Implementing Science Notebooks *in the* Primary Grades

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Abstract. In this article, the author details the process teachers can use to teach primary-age children how to use science notebooks. To lay the foundation for using notebooks, the author describes important elements of science notebooks and makes a distinction between science notebooks and journals. In addition, the article highlights the benefits associated with using notebooks. Finally, connections are included to the National Science Standards, as well as supporting resources for teacher use.

Key words: primary students, science writing, journal, notebooks

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A gentle storm swept through New Hanover County Elementary Schools in the fall of 2000. Unlike the usual hurricanes to which this southeastern North Carolina county has become accustomed, this storm came in the form of science reform using inquiry-kit-based instruction. In the eye of the storm were the children who were benefactors of this strong and engaging science, a science that not only is "hands-on," but "minds-on," as it inspires and prepares children for the future.

The science program is known throughout the county as "SciFi" (Science Centered Infrastructure for Inquiry). Although research-based kits are the focal point of the program, local educational agencies, the University of North Carolina at Wilmington, and the North Carolina Department of Public Instruction have contributed greatly to the success of the program. The program has developed a science notebook component to enhance student achievement in writing as well as other curricular areas.

In this article, we will present the rationale for using science notebooks, explain what a science notebook is, describe how to help primary students use notebooks, and discuss how to assess notebooks.

New Hanover County Schools have focused on using science notebooks as part of their reform movement for a number of reasons. First, the use of science notebooks increases scores on standardized tests, which is becoming increasingly more appealing as high-stake accountability programs are implemented nationwide. There are startling results on student achievement when an active science program that includes science notebooks is implemented. Student achievement in science, mathematics, reading, and writing is greatly improved (Klentschy, Garrison, and Amaral 1999). Having experienced the active science program for 4 years, fourth graders in El Centro School District more than doubled their scores in science and reading and almost doubled their scores in mathematics. Even more astonishing, after experiencing the program for 4 years the sixth graders' writing scores almost quadrupled.

Although there is value in increasing student achievement on summative evaluations, perhaps the most powerful assessment data is that which is formative in nature. Therefore, the second reason for using science notebooks is to provide feedback to teachers about their instruction to students through an authentic record of each student's thinking. Formative assessment data is evaluation done within instruction for the purpose of informing instruction. To grasp whether students can effectively design and execute an experiment and then gather and analyze data, alternative forms of assessment are needed. The following statement is illustrative of the need for alternative ways to assess students'scientific abilities:

> Assessing science through paper-and-pencil tests is akin to assessing a basketball player's skills by giving a written test. We may find out what someone knows about basketball, but we won't know how well that person plays the game. (Hein and Price 1994, 100)

Data from science notebooks provide the teacher with a true record of each student's thinking and level of understanding over the course of the investigation. This information can prove to be extremely insightful as teachers begin to understand how each student thinks, where their strengths and weaknesses lie, and why they make the mistakes they make. This information should be used to improve classroom practice, correct misconceptions, and guide the student toward developing a deeper understanding of content. What is even more powerful is that content knowledge may span several disciplines. The science notebook can be used as a tool to measure students'understanding of a variety of areas including, but not limited to, science, mathematics, and writing.

The third reason for using this strategy is because real scientists use science lab books. Science notebooks have long been an integral tool that scientists use when conducting their scientific investigations. Scientists use lab books to record data and their thoughts about data, to draw images that represent their ideas, to formulate questions, and draw conclusions. Individual in nature, their notebooks help them make sense of their investigations and reflect thoughts, trial-and-error experimentations, data, drawings, charts,and graphs. This process of recording information provides a format for scientists to organize their thoughts,confront and formulate what they believe or do not believe, and form conclusions. For example, if we look at some of Darwin's early notebooks we can see him formulating his ideas of evolutionary change. His early lab books have a reoccurring drawing, a tree-like image that represents nature. In addition to the drawings, Darwin included an explanation of his thinking about the drawings over time. See http://www.uwe.ac.uk/fas/wavelength/wave21/gooding.html for an entry in Darwin's notebook as well as notebook entries from other scientists. Science notebooks also provide scientists with a way of telling others about their findings and conclusions, and unless scientists can share what they have learned, their efforts are fruitless.

What Is a Science Notebook?

Science notebooks and journals are often terms that teachers use interchangeably and many teachers consider them to be the same. Although they do share some characteristics (e.g., both include questions and are creative), they also differ a great deal (See Figure 1).

