The P.O.E.T.R.Y. of Science

A flexible tool for assessing elementary student science journals

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Inquiry-based science offers rich hands-on and mind-on experiences that encourage students to ask and search for answers to their own questions. Writing about inquiry-based science experiences can provide students with opportunities to communicate their questions, observations, and reflections while expanding our instructional and assessment options as teachers. But how can teachers encourage and assess student writing in science? In this article, we describe P.O.E.T.R.Y., an authentic assessment tool that can be used to analyze elementary student science journal entries and track the development of both language arts and science skills and concepts.

Figure 1.

Explanation of the P.O.E.T.R.Y. acronym.

	Description
Predict	The student makes a prediction about what is to occur and explains her reasoning. Example: I think that the bean plant will grow towards the light because it needs light to grow.
Observe	The students makes accurate observations or measurements. Example: The length of feather is 5.5 cm. It is grey and soft.
Explain	The student uses evidence to evaluate her prediction and to develop an explanation for her observations. Example: I predicted the temperature of the bag would not change, but I felt the bag get hotter after I added the water. I think that chemical reaction happened because a temperature change is a sign of one.
Think	The student devises alternative explanations for her observations. Example: I think that paper airplane B flew farther not because it was lighter but because there was a little bit of wind that helped it go farther.
Reflect	The student evaluates the approach used to collect data. Example: I think that we should have measured the amount of water we gave each of the plants during our experiment. Some of the plants may have gotten more water than others, making them grow more.
Yearn to learn more	The student generates new questions and approaches to investigate her questions. Example: I want to find out if earthworms can see. I will put a bunch of earthworms near a light and see if they move away.

What Is a Science Journal?

The terms science *journal* and science *notebook* are often used interchangeably. Although both provide students with opportunities to write about their individual science learning experiences, journals and notebooks differ significantly in both format and purpose. Consider these two examples:

Example 1:

In Mr. Mendez's classroom, students record their observations and measurements from an investigation of the physical properties of water (cohesion and adhesion) in their science notebook. They may also paste their instruction sheet and copy notes from the board into their notebook.

Example 2:

In Mrs. Nelson's classroom, students record their predictions, observations, and measurements during an investigation of seed germination in their science journals. After completing the investigation, they reflect on their predictions and use their own observations and measurements to explain what factors are essential for seed germination. Students are also encouraged to write about their own prior experiences growing plants from seeds and share information they remember from a previous week's video about the life cycle of plants.

As evidenced in these two examples of science writing, journal entries are more flexible in their format and contain written and drawn observations and interpretations of observations as well as personalized reactions/perceptions (Dirnberger, McCullagh, and Howick 2005). Science notebook entries are more formal and structured and focus on the collection, organization, and objective analysis of evidence. Common components of science notebook entries include written observations, scale drawings, diagrams, and numerical data such as charts, data tables, and graphs. Simply put, science notebooks focus on recording what students have done while journals focus on what students have learned.

What Is P.O.E.T.R.Y.?

The acronym P.O.E.T.R.Y. stands for Predict, Observe, Explain, Think, Reflect, and Yearn to learn more (Figure 1). P.O.E.T.R.Y. was adapted from White and Gunstone's POE (Predict-Observe-Explain) strategy (1992), which is typically used to guide student learning during an inquiry-based science investigation or demonstration. While the POE strategy focuses on three science-process skills, P.O.E.T.R.Y. focuses these three science-process skills as well as higher-order processes (thinking and reflecting) and scientific habits of mind (yearning to learn

more). In addition, while POE is primarily designed for use in inquiry-oriented science lessons, P.O.E.T.R.Y. focuses on process skills, thinking skills, and habits of mind that represent essential elements of inquiry in both science and language arts contexts.

Uniting Science and Language Arts

Understanding that time is a limited commodity in elementary classrooms, P.O.E.T.R.Y. was designed to incorporate key elements of both national language arts and national science standards. Combining science and language arts skills in one assessment tool was both logical and desirable because so many of the skills standards for the two subjects clearly complement and reinforce each other. For example, the National Science Education Standards require that students "use data to construct a reasonable explanation," while the National Language Arts Standards require students to "gather, evaluate, and synthesize data from a variety of sources" (IRA/NCTE 1996; NRC 1996).

