a fundamental part of what is learned. When students learn some subject matter or concept in only a limited context, they often miss seeing the applicability of that information to solving novel problems encountered in other classes, in other disciplines, or in everyday life situations. By encountering a given concept in multiple contexts, students develop a deeper understanding of the concept and how it can be used and applied to other contexts. Faculty can help students apply subject matter to other contexts by engaging them in learning experiences that draw directly upon real-world applications, or exercises that foster problem-solving skills and strategies that are used in real-world situations. Problem-based and case-based learning are two instructional approaches that create opportunities for students to engage in practices similar to those of experts. Technology also can be used to bring real-world contexts into the classroom.[4]

7. Learning is enhanced through socially supported interactions.

Learning can be enhanced when students have opportunities to interact and collaborate with others on instructional tasks. In learning environments that encourage collaboration, such as those in which most practicing scientists and mathematicians work, individuals have opportunities to test their ideas and learn by observing others. Research demonstrates that providing students with opportunities to articulate their ideas to peers and to hear and discuss others' ideas in the context of the classroom is particularly effective in enhancing conceptual learning. Social interaction also is important for the development of expertise, metacognitive skills (see learning principle #3), and formation of the learner's sense of self (see learning principle #5).

CHARACTERISTICS OF EFFECTIVE TEACHING

If teaching and student learning are to improve, faculty and those who evaluate them must recognize the characteristics of effective teaching. The research literature contains many examples of successful standards and practices for effective teaching that are based on evidence of enhanced student learning (e.g., Braskamp and Ory, 1994; Centra, 1993; Davis, 1993: Lowman, 1995; McKeachie, 1999; Neff and Weimer, 1990; Perry and Smart, 1997; references in NRC 2000c, 2001, and 2002b). On the basis of that literature, the committee articulates five characteristics of effective teaching that can be used as a starting point for improving teaching. In Chapter 6, these characteristics are elaborated as criteria that could serve as the basis for evaluating teaching effectiveness.

There are numerous definitions of what constitutes effective student learning. For purposes of this report, the committee has adopted the definition from the NRC report *How People Learn: Brain, Mind, Experience, and School: Expanded Edition* (National Research Council [NRC], 2000c, p. 16): "To develop competence in an area of inquiry, students must (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application."

[2] Examples are *Microbiology Education,* published by the American Society of Microbiology; *Journal of Chemical Education,* published by the Division of Chemical Education of the American

Chemical Society; and *Physics Today,* published by the American Institute of Physics.

1.Knowledge of Subject Matter

Although it appears obvious, any list of characteristics of high-quality teaching of STEM that is centered on desired student outcomes must begin with the premise that faculty members must be well steeped in their disciplines. They must remain active in their areas of scholarship to ensure that the content of their courses is current, accurate, and balanced, especially when presenting information that may be open to alternative interpretation or disagreement by experts in the field. They also should allow all students to appreciate "… interrelationships among the sciences and the sciences' relationship to the humanities, social sciences, and the political, economic, and social concerns of society" (NRC, 1999a, p. 26).

Knowledge of subject matter can be interpreted in other ways. For example, several recent reports (e.g., Boyer Commission, 1998; NRC, 1999a; National Science Foundation [NSF], 1996) have emphasized that the undergraduate experience should add value in tangible ways to each student's education. Faculty must teach subject matter in ways that encourage probing, questioning, skepticism, and integration of information and ideas. They should provide students with opportunities to think more deeply about subject matter than they did in grades K–12. They should enable students to move intellectually beyond the subject matter at hand.

Faculty who possess deep knowledge and understanding of subject matter demonstrate the following characteristics:

They can help students learn and understand the general principles of their discipline (e.g., the processes and limits of the scientific method).
They are able to provide students with an overview of the whole domain of the discipline (e.g., Coppola et al., 1997).
They possess sufficient knowledge and understanding of their own and related sub-disciplines to answer most students' questions and know how to help students find appropriate information.
They stay current through an active research program or through scholarly reading and other types of professional engagement with peers.
They are genuinely interested in what they are teaching.
They understand that conveying the infectious enthusiasm that accompanies original discovery, application of theory, and design of new products and processes is as important to learning as helping students understand the subject matter.