Whereas science notebooks focus on the more structured type of writing that accompanies the scientific method and the use of science process skills, journals emphasize a more free-form type of writing that often expresses feelings and is found in literature reflection, fiction, and poetry. Therefore, although it is important for students to learn how to use both types of writings, they should be distinguished from each other and kept in their respective book types.

How to Help Primary Students Use Notebooks: A First-Grade Teacher's Diary

This section focuses on how I use science notebooks with my primary-age students (see Figure 2). The first thing I do as a first-grade teacher is to introduce the idea of keeping a science notebook by reading books such as *Let's Experiment* (Lunis and White 1999) and *Being a Scientist* (Lunis and White 1999).

After using a circle map to generate a list of what students know about what a scientist does, I discuss each idea and guide students to a specific list that may include ideas such as, Scientists... Record the date and time, ask questions, make predictions, observe and record what they learn. I post this list for easy referral (see Figure 3).

Next, I set the stage for the science experiment by conducting a minilesson on asking questions. For example, during a unit on pumpkins, I allow the children to freely explore pumpkins, meaning they can do anything within reason to the pumpkin. At the same time, I encourage them to generate as many questions as they can. I collect all of their questions. Often many of their questions can be investigated.

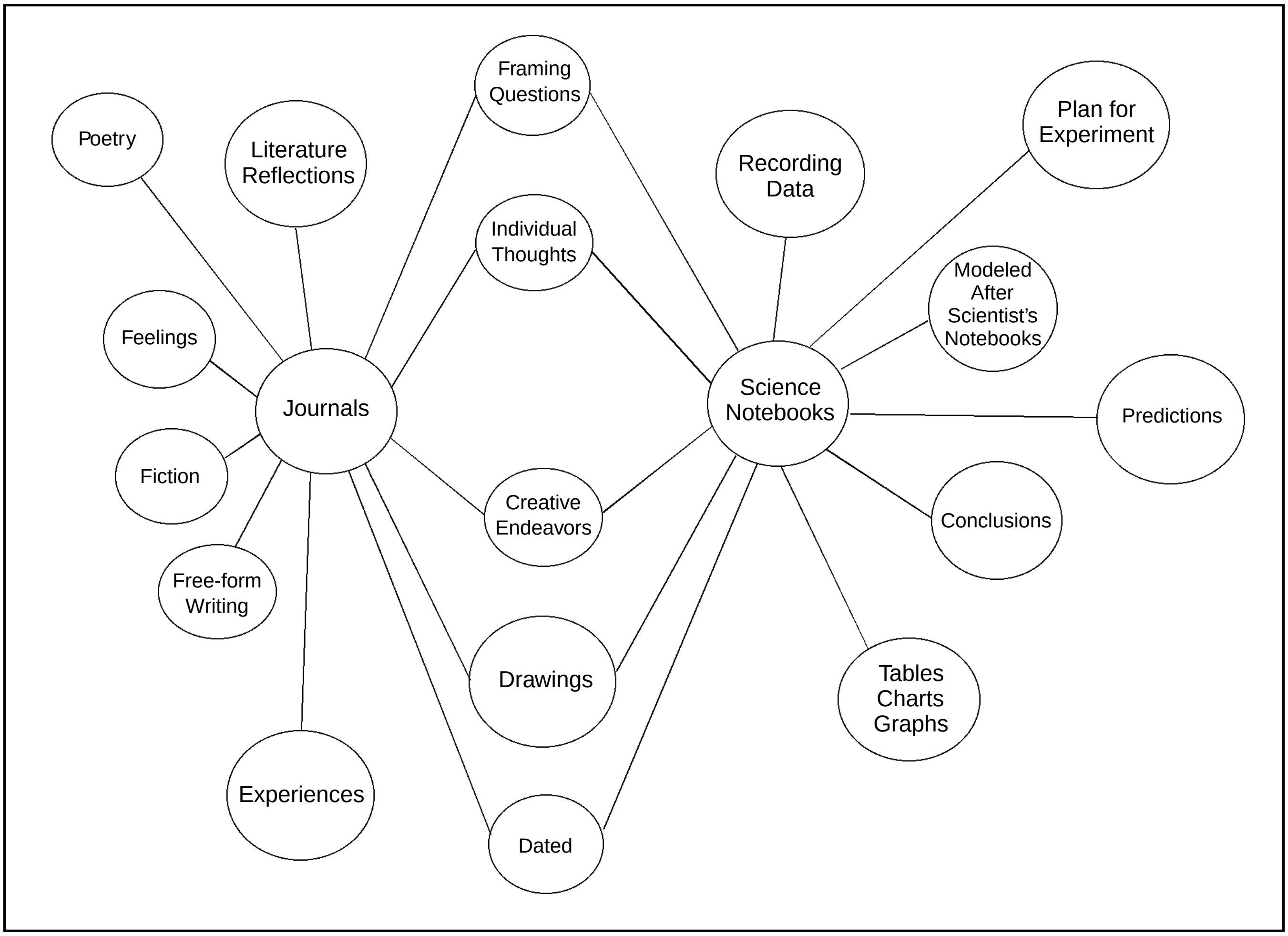

Figure 1. Bubble map comparing and contrasting journals and science notebooks.