We created three different scoring guide versions These three scoring guides (a traditional rubric [Figure 2], a holistic rubric, and a checklist [see NSTA Connections for examples of these rubrics]) differ only in their format; the language used in each is identical. Depending on your preferences, you can use any one of these three versions to evaluate your own students' individual science journal entries or entire journals.

Scoring Through P.O.E.T.R.Y.

To determine if the P.O.E.T.R.Y. assessment tool was understandable and easy to use when analyzing student journals, we worked with a local third-grade teacher who had her students keep science journals for an entire school year. In order to get a more authentic picture of how science journals are actually used in elementary classrooms, we did not prompt her with specific instructions regarding the content or format of the journals nor did we provide any specific writing prompts. In order to determine if the P.O.E.T.R.Y. assessment tool could be used to identify differences in the quality and content of student science writing over time, three journal entry samples were selected from the beginning, middle, and end of one third grader's science journal (Figures 3–5, pp. 40–41). Each entry was then "scored" using the traditional version of the P.O.E.T.R.Y. tool.

Entry #1: *Developing*

The first entry (Figure 3) received an overall rating of *developing* for two reasons: (1) the entry indicated a limited understanding of how to make good predictions, observations, and explanations; and (2) the entry did not include significant examples of thinking, reflection, or yearning to learn more. In this early entry, the student wrote about an activity investigating a mysterious substance called "goo yuck." She was challenged to conduct several different tests to determine if goo yuck was a solid or a liquid. The student provided a *prediction* and a list of *observations*, but she did not provide any reasoning for her predictions nor did she provide much detail in her observations. The beginning of an *explanation* can be seen at the end of the entry where she attempted to draw a conclusion about the physical state of the substance. Although she came to different conclusions (solid versus liquid) for different tests, there was little evidence of *thinking* because she did not attempt to summarize and compare the relative number of tests that indicated solid versus liquid but instead formed separate conclusions for each test. Furthermore, in this entry, she did not *reflect* on her experience or indicate a *yearning* to know more.

Although the predictions and observations in the first entry were more characteristic of a science notebook, the student used several language arts skills to develop her ideas. Accessing prior knowledge of the terms *liquid* and *solid* was necessary to form an appropriate prediction, organizational strategies were used to communicate the observations in a list appropriate for science, and the use of symbols in her explanation showed knowledge of alternative forms of written language.

Entry #2: *Basic*

This second entry (Figure 4) received an overall rating of *basic*. More P.O.E.T.R.Y. skills were included and the entry contained more detail, but the student still did not demonstrate an understanding of alternative explanations or a desire to know more about the topic being explored. In this entry, the student was asked to reflect on an energy lab conducted the previous day. Her *prediction* was advanced because she used several past experiences with heat and energy (such as her classmates' water fountain choices and the coolness of grass) to make the prediction "I thought the grass was going to be the coldest." Her *observations* were *basic* because several of them (such as temperature ranks of the rock and road) did not include detailed descriptions. As in the first entry, her *explanation* was not supported with evidence, no alternative explanations were included, and no evidence of higher-order *thinking* was included. The second entry did contain some evidence of *reflection* when she described the process of reading her thermometer. However, nothing in her writing indicated a *yearning* to know more.

Regarding language arts skills, her basic language skills did improve in the second entry. Her predictions, observations, and explanations were more detailed and employed a greater use of symbols to convey meaning (e.g., emphasizing "energy" by surrounding it with rays like the sun). She also used alternative forms of technol-

Figure 2.

Traditional P.O.E.T.R.Y scoring rubric. (See NSTA Connections for holistic and checklist versions of this rubric).

