We are all accustomed to periodic summative testing for achievement, but in this chapter the importance of requiring mastery of fundamentals as the baseline for evaluation, regardless of the level of the class involved, is discussed.

Assessing Fundamentals in Every Course Through Mastery Learning

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Almost every course has several essential objectives that are considered basic or fundamental to the discipline—so fundamental that the failure to master those essentials elicits such comments as “How can one of our graduates not know that?” These essentials range from basic facts or principles to research methods, or from great discoveries in the field to current personalities or theoretical debates.

Given the centrality of these fundamentals to the larger discipline, we might expect them to be central instructional objectives for each course, with periodic assessment to assure that no one squeaks by without mastering them. Often, however, these objectives are so fundamental that we assume they have been mastered, perhaps mentioning them in passing, but mostly taking them for granted.

Assuming knowledge or skill is never as good as assuring it, or at least assessing systematically to distinguish what has been adequately mastered and what has not. In this chapter, I provide a rationale for the assessment of the fundamentals, along with some specific methods for doing so based on principles of mastery learning (for example, Block, Efthim, and Burns, 1989; Gentile and Lalley, 2003). These methods are intended to supplement, not replace, other assessments regularly used in the course. For example, for a second-level or more advanced course, the usual course objectives and assessments may suffice for testing and grading students’ acquisition of the new material. Assessing the fundamentals through a mastery learning approach supplements this by testing—and reteaching, if necessary—prerequisite knowledge that may have been inadequately learned.
or partly forgotten or current information or skills that are prerequisites for later units or courses in the discipline.

The structure of this chapter, then, is first to suggest why a systematic assessment of fundamentals is essential, based on what is known about learning and memory; the advantages of a spiral curriculum; higher levels of thinking; and the distinction between norm-referenced and criterion-referenced assessment. Second, we will consider how mastery-learning principles and procedures can be adopted for or adapted to a particular course to provide systematic assessment of fundamentals to the benefit of both students and faculty. In the last section of the chapter, I discuss these procedures as they relate to the broader goals of classroom assessment.

Initial Learning, Memory, and a Spiral Curriculum

“Learning should not only take us somewhere; it should allow us later to go further more easily.” So said Jerome Bruner in his classic book, *The Process of Education* (1960, p. 17). A good curriculum needs to spiral around the great ideas, principles, and values of a field. Thus, our initial learning, which by definition will necessarily be basic and incomplete (but hopefully still accurate), will be revisited later in this spiral curriculum. This provides the kind of usable knowledge that Bruner placed “at the heart of the educational process—the continual broadening and deepening of knowledge in terms of basic and general ideas” (p. 17).

The journey of a thousand miles, or instructional objectives, begins with a single step. That step, original learning, is usually described as an S-shaped learning curve that progresses from little or no knowledge or skill to an acceptable level of mastery over time. Time needed to achieve adequate original learning varies considerably among learners (see the definition of aptitude in Carroll, 1963, 1989), owing in considerable part to how well prerequisites have been mastered and the number and severity of students’ misconceptions.

In addition, because the almost-inevitable result of all initial learning is forgetting, then even initial mastery must be reinforced with additional practice, called overlearning, to create synaptic connections (on the physiological level) and allow comprehension and organization of the material (on the psychological level). The good news is that well-learned but forgotten material can be relearned in a fraction of the time required for initial learning—that is, there are savings in relearning. Inadequate original learning, in contrast, demonstrates no savings because little or no residue exists in memory. Thus, for overlearning to consolidate accurate and useful memories, original learning must be essentially correct; otherwise, students will be practicing and consolidating their misconceptions.

As the above descriptions imply, a novice’s mind is not a tabula rasa, although it may be a sieve. Enter the spiral curriculum, which builds on previous learning in at least two important ways, both of which assume that
initial learning was mostly accurate even if not easily accessible at the moment. First, it reviews prior material to allow relearning of its central concepts or procedures in the context of the current instructional objectives. This not only activates prior knowledge but encourages reorganization of that knowledge in the context of the new lessons. Second, a spiral curriculum builds on initially learned concepts, which are usually just the beginning of comprehension or simply memorized facts or procedures, and develops them into higher levels of thinking: other applications, analysis, critical thinking, and so forth (for example, Bloom’s “taxonomy of educational objectives,” 1956). These two functions of the spiral curriculum may be considered roughly equivalent to what Bruner meant (in the above quote) by “the continual broadening and deepening of knowledge.”

**Norm-Referenced Versus Criterion-Referenced Assessment**

Much assessment in higher education is done for competitive purposes, namely, to compare students’ performances for selection into the program or major, for academic awards or rank in class, or for grading on a curve. These are technically known as norm-referenced assessments because each person’s score is interpreted relative to the performance of others who provide the comparison norms.

Another tradition also prevails in academic settings: setting high standards and then certifying that each student who achieves them has earned the right to be designated or licensed as a professional in that field. This is a criterion-referenced purpose, where accomplishments are assessed not in competition with others but rather in relation to specific criteria for what is excellence and what are minimally acceptable levels of competence.

It is my argument in this chapter that, whatever other assessment purposes we may have in a course or program, we must include criterion-referenced assessments for those basic instructional objectives that are so central to the discipline that they inevitably show up in later units or courses. In addition to comparing each individual’s performance with some accepted standard, criterion-referenced assessment also requires that we specify and publish the particular knowledge or skills to be learned so that there is no mystery regarding the essentials of proficiency (Glaser, 1963; Popham, 1978; Gentile and Lalley, 2003).

