NEGOTIATING SCIENCE

The Critical Role of Argument in Student Inquiry

Brian Hand • Lori Norton-Meier • Jay Staker • Jody Bintz

FOREWORD BY WENDY SAUL

HEINEMANN
PORTSMOUTH, NH
Contents

Foreword ........................................................................................................ ix
Acknowledgments ..................................................................................... xiii
An Introduction: It’s All About Learning .................................................. 1

SECTION I Examing Teaching in the Service of Learning ..................... 7
Chapter 1 Introduction to the Science Writing Heuristic (SWH) Approach ................................................................. 9
Chapter 2 What Do We Have to Know? (Theory and Practice) .......... 21
Chapter 3 Teaching Skills Key to the SWH Approach ......................... 35
Chapter 4 Writing in the Science Classroom ........................................... 57

SECTION II Examining the Science Writing Heuristic Approach ......... 75
Chapter 5 Getting Started with the SWH Approach ............................ 77
Chapter 6 Questions, Investigations, and Justifying Claims with Evidence ........................................................................ 93
Chapter 7 Reading and Reflection ............................................................... 133
Chapter 8 Wrapping Up an SWH Unit: The Summary-Writing Experience ............................................................................. 157

SECTION III Examining Our Own Practice .......................................... 171
Chapter 9 Measuring Your Progress ......................................................... 173
Chapter 10 Frequently Asked Questions and Benefits of the SWH Approach ........................................................................... 188

Have a Go! Appendix Overview ................................................................. 197
<table>
<thead>
<tr>
<th>Appendix</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>The Start of Your Journey</td>
<td>198</td>
</tr>
<tr>
<td>B</td>
<td>Your Teacher Voice</td>
<td>199</td>
</tr>
<tr>
<td>C</td>
<td>Aligning Learning and Teaching</td>
<td>200</td>
</tr>
<tr>
<td>D</td>
<td>Negotiating Your Own Meaning</td>
<td>202</td>
</tr>
<tr>
<td>E</td>
<td>Examining Conceptual Frameworks</td>
<td>203</td>
</tr>
<tr>
<td>F</td>
<td>Management vs. Teaching</td>
<td>206</td>
</tr>
<tr>
<td>G</td>
<td>Custom Professional Development Program Design</td>
<td>208</td>
</tr>
<tr>
<td>H</td>
<td>What Do You and Your Students Think About Teaching</td>
<td>209</td>
</tr>
<tr>
<td>I</td>
<td>Student Questions</td>
<td>212</td>
</tr>
<tr>
<td>J</td>
<td>Using Questions to Guide Discussion</td>
<td>213</td>
</tr>
<tr>
<td>K</td>
<td>Making Claims, Providing Evidence</td>
<td>215</td>
</tr>
<tr>
<td>L</td>
<td>Assessing Student Writing</td>
<td>219</td>
</tr>
</tbody>
</table>

References ........................................................................ 221
Index ............................................................................. 223
How can students’ work in literacy support their understanding of science? How can their work in science actually improve literacy skills? These two questions serve as bookends for educators seeking to build curricula—curricula that is intellectually rich, that invites work from students with various abilities and interests, and that enables teachers to do “more than one thing at a time.” While others have sought to build and provide advice on using content-rich reading materials, the authors of Negotiating Science: The Critical Role of Argument in Student Inquiry, Grades 5–10 have instead—and perhaps more effectively—exploited the deep connections between science and writing. For those who value inquiry, these are arguably the most robust and easiest connections to mine, for both teachers and students.

Inquiry, ultimately, is about finding thoughtful answers to questions that matter. In this book—chock-full of sage advice and real examples—teachers learn how to scaffold inquiry. This is not, however, a step-by-step scripted program. Rather, the authors are clear in their commitment to “teaching in the service of learning.” What this means in practical terms is that teachers become more adept at listening carefully to students, interacting with them as they interpret puzzling scientific events, encouraging conversation and written documentation of what has happened, and, most important, helping them identify their claims and evidence. Perhaps more than teaching in the service of learning, this program supports teaching in the service of understanding.

