Applying the Science of Learning to the University and Beyond

By Diane F. Halpern and Milton D. Hakel

Teaching for Long-Term Retention and Transfer

There is nothing more annoying than telling a new acquaintance that we are college professors and getting the enthusiastic reply, “It must be great to have all your summers off.” Most of the general public—including the parents of the students we teach, students themselves, and many of the people who ultimately pay our salaries—believe that college faculty are primarily teachers who have little to do when classes are not in session.

Of course, most of the general public know that we also “do research” and committee work. But they believe that these other parts of the professor’s job are secondary to teaching. Those outside academia further assume that because we are college faculty, we actually have a reasonable understanding of how people learn and that we apply this knowledge in our teaching.

It is easy to imagine where these fantastic notions come from. Have you actually read those glossy brochures (known as “View Books” to those in the trade) that our colleges and universities send out to prospective students and to others they want to impress? Invariably, beautiful images of campus life are presented, together with well-crafted language that explains how our students learn lifelong skills that prepare them for lucrative careers and to face the many challenges of adult life.

It would be reasonable for anyone reading these fine words to assume that the faculty who prepare students to meet these lofty goals must have had considerable academic preparation to equip them for this task. But this seemingly plausible assumption is, for the most part, just plain wrong.

The preparation of virtually every college teacher consists of in-depth study in an academic discipline: chemistry professors study advanced chemistry, historians study historical methods and periods, and so on. Very little, if any, of our formal training addresses topics like adult learning, memory, or transfer of learning. And these observations are just as applicable to the cognitive, organizational, and educational psychologists who teach topics like principles of learning and performing, or evidence-based decision-making.

We have found precious little evidence that content experts in the learning sciences actually apply the principles they teach in their own classrooms. Like virtually all college faculty, they teach the way they were taught. But, ironical-

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The benefits of retrieving information learned earlier to produce re-representations in new forms is among the most robust findings in the learning literature. Practice at re-trieval necessarily occurs over time and within a particular context. Transfer of learning can be aided by altering the con-text to which the knowledge is applied. For example, students can practice retrieval by teaching learned concepts and skills to other students, or by responding to frequent questions asked in class or posed online.

The effects of practice at retrieval are necessarily tied to a second robust finding in the learning literature—practiced prac-tice is preferable to massed practice. For example, Bjork and his colleagues recommend spacing the intervals between in-stantaneous retrieval of the same concept or element of knowledge over time. Otherwise, practice at retrieval may become increasingly longer—but not so long that retrieval accuracy suffers (see deWinstanley and Bjork in Suggested Readings).

Attest at retention to test a given concept or element of knowledge might be given to students one day after the initial learning, the second exam a few days after the first, the third a week after the second, and the fourth a month after the third, with the interval for each subsequent exam determined by the level of accuracy of student perfor-mance on the preceding one.

1) The single most important variable in promoting long-term retention and transfer of learning, we need to apply a few basic laboratory-tested principles. Like practice at retrieval, varied learning conditions pay high dividends for the effort exerted. In the jargon of cog-nitive psychology, when learning occurs under varied condi-tions, the correspondingly higher accuracy is referred to as “generalization” or “transfer.”

2) Varying the conditions under which learning takes place can enhance learning by having results in better learning. Like practice at retrieval, varied learning conditions pay high dividends for the effort exerted. In the jargon of cog-nitive psychology, when learning occurs under varied condi-tions, the correspondingly higher accuracy is referred to as “generalization” or “transfer.”

3) Learning is generally enhanced when learners are re-quired to take information that is presented in one format and “re-represent” it in an alternative format. Cognitive re-presentation is a process by which we simplify, transform, and personalize information by means of two distinct channels—one for visuospatial information and one for auditory-verbal information. A given piece of information can be organized and “stored” in memory in each of these formats. Further, the act of taking a particular test often facilitates subsequent better performance—only if those items were included in the first test.
how to multiply matrices. It is only after an initial investment in the hard work of learning that additional learning in this field becomes more automatic, and consequently becomes easier. Determining the best way for students to learn and recall something will thus depend on what you want learners to learn and how well and accurately they need to recall it. They may also need to recall it at some unknown time and place. The detrimental effect of testing is that students are often asked to demonstrate that they have learned, how well it will be remembered, and the conditions under which it will be recalled. This is especially the case when external bodies care large-lecture learning settings are often associated with forgetting of related information that they were not asked to recall. And even if they do well on a test taken soon after initial learning, students often perform less well on a later test after a longer retention interval.

Principles of learning are difficult to discuss in isolation because the experiences that lead to learning are so different in your understanding. Virtually all introductory college courses involve a lecture portion, in which a lone teacher mostly talks and writes on the board, while students take notes. This is a satisfactory arrangement for learning in which the knowledge of the subject is not widespread use of this pedagogical model for large-enrollment courses on college campuses. But understanding is an interpretive process in which students must be active participants. Learners need “cues” that trigger interpretation and force them to engage the material actively, even if they are sitting silently in a large lecture hall. For example, it is possible to get students to elaborate on particular pieces of information by lectures by relating it to information that they already know through the use of imagery or probing questions that test for understanding.

A major problem with recognition-based tests like multiple-choice exams where questions tap only lower-level cognitive processes, or with tests that require students only to repeat back course material, is that both faculty and students believe that achieving high scores on tests like these is what it means to learn. Unfortunately, it is quite possible for students to achieve high scores on tests like these and not be able to recognize a given concept’s application in a slightly altered context, or not be able to apply the concept at some time in the future. The amount of detail that learners will need at this future, unknown time and place is what should be guiding decisions about how deeply a particular element of content should be learned. The fact that knowledge of a broad area is indeed desirable, as it sometimes is, then instructors and learners should be collectively conscious of this goal so that they can learn and teach in ways that achieve broad coverage. But if deep understanding of basic principles is what is wanted, then the teaching and learning process needs to be structured accordingly. This means that instructors and learners ought to have clearly articulated goal statements at the start of instruction that guide instructional design and learning activities. And they need to carefully match the learning activities to these goals.

10) What learners do determines what and how much is learned, how well it will be remembered, and the conditions under which it will be recalled. There is an old saying in psychology that “novice pass recognition tests, but experts do not.” One of the most important roles of teachers is to direct learning activities in ways that maximize long-term retention and transfer. What professors do in their classes matters far less than what they ask of students. Instructional designers need to make careful choices about curriculum content to do. We need to look constantly for concrete evidence when we engage Effective Processing,” in D. F. Halpern and M. D. Hakel (eds.), Applying the Science of Learning to University Teaching and Beyond, New Directions for Teaching and Learning, No. 89. San Francisco, CA: Jossey-Bass, 2000, pp. 9-18.

Suggested Readings

- Applying the Science of Learning to the University and Beyond: Cognitive, Motivational, and Social Factors. Online at berger.clairemontcc.edu/.

We urge you to develop a healthy skepticism about all education claims. For example, if a corporate newsletter says, for example, that you should match student learning styles with your own teaching style, or that giving students an outline of the text will promote retention, employ some basic concepts of critical thinking and ask about the evidence that supports these claims. There is a large amount of well-intentioned, feel-good psychobabble about teaching out there that is more of an interesting exercise in investigation of the validity of its supporting evidence. As college faculty, we can have a lifelong effect on what our students remember, and consequently on what they will think and do. Or we can have a minimal effect. Most of the difference depends on how we design and direct learning activities. It’s time we applied what we know about learning generated in our own cognitive laboratories and applied research settings to systematically enhance teaching and learning practice in college.