2. Skill, Experience, and Creativity with a Range of Appropriate Pedagogies and Technologies

Deep understanding of subject matter is critical to excellent teaching, but not sufficient. Effective teachers also understand that, over the course of their educational experiences, undergraduates develop different strategies for maximizing their individual abilities to learn, reason, and think critically about complex issues (King and Kitchener, 1994; National Institute for Science Education, 2001c; NRC, 1997a, 1999a). To be most effective, teachers need to employ a variety of learning strategies and contextually appropriate pedagogies[3] that serve the range of students' learning styles (see, e.g., Annex Box 1-1, Chapter 1). Faculty who are effective in this regard demonstrate the following characteristics:

They are organized and communicate clearly to students their expectations for learning and academic achievement.
They focus on whether students are learning what is being taught and view the learning process as a joint venture between themselves and their students.

They encourage discussion and promote active learning strategies (see Annex Box 1-1, Chapter 1).
They persistently monitor students' progress toward achieving learning

goals through discussions in class, out-of-class assignments, and other forms of assessment.
They have the ability to recognize students who are not achieving to their fullest potential and then employ the professional knowledge and skill necessary to assist them in overcoming academic difficulties.

[3] "Contextually appropriate pedagogies" is also known in the research literature as "pedagogical content knowledge" (defined earlier in note).
[4] For further discussion of digital libraries and their importance in undergraduate STEM education, see Borgman et al. (1996) and NRC (1998b). NSF is now engaged in developing a digital national library for undergraduate STEM education (additional information is available at <http://www.ehr.nsf.gov/ehr/due/programs/nsdl>.

Along with these characteristics, an increasingly important component of pedagogy is the appropriate use and application of information technologies to enhance learning. Electronic networking, the Internet, remote sensing, distance learning, and databases and digital libraries (e.g., NRC, 1998b, 2000c; NSF, 1998)[4] are changing fundamentally the ways in which teaching and learning take place in higher education. Although no one would suggest that top-quality instruction cannot be attained without the use of networking resources, instructional changes made possible through information technology are profound and have already imbued research communities in the natural sciences, mathematics, and engineering. Professional development can assist faculty in deciding whether and how they might use these tools most effectively for enhancing learning. The role of information technology in undergraduate classrooms, laboratories, and field environments is an important area for continued investigation (e.g., American Association for Higher Education [AAHE], 1996; Collis and Moonen, 2001; National Institute for Science Education, 2001a).

As information and other technologies become more pervasive in teaching and learning of the natural sciences, mathematics, and engineering, a faculty member's use of such resources is likely to become an increasingly important component of teaching evaluations. As with other areas of pedagogy in which college-level faculty have had little formal training or professional development, they will have to learn appropriate and effective uses of hardware and software that are coupled with new ways of viewing teaching and learning.

3. Understanding of and Skill in Using Appropriate Assessment Practices

In part, proficiency in assessment involves a faculty member's skill in evaluating student learning. This skill is evident when teachers:

Assess learning in ways that are consistent with the objectives of a course and integrate stated course objectives with long-range curricular goals.
Know whether students are learning what is being taught. This requires that faculty be persistent in collecting and analyzing assessments of student learning and committed to using the data collected as a tool for improving their own teaching skills (see, e.g., principle 5 in Astin et al., 1996).
Determine accurately and fairly students' knowledge of the subject matter and the extent to which learning has occurred throughout the term (not just at the end of the course).

4. Professional Interactions with Students Within and Beyond the Classroom

Teaching responsibilities extend beyond designing and offering courses. Faculty are expected to direct original student research and involve students as collaborators in their own research, advise and mentor students, participate in departmental and campus curricular committees, and sometimes supervise teaching assistants. Students may also view their teachers as role models for life as responsible, educated citizens. For example, beyond helping students learn scientific principles or technologi-cal processes, faculty can help them open their eyes to the ethical issues and political decisions that often affect science and technology (e.g., Coppola and Smith, 1996).