The investigable questions are those where students are able to find answers to the question by manipulating materials. Often these investigations involve students in measuring or observing phenomena. These questions can be "What if" type questions. Some examples of investigable questions are: What if I cut the pumpkin open, what will I find inside? What if I cut larger pumpkins, will they have more seeds than smaller pumpkins? Many times students ask questions that cannot be investigated such as, "Why is the pumpkin orange?" "Why is the pumpkin heavy?" When this happens I help them when possible to reword these questions so they can be investigated. For example, when they ask the noninvestigable question, "Why is the pumpkin heavy?" this opens the door for me to guide them in constructing an investigable question, "Will pumpkins float when placed in a tub of water?" The process of creating an investigable question takes a great deal of time and skill on my part because it is very important that students still have ownership of the questions when questions are changed.

At this point, the class is ready to be introduced to science notebooks by creating a class-sized notebook. I take ten or twelve 18 in. x 24 in. drawing papers and staple them together. By using the circle map describing what a scientist does as a reference, I introduce the science notebook and remind students that we are also scientists; therefore, we need to keep records of our experiments. The first thing we do as scientists is to write our name, the time, and the date in the upper right-hand corner. Then we write the **question** that the students generated, which in this case is "Will pumpkins float in a tub of water?" Together, the students and I make **predictions**. When predicting whether a pumpkin will float, often students say it will not float because they think it is too heavy. We then discuss the materials that will be needed to answer the question. The next entry in the notebook tells **What We Did**. In this section, we both write a procedure and draw pictures showing what we did with the pumpkins. I always stress that each part of the drawing needs to be labeled with clear, precise language.