Having abolished mystery learning, we replace it with mastery learning. Earning the minimum passing grade in the course becomes contingent on demonstrating mastery of these fundamentals. Higher grades can be earned in other ways: by passing other more competitive tests on additional material, demonstrating higher levels of thinking about the material, or showing creativity or ability to apply the information to other problems or settings. Of course, if at first students do not succeed in passing the mastery test on fundamentals, they must try, try again.
Structuring a Course to Assess Mastery of Fundamentals

The following steps provide a structure for implementing the above ideas (based on Block, Efthim, and Burns, 1989; Gentile, forthcoming; Gentile and Lalley, 2003).

Step 1. Identify the fundamental knowledge and skills in your discipline that are (a) assumed as prerequisites for your course and (b) are expected to be learned in your course (and are therefore likely prerequisites for subsequent courses).

Publish these as mastery objectives or study questions in the syllabus or as a course handout.

Begin the course with a review of the concepts in step 1a, including a test on those concepts within two or three weeks of the semester. This emphasizes the connectedness of the central concepts in the discipline while either refreshing students’ memories or giving them an opportunity finally to learn these concepts (if they had somehow missed them). For any student who cannot pass this test at some reasonable level of competence (at least 75 or 80 percent correct), two alternatives seem sensible: students should either drop the course (and enroll in a more basic one or opt for a different field), or they should commit to attend remedial sessions and do whatever is necessary to pass an alternative form of that test or risk failing the course (see step 3).

Following the review of prerequisites, move on to the crucial course objectives in step 1b, emphasizing that passing a similar test (or tests) on those objectives will be required to pass the course.

Step 2. Identify and publish the other objectives for your course—those designed to go beyond the basics but that are required for all, as well as those that are optional or enrichment objectives.

These objectives will be the focus of classroom presentations, discussions, and other assignments alongside the fundamentals (in step 1b), but they will be tested and graded separately as higher-level cognitive processes to organize, apply, or think critically or creatively about the material in the course.

Step 3. Adapt your grading scheme to be clear that the lowest passing grade in the course is earned by demonstrating mastery on both the prerequisite and fundamental objectives in the course (identified in steps 1a and 1b). Build your usual grading scheme on top of that but consider also adding opportunities for students to learn by teaching.

You will need to make a convincing argument (likely in the course syllabus) that passing the fundamentals tests, even with 100 percent correct, earns the lowest passing grade (for example, D or 70). Just as all people get the same driver’s license whether they passed the test on three tries or “maxed” the test on the first try, they are still demonstrating only initial competence and will therefore forget what they have learned. Thus, we need to argue (as Gentile and Lalley, 2003, p. 147, put it): “Congratulations,
you’ve learned the basics and are now ready to begin to use this knowledge or skill.” That implies overlearning, application, and the development of fluency through the spiral curriculum.

When you think about your own development from novice to expert, your fluency and ability to apply the knowledge easily arose only as you started teaching the material. Bruner (1960, p. 89) quoted a distinguished physics teacher making that point about his difficulty in teaching quantum theory: “I went through it once and looked up only to find the class full of blank faces—they had obviously not understood. I went through it a second time and they still did not understand it. And so I went through it a third time, and that time I understood it.”

My conclusion: Students will probably have to teach what they are learning before they can truly comprehend or apply their knowledge.

Teaching fellow students should therefore be built into the advanced objectives and opportunity for raising grades. For example, form a cadre of volunteers from among those who passed the fundamentals test to tutor those who need extra help. When the tutored students pass, the tutors earn points or a higher grade as an enrichment project.

The above ideas are not meant to replace the usual activities and assignments of the course. Rather, they are to supplement them and assure mastery of fundamentals.

Step 4. Write several test questions for each mastery objective (in steps in 1a and 1b) and randomly assign them to parallel forms of the tests. Do this before the course begins.

It is virtually impossible to invent a parallel form of a test—that is, one that covers the content in the same way and at the same level of difficulty—after students did not pass your single version of the test. Thus, you must anticipate the need for several versions of the test and write them before you begin the course. This also helps define the fundamental mastery objectives: anything you cannot clearly define or write test questions for should probably be considered enrichment rather than fundamental objectives.

Conclusion

The overarching goal of these procedures is to assure the mastery of a discipline’s fundamentals by systematic testing. This has the distinct advantage of emphasizing the centrality of these concepts or methods to the discipline and focusing study time. A further advantage is that many of these fundamentals can be relatively easily assessed by multiple-choice or other objective tests and may even be administered online. A disadvantage is that these mastery tests will likely be perceived as “high-stakes” exams, in that the course grade depends on passing them. Students’ anxiety over this can be reduced by scheduling review sessions (for example, by teaching assistants or other students who have passed the test as suggested under step 3) or by requiring students who did not pass to attend remedial sessions to prepare for the next test.
Once a procedure is in place for guaranteeing mastery of fundamentals, then the other, higher-level course concepts can be assessed by written reports, essays, performances, portfolios, and other more time-intensive evaluations. Inquiry and critical thinking skills, laboratory procedures, and artistic or athletic skills require performances, which is why such assessments are often called “authentic” (Wiggins, 1989). Whatever else is done to score and evaluate such performances, they also require feedback from a coach or instructor if any improvement is to occur. And coaches everywhere continually speak of the necessity of sound fundamentals for achieving true excellence. Testing for and assuring mastery of fundamentals is a step in that direction.

References