Professionalism in a faculty member's relationships and interactions with students also should be based on criteria such as the following:

> Faculty meet with all classes and assigned teaching laboratories, post and keep regular office hours, and hold exams as scheduled.
> They demonstrate respect for students as individuals; this includes respecting the confidentiality of information gleaned from advising or student conferences.
> They encourage the free pursuit of learning and protect students' academic freedom.
> They address sensitive subjects or issues in ways that help students deal with them maturely.
> They contribute to the ongoing intellectual development of individual students and foster confidence in the students' ability to learn and discover on their own.
> They advise students who are experiencing problems with course material and know how to work them in venues besides the classroom to help them achieve. On those occasions when students clearly are not prepared to undertake the challenges of a particular course, faculty should be able to counsel them out of the course or suggest alternative, individualized approaches for learning the subject matter.
> They uphold and model for students the best scholarly and ethical standards (e.g., University of California Faculty Code of Conduct).[5]

5. Involvement with and Contributions to One's Profession in Enhancing Teaching and Learning

Effective teaching needs to be seen as a scholarly pursuit that takes place in collaboration with departmental colleagues, faculty in other departments in the sciences and engineering, and more broadly across disciplines (Boyer, 1990; Glassick et al., 1997; Kennedy, 1997). Faculty can learn much by working with colleagues both on and beyond the campus, thereby learning to better integrate the materials they present in their own courses with what is being taught in other courses (Hutchings, 1996; NRC, 1999a).

Assessment Is More Than Grades

To many, the word "assessment" simply means the process by which we assign students grades. Assessment is much more than this, however. Assessment is a mechanism for providing instructors with data for improving their teaching methods and for guiding and motivating students to be actively involved in their own learning. As such, assessment provides important feedback to both instructors and students.

Assessment Is Feedback for Both Instructors and Students

Assessment gives us essential information about what our students are learning and about the extent to which we are meeting our teaching goals. But the true power of assessment comes in also using it to give feedback to our students. Improving the quality of learning in our courses involves not just determining to what extent students have mastered course content at the end of the course; improving the quality of learning also involves determining to what extent students are mastering content throughout the course.

SOURCE: Excerpted from National Institute for Science Education (2001b).

IMPROVING TEACHING BY EXAMINING STUDENT LEARNING: OUTCOME ASSESSMENT

One approach to improving student learning is outcome assessment—the process of providing credible evidence that an instructor's objectives have been obtained. Outcome assessment enables faculty to determine what students know and can do as a result of instruction in a course module, an entire course, or a sequence of courses. This information can be used to indicate to students how successfully they have mastered the course content they are expected to assimilate. It can also be used to provide faculty and academic departments with guidance for improving instruction, course content, and curricular structure. Moreover, faculty and institutions can use secondary analysis of individual outcome assessments to demonstrate to prospective students, parents, college administrators, employers, accreditation bodies, and legislators that a program of study produces competent graduates (Banta, 2000).

Outcome Assessment Activities

Faculty members, both individually and as colleagues examining their department's education programs, have found the following activities helpful when undertaking outcome assessment:

Developing expected student learning outcomes for an individual course of study, including laboratory skills.
Determining the point in a student's education (e.g., courses, laboratories, and internships) at which he/she should develop the specified knowledge and skills.
Incorporating the specified learning outcomes in statements of objectives for the appropriate courses and experiences.
Selecting or developing appropriate assessment strategies to test student learning of the specified knowledge and skills.
Using the results from assessment to provide formative feedback to individual students and to improve curriculum and instruction.
Adjusting expected learning outcomes if appropriate and assessing learning again. Such a process can lead to continual improvement of curriculum and instruction.

Improving the Assessment of Learning Outcomes

The committee took particular note of Astin et al.'s (1996) *Assessment Forum: Nine Principles of Good Practice for Assessing Student Learning*. Because these authors articulate succinctly the position the committee has taken in this report, their principles are presented verbatim in Box 2-1. These principles also could be applied in evaluating departmental programs.

Preparing Future Teachers

Scientists have an obligation to assist in science teachers' professional development. Many scientists recognize the obligation and are ready to get involved. Scientists can provide opportunities for teachers to learn how the scientific process works, what scientists do and how and why they do it. They can provide research opportunities for practicing teachers; act as scientific partners; provide connections to the rest of the scientific community; assist in writing grant proposals for science-education projects; provide hands-on, inquiry-based workshops for area teachers (e.g., NRC, 2000a); and provide teachers access to equipment, scientific journals, and catalogs not usually available in schools. They can help teachers to review educational material for its accuracy and utility.

