Science notebooks are meant to be tools for students, utilized during science investigations and discussions as records of information and resources in conversations. Students capture data, drawings, questions, and reflections in their notebooks. They reference them during group discussions to synthesize their ideas. As students gain experience with utilizing notebooks, their abilities within each of these areas progress. Students routinely assess their work and set goals for themselves as learners. This chapter examines how students progress in utilizing notebooks from beginning to more advanced stages of use.

Predicting

What evidence of progress is there in students' predictions?

Prediction is the use of knowledge to identify and explain observations, or changes, in advance. (National Research Council 1996, 116)

Too often, students equate making a prediction with guessing; they attempt to decide an outcome without the benefit of any experiences on which to base the decision. For this reason, students' predictions may begin as nothing more than random guessing. Their predictions may make little sense in the scheme of their notebooks. Without the fundamental understanding of predictions, students sometimes become frustrated when confronted with data that does not match their prediction. At this stage, students often want their predictions to be correct, so they look for indications of this and end up reading more into the data or manipulating it to make it match their ideas. Other students may actually alter their predictions, as evidenced by erasing or crossing out, after observing an event to ensure that they are correct. At this point, students struggle with the purpose of predictions and with recording them in their notebooks.
As students gain an understanding of what it means to predict, they progress by using their prior experiences when making predictions. Students may refer to previous notebook entries and provide evidence to support their thinking. Predictions begin to make sense in their entries and are not entered haphazardly. There is no longer a sense that predictions must be changed in order to be correct; rather, students revisit their predictions as they gather data and express new ideas based on evidence. They no longer equate information that does not agree with their prediction with being wrong, but rather look at it as a learning opportunity. At this point, students may need prompting from the teacher to make a prediction, as it is not yet automatic.

As students progress further, they recognize the value in recording their predictions, and predictions become a natural part of their scientific entries, as Figure 3–1 demonstrates. Although not always accurate,

\[ \text{Isopods & Beetles} \]

What we're going to do is see if the isopods and beetles like light or dark more. What we did was we covered one side of a container so it was dark, and kept one uncovered. First we're going to see what the isopods environmental preference. I think that they'll like the dark because they don't go underground. The next day we are going to do the same thing with the beetles. I think they'll like the dark because they dig underground.

FIGURE 3–1 A fifth-grade student considers what the outcome of the investigation will be.
their predictions are supported by evidence from previous experiences with the materials. They realize that their predictions should be examined and that they should base future predictions on data collection.

Recording and Organizing Data

What evidence of progress is there in students’ recording and organizing of data?

[Students] collect data and decide how to represent it, they organize data to generate knowledge, and they test the reliability of the knowledge they have generated. (National Research Council 1996, 33)

When students begin using notebooks, they may not focus on the data as a whole but instead focus on individual pieces. Students are often busy exploring the materials and may not think to record their ideas unless prompted to do so by the teacher. Data collection may not be focused and it is often entered randomly rather than in an organized manner. This often makes it difficult to revisit information and make sense of it at a later date. Materials and procedures are often forgotten at this point and instead students focus on the results, which may be a blend of data and fictional thoughts.

After some time, students begin to show progress by experimenting with different methods of data collection; however, some may still rely on the teacher’s directions for guidance with their entries. In addition to recording their ideas in lists, students may draw pictures with labels or descriptions, write sentences to describe their thinking, or create thinking maps. They begin to organize their information, using titles for their entries and grouping sections together. This organization allows them to utilize the data at a later date and build upon their understandings. Students no longer focus solely on data collection but begin to reference procedures and/or materials in their entries.

As students become more comfortable with notebooks, their method of recording progresses by taking several different forms, such as drawings, sentences, charts, and tables. As students feel more confident in their abilities to observe and record information, they often exceed the teacher’s expectations. There is the realization that organization helps make sense of data, so students strive to organize their entries in a meaningful manner. Therefore, students consider the recording method prior to recording the information, and they can justify the appropriateness of one method over another. Students strive to include information in their entries so they or someone else might be able to replicate their work in the future.
Drawing

What evidence of progress is there in students’ drawings?