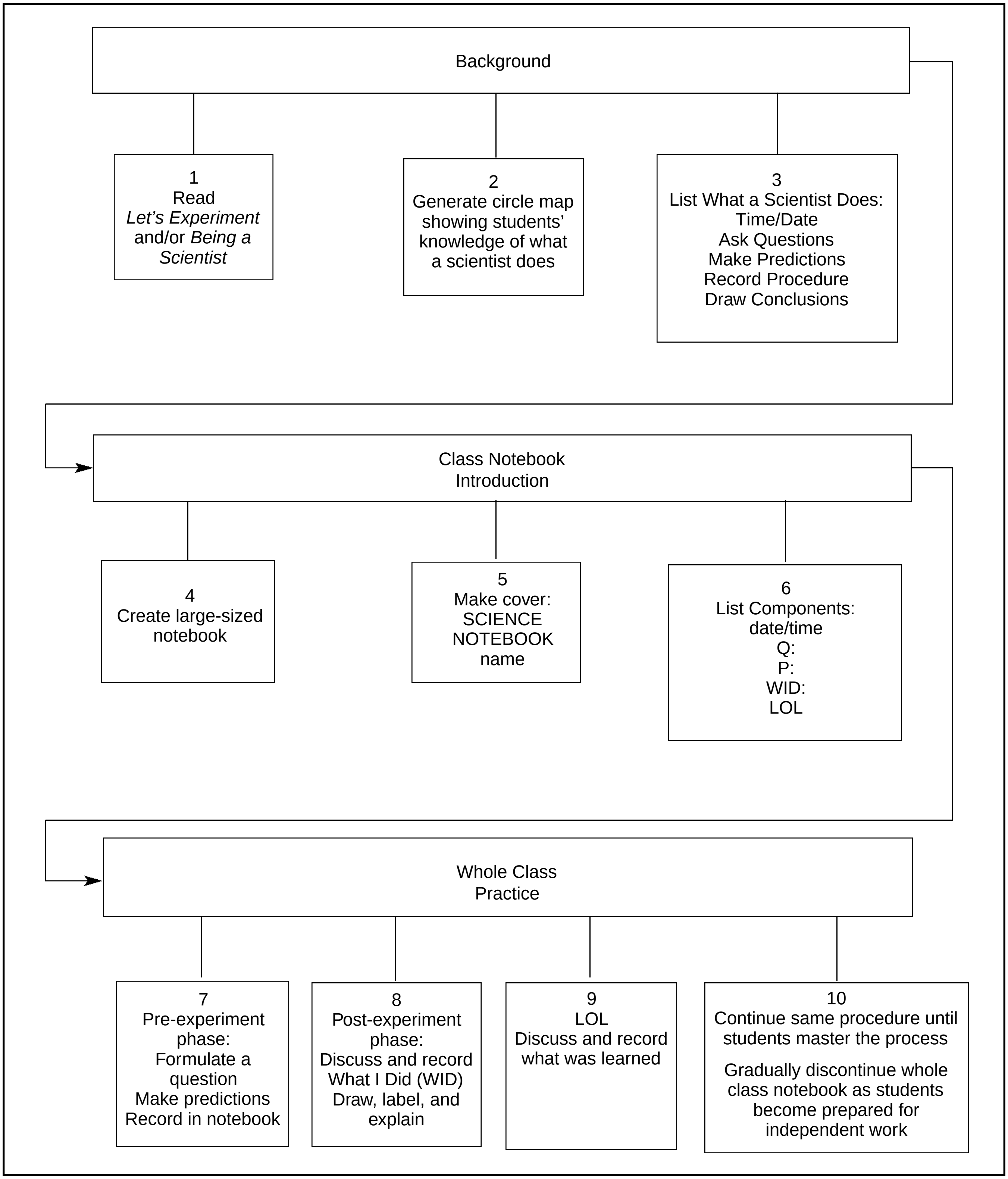

Figure 2. Flow chart detailing the process used to teach primary-age children how to use science notebooks.