When scientists teach their undergraduate classes and laboratories, potential science teachers are present. Scientists should recognize that as an opportunity to promote and act as a model of both good process and accurate content teaching and so strive to improve their own teaching (NRC, 1996c, p. 3).

Box 2-1. Nine Principles of Good Practice for Assessing Student Learning

1. The assessment of student learning begins with educational values. Assessment is not an end in itself but a vehicle for educational improvement. Its effective practice, then, begins with and enacts a vision of the kinds of learning we most value for students and strive to help them achieve. Educational values should drive not only what we choose to assess but also how we do so. Where questions about educational mission and values are skipped over, assessment threatens to be an exercise in measuring what's easy, rather than a process of improving what we really care about.

2. Assessment is most effective when it reflects an understanding of learning as multidimensional, integrated, and revealed in performance over time. Learning is a complex process. It entails not only what students know but what they can do with what they know; it involves not only knowledge and abilities but values, attitudes, and habits of mind that affect both academic success and performance beyond the classroom. Assessment should reflect these understandings by employing a diverse array of methods, including those that call for actual performance, using them over time so as to reveal change, growth, and increasing degrees of integration. Such an approach aims for a more complete and accurate picture of learning and therefore firmer bases for improving our students' educational experience.

3. Assessment works best when the programs it seeks to improve have clear, explicitly stated purposes. Assessment is a goal-oriented process. It entails comparing educational performance with educational purposes and expectations—those derived from the institution's mission, from faculty intentions in program and course design, and from knowledge of students' own goals. Where program purposes lack specificity or agreement, assessment as a process pushes a campus toward clarity about where to aim and what standards to apply; assessment also prompts attention to where and how program goals will be taught and learned. Clear, shared, implementable goals are the cornerstone for assessment that is focused and useful.

4. Assessment requires attention to outcomes but also and equally to the experiences that lead to those outcomes. Information about outcomes is of high importance; where students "end up" matters greatly. But to improve outcomes, we need to know about student experience along the way—about the curricula, teaching, and kind of student effort that lead to particular outcomes. Assessment can help us understand which students learn best under what conditions; with such knowledge comes the capacity to improve the whole of their learning.

5. Assessment works best when it is ongoing not episodic. Assessment is a process whose power is cumulative. Though isolated, "one-shot" assessment can be better than none, improvement is best fostered when assessment entails a linked series of activities undertaken over time. This may mean tracking the progress of individual students, or of cohorts of students; it may mean collecting the same examples of student performance or using the same instrument semester after semester. The point is to monitor progress toward intended goals in a spirit of continuous improvement. Along the way, the assessment process itself should be evaluated and refined in light of emerging insights.

6. Assessment fosters wider improvement when representatives from across the educational community are involved. Student learning is a campus-wide responsibility, and assessment is a way of enacting that responsibility. Thus, while assessment efforts may start small, the aim over time is to involve people from across the educational community. Faculty play an especially important role, but assessment's questions can't be fully addressed without participation by student-affairs educators, librarians, administrators, and students. Assessment may also involve individuals from beyond the campus (alumni/ae, trustees, employers) whose experience can enrich the sense of appropriate aims and standards for learning. Thus understood, assessment is not a task for small groups of experts but a collaborative activity; its aim is wider, better informed attention to student learning by all parties with a stake in its improvement.

7. Assessment makes a difference when it begins with issues of use and illuminates questions that people really care about. Assessment recognizes the value of information in the process of improvement. But to be useful, information must be connected to issues or questions that people really care about. This implies assessment approaches that produce evidence that relevant parties will find credible, suggestive, and applicable to decisions that need to be made. It means thinking in advance about how the information will be used, and by whom. The point of assessment is not to gather data and return "results"; it is a process that starts with the questions of decision-makers, that involves them in the gathering and interpreting of data, and that informs and helps guide continuous improvement.