A few key ideas continue to impress me as I work with SWH (Science Writing Heuristic) methods and strategies. First, as the authors insist, I am increasingly convinced that curiosity is essential but not enough—that it is the job of the school to help situate curiosity in what are called the “big ideas” of science. In this sense, it is the teacher’s job to tie the curriculum to curiosity-producing hands-on activities, and tie hands-on activities to the communication of those big ideas. This matrix—
the curricular ties, the hands-on investigations, and the assessment of student understanding—is realized through student explanation.

Reading-based approaches often begin by foregrounding the big ideas of science with chapter previews and a study guide, in a sense making science appear to be a recitation of big ideas. By contrast, in this book Hand, Norton-Meier, Staker, and Bintz begin by challenging students and engaging them in finding out how things work and what works most reliably and best. Once these students are fully engaged in the doing of science, once they have identified questions of interest and import, other literacy opportunities are introduced, from reading books to a variety of summary-producing activities, from writing letters to creating authentic texts that explain in the students’ own words and with their own examples what they have learned.

Those of us in the writing community often talk about “learning to write” as distinct from “writing to learn.” The program described here in fact includes both. In the early stages of the process, writing is used as a way to keep track of ideas, notes, and other forms of documentation to help learners rethink and revise their claims. This is what we call writing to learn, that is, using writing as a way to track ideas and make them explicit, to sort out confusions, and to identify contradictions.

In the writing-to-learn phase of the program students use what they have learned to create a variety of genre-based pieces—from stories to descriptions. In so doing they begin to think about their audience, the level of detail, and the kind of examples a reader might need in order to understand a concept. Interestingly, while writing for a reader with less science experience, our student/scientist/author becomes an expert of sorts and takes on the responsibility of presenting clear ideas in a cogent format.

In this sense as students “write in order to learn” they are, in effect, scaffolding their own understanding and allowing their teachers to check in on their metacognitive processes. And when they develop written documents to be shared in some more public forum, they are offering a demonstration of their summative understanding. Of course, from a teacher’s perspective this offers educators a double benefit: first, the opportunity to assess student thinking in situ as they write to learn, and second, performance-based assignments that can be used for assigning grades.

So let’s return to our two overarching goals—to find ways that literacy can support students’ understanding of science and ways science can actually improve literacy skills. I think we have both in the SWH program. Literacy is used here to enable the doing of science. As students identify questions and posit claims, they are deeply engaged in the authentic processes of meaning making as practiced by those seeking to better understand the physical world. The writing—and later, the reading about the topic they have chosen to explore—functions somewhat like the crumbs Hansel and Gretel left in order to find their way out of the woods; that is, they provide a
record of thinking. Thus, when confused, SWH writing offers students a way to go back when something no longer makes sense or they have lost their intellectual bearings. This is precisely what real scientists do. They make claims and seek evidence to support those claims—and they track those claims and that evidence. But when evidence is not apparent, good scientists need to go back and begin again or pick up from the place that last made sense. It is the writing that allows them to do this.

There is, happily, the added benefit here that actually improves students’ literacy skills. It is through the critical thinking that is triggered and practiced in learning science that students ultimately learn to write and read expository text. Knowing from the inside out, as a writer as well as a reader, how argument—that is, claims and evidence—works is a literacy skill now universally recognized as essential. This is the goal of real reading, writing, and speaking and, finally, the gift of real science. I am grateful to the authors of this volume for making these gifts available to science and literacy teachers, but most important, to all of our students.

—Wendy Saul
Examining the Science Writing Heuristic Approach

With the theory laid out in the first four chapters, it is now time to examine closely the components of the SWH and how these components lead to a learning approach that puts teaching into the service of learning. The next chapters break down the SWH approach into the parts that make up the whole learning experience.

We often talk about the SWH as a “lens” through which to take a look or a new perspective on your science teaching and the learning of your students. It is not a tool kit of strategies but rather a way of thinking based on the theory and philosophy of learning that you just read and experienced in the first section of this book. Now it is time to delve into the SWH process. Get ready to dig deeper into your own teaching and learning experiences. Put the book down and walk away when frustrated, but keep thinking and processing. As you argue and wrestle with these ideas, listen to your students and ask them to join you in this process of examining teaching in the service of learning.

