Guest Editorial: Reexamining Inquiry Pedagogy in the Science Classroom

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> "Science is experience becoming rational. The effect of science is thus to change men's idea of the nature and inherent possibilities of experience. … Instead of being something beyond experience, remote, aloof, concerned with a sublime region that has nothing to do with the experienced facts of life, it is found indigenous in experience: -- the factor by which past experience are purified and rendered into tools for discovery and advance."
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> -- John Dewey (1910), *Democracy and Education: An Introduction to the Philosophy of Education*, pgs. 263-264.

John Dewey, in the early 1900s, called for students to experience learning, embracing indigenous experience, rather than simply learning through passive means. In the last century, we collectively struggled with the pedagogy regarding student learning as we rethought the "sage on the stage" method of teaching. While pockets of educational progressives since that time have embraced Dewey's ideas of engagement of learners, enacting the actions of science in science classrooms, these practices have not become widespread. On a personal note, when I was looking through my son's science book and commented on how fun it must be to make mixtures and to examine states of matter, he said, "Mommy, we don't do science. We read about it." Yes, they read about the activities but they did not actually do them.

On the other side of the spectrum, some educators attempted to have students practicing science by hoping that free-exploration of science materials would lead to the students' re-discovery of scientific ideas. "Pure" discovery learning has been criticized for some time as we have learned that facilitation, discussion, reflection and argumentation are sorely needed to process ideas (Mayer, 2004). While the pendulum of science reform has moved between teacher-centered instruction to student-centered instruction, we find ourselves examining aspects of each and considering how we can use the appropriate methods at the more appropriate times. In the late 1980s, inquiry instruction moved to the forefront of discussion in science education circles although many science classrooms remained in the status quo of teacher-centered instruction.

Today, with the international emphasis on inquiry experiences for students in the science classroom (e.g., European Union's Science Teacher Education Advanced Method (S-TEAM), 2011; the United States Science for All Americans, Rutherford & Ahlgren, 1989; National Science Education Standards, NRC, 1996) there has been a continued call for the investigation into the effects of pedagogy in the science classroom. Researchers asked "Is inquiry instruction better than direct instruction?" What is inquiry? What is "good" direct instruction versus "bad" direct instruction? What is blocking the use of inquiry pedagogy in the science classroom?

The empirical investigations taking place have mixed results at best. There are reports that direct instruction is better (Chen and Khlar 1999; Khlar & Nigham, 2004), inquiry is better (Blanchard, 2006), and also studies saying that there is really not much difference if both types of pedagogy are enacted "well" (Lederman, Lederman & Wickman, 2008). Complicating factors included the notion of direct instruction teaching scientific processes, which typically many do not think of when they hear the term "direct instruction" or DI. The term DI sounds more like the teacher is simply telling students what they need to know in a passive fashion. Others conflate discovery learning with inquiry. This is inappropriate as unguided discovery learning is not what one would necessarily label as inquiry as described in the National Science Education Standards (1996). "Pure" or unguided discovery learning has been described as a widely open exploration with minimal guidance from an instructor (Hmelo-Silver, Duncan, Chinn, 2007). Inquiry, with its many variations, requires facilitation, discussion, and argumentation. To complicate matters further, facilitation, discussion, and argumentation can all be termed as types of DI, so one begins to wonder what exactly is it that we are attempting to measure? With mixed results in comparing the effectiveness of DI and inquiry pedagogy, it is appropriate to revisit the purpose for the emphases on inquiry pedagogy. *Why inquiry?*

Inquiry pedagogy's strength is not only that it can be a powerful way to learn many science concepts, but also that it allows students to experience the processes involved in scientific methods (2004). As a colleague from The University of Iowa once said, "If you aren't doing inquiry, you are not doing science," (J. Dunkhase, personal telephone communication, November 18, 2006). Using more traditional methods, students may be learning *about* science but many of the actions of a scientist are missing. This is an interesting point that centers on the very essence of what science is. Science is not only the modification and accumulation of knowledge about the natural world but science also includes the processes of how science is conducted. Scientific inquiry is the pursuit of scientific knowledge. These ideas are central to the *nature of science*, a reoccurring topic in this volume.

All of this is not to say that inquiry pedagogy should be used at all times. (Kuhn, D., 2007) When one is learning how to use a microscope, direct instruction is probably the best tack to take. Many times, there is direct instruction within an inquiry investigation, when it is appropriate for directinstruction to take place. For instance, it is imperative that the facilitator directs discussion among students for validation and refutation of claims being made through their investigations. When inquiry is taught, one cannot assume that students now understand what scientists do when they inquire. Explicit discussion and reflection about nature of science concepts is necessary to help students attend to these sophisticated understandings (Schwartz, Lederman & Crawford, 2004). What is central to the themes in the pedagogical debates is that the goal should not be for students to simply tell back scientific facts, but that we are to foster the development of critical thinking skills (Kuhn, D., 2007).

Change is difficult. Many times, roadblocks to inquiry teaching are excuses that are used to simply maintain status quo. While one may need to change planned activities drastically to accommodate large class sizes, inquiry does not need to be devoid from instruction. Large college classes of 300 have participated in aspects of inquiry with some creative planning. We must remember, if one is unfamiliar with these teaching practices and have never experienced inquiry in a science content classroom, learning how to teach using inquiry pedagogy can be difficult taking time and guided practice (Martin-Hansen, 2009; Van Hook, Huziak-Clark, Nurnberger-Haag, Ballone-Duran, 2009). I have always shared with my pre-service science teachers that it took me five years to feel comfortable creating, implementing, and assessing inquiry lessons in my own science classroom. A definite learning curve is involved.

To end, a good question for us to consider when examining pedagogy in the science classroom could be, "Are we doing science or simply talking about it?"

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