Initial sketches and single-word descriptions lead to increasingly more detailed drawings and richer verbal descriptions. (National Research Council 1996, 123)

Students’ drawings usually begin as symbols of objects, such as daisy-type flowers or stick figures. The symbols represent the materials but do not include details specific to the object being drawn. Students are usually familiar with drawing for enjoyment but often do not understand the significance of drawing for understanding. Therefore, materials may be drawn in imaginary scenes or color may be used inaccurately, such as coloring a mealworm purple or orange. Students may label their drawings, but they are not sure of the purpose of labels at this point and end up labeling everything on their drawings rather than specific aspects.

FIGURE 3–2  A second grader’s notebook in September
Students show progression as they begin to see drawings as learning tools. They pay attention to details, such as drawing the leaf veins or recording segments in an insect's leg. They pay attention to color and proportion for a more accurate representation of the material. They now use labels sparingly in order to clarify aspects of their drawings. There is the realization that drawing portions of the material may provide more information than drawing the entire object.
With experience, students begin using drawing techniques such as shapes and proportion, in order to provide detail in their work. They see labels as tools to enhance the drawings and define terminology. Beyond labels, students may begin to use captions in order to expand upon the entry, for example, “Bird's-eye view of isopod habitat.” Students begin to manipulate the objects and may draw them from various perspectives or in different scales. They use color and shading techniques to better depict the characteristics of the object.

In the following vignette, a teacher describes how fifth-grade students progressed as they worked with drawings in their notebook entries.

Knowing that my students had had limited exposure to various drawing techniques, I was curious to see how they would record their observations as we examined plant structures. I noticed some of the drawings contained color but seemed to lack details. The plants being observed had leaves with many shades of green; however, in their notebooks many of the students colored the leaves a solid green and seemed to miss the intricate patterns created by the variation in color. The drawings also seemed to consist of the basic outlines of the plants and contained few other internal details.

As the days progressed, we utilized various techniques, such as shading, labeling, and guided drawings. Students began adding details to their drawings as we discussed specific plant features. As the study continued, their drawings became larger and they used labels to identify unique features of the plants (node, parallel veins) instead of more obvious features. Shading techniques were used, giving the drawings depth. Students began to see how powerful drawings could be in representing their understandings.

Questioning

What evidence of progress is there in students’ questioning?

In the same way that scientists develop their knowledge and understanding as they seek answers to questions about the natural world, students develop an understanding of the natural world when they are actively engaged in scientific inquiry—alone and with others. (National Research Council 1996, 29)

As students work with materials, they are constantly asking questions although they may not realize it. Science notebooks become important...
tools for the students to capture these questions for future investigations. In the beginning, students may not be clear in recording their questions; instead, their questions are intermingled within their observations, making it difficult to distinguish them from other elements of their notebooks. Questions may go unexplored and unaddressed anywhere in their work. Questions they record may not be relevant to their investigation, as the role of questions is not clear to many students at this point.

With more experiences, students progress by beginning to recognize valuable questions. They record these in a manner that sets them apart from other elements of their notebooks. Students use techniques that allow them to quickly locate their questions, such as beginning their entries with their questions, designating a specific area of their notebooks for questions, or coding their questions in some manner. At this stage, students' questions are relevant to their investigations and may be actively pursued if time is provided. There is an understanding that questions are an important part of scientific inquiry and therefore an important component of science notebooks.

Over time, the questions that students raise are not only easy to find but may be organized in a meaningful manner as well. Students may begin grouping questions according to aspects of their investigations, such as behaviors or physical characteristics. Questions serve a purpose and are thoughtfully considered by the students as they revisit them from time to time, address them within their entries, and view them as starting points for new questions.