In this section, we will take you through the SWH process:

❖ Getting started with your first SWH unit in Chapter 5
❖ Learning to use Questions, Claims, and Evidence in Chapter 6
❖ Using Reading and Reflection to energize thinking in Chapter 7
❖ Wrapping up a unit with the summary-writing experience in Chapter 8

HAVE A GO!

Professional development often produces a less-than-positive response in teachers. Often we are forced into the current required meeting sessions that usually wouldn’t be what you would choose to do with your time. Section I is very theoretical and hopefully made you think about teaching and learning in deeper, fresher, and unique ways. Have a go at describing what you would want in a professional development program in Appendix G.
Figure II.1. Students examining forces as they answer their questions using the SWH approach.
Teacher’s Voice

One teacher’s thoughts: I really want to examine the beginning of the whole process. I’d like to give up the ownership of providing the kids the guided inquiry. I used to go that way to be safe so that we could focus on what I thought would be more valuable. I really want to get the students mature enough to be able to start right off the bat with their own questions.

The first four chapters have set the foundation needed for transitioning to a learner-centered classroom where teaching shifts to focus on learning. When considering the changes necessary to implement the SWH approach effectively it could be easy to view the SWH-related learning processes as only slightly different from what has traditionally happened in science classrooms. However, nothing could be further from the truth. The orientation of the classroom, planning, questioning, and management take on radically altered forms in such a setting. In an SWH research study, a student in anonymous interviews commented on her view of the change in classroom culture prompted by the SWH process (see the “From the Students” below).

From the Students

I don’t like the SWH. Before, I was always the top student. I know how to play the game and score well on tests. Now the rules have changed. It isn’t about playing the game, it is about learning, and I have to work just like everyone else. Just memorizing doesn’t work anymore and I have to work at this.
The next three chapters will guide you through the implementation of the SWH approach from start to finish. But make no mistake: The changes called for in this text are difficult to achieve and will necessitate honest self-assessment about your own content knowledge and teaching practices, the learning environment you create in your classroom, and your beliefs about learning and teaching. This is not your traditional science class, it is not your traditional science teaching, and it is not your traditional science learning. This is a process that builds from what students already know to a conceptual understanding of the big ideas of science. Let’s take a look in this chapter at the following questions:

1. What is the SWH?
2. Why should I use the SWH?
3. How do I start using the SWH?

What Is the SWH?

The Science Writing Heuristic is an approach used in science classrooms that actively encourages students to negotiate meaning both privately and publically, creating a learning environment that is rich in opportunities for argumentation and learning. The process uses argumentation as the center where learners must build a conceptual understanding of whatever concepts are being studied and defend their ideas in a public setting. Sound familiar? It should. This is the process of science. Scientists explore their questions and must defend their ideas about answers with their colleagues and the scientific community.

While the SWH approach can be seen as a series of templates, teacher, and students, it is much greater than that. The resemblance to a traditional lab write-up is superficial. The approach reaches across curricular areas and incorporates language, reasoning, argumentation, and critical thinking. In the primary and elementary grades the opportunity exists for the SWH approach to reach across all classroom activities, whereas in the secondary classroom the teacher has to be oriented to make those connections and opportunities. Developing these connections is a critical component to the approach, and finding other faculty that will make those connections with you enhances the science learning. For the connecting faculty, this approach will also strengthen student reasoning, literacy, numeracy, and the elusive but continually sought-after critical thinking.

The actual heuristic is a structure that helps students develop a deeper understanding of the big ideas of science. When considered in its entirety, students develop and test questions, justify their claims with evidence, compare their ideas with others,
and consider how their ideas have changed throughout the process. At the conclusion of a series of SWH experiences focused on big ideas of science, students write about their learning not only to communicate with others but also in the spirit of a writing-to-learn experience.

Unit Planning Using the Science Writing Heuristic (SWH)

The graphic in Figure 5.1 represents the structure that forms the foundation for the SWH experience. Notice the unit is planned around a big idea of science; the first thing that happens in the classroom with students is the assessment of their prior knowledge. As students move through the process, they engage in a series of SWH activities, with each experience generating questions to guide the next. The final step in the process involves a summary-writing experience.