	Predict	Observe	Explain	Think	Reflect	Yearn
Advanced	The student provides a reasonable prediction that is related to the topic at hand and uses many details from her prior knowledge to support it.	The student provides a detailed description of many characteristics of an object or person.	The student evaluates her prediction and poses a reasonable explanation, using many details from her prior knowledge and observations.	The student poses a reasonable alternative explanation, using many details from her prior knowledge and observations.	The student evaluates how she gathered information and suggests many reasonable ideas for improvement.	The student poses many new questions to investigate that are related to the topic at hand and suggests reasonable methods of for investigating them.
Proficient	The student provides a reasonable prediction that is related to the topic at hand and uses a few details from her prior knowledge to support it.	The student provides a detailed description of a few of the characteristics of an object or person.	The student evaluates her prediction and poses a reasonable explanation, using many details from her observations.	The student poses a reasonable alternative explanation, using many details from her observations.	The student evaluates how she gathered information and suggests a few reasonable ideas for improvement.	The students poses a few new questions to investigate that are related to the topic at hand and suggests reasonable methods for investigating them.
Basic	The student provides a reasonable prediction that is related to the topic at hand and uses at least one detail from her prior knowledge to support it.	The student attempts to describe more than one characteristic of an object or person.	The student evaluates her prediction and poses a reasonable explanation, using at least one observation.	The student poses a reasonable alternative explanation, using a few details from her observations.	The student attempts to evaluate how she gathered information and provides at least one reasonable suggestion for improvement.	The student poses at least one new question to investigate that is related to the topic at hand and suggests a reasonable method for investigating it.
Developing	The student provides a reasonable prediction that is related to the topic.	The student attempts to describe at least one characteristic of an object or person.	The student evaluates her prediction or poses a reasonable explanation, using at least one observation.	The student poses a reasonable alternative explanation, using at least one observation.	The student attempts to evaluate how she gathered information or provides at least one reasonable suggestion for improvement.	The student poses at least one new question to investigate that is related to the topic at hand.

Circle One: Advanced   Proficient   Basic   Developing

Figure 3.

Sample entry #1.

What Is Goo?

Prediction
Goo is a liquid

Observations
- Liquid on top
- Solid on the bottom
- Sinks
- Light green
- Cold
- Stinks
- Smooth
- Gooey

Exp. #1=solid
Exp. #2=liquid

Entry #3: *Developing*
The third entry (Figrue 5) would receive an overall rating of *developing* because it contained fewer P.O.E.T.R.Y. elements and lacked supporting details for each element. This third entry was much stronger in terms of language arts skills than science inquiry skills. In terms of science skills, she did not offer a prediction. She proposed that lichens can only live in specific types of locations (*explanation*) but did not provide any of her own observations to support her claim. The entry consisted of things she was told about lichens but did not include evidence of any of her own *thinking*, *reflection*, or *yearning to learn more* about lichens.

Interestingly, with no prompting, the student drew on her own knowledge of phonics to examine and comment on the sounds in the word *lichen*, which is characteristic of making *predictions* in language arts. Another language skill demonstrated in this entry was the use of a word web to communicate the meaning of the term *lichen*. This is

Figure 4.

Sample entry #2.

Heat Energy Lab

Yesterday in lab we started talking about ENERGY. This is what I know about energy. I know that it is run by the Sun.

When we went outside to measure temperatures, or heat energy, on different surfaces around my school yard, I noticed that you had to count to 50 to make a difference in the temperatures. My highest temperature was a rock. It was 84°F and 28°C.

My noticings:
- The road was the second hottest because it was dark colored.
- I thought the grass was going to be the coldest, and it was because grass is actually cool.
- We observed metal, wood, asphalt, concrete, brick, and rock.
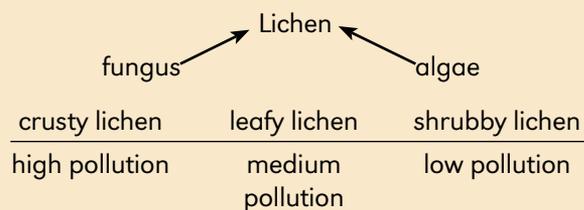- The range wasn't that great because it was a cool day.