Reflecting

What evidence of progress is there in students' reflection upon their work?

Students assess the efficacy of their efforts—they evaluate the data they have collected, re-examining or collecting more if necessary and making statements about the generalizability of their findings. (National Research Council 1996, 33)

When students first begin to use notebooks, they may simply record information and not interpret their findings. Students may see their notebooks as collections of data that they can look through, but they do so with the purpose of reexamining facts rather than trying to make sense of their thinking. As students share with a partner or a group, they focus on factual information. Students often look to the teacher for direction or confirmation that they are doing well, rather than relying on their own interpretation of their work.

As students become more experienced with science notebooks, they begin to see them as tools for making connections between what they are
observing and their prior experiences. They no longer utilize notebooks solely for data collection; instead, they begin to synthesize their thoughts, which may include writing for several minutes after an investigation. Students attempt to explain their thinking and begin to formulate explanations, such as “I think that the sloped stream tables made deeper canyons because the water carries the deposits away faster.” As students become more reflective, they recognize both patterns and inconsistencies in their data.

**Using Notebooks as a Resource**

**What evidence of progress is there in students’ use of notebooks as a resource?**

Community-centered environments require students to articulate their ideas, challenge those of others, and negotiate deeper meaning along with other learners. (National Research Council 2000, 122)

Science notebooks do not serve their true purpose unless students utilize them as resources. This is accomplished any time students refer to the information within their notebooks. For many students, referencing their notebooks helps establish a purpose for recording and organizing the information pertaining to an investigation. This can be accomplished by asking students to refer to their notebooks when discussing ideas with a partner or group. Students also reference their notebooks as they look back through their work and reflect on their understandings.

As students become more comfortable with using notebooks as a resource, they begin to reference the information within them for more formal sharing. Just as scientists present their ideas to others, students need to be encouraged to present their findings beyond their casual conversations. At the end of an investigation, students might be asked to present their findings in a more formal manner, such as a science conference, slide show, informational writing piece, or big book. The importance of having pertinent, accessible information in their notebooks takes on new meaning once the materials are no longer available for reference.

In the following vignette a teacher describes how notebooks are utilized as resources in a second-grade classroom.

> After studying the mealworm for several weeks, we had a class discussion of how we could share this information with others. One student suggested that the class could make a book. After reviewing their notebooks, the class brainstormed a list of ideas they felt should be included in the book and listed these on the
board. The students decided to take a chronological approach to sharing the information and determined that the book should focus on the life cycle of the mealworm. Students broke up into groups of four, with each group focusing on a different component of the life cycle. Within the groups, students shared tasks such as writing, drawing, and organizing their page of the book. Each page was created using information from their notebooks.

Self-Assessing

What evidence of progress is there in students’ self-assessment?

Students are the ones who must ultimately take action to bridge the gap between where they are and where they are heading. (National Research Council 2001, 17)

In order for students to fully realize the notebook’s potential, they must reflect on the work they are doing to determine understandings and new goals. Students who are new to notebooks may require assistance to reflect upon their work and determine next steps to take. As they begin this process, students may assess themselves not by asking “Does the work show what I learned?” but rather “Does it look neat?” or “Did I finish?”

Eventually, goals become a focus for improving the overall notebook so that it becomes a valuable tool. For example, a student may indicate that she needs to work on organizing her data and experiment with different methods. As sole consumers of their notebooks, students continually self-assess their progress toward their goals. The students then adjust their work based upon how well they think they are meeting their goals.

Notebooks are essential components to learning science and need to be developed over time. Students will approach each of the areas discussed in this chapter in very unique ways, and they will improve their skills at various rates. It is important that students recognize the uniqueness of their notebooks and view other students’ notebooks as models rather than as means of comparison.

Thinking point: How will you gather evidence of how your students are progressing within each of the areas discussed in this chapter? What opportunities will you provide to allow students to improve in each of these areas so that their notebooks support learning in science?
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