8. Assessment is most likely to lead to improvement when it is part of a larger set of conditions that promote change. Assessment alone changes little. Its greatest contribution comes on campuses where the quality of teaching and learning is visibly valued and worked at. On such campuses, the push to improve educational performance is a visible and primary goal of leadership; improving the quality of undergraduate education is central to the institution's planning, budgeting, and personnel decisions. On such campuses, information about learning outcomes is seen as an integral part of decision making, and avidly sought.

9. Through assessment, educators meet responsibilities to students and to the public. There is a compelling public stake in education. As educators, we have a responsibility to the public that supports or depends on us to provide information about the ways in which our students meet goals and expectations. But that responsibility goes beyond the reporting of such information; our deeper obligation—to ourselves, our students, and society—is to improve. Those to whom educators are accountable have a corresponding obligation to support such attempts at improvement.

SOURCE: Astin et al. (1996); see <**http://www.aahe.org/principl.htm**>.

Providing Engaging Laboratory and Field Experiences

Recent reports suggest that at least some barriers and limitations can be overcome by emphasizing inquiry-based approaches to learning during classroom instruction (e.g., Ebert-May et al., 1997). As defined by the *National Science Education Standards,* "Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations" (NRC, 1996a, p. 23). Additional detail on inquiry-based approaches to teaching and learning (focused on grades K–12 but applicable in many ways to higher education) can be found in NRC (2000a).

CHARACTERISTICS OF EFFECTIVE TEACHING-REVISIT

1. KNOWLEDGE OF AND ENTHUSIASM FOR SUBJECT MATTER

Summarizing the discussion of this characteristic from Chapter 2, effective teachers:

> Understand and can help students learn and understand the general principles of their discipline (e.g., the processes and limits of the scientific method).
> Provide students with an overview of the whole domain of the discipline.
> Possess sufficient knowledge and understanding of their own and related subdisciplines that they can answer most students' questions or know how to help students find appropriate information.
> Keep their knowledge about a field of study current through an active research program or through scholarly reading and other types of professional engagement with others in their immediate and related disciplines (e.g., participation in professional meetings and workshops).
> Are genuinely interested in—and passionate about—the course materials they are teaching. Practicing scientists, mathematicians, and engineers understand and appreciate the infectious enthusiasm that accompanies original discovery, application of theory, and design of new products and processes. Conveying that sense of excitement is equally important in helping students appreciate more fully the subject matter being taught.

The following questions might be posed for evaluation for this characteristic:

> Does the instructor exhibit an appropriate depth and breadth of knowledge?
> Is the instructor's information current and relevant?
> Does the instructor show continuous growth in the field?

2. SKILL, EXPERIENCE, AND CREATIVITY WITH A RANGE OF APPROPRIATE PEDAGOGIES AND TECHNOLOGIES

Summarizing the discussion of this characteristic in Chapter 2, effective teachers:

Have knowledge of and select and use a range of strategies that offer opportunities for students with different learning styles to achieve.

Are organized and clearly communicate to students their expectations for learning and academic achievement.
Focus on whether students are learning what is being taught and view the learning process as a joint venture between themselves and their students.
Give students adequate opportunity to build confidence by practicing skills.
Ask interesting and challenging questions.
Encourage discussion and promote active learning strategies.
Persistently monitor students' progress toward achieving learning goals through discussions in class, out-of-class assignments, and other forms of assessment.
Have the ability to recognize those students who are not achieving to their fullest potential and then employ the professional knowledge and skill necessary to assist them in overcoming academic difficulties.

The following questions might be posed for evaluation for this characteristic:

Does the instructor clearly communicate the goals of the course to students?
Is the instructor aware of alternative instructional methods or teaching strategies and able to select methods of instruction that are most effective in helping students learn (pedagogical content knowledge)?
To what extent does the instructor set explicit goals for student learning and persist in monitoring students' progress toward achieving those goals?

3. UNDERSTANDING OF AND SKILL IN USING APPROPRIATE TESTING PRACTICES

Summarizing the discussion of this characteristic in Chapter 2, effective teachers:

Assess learning in ways that are consistent with the learning objectives of a course and integrate stated course objectives with long-range curricular goals.
Know whether students are truly learning what is being taught.
Determine accurately and fairly students' knowledge of the subject matter and the extent to which learning has occurred throughout the term (not just at the end of the course).

