

What students know prior to taking our courses

Science of Learning

Best Practices for Teaching and Learning

Now, let's take a look at how understanding what students know before taking our courses can transform our teaching. Learning research indicates that the single most important determinant influencing students' learning is how much students already know and what they know prior to taking our courses.

Rather than being blank slates, students enter the classroom with personal notions about how the world works, which are determined by previous classes, personal experiences, the media, peers, family, et cetera. Some of these notions might contain faulty logic or misconceptions.

When students come into our classrooms and encounter new information, they have to reconcile it with their own previous ideas and notions. Research on misconceptions has shown that once these faulty ideas take place, they're very persistent and difficult to change. Given the importance of prior knowledge on learning, understanding what students know is key for effective instruction.

This can be accomplished in different ways. You can start by assessing knowledge on understanding at the start of each course. Probing for conceptual understanding. This will allow you to know the knowledge base of our students, including what they already know and what they have difficulty with understanding. You can then provide the same test several times during the duration of your course and at the end of the course to continue to probe for understanding.

As an added benefit, administering a pre-test can also help diagnose which students might be in danger of not passing your course, and be able to advise them on the resources and strategies available. Pre-tests come in various shapes and sizes. You can certainly design your own, using questions that you have developed in the past. There are also several published and validated pre-tests for undergraduate education called "concept inventories" that are available for many disciplines.

Another strategy for determining prior knowledge is to use in class concept questions. These questions are designed to expose common difficulties in understanding and misconceptions, and can require problem solving. Here's an example of a concept question relevant to Introductory biology.

"The majority of actual dry mass gained by plants as they progress from seed to adult plants comes from which of the following substances? A, nutrients in soil that are taken up by plant roots? B, molecules in the air that enter through the holes in the plant leaves? C, water taken up directly by plant roots? And D, energy from the sun."

Pause the video here and take a moment to think about the answer to this question. The correct answer to this question is B. "Molecules in the air that enter through the holes in the plant leaves." 80% to 90% of a plant's overall mass is water. 96% of the dry mass is organic substances, such as cellulose and proteins.

The plant absorbs carbon dioxide through its leaves. And through photosynthesis, the carbon dioxide is combined with hydrogen atoms from water to form carbohydrates, the basic

components of cellulose. The energy from the sunlight is converted into chemical energy, which serves to catalyze critical reactions during photosynthesis. But energy itself is not converted to mass.

As you can see, this question is designed to document a common set of misconceptions in biology, that nutrients in the soil taken up by the roots make up most of the actual mass of the plants, or that the energy from the sun's energy is directly converted to dry biomass. When this question was given to Introductory biology students at Michigan State University, only 4% of the students chose the correct answer.

Questions such as this one can be designed for every class and given throughout the semester to document what students know. In the session on interactive teaching and active learning, we will discuss ways in which concept questions can be utilized to introduce small group activities in active learning during class time. Another recommendation for determining what students know is the use of MUD cards. What are MUD cards? MUD, M-U-D, stands for "muddiest point."

MUD cards are provided at the end of each class, and typically contain one or two questions, such as "what was the muddiest point in class today?" "What remains unclear to you?" "What other comments do you have about today's session?" MUD cards can be incredibly useful at documenting what concepts are difficult or what was not clearly explained during class. And they're very useful in uncovering faulty thinking and logic.

MUD cards are typically used by faculty to better understand what remains unclear after each class. They can also identify incorrect prior knowledge or assumptions, which may be exposed in students' explanations. Also, answers to common questions written by students in the MUD cards can be addressed in the first few minutes of the next class. It is important to remember that for students to value filling out MUD cards, it is necessary to make sure that you, as a teacher, take time to address their questions and difficulties.