The framework in Figure 5.2 outlines the SWH process that guides students to examine their thinking and test their ideas as they move throughout the unit. While seven steps are listed to steer students through the learning process, the order and flow may be altered to meet student learning needs. Remember that the learner is in control of his or her learning and the process should align with the students’ learning needs. The open nature of the circles in the model in Figure 5.1 is meant to represent this flexibility.

The SWH in Figure 5.3 allowed the students to explore the problem and put their claims and evidence down on paper. Even though the claim is faulty, it will move the learning forward. With questions and just-in-time teaching the teacher can use this SWH experience to move learners forward and help them construct a more accurate understanding of the big idea here. Teachers often will tell students the correct answer. Providing correct answers doesn’t make students correct their conceptual framework to match the teacher’s conceptualization. Incorporating new information into a student’s conceptual framework isn’t that easy, and you as teacher providing information probably isn’t enough to produce a shift in learning. If students are at the point of frustration, providing information to keep them engaged is warranted at appropriate times, but the information-provider model of teaching doesn’t align with the SWH approach.

In this case the teacher chose to tell the students that they were wrong, but a simple question in the process would have been powerful. “Aren’t these times basically the same? Is the mass making a difference?” These questions, asked either by teacher or other students, are part of the negotiation process and the construction of meaning.
The large circle represents the unit. The big idea is the beginning point for the unit and the rest of the process flows from that big idea. Student understandings of the big ideas are assessed and then the unit flows from that assessment through the SWH experiences and a summary-writing experience leading to the final assessment.

**Figure 5.1.** Graphic representation of the flow of an SWH unit
**The Science Writing Heuristic**

<table>
<thead>
<tr>
<th>Name</th>
<th></th>
</tr>
</thead>
</table>

1. **Beginning Ideas:** What questions do I have?

2. **Tests:** What did I do? (How did you test to answer your questions?)

3. **Observations:** What did I find? (What did you find when you tested?)

4. **Claims:** What inferences can I make? (Explain what you think happened.)

---

The Science Writing Heuristic

5. Evidence: How do I know? (Justify your claims by providing evidence for them.)

6. Reading: How do my ideas compare with those of others?

7. Reflection: How have my ideas changed?
Why Should I Use the SWH?

The SWH is a process that is consistent with what research tells us about learning and effective teaching. The SWH approach brings together inquiry, reading-to-learn strategies, writing-to-learn strategies, and classroom discourse into an intentional and student-centered process for developing understanding of the big ideas of science.

The evidence of the impact of the effective implementation of the SWH approach on student learning has been very encouraging. The effective implementation of the SWH increases all students’ conceptual understanding of the big ideas of science as measured using student responses to open-ended questions and increases the achievement of all students on standardized assessments. Even more significant is how the effective implementation of the SWH approach closes the achievement gap—it has a greater impact on traditionally low-achieving students. For more details, see Chapter 10.

From the Students

The following student work sample is from an SWH-focused pendulum motion addressing the big idea that the acceleration of the object is not a factor of mass. Note how the student recorded questions and described the tests and observations using a combination of common language and scientific vocabulary. The student constructed a claim and then supported the claim with evidence. In the reading section, there is no indication of the source(s) and the student reported that his or her ideas compared with the class but were wrong. The students worked through the process and their prior conceptions influenced their claims and evidence. The times for all masses as noted by the teacher are nearly the same, yet the student claim indicates that the mass makes a difference in the energy and the evidence is the comparisons of time. This SWH allowed the teachers to really see the class’s conception of acceleration due to gravity. Also note that the sample shows evidence of scoring by the teacher.

continues on next page
Figure 5.3. Student example of the SWH process

Science Writing Heuristic Template

Name

Hour Period E
Date 1/15/92

Science Writing Heuristic Lab:

1. Beginning ideas...What questions do I have?
   How does Iu
   How does energy cause motion?

2. Tests...What did I do? (How did you test to answer your questions?)
   We swung the pendulum to see how long it took for it to swing back and forth 10 times. And we kept adding more weight. Our string was one meter long and we dropped the weight from table height.

