**The Development of my Understanding of the Methods of Inquiry in the Earth Science**

**My first job after college was working for a small, private weather firm. One of my responsibilities was organizing community outreach programs such as teaching elementary and middle students about the weather. During these programs, I conducted short, high-interest weather demonstrations with students such as making “tornados” and “lightning.” Based on students’ enthusiasm during these demonstrations, this was the method of teaching I thought science ought to be taught.**

**A few years later, I obtained my teacher certification to teach secondary earth science. Similar to the outreach programs, my method of teaching was limited to lecturing from the textbook and implementing traditional lab activities (e.g. cook-book labs, demonstrations). Students seemed satisfied. My principal, however, encouraged me to embed student-centered inquiry-based labs as part of my instruction—a “new” instructional method that I was unfamiliar with. She encouraged me to do this because these “new” labs were similar to the ones that the tenth-grade students would now complete for the state’s new science assessment.**

**As part of this changing emphasis, I also learned about these student-centered inquiry-based labs from the state’s new teacher induction program. I learned that inquiry required students to identify a related set of variables to test (e.g. independent and dependent variables), pose testable questions, develop valid procedures, collect quantitative evidence, and draw evidence-based conclusions. This was the experimental method of doing science. Since I was previously unfamiliar with “inquiry,” this process was how I began to develop my understanding.**

**Although I do not recall the exact content of the first inquiry-based lab that I gave to students, I certainly remember implementing it. This was because students did not understand the goal of the lab or what to do. For instance, they did not know how to identify a variable and they did not know how to write a problem. Worse, I did not know how to guide my students. As a result, the lab was a disaster. Since I worked for a high-achieving district, I knew I had to figure out a better way to implement these inquiry-based labs. So, I spent the next several years trying to figure out how to scaffold these labs for my students.**

**During my first five years of teaching secondary earth science, I continued to develop my pedagogical content knowledge of inquiry. I taught my students how to do this experimental method of inquiry. Over time, my students were more successful doing these kinds of labs. In fact, the majority of them were able to identify a related set of variables to test, pose a testable problem, and draw evidence-based conclusions.**

**As I developed my confidence to teach this method of inquiry, I began to think more deeply about the different kinds of methods earth scientists use to conduct their own investigations. I also thought about the scientific practices that I employed as a meteorologist. To forecast the weather, for instance, I collected and analyzed past and present weather data as well as various computer forecasting models. Based on this evidence, I then developed a forecast. At times, I questioned if what I was doing was “inquiry” because it did not seem align with experimental method of doing inquiry. I felt this way because this experimental method was expected to be implemented with students (e.g. the state science assessment). This view was reinforced by some of my science colleagues too. They viewed earth science as a descriptive science wherein students made simple “observations” of the world such as identifying sun spots or differentiating between an igneous rock and a metamorphic one. Thus, the methods inquiry in the earth sciences was limited to students observing the world around them.**

**Over time, I began to appreciate the differences and similarities between the experimental method of inquiry and with the alternative methods of inquiry used to study the earth systems. I realized that understanding the factors that affect the erosion of a stream (e.g. experimental method) was just as important as studying the dynamics of an entire watershed (e.g. systems thinking). In either case, there were three common elements of inquiry: research questions, evidence, and conclusions. I also realized was that making detailed observations as well as developing and experimenting with models to understand the earth’s natural systems, both spatially and temporally, was also a valid method of inquiry.**

**Thus, I embedded new types of inquiry-based instructional activities in order to develop my students’ understanding of the earth systems. One of the first challenging lessons I had my students do was an activity called “Discovering Plate Boundaries” by Dale Sawyer. In this activity, students were given four data-based maps that depicted earthquakes, volcanoes, topography, and the age of the ocean floor. In essence, students classified different kinds of plate boundaries based on the data they observed and analyzed—similar, yet more simplistic, way scientists began to develop the theory of plate tectonics.**

**Another strategy that I employed was using online real-world data to teach weather concepts with my high school meteorology class. Most of the course used current and past weather data to inquire and understand major meteorological topics such as diurnal cycle, seasons, and high and low pressure systems. One activity I did with my students was “The Reasons for the Seasons,” which was an activity I recently published in the *Science Teacher*. In this activity, students predicted the mean average high temperature for five cities along the east coast of the United States and then compared their predictions with data they collected from the Northeast Regional Climate Center at Cornell University. Based on their analysis, students’ hypothesized factors might contribute the seasonal differences among these cities such as distance from the sun, the amount of daylight hours, and the angle of the sun’s energy striking the surface of the earth. Students then collected data, from multiple online data sources, to confirm or reject their hypotheses.**

**After 11 years as a secondary earth science teacher, I now teach science methods and a few introductory science courses. For all of my courses, students conduct investigations that utilize multiple methods of inquiry. My students, for example, still do Dale Sawyer’s Discovering Plate Boundaries activity—an inductive method of inquiry that focuses on spatial reasoning. Similar to my high school students, they too, need scaffolding to help guide them through the inquiry process.**

**Overall, the progression of my understanding the methods of inquiry has evolved from naïve (e.g. cook-book labs, demonstrations), to narrow (e.g. experimental), to broadening conceptions (e.g. systems thinking). I look forward to developing instructional strategies to engage all students in the methods of geoscience.**