

How People Learn

Science of Learning

Best Practices for Teaching and Learning

Let's begin by exploring how people learn. In the past 50 years, cognitive and learning science research has truly revolutionized and changed our understanding of how learning occurs.

Prior views about learning included the notion that learning is transmitted from the teacher to the student. In this view, the student could be compared to an empty vessel that could be filled with knowledge through teaching. In this view, teaching equals learning.

In recent years this teacher-centered view has fallen out of favor. This has come as a result of our increased understanding of how people learn. Current views about learning argue that students construct their own knowledge. In this view, knowledge is not acquired from the teacher but rather constructed through the learner's own experiences and reflections.

Knowledge is formed when new information gets incorporated into preexisting mental frameworks which are based on prior experiences and notions. New information is either readily assimilated into preexisting mental frameworks or causes their revision.

In this view, teaching does not equal learning. We need to invest in strategies that facilitate our students' processes of knowledge construction which may or may not involve actual teaching. This is one of the critical concepts of this course and will be addressed in more detail in the session on Interactive Learning and Active Teaching.

The finding that learning takes place through the construction of knowledge by the learner has significant implications for classroom instruction and course design. This means that we, as teachers, should think of ways to support our students with knowledge construction.

We can do this through activities that facilitate meaning making and promote adaptation and revision of preexisting mental frameworks. To support meaning making and help students adapt to existing frameworks, we suggest two different accommodations as discussed in the pre-session reading titled, *Applying the Science of Learning*, by Halpern and Hakel-- vary the conditions under which learning takes place, and facilitate retrieval.

Let's explore these two recommendations in more detail. When we vary the conditions in which learning takes place, students associate multiple retrieval cues with key ideas or concepts. This makes it easier for the information to be retrieved.

The ability to retrieve information and make use of it in a new scenario or application is called knowledge transfer. Knowledge transfer is what we like our students to be able to do. Without it, our students will acquire knowledge that they're not able to apply to different or novel situations.

Noble Laureate Herbert Simon stated, "The meaning of knowing has shifted from being able to remember and repeat information to being able to find and use it."

We can change the conditions in which learning takes place through several methods.

During class, use both verbal and audiovisual representations of the same concept. Also use diverse examples that illustrate a concept. A concept without examples is difficult to grasp. Examples contextualize the concept and allow

learners to be able to separate a concrete illustration, the example, with the enduring, more abstract transferable concept.

Let's say that you explain a particular concept and then provide a single example to illustrate that concept. For the learner who is not an expert in the subject, there's no real difference between the concept and the example. The two tend to merge together in the learner's mind. The learner is often unable to separate the concept from the example.

One solution is to provide a second, similar example. If an example is similar enough, there will be substantial overlap between the concept and example one and the concept plus example two. This overlap is smaller than a concept and a single example. And the two examples serve to create the boundaries of the concept more clearly.

It's even better to provide a third example that is distinct from the first two. This helps students differentiate the overlap between concept and examples. The concept stands out more clearly.

Another useful way to vary the conditions in which learning takes place, is to provide students with opportunities to represent the information in an alternative format. For example, you can ask for students to describe and explain in words the concepts they have learned through mathematical equations-- or vice versa. Ask students to visually, through a diagram, represent descriptions of concepts, reactions, et cetera.

Learning and retrieving is enhanced when students are asked to retrieve and integrate information both verbally and visually. As we have previously mentioned, knowledge transfer is the consequence of understanding, or deep learning-- learning that is really understood and can be applied.

As Halpern and Hakel remind us in the Applying the Science of Learning pre-session reading, "We need to always remember that we are teaching toward some time in the future when we will not be present-- and preparing students for unpredictable real-world tests that we will not be giving-- instead of preparing them for the traditional midterm and final exams."

Long term retention and transfer can be achieved through retrieval and application. The strength of the memory trace where the connections in the brain made through the process of remembering and eliciting information becomes stronger each time a student is asked to retrieve the same information. Particularly if they are asked to apply the information in new, novel ways.

There are many ways in which you can ask your students to retrieve information or concepts. One strategy you can use is to ask your students to explain to each other their answer to a question or problem.

As we will see in the session on Interactive Teaching and Active Learning, this strategy can result in higher learning gains and increase student attention. Asking your students to respond to questions or solve problems on a particular concept, even after it has been taught, can also facilitate retrieval.

Spacing the retrieval opportunities so that the time interval between opportunities increases is preferable to constant retrieval for a short amount of time. Instead of always asking students to retrieve something right away, vary the time between presenting the concept and asking them to retrieve it. This allows for concepts to be integrated into existing frameworks more robustly, and for those connections to deepen over time.

As we have already mentioned, applying knowledge to new situations leads to transfer. Whereas applying the learned knowledge to similar situation only results in memorization. Therefore don't just change a few variables within a problem. But instead provide your students with substantially different problems that illustrate the same concept.