3. Observations...What did I find? (What did you find when you tested?)
   \[
   \begin{align*}
   100g & : 20.47 \text{ sec} \\
   200g & : 20.59 \text{ sec} \approx 0.49 \text{ sec/p} \\
   300g & : 20.38 \text{ sec} \approx 0.49 \text{ sec/p} \\
   400g & : 20.70 \text{ sec} \approx 0.48 \text{ sec/p}
   \end{align*}
   \]
   Actually, all pretty much the same.
   Do we know gravity causes all mass to accelerate same rate.
Figure 5.3. (Continued)

4. Claims... What inferences can I make? (Explain what you think happened.)
   The more mass the less energy you have and the less mass the more energy you have.

5. Evidence... How do I know? (Justify your claims by providing evidence for claims.)
   I think this because when 100g was on the pendulum it swung 10 times in 20.47 sec and when 400g was on the pendulum it swung 10 times in 20.70 sec.

6. Reading... How do my ideas compare with others?
   when we compared with other people we all agreed on the same claim but it was wrong.

7. Reflection... How have my ideas changed?
   I learned the more mass the more energy and the less mass the less energy.
Teacher’s Voice

From my perspective, we have been working hard to develop an inquiry approach to our science curriculum and we lacked the means to effectively evaluate and write up the lab experience. The traditional lab write-up was inadequate. From the SWH experience, I saw much more investment on the students’ part in the inquiry process. They understood that they were writing their thoughts down and they were keeping track of their questions and the tests they ran instead of me always assuming the students could hold that in their minds and then produce the final report or final work. So, I liked the SWH approach and the way students took an active view of work in progress, the heuristic format, journaling, and the writing that I saw taking place.

I think that manifested in the interviews. When I give students a lab and they follow Step 1, Step 2, Step 3, even if I encourage them to branch from there with their own technical question and their own experiments, they often asked “What are we doing this for? What are we supposed to learn from this? What does this have to do with the chapter?” Those would be the kinds of questions or comments. When the students were engaged in their own SWH process they knew what they were doing it for because they had ownership. They sought a link to acceleration that they understood. I know that took some teacher guidance and some scaffolding questions but they engaged because they owned the work—it was theirs, not mine.

The SWH approach also creates a pattern of reasoning that is embedded in a structure of argumentation. Learners in the SWH approach have two roles: construct knowledge and critique knowledge in the argumentation process (Ford, 2008). This approach is more than just the practice of knowledge construction in science. The roles learners engage in are the very foundation of reasoning, critical thinking, and engaging with new ideas and information. These roles within the approach are the basic building blocks of all knowledge construction, not just science.

How Do I Start the SWH?

The SWH begins with you:
❖ your ideas about teaching and learning,
❖ the classroom environment you create with your students,
❖ the unit planning you do for the students.
Given the importance of beliefs about teaching and learning to the successful implementation of the SWH approach, think about how you have responded to the following questions related to the work you did in Appendix A, C, and D:

What is learning?
What is teaching?
How do you like to learn?
How do you like to teach?

You may have struggled with the complexity of these questions. As you consider your responses, examine whether there is a disconnect between how you like to learn and how your classroom is structured. Remember, you construct the learning environment, and your ideas about teaching and learning will impact whether and how well you implement the SWH approach. Your ideas about teaching and learning should align with how you structure your classroom in general and how you implement the SWH in particular. As you begin the process, work to align the classroom with the learning and teaching concepts you developed and strengthened in Section I.

Did you find their answers interesting? Some examples of student responses to these questions are listed in Figure 5.4.

How do these responses match your classroom? These answers indicate a very sophisticated understanding of how we “do school.” Traditionally high-achieving students often are adept at describing a traditional model. Their success has been predicated upon their ability to understand that model and excel within that learning environment as voiced in Figure 5.4. When implementing the SWH approach, preparation is critical to a much greater degree than in traditional lesson planning because the teacher doesn’t predetermine the learning path. Instead, the learning path is a product of individual learners, small groups of learners, and the class as a whole. If they choose a direction that wasn’t anticipated or planned for it can be very disconcerting for the teacher. In this kind of learner-centered classroom, the teacher needs to be flexible while maintaining a focus on the intended learning goals framed by your student learning standards.
Starting with a well-thought-out personal conceptual framework around the big idea will allow you to maintain flexibility and focus. Consider your own understanding of the content. A teacher concept map is an excellent place to start. The core of the content is based on your standards or grade-level expectations. You have a curriculum that you are responsible to teach that includes standards. This approach isn’t asking you to change your curriculum, just how you teach and support your students’ learning of that curriculum.