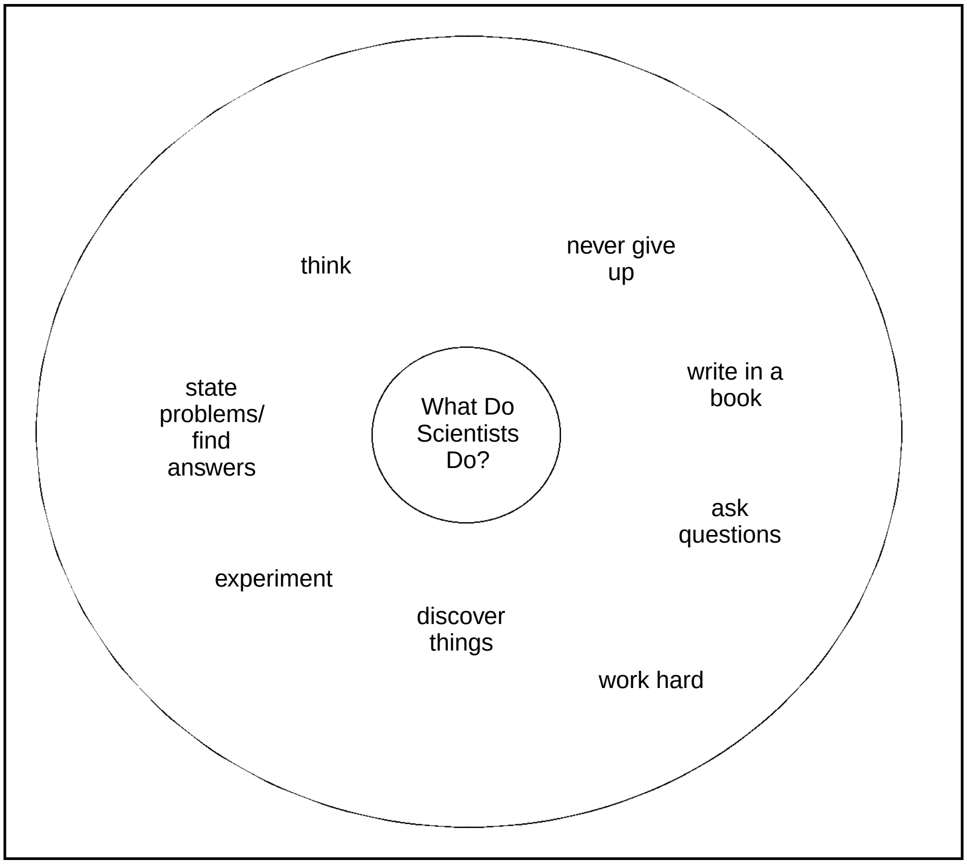

Figure 3. Circle Map illustrating what scientists do.

The procedure section often is difficult for primary-age students because they do not know how to control variables. My job is to guide them in performing a fair test in which they investigate one variable at a time while holding other variables constant. For example, if the students are investigating whether the size of the pumpkin affects its floating ability, all other experimental variables remain the same such as amount of water, container, temperature of the water, etc. The only variable that is changed is the size of the pumpkins.

Finally, we are ready for the **Line of Learning (LOL)** section. Here students summarize what they learned about floating pumpkins. At this point,more questions usually are generated, and we often use these questions as stimuli for other experiments. During this phase of the investigation, I often give the students additional content information on the topic we have been investigating. A sourcebook I find particularly helpful in keeping me informed and up-to-date on my content is *Science for the Elementary and Middle School* (Victor and Kellough 2000).

The process of setting up a science notebook can be a major challenge for many primary-age students, so I simplify the process for them as much as I can. For example, when students first start writing in their notebooks, the younger students have difficulty writing many words, so I have them simply write the different sections by recording **Q** for **Question**, **P** for **Prediction**, **WID** for **What I Did** and **LOL** for **Line of Learning**. As the students mature, they begin writing the whole words.

I continue to use the class notebooks as we do our experiments until most students have a clear understanding of the process, and then I slowly fade out the whole class entries. At first, I have the students keep individual notebooks by allowing them to copy from the class notebook all of the entries, except one. The first entry I usually have them do individually is the **Line of Learning** section. Although they are writing this section individually, we as a class still discuss what they have learned, repeating key points, and then from this discussion they individually record what they learned from their experiments in their own notebooks. As they are doing their individual work, I am constantly monitoring and guiding them by asking questions. This process of allowing the students to write their own sections continues until students are doing all sections independently. Figures 4, 5, and 6 are examples of 1st graders'notebook entries.