The following questions might be posed for evaluation for this characteristic:

Is the instructor aware of a range of tools that can be used to assess student learning?
Does the instructor select assessment techniques that are valid, reliable, and consistent with the goals and learning outcomes of the course?

Are students involved in contributing to the development of the assessment tools used?

Are assignments and tests graded carefully and fairly using criteria that are communicated to students before they begin a task?
Do students receive prompt and accurate feedback about their performance at regular intervals throughout the term?
Do students receive constructive suggestions on how to improve their course performance?

4. PROFESSIONAL INTERACTIONS WITH STUDENTS WITHIN AND BEYOND THE CLASSROOM

Summarizing the discussion of this characteristic in Chapter 2, effective instructors:

Meet with all classes and assigned teaching laboratories, post and keep regular office hours, and hold exams as scheduled.
Demonstrate respect for students as individuals; this includes respecting the confidentiality of information gleaned from advising or student conferences.
Encourage the free pursuit of learning and protect students' academic freedom.
Address sensitive subjects or issues in ways that help students deal with them maturely.
Contribute to the ongoing intellectual development of individual students and foster confidence in their ability to learn and discover on their own.
Act as an advisor to students who are having problems with course material and know how to work with such students in other venues besides the classroom to help them achieve. When a student clearly is not prepared to undertake the challenges of a particular course, the effective instructor may counsel that student out of the course or suggest alternative, individualized approaches for the student to learn the subject matter that is prerequisite for the course.
Uphold and model for students the best scholarly and ethical standards (e.g., University of California Faculty Code of Conduct).[1]

The following questions might be posed for evaluation for this characteristic:

Taking into account differences in the difficulty and cost of undertaking research in various disciplines, undergraduate research experiences should engage students in interesting and challenging projects that help them develop additional insight into and understanding of science, as well as the specific topic on which they are working. How active has the instructor been in directing student research projects and independent studies? What is the caliber of these student projects? To what extent has the instructor fostered independent and original thinking by students and inspired them to develop sufficient independence to pursue the subject on their own? Have students been encouraged to participate in professional meetings? Has student work led to professional publications or acknowledgments?
Does the instructor take an active interest in advisees' individual academic and career choices? How well informed is the instructor about department and university policies and procedures that concern advisees? Does the instructor provide sufficient office time for students to obtain clarification and guidance?

How effectively does the instructor train and supervise teaching assistants assigned to his or her courses? How does the instructor contribute to the professional development of teaching assistants? Does the instructor treat his or her assistants with courtesy and as professional colleagues?

5. INVOLVEMENT WITH AND CONTRIBUTIONS TO ONE'S PROFESSION IN ENHANCING TEACHING AND LEARNING

Much can be learned from teachers who work with colleagues both on and beyond the campus. Effective teaching needs to be seen as a scholarly pursuit that takes place in collaboration with departmental colleagues, faculty in other departments in the sciences and engineering, and even more broadly across disciplines. Such conversations enable faculty to better integrate the course materials they present in their courses with what is being taught in other courses.

Summarizing the discussion of this characteristic in Chapter 2, effective teachers:

> Work with colleagues both on and beyond campus, collaborating with departmental colleagues; faculty in
>
> other departments in the sciences, mathematics, and engineering.
>
> Work to better integrate the materials they present in their courses with what is being taught in other courses.

The following questions might be posed for evaluation for this characteristic:

> During the term, has the instructor specifically elicited feedback from students, colleagues, or instructional experts (e.g., from the campus teaching and learning center) about the quality of his or her teaching?
> To what extent does the instructor meet his or her teaching obligations and responsibilities?
> Has the instructor made noteworthy contributions to the design and development of the department's curriculum? Has the instructor produced valuable instructional materials or publications related to teaching effectiveness or classroom activities? Has the instructor been involved in efforts to improve education or teaching within the discipline or across disciplines? Has the instructor participated in seeking external support for instrumentation or education research projects?

[1] The University of California System's *Faculty Code of Conduct Manual* is available at <http://www.ucop.edu/acadadv/acadpers/apm/>.