From there, your own concept map can provide a concrete guide to learning no matter where the students begin and no matter what learning path they choose to build their own understanding. In Figure 5.1 the process starts with assessing students’ prior knowledge about the big ideas of the unit. A strong concept map that shows your understanding of how the ideas in the unit are connected provides a map for learning as well. When students reveal their prior knowledge on the topic, the map then can serve as a guide to you to help take them along the path of constructing a more complete understanding of the big ideas of your unit.

From the Students

Figure 5.4. Student answers to what is teaching and learning (generated by students who have not had SWH training)

#1: Explain what learning is and support it:
Learning is the gaining of knowledge of subjects. For example, a student learns from watching and listening to what a person says and does.
Learning is figuring out new things to help you in the future.
Learning is receiving knowledge not known before, such as learning how to draw an object to scale using proportions.

#2: Explain what teaching is and support it:
Teaching is sharing the knowledge that was learned. For example, information is shared and given to students for the students to learn.
Teaching is passing on knowledge to someone else. For example, a teacher taught us how to draw an object to scale.
Teaching is imparting knowledge upon another individual.

Starting with a well-thought-out personal conceptual framework around the big idea will allow you to maintain flexibility and focus. Consider your own understanding of the content. A teacher concept map is an excellent place to start. The core of the content is based on your standards or grade-level expectations. You have a curriculum that you are responsible to teach that includes standards. This approach isn’t asking you to change your curriculum, just how you teach and support your students’ learning of that curriculum.

From there, your own concept map can provide a concrete guide to learning no matter where the students begin and no matter what learning path they choose to build their own understanding. In Figure 5.1 the process starts with assessing students’ prior knowledge about the big ideas of the unit. A strong concept map that shows your understanding of how the ideas in the unit are connected provides a map for learning as well. When students reveal their prior knowledge on the topic, the map then can serve as a guide to you to help take them along the path of constructing a more complete understanding of the big ideas of your unit.
This also includes finding out what students already know about the concepts to be learned as a significant part of the planning. Students come to the classroom with lots of ideas—they have a conceptual framework that is built from prior experiences and knowledge—about the big ideas. We need to think about what these frameworks might look like before the unit begins in order to deal with the range of student ideas.

As you think about the various learning paths that might be chosen by students, you will also want to consider what is possible in your classroom with the available materials and equipment. You may choose to “seed” the questions that will likely be asked by putting equipment out on tables that could be used in an investigation into the big idea. You might also choose to set up a demonstration or stations to prompt student questions. Even with these prompts, students will choose their own paths. For example, they might test mass before speed, or pH before temperature, or surface area before weight. Your challenge is to consider the range of possibilities and be prepared to support students in finding the answers to their own questions.

Another challenge is to guide them through the use of scaffolding. Students may generate a question that involves many different variables. Help them think about where to start with their investigation. Some of the questions that they ask may be more easily researched than tested. In this case, you’ll want to be prepared to help them find the experts or text resources to “investigate” or help them think outside the box and look for ways that they might build models or run tests with the available equipment. They may surprise you with their creativity.

Considering student learning standards raises the issue of “covering the curriculum.” You as the teacher are required to cover your curriculum and likely “prepare” students to do well on standardized assessments. When using the SWH, the preparation looks different. Rather than focusing on covering facts and memorizing vocabulary, the focus is on the students’ development of conceptual frameworks. This development will require students to examine their own thinking and test their ideas.