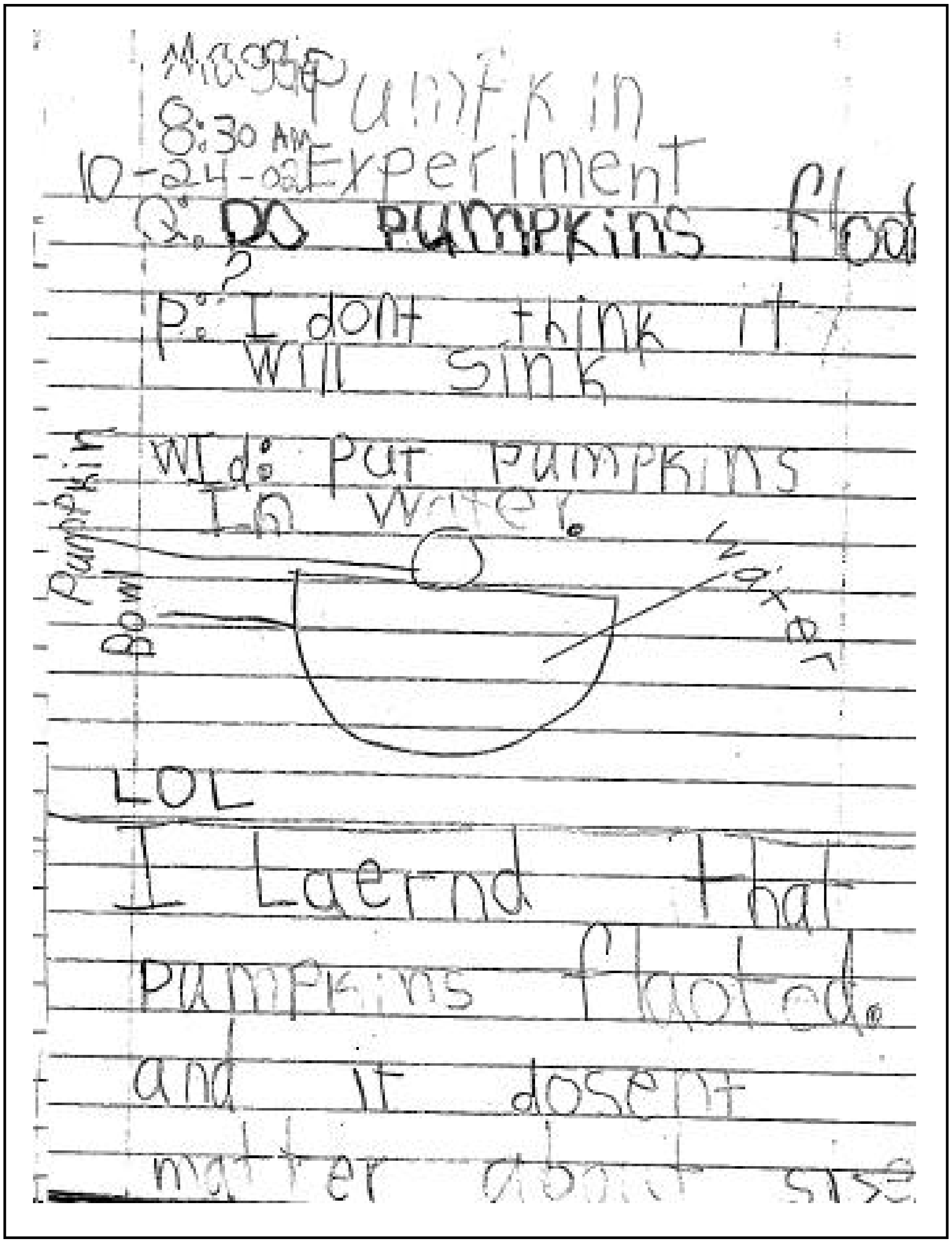

Figure 4. Example of notebook entry written by a 1st-grade student.

How to Assess Notebooks

There are several important considerations related to the assessment of science notebooks. First and foremost, it is important to remember that the science notebook ultimately belongs to the student. It is their authentic record and should be revered as a personal document. For this reason, comments from the teacher should be recorded in a way that is not permanent. One effective strategy for recording on each individual page is to use sticky notes so that students can remove them if they wish. For the teacher wanting a more permanent location for assessment, a small portion of the notebook might be designated (perhaps the last 5 pages) on which the teacher could make evaluative comments. Upon completion of the unit, the student may then opt to remove this section of the notebook.

It is also important that the focus of the assessment be on acquiring knowledge related to the student's level of understanding. The eventual goal of inquiry-based instruction is to foster independence related to designing and executing

