# *Taking a Small Step Toward Conceptual Learning*

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Are you an expert at something? Can you play the guitar like Jimmy Page, ride a bike like Lance Armstrong, or hit a tennis ball like Serena Williams? Or maybe your expertise is something more germane to HAPS like neurophysiology or muscle anatomy. To become an expert requires both time and talent. Malcolm Gladwell in his book, *Outliers*, claims that at least 10,000 hours must be devoted to practice before one can maybe (yes, maybe!) be considered an expert. Ten thousand hours of studying neurophysiology or muscle anatomy. For most of us, the bulk of these hours can be summed up by saying "graduate school."

Along with being experts in anatomy and physiology, we are also expected to be experts at teaching and learning – another investment of 10,000 hours thinking, reading, and experiencing the enormously complex world of cognitive science. And then to prove that we are indeed teaching experts, we try to develop teaching methods to transform our students from novices to experts in one or two semesters. Gladwell would laugh at that goal. But if an expert is a "10" and a typical student is a "1," in terms of knowledge and understanding of anatomy and physiology, what should our goal be? 1.1? 2? 5?

First, some bad news. In many cases our students go through our science courses and don't learn anything of significance. Sorry. It's true. The key word there of course is significance. Sure, they learn the origin, insertion, and action of the biceps brachii, the branches of the aorta, the thoracic cavity, and maybe even the parts of the myocardium that are fed by the left circumflex artery. But instead of developing a robust understanding of the principles of anatomy and physiology, students frequently walk away with an unorganized spew of facts that are easily forgotten unless quickly reinforced in their next courses.

But there is more to our discipline than the collection of facts and details that students, and many HAPS members, associate with human anatomy and physiology. Enter the world of conceptual learning, where understanding is the goal and the ability to memorize long lists of structures becomes not all that important.

A concept is more than a collection of facts; it's a set of ideas that can be used over and over again to solve problems. Concepts are cognitive tools used to describe, control, predict, and explain events in nature: events like the flow of information within the body, like the energy dynamics required to maintain life, like …. Nuts. I have trouble thinking of many more. And this is important for anatomy and physiology education.

I've been teaching anatomy and physiology for twenty years and I'm still struggling with identifying the central concepts. In general biology courses the central concepts, or "big ideas," are easy to identify (but of course, not so easy to teach and learn), e.g., evolution by natural selection, the flow of genetic information from one generation to the next, energy flow through the ecosystems, etc. But what about human anatomy and physiology? What are the big ideas that help all the details fall into place? And holy smokes, do we have details! How many muscles, bones, blood vessels, tissue types, etc. do we require our students to memorize? Oops, sorry, I mean "learn." And why do we do it? First and foremost, it's what we were made to do when we were students. And because we learned that way, we teach that way. (General principle of teacher education: we teach the way we were taught.) And most all of us can live very comfortably in the world of anatomical facts.

Instructor: "OK class, here is your mandible, here are your maxillae, here is your nasal bone."

Student question: "Where did you say your mandible was located?"

Now there is a question we can all answer. A factual question. Nice and easy. We all know thousands of facts about the human body, and when a student asks us about one of those facts, we can quickly and easily give him an answer. Now where's my paycheck?

But there is another end to the cognitive swimming pool--the deep end. At this end we have questions that are not so clean and simple.

If we know so much about the human digestive system and nutrition, how come so many people are getting type 2 diabetes and atherosclerosis?

Two kidneys but only one heart. Why?

What are the implications behind only a few people having Thebesian valves? Don't we need them? And if we don't need them, why do some people have them?

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It is important to state clearly that facts are needed in order to build concepts; conceptual understanding requires detail. (You have to know what a Thebesian valve is before you can ask a good question about it.) However, if we focus only on details, conceptual understanding is rarely developed. And without a conceptual understanding, the details that students learn are quickly forgotten.

If you're interested in teaching for conceptual learning, a good place to start is at the beginning of a teaching unit. Try to identify one or two big picture questions that you would like students to "sort of" or "begin to" answer by the end of the unit. "Sort of" answer is necessary because the big questions do not have easy answers. They evolve with increasing understanding, and your "A" students will answer the questions differently from your "C" students. And their answers cannot be evaluated as right and wrong, but rather more or less in line with the way current scientists are thinking.

For example:

Explain the importance of ion gradients in muscle and nerve cells.

How are ion gradients generated and maintained?

Or even:

What's the big deal about the sodium / potassium pump?

Or

When you stub your toe, how does the information get to your brain?

Students can help you generate the questions. During the first day of teaching a new body system, it's good practice to let students work in small groups for a few minutes to generate their own questions. Specifically, after a brief instructor introduction to identify major organs and functions, have students brainstorm their own questions about the system, and have them write those questions on the board for all to see. Assimilating those student questions into your presentation is a first step to conceptual teaching. ("Oh! That's why gradients are important!")

So on the above 1 to 10 scale, what should be our goal? That's entirely up to each instructor and the goals of the program. Are you trying to produce nurses? Research scientists? Or maybe you're like me and teach in a liberal arts curriculum and are trying to produce literate citizens. In each case, the goals will be different. But we're still faced with grading. And what level of understanding warrants high grades? Low grades? Etc. And how do we assess the many different levels of understanding? (That's a whole different kettle of Thebesian valves.)

The simplest procedure is to give tests (remember, we teach the way we were taught – and we all took tests.) The highest marks on the test get "A's" … easy. Yawn! Here is something new (and I'm trying it out with my students this semester): give credit for good questions. If a student asks an insightful question during class, give her some credit on the next exam. Reason here is that it takes a very robust and dynamic conceptual understanding of a topic to generate a question that makes you, an expert in the field, pause and think back on your 10,000 plus hours of study, (i.e., your own conceptual understanding), and generate an answer that may not be identical to the current paradigm used in scientific literature, but is still "pretty good."

Cool. Now this is why teaching is fun. ■