Models of Unit Plans Using the SWH Approach

The following table shows alternatives used by four teachers as they used the SWH approach to teach a unit on ecosystems. The table represents the pathways the teachers followed through the process. Keep in mind, there is no one right way to do this. The following chart is meant to illustrate for you the multiple paths that a teacher can take to help individual learners develop the frameworks necessary to understand the big ideas of the unit.
### SWH Tool

**Unit Concepts (or “Big Ideas”)**

<table>
<thead>
<tr>
<th>Unit Flow</th>
<th>Teacher 1</th>
<th>Teacher 2</th>
<th>Teacher 3</th>
<th>Teacher 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Planning</td>
<td>Teachers complete their own concept map</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beginning point for unit</td>
<td>Teacher poses questions about topic</td>
<td>Teacher provides topic and students build concept map as individuals, in small groups, and as a whole group</td>
<td>Students work in small groups to research biomes and make presentations</td>
<td>Teacher provides the topic</td>
</tr>
<tr>
<td>Assessment of prior knowledge</td>
<td>Teacher to assess students' prior knowledge and gives pretest to assess prior knowledge</td>
<td>Concept maps are used to assess students' prior knowledge</td>
<td>Presentations used to assess prior knowledge</td>
<td>Student-generated questions and student dialogue are used to assess prior knowledge</td>
</tr>
<tr>
<td>Teacher planning</td>
<td>Adapting of activities and materials to student needs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question generation</td>
<td>Student questions are based on what they want to know</td>
<td>Habitat study in the park using a transect technique is used as lead-in to students generating questions</td>
<td>Student questions are generated based on presentations</td>
<td>Students work in small groups and pose questions about the topic</td>
</tr>
</tbody>
</table>
### SWH Tool

**Figure 5.5. (Continued)**

<table>
<thead>
<tr>
<th>Unit Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple SWH activities emerge to address student questions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teacher 1</th>
<th>Teacher 2</th>
<th>Teacher 3</th>
<th>Teacher 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWHs are varied based on student questions; each student or group of students will do tests to answer their questions</td>
<td>SWHs are based on variation of the transect technique and questions are tested in park</td>
<td>SWHs are structured based on research in written materials to determine what is in an ecosystem</td>
<td>Teacher and students work together to plan tests based on student questions; SWHs are based on students’ questions about balanced systems and habitat destruction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summary-writing task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students create a biome proposal and present it to peers; peers evaluate the proposal and accept or reject it based on student-generated criteria</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Controversial topic: persuasive argument or position paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students respond to speculative questions (e.g., What will happen if...)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Public service announcement about ecosystems and habitat destruction</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Unit Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit assessment including conceptual questions</td>
</tr>
</tbody>
</table>
Teacher’s Voice

I think benefits of using the SWH approach include that it breaks the classroom out of a traditional model of teacher-to-student learning. Their world has now changed and it’s not something that they have always done. This makes them approach their learning with a “new vision,” so to speak. Also, they have to invest some of themselves into the process, which is the difficult change for my students. Having to invest of themselves into their intellectual path as active participants who have questions or claims and evidence they had to defend in public with their peers was uncomfortable in the beginning. And the idea that they have to really build an argument and see if that argument will stand in comparison to classmates and their work is both threatening and satisfying. Our ideas are just that, our ideas, and we get a great deal of satisfaction when our ideas can stand on their own. I think those are the biggest issues. Some side issues are just the idea of you and your students negotiating your way through and fighting with each other to come to some kind meaning, or their egocentric hold onto their ideas or set of ideas and defending them until they either give up or see a better solution can create a classroom that is energized and students leave exhausted from the challenge of all this.

Revisiting the Big Idea

To successfully implement the SWH approach, you must examine your beliefs about learning and teaching, content knowledge, teaching practices, and classroom environment with an emphasis on change. Planning is critical as you think about your own conceptual framework as well as consider the range of ideas students will bring to the classroom around the big idea to be addressed in the unit. The SWH is an iterative process that begins with a focus on a big idea of science, involves assessment of students’ prior knowledge, helps students examine and test their ideas through multiple learning experiences, and ends with a summary-writing experience. The effective implementation of the SWH has yielded strong gains in learning as measured using student responses to open-ended questions as well as in student achievement on standardized tests.

Using the SWH approach means that you and your students will need to change the way that you “do school” in your classroom. Skills at classroom negotiation are critical to affecting this kind of change and the creation of a learner-centered classroom.
Thank you for sampling this resource.

For more information or to purchase, please visit Heinemann by clicking the link below:


Use of this material is solely for individual, noncommercial use and is for informational purposes only.