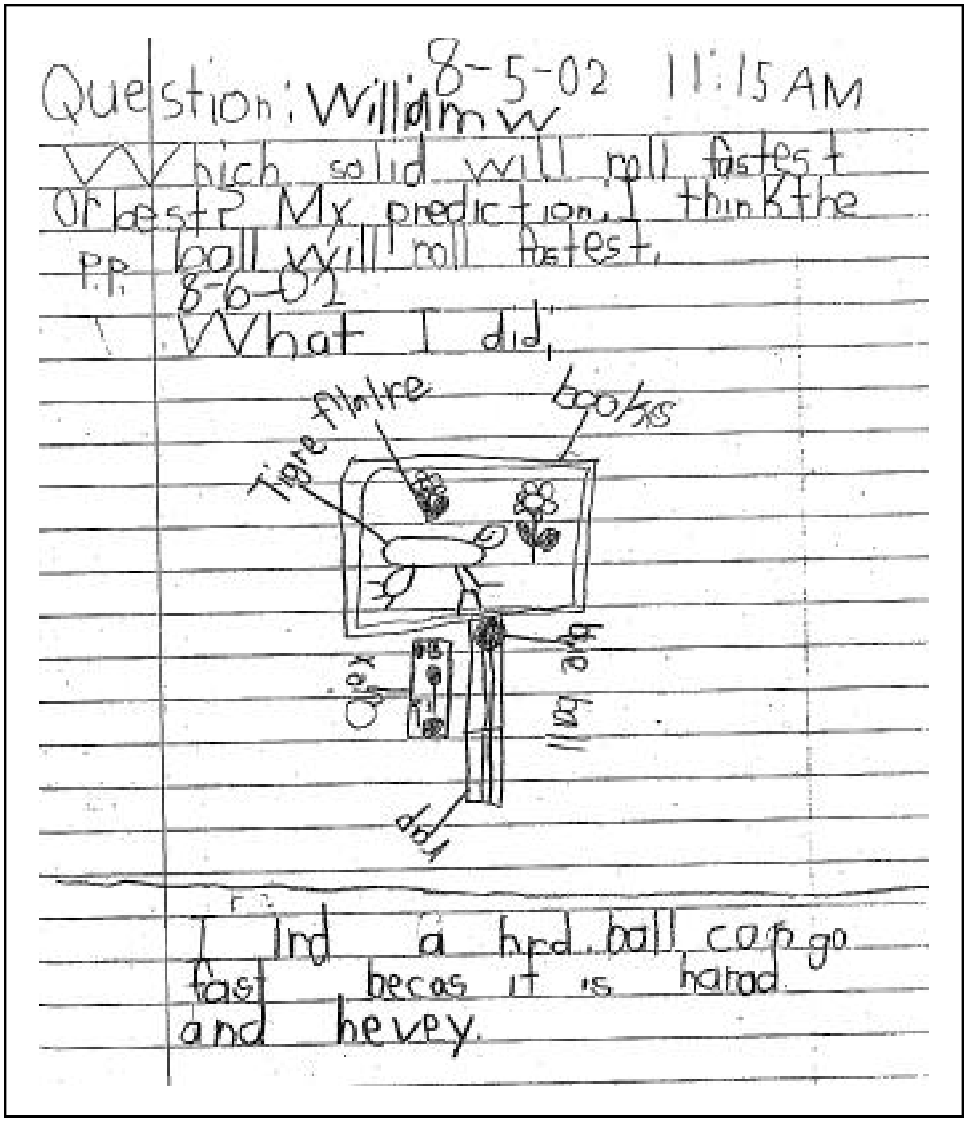

Figure 5. Student notebook entry investigating objects' speeds going down a ramp. Objects used: cork, marble, ping pong ball, steel ball, button, cup lid, and washers.

scientific investigations. Naturally, the teacher will provide appropriate scaffolding in the early grades and at the beginning of a new course. Being cognizant of whether or not students are developing this level of independence is important to successful implementation of a science notebook program. Rubrics can be an effective tool for articulating where a student is functioning on this independence continuum. According to Shepardson and Britsch (1997), the rubric should contain between four and six performance levels. Explicit criteria for each level along the continuum should be provided so that students understand what is expected. To this end, it is always a good idea to make the rubric available to students and parents before students even begin to use the science notebook. If possible, it is also helpful to provide students with samples from each performance area. These samples should include exemplary work as well as entries that need improvement. Guiding students in their understanding of why one paper received a high mark and why another did not can lead them to be more introspective.

Conclusion

Students must be guided in how to set up and maintain a science notebook. This maintenance includes an understanding of scientific inquiry and an ability to communicate about their scientific observations. These two components connect science notebooks to the National Science Education Standards (National Research Council 1996). In the

