

return journals by the end of the week. For those who need more time, assess journals every other week, or allow students to respond to fewer prompts. Regardless of the approach the teacher uses, the feedback must be timely in order to keep students engaged in the writing process.

## Conclusion

When students are given a variety of opportunities to express themselves, they may be more willing and motivated to write. Providing support to students and encouraging them to explore their own interests and their curiosity about the world around them may increase achievement, knowledge, and an understanding of science. Regardless of the teacher's time and approach to assessing journals, journal writing presents a viable option that can help students learn science. Specifically, science journals are one effective tool that teachers can use to help build students' interest and motivation to learn to write and write to learn about science. Journals can also provide evidence and timely feedback to teachers to improve their own teaching during this current time of heightened teacher accountability.

## References

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## Science and literacy: Making connections through writing



At the beginning of each major unit in my science class, I present students with an open-ended question (OEQ), a divergent assessment in the form of a writing prompt (a situation) with directions for writing. Students complete this assessment by the end of the unit. Students mostly work on it as homework, with three in-class updates. Our middle school is divided into teams, and I have an agreement with our language arts teacher: He grades the first draft of each OEQ report and I grade the final work for science content. For this assessment, we (both teachers) use the same checklist scoring guide (see Figure 1), which includes a student self-evaluation section (Erwin 2004). Through the OEQ reports, students build competence in literacy skills in two curricular areas, science and language arts (Harris-Freedman 1994).

**FIGURE 1** Checklist scoring guide

**Style 1. Description report**

- \_\_\_ Details described are clear and concise (up to 4 points).
- \_\_\_ Describes the current status/stage of development (up to 3 points).
- \_\_\_ Describes problems/challenges with installation (up to 2 points) and maintenance (up to 2 points).
- \_\_\_ Describes successes with installation (up