Active Learning Instructional Strategies

Think-Pair-Share

Give students a task such as a question or problem to solve, an original example to develop, etc. Have them work on this 2-5 minutes alone (think). Then have them discuss their ideas for 3-5 minutes with the student sitting next to them (pair). Finally, ask or choose student pairs to share their ideas with the whole class (share). I have used these in classes ranging from 12 to 340 students.

Collaborative learning groups

These may be formal or informal, graded or not, short-term or long-term. Generally, you assign students to heterogeneous groups of 3-6 students. They choose a leader and a scribe (note-taker). They are given a task to work on together. Often, student

preparation for the CLG has been required earlier (reading or homework). The group produces a group answer or paper or project. These work best in small to medium size classes, but I have also used them in a class of 340 students. If interested, see my short paper on "Collaborative Learning Groups in the Large Class: Is it Possible?" in Teaching Sociology, 1993, 21, 403-408.

Student-led review sessions

Instead of the traditional instructor-led review session, have the students do the work. For example, in my review sessions, we spend half the time working in small groups. Each student is to ask at least one question related to the material he or she doesn't understand, and to try to answer a question raised by another student. Students can also practice discussing, illustrating and applying difficult material or concepts, or drafting exam questions. For the second half of the review session, the whole class works together. Students may ask questions; other students volunteer to answer them. All students who ask or answer questions receive a "treat" (I bring small candy bars, gum, and boxes of raisons). I try to only speak if there is a problem. Again, I have done these in classes as large as 340 students. Be sure to explain what will be going on ahead of time so students are less frustrated when you don't stand up there and simply review the material or give the answers or tell them what to study!

Games

Games such as jeopardy and crossword puzzles can be adapted to course material and used for review, for assignments, or for exams. They can be used at the individual, small group or full class levels. There are now some computer programs, for example, to help you create crossword puzzles.

Analysis or reactions to videos

Videos offer an alternative presentation mode for course material. Videos should be relatively short (5-20 minutes). Screen them to make sure they are worth showing. Prepare students ahead of time with reaction or discussion questions or a list of ideas on which to focus; this will help them pay attention. After the video, have them work alone or in pairs to answer critical questions, write a "review" or reaction, or apply a theory.

Student debates

These can be formal or informal, individual or group, graded or not, etc. They allow students the opportunity to take a thesis or position and gather data and logic to support that view, critically. Debates also give students experience with verbal presentations. Some faculty members ask students their personal view on an issue and then make them argue the opposite position.

Student generated exam questions

This can be used for review or for the actual exam. This technique helps students actively process material, gives them a better understanding of the difficulties of writing reliable and valid exam questions, helps them review material, and gives them practice for the exam.

Mini-research proposals or projects; a class research symposium

Have the students work on designing a research study on a topic from the class. In some situations, you may be able to have them collect data during class time (observe some situation or give out some short surveys) or you may have them doing this as part of an outside-of-class project. Either way, have students present their research in a class research symposium similar to what we do at professional meetings. Invite other faculty and students.

Analyze case studies

Bring in case studies for students to read (for example, I will put a case example of sexual harassment on an overhead). Have students discuss and analyze the case, applying concepts, data, and theory from the class. They can work as individuals or in groups or do this as a think-pair-share. Consider combining this with a brief in-class writing assignment.

Keeping journals or logs

Have students make journal or log entries periodically (on paper or computer, in or outside of class). Require a brief critical reflection or analysis of each entry as well. For example, in my gender class, students must record instances of sex inequality (sex discriminations, sexism, sexual harassment against women or men) they observe. They then discuss this instance applying course terms and theories. Be aware of ethical issues if you ask students to record and analyze personal events or issues.

Write and produce a newsletter

Have small groups of students produce a brief newsletter on a specific topic related to class. Students should include articles with relevant research, post information on upcoming related public events, and so on. Share these with faculty and students in related courses or in the major.

Concept mapping

Here students create visual representations of models, ideas, and the relationships between concepts. They draw circles containing concepts and lines, with connecting phrases on the lines, between concepts. These can be done individually or in groups, once or repeated as students acquire new information and perspectives, and can be shared, discussed, and critiqued.