The kids in my class always want to get a drink of water at the wing because the water is colder. It is colder because it is in the shade and the other one isn't.
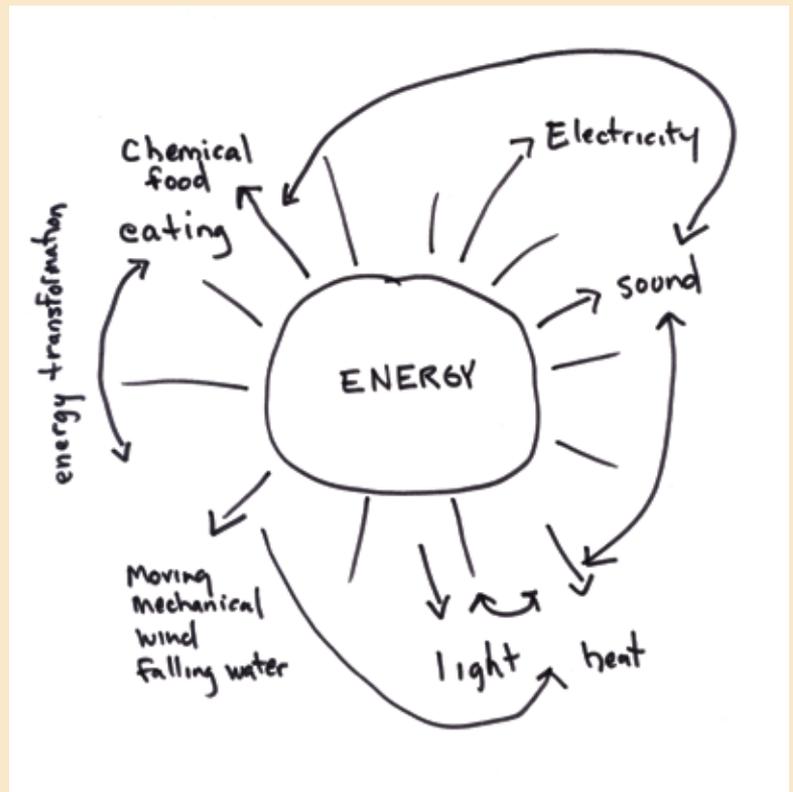
Figure 5.

Sample entry #3.

Lichen Lab
Yesterday we learnt [sic] that there are three different types of lichen:
- Crusty, shrubby, and leafy.
- Lichen is a funny word because the "ch" sounds like "k" and the "en" sounds like "in."

Lichen

fungus → Lichen ← algae

crusty lichen	leafy lichen	shrubby lichen
high pollution	medium pollution	low pollution

This is a scale to show what kind of lichen can live where.

characteristic of making *observations* and *explanations* in language arts.

Informing Through P.O.E.T.R.Y.

Analyzing these three journal entries provides valuable insights into this student's mastery of three science-process skills, two higher-order thinking skills, and an essential scientific habit of mind. Without the aid of a tool such as P.O.E.T.R.Y., a teacher might conclude that since the second and third entries were longer and more detailed than the first, this student's scientific thinking and understanding significantly improved over the course of the school year. However, when examined more closely, results of the P.O.E.T.R.Y. assessment indicate that while this student's language arts skills improved, a corresponding growth in her ability to think scientifically did not occur. In this case, the teacher we worked with assumed that her students' ability to think scientifically naturally improved as a result of required journaling time. She now realizes that her students need more specific prompts for journal entries, especially if her goals include helping students improve their ability to think and reflect and promoting a desire or yearning to learn more about the world around them.

Other classroom teachers can use P.O.E.T.R.Y. as both a formative and summative assessment tool. In its simplest application, it can be used to assess individual journal entries regarding one specific science inquiry activity, and future instruction could be adjusted to address identified areas of weakness. As a more holistic assessment, multiple student writing samples could be scored and compared throughout the year to document student growth and progress over an extended period of time.

P.O.E.T.R.Y. can also be used to inform your own instruction. After scoring student journal entries, you may find that you need to provide more or less structure in a science inquiry activity, provide more explicit instruction regarding how to make good predictions and observations, provide more examples or prompts to promote thinking, provide more links with previous learning to promote reflection, or even include more creative/unusual experiences to stimulate a greater yearning to learn more.

Regardless of how the scoring guides are used, P.O.E.T.R.Y. offers a more complete picture of your students' mastery of the skills and habits of mind used in true scientific inquiry while also assessing development of key language arts skills. This easy-to-use tool can help you make the most of your classroom journaling time and promote the development of both language arts and scientific thinking skills in the process! ■

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NSTA Connections

Find the holistic and checklist versions of the P.O.E.T.R.Y assessment tool at *www.nsta.org/sc0811.*

Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996).

Content Standards
Grades K–4
Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry

National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academy Press.