SCIE 201: Investigative Science I

Prelude:
One of the goals of this class is to help you develop your skill in "thinking scientifically". Learning and thinking about different subjects requires different strategies (learning Spanish really is different than learning Science). Thus, it's important to learn how to think within the *context* of a discipline.

One of the proven strategies that helps facilitate learning is to ask a student to engage in some concrete experience and then to make observations about, or to reflect upon, that experience. You might think that "making observations about" is different than "reflecting upon", particularly in science. However, I'd argue that they are the same. Why? Because the nature of one's observations is shaped by prior experience.

One of the great misconceptions of science is the notion that scientific observations are "objective". Nonsense. The way we conceptualize something new is necessarily shaped by our prior experiences. There's a great children's story that well illustrates this point. It's called "Fish is Fish" (by Leo Lionni). In this story, a fish and a tadpole are good friends. The tadpole grows into a frog, and leaves the water to explore the world. He returns to tell his friend, the fish, about what he saw. He describes birds and cows and people to the fish, and the fish pictures each in his mind, based on what he knows of his own experiences. Each new animal resembles a fish. Birds are fish with colorful wings; cows are fish with "pink bags of milk". Because the fish had never been out of the water to see the great diversity of life on land, he is unable to develop a picture of these land-dwelling creatures that matches what the frog describes. His observations are clouded by his prior experience.

Thus, it's critically important, as a scientist, to reflect upon how your prior experience impacts your observations. As a teacher, it's equally important to recognize that your students come to your classroom with a vast diversity of experiences. For this reason, it's important to assess prior knowledge; you can't assume that everyone comes to you from the same background or with the same prior experiences.

Both of these are incredibly challenging tasks.
We'll tackle the first one here – what do we mean when we say you should "reflect upon" your experience? First, let's be clear about what we mean by "experience". It could be a physical demonstration, it could be an experiment you perform, or it could be a field trip you take. It could also be something less physically tangible: you could reflect upon the experience of writing a lab report, or of developing a dichotomous key, or of making a concept map. In the former, you're likely to focus upon the mechanics of how you did the experiment, or what you learned from the demonstration or on the field trip. Your focus is likely to be upon the "content" or subject matter knowledge. In the latter, you're more likely to focus upon analyzing your thinking process: what you were thinking that led you to choose one strategy over another as you developed your key or drew your concept map. It's this activity that is often left "untaught" in schools nationwide, but research shows clearly that this kind of reflection is critical to helping students learn about how they think in a particular discipline. Not only is content knowledge important, so too is knowledge of and about the variety of strategies one can employ to learn different things. Unfortunately, knowledge about individual learning strategies can't be taught, because it is extremely personal and differs tremendously between individuals.

Stages of Reflection

1) According to Farrell (2001), critical reflection (i.e. stage 3 of reflection) challenges us to move beyond stage one and stage two reflections outlined below.

Levels/Patterns of Reflection

Level 1: (this is the F – D grade range; We know that you can do better than this)

Metacognition: Not much metacognition here.

Content: This level of reflection focuses on the *what*.
Level 1 reflections are primarily *descriptions* of *what* the learner did in a learning activity or *what* they learned.

> Ex: *Today we did this cool activity where we had to identify our own culture. In the activity I identified the type of music that I listened to, my religion …. I'd never thought about having a cultural background. Culture was something people of a different color or who spoke a different language, or who were from another country had. So I learned that everyone has a culture and that mine involves my language, my religion, my SES, region of birth, and so on.*

Level 2: (This is the C – B grade range; This is the 'target' range)

Metacognition: This level is includes Stage 1 plus it focuses on the *how* of learning and metacognitive processes. Level 2 reflections are deeper and occur at a higher level of interaction with content and learning process. Here, the learner reflects on *how* they went about the learning process (e.g. what strategies they used, how effective they were, what they might do differently next time.) It is at this level that students confront their assumptions, beliefs, and any misconceptions they had about "how they learned it". Connections are made to past experience on "how you learned it". In other words, how do you really know what you know?

Content: It is at this level that students confront their assumptions, beliefs, and any misconceptions they had about "what they learned". Reflections provide evidence for their assertions for what they've

learned. Connections to what you have learned in the past are made. It is at this level that the learner begins to question the evidence that supports their ideas - possibly looking at things from a different perspective.

It is at this level that learning becomes more cyclical: You question something about your answer, try to find reasonable evidence to support your position and then evaluate your answer again by asking more questions.

> Ex: *I'm finding that using concept maps really helps me learn and retain information better because it forces me to concentrate on the essential concepts as well as the details to support each concept. I think it's important to learn about flood plains in order to understand. . . . I'm also finding that concept maps are useful in my other classes. For example, ...*

Level 3: (This is the B – A grade range; The "bravo, pat yourself on the back" Level)

This level of reflection includes Stage 2 plus it focuses on more purposeful and intentional learning. Stage 3 involve critical reflection. The reflector is able to engage more deeply and analytically in self-dialogue to reveal and interpret the holistic nature of their content/skills/process learning by examining, questioning, and investigating real-world or simulated problems in the content. The reflector shows that they are trying to take their knowledge and expand it to other scenarios and asking "what if this happens? How would my results change?" – in other words, hypothesizing and theorizing. At level 3, reflections really zero in on the "so what" question, i.e. why does it matter that I learn this skill, information, process, perspective, self-assessment, etc. anyway?

> Ex: *I found this particular assignment very challenging. I tried using the strategies I'd learned before, but they didn't work for me this time. As I thought about it, I realized that I just started with the same strategies I used in the previous assignment; I found out very soon that I was using the wrong strategies for learning this process. I had assumed that the two activities were more similar than they actually were. So I went back and looked more closely at what the problem asked me to do. That helped me design a more effective strategy.*