GRADES
5–10

NEGOTIATING SCIENCE

The Critical Role of Argument in Student Inquiry

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CHAPTER 1

Introduction to the Science Writing Heuristic (SWH) Approach

Teacher's Voice

After a twenty-five-year career as a high school science teacher I was pretty much set in my ways of disseminating information to my students. We would have lecture/note taking, discussion, lab investigations, worksheets, cooperative learning groups, projects, and so on. It was not a bad classroom in my opinion: It was very organized. The activities were varied. I was trying to include all students by doing different activities and using a variety of methods that would incorporate the diverse learning styles of students.

But as the science teachers in our school began to learn about the SWH process and think about what learning and teaching were, we made some discoveries of our own. The key ones were that the students are in control of what they learn and that teaching can move from a method of giving information to a method of guiding students to build their knowledge based upon what they already know.

So we moved from how much material we could present to figuring out what was really important. We tried to come up with the "big ideas" for the units we were teaching. We found out what the students knew and modified the kinds of activities we were already doing so the students could explore, inquire, build on concepts of which they had some prior knowledge, and make connections.

To do this we were willing to change from a teacher-centered classroom to a student-centered classroom. We were asking the students to be more active and take control of their learning by posing questions, exploring, discussing, and writing about what they discovered. As teachers we were also becoming more active as we designed units that would engage the students and exploring ways to make the units meaningful. What do we want students to know and how are we going to accomplish that? What kinds of questions can we ask? How do we get all students involved? We planned for these things, but each day

as I got up to get ready for school the process of getting students involved was on my mind. The process was making me think about teaching. I get up in the morning and am always thinking about exactly how things are going to go. You know, you are really thinking more about your subject matter than before. That is different. You are trying to come up with better ways of posing questions to students.

What is so good about this approach? Seeing students design experiments to answer a question that they want to know about. Seeing students who do not usually say much actually have an opinion that others listen to and think about. Seeing students research what others have done to answer a question similar to theirs. Seeing students express what they have found out with the written word. Seeing students discuss, argue, or debate points of view. Seeing students make connections with their world and the world of science. Students are in control of their learning—we finally began to understand that we never really had control even though we thought we did. We can guide them so that they have a real stake in the learning process.

HAVE A GO! YOUR TEACHER VOICE

If you were to write your own first paragraph as you enter this process, how would it compare to the teacher above? If you are new in your career, in the mid-years, or a seasoned veteran, what would you say about yourself? Appendix B will help you form your own beginning paragraph for your SWH journey.

The teacher's voice from the passage at the beginning of the chapter may sound like you. This is from an actual teacher who is in the process of implementing the SWH and becoming a better teacher of science. Like so many teachers, this teacher had what would be described by almost all observers as a good classroom. The teacher was doing all the "right" things, the class climate would be seen by most as excellent, and teacher evaluations were outstanding. But here is a teacher nearing the end of his career who had a sense that something was missing. Are you confident that your classroom provides for the best learning possible for your students? If you are like this teacher and sense that something is lacking, take the time and effort to work through this book with your classroom and you may find yourself making the same comments in a few years about your students.

What Is the SWH Approach?

So, what is the process that is supposed to help students learn science better? How do we encourage our students to pose questions and explore their answers while

better representing that learning on standardized tests? Why is there a need to move away from the traditional approaches to science teaching? We know that the number of students moving into science and science-based careers is decreasing—why? Many factors are present, but as science educators we have to ask ourselves, "What are we doing in our classrooms that does not promote, encourage, and stimulate students to consider and choose careers in science?"

When considering why this lack of interest in science exists, we need to look critically at the approaches to science teaching and learning that have historically permeated our work. Traditional science laboratory activities are structured around the laboratory report format. Students are expected to engage in a format that outlines the hypothesis, procedures, observations, results, and discussion. Unfortunately, scientists use this format not in the laboratory but primarily to report their work in journals for publication. In the lab, they pose questions, make claims, gather evidence, debate with each other, compare their answers with others in the field, and attempt to look for patterns across their results. Scientists are engaged in argumentation—at the very core of science activity is scientific argument. Having completed this process of argument, scientists then prepare their written reports for publication.

While a great deal of work has been done on examining the strategies required by teachers to be successful when using inquiry, there are still two areas of concern. The first is that there has been a lack of emphasis on argumentation; the second is that there has been very limited or almost no focus on language and science. To address these concerns, Carolyn Keys and Brian Hand in 1997 developed the Science Writing Heuristic (SWH) as an approach to use in school classrooms (see Figure 1.1).

The SWH approach consists of a framework to guide activities as well as a "metacognitive" support, or support of thinking and discussion about thinking, to prompt student reasoning about data. Similar to Gowin's Vee heuristic (1981, p. 157), the SWH approach provides learners with a heuristic template or plan to guide science activity and reasoning in writing. Further, the SWH approach provides teachers with a template of suggested strategies to enhance learning from laboratory activities. As a whole, the activities and metacognitive scaffolds seek to provide authentic meaning-making opportunities for learners. The negotiation of meaning occurs across multiple formats for discussion and writing. The SWH process is conceptualized as a bridge between informal, expressive writing modes that foster personally constructed science understandings and more formal, public modes that focus on canonical forms of reasoning in science. In this way, the heuristic scaffolds learners in both understanding their own lab activity and connecting this knowledge to other science ideas. The template or plan for student thinking (see Figure 1.1) prompts learners to generate questions, claims, and evidence for those claims. It also asks them to compare their laboratory findings with others, including their peers and information in the textbook, Internet, or other sources. The template for student thinking also

Figure 1.1. *The Science Writing Heuristic teacher and student templates*

The Science Writing Heuristic, Part I	**The Science Writing Heuristic, Part II**
A plan for teacher-designed activities to promote laboratory understanding	**A plan for students**
1. Exploration of preinstruction understanding through individual or group concept mapping	1. Beginning ideas—What are my questions?
2. Pre-laboratory activities, including informal writing, making observations, brainstorming, and posing questions	2. Tests—What did I do?
3. Participation in laboratory activity	3. Observations—What did I see?
4. Negotiation phase I—Writing personal meanings for laboratory activity (for example, writing journals)	4. Claims—What can I claim?
5. Negotiation phase II—Sharing and comparing data interpretations in small groups (for example, making group charts)	5. Evidence—How do I know? Why am I making these claims?
6. Negotiation phase III—Comparing science ideas to textbooks or other printed resources (for example, writing group notes in response to focus questions)	6. Reading—How do my ideas compare with others' ideas?
7. Negotiation phase IV—Individual reflection and writing (for example, creating a presentation such as a poster or report for a larger audience)	7. Reflection—How have my ideas changed?
8. Exploration of postinstruction understanding through concept mapping	

prompts learners to reflect on how their own ideas have changed during the experience of the laboratory activity. The SWH approach to teaching science includes what can be understood as an alternative format for laboratory reports. Instead of responding to the five traditional sections—purpose, methods, observations, results, and conclusions—students are expected to respond to prompts eliciting question-