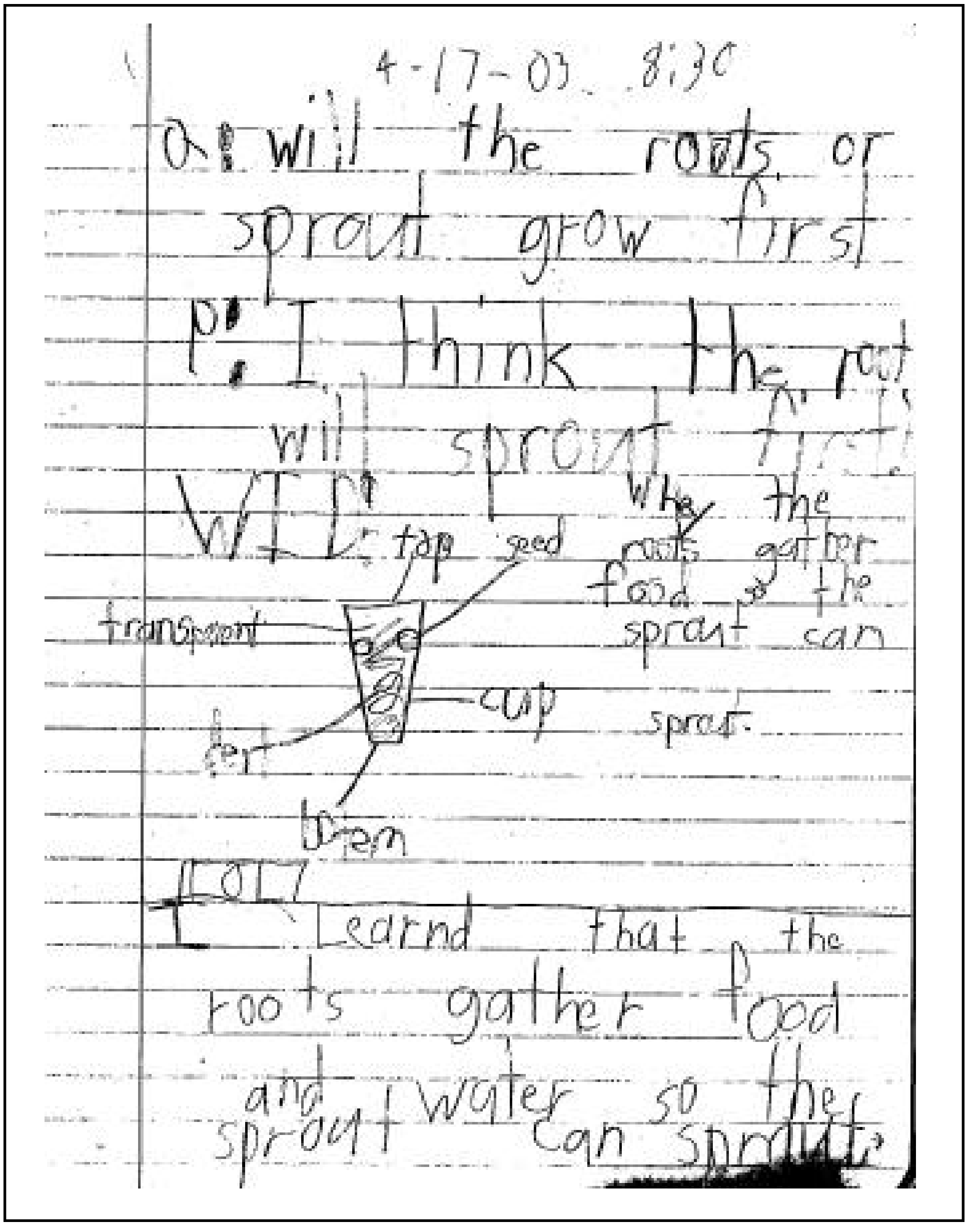

Figure 6. Student notebook entry investigating whether the roots or stem of a plant will sprout first.

beginning, students may struggle with the logistics of setting up the notebook. They may skip entries or include ones that are incomplete or forget to record the date. As they continue to work with science notebooks, they may find it difficult to articulate their understanding of scientific content. What is important to note is the child's development over time. Not only are students developing scientific literacy, but they are honing their writing skills and demonstrating growth in other areas of the curriculum.

The following guidelines may be useful if you are interested in using science notebooks with your students:

1. Do not wait to implement science notebooks until you feel you know everything there is to know about science notebooks or until you feel your students are "ready." Science notebooks improve with time. Start small and build on the process. Teacher resources that may help you as you begin teaching students how to use science notebooks are listed at the end of this article.
2. Model…model…model.
3. Provide students with adequate time for writing. Younger students will naturally take more time to complete an entry, and older students need more time to include more details.

4. Make sure that students know to include scientific drawings, maps, graphs, tables, and charts in addition to their written work.
5. Interpretation of the data is critical. It is not sufficient to simply report findings. Ask students to be as descriptive as possible when they interpret data, explaining their interpretation of their data. This is difficult for students to do and should be modeled.
6. Think about how you want students to set up their notebooks. Decide ahead of time how you will facilitate the notebook writing process.
7. Think about how you will assess student progress through the use of science notebooks. Remember to look for evidence of growth.

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Additional Teacher Resources

Information on research-based kits

- FOSS (Full Option Science System)—http://www.1hs.berkeley.edu/FOSS/FOSS.html
- Insights—http://www.edc.org/CSE/
- STC (Science and Technology for Children)—http://www.si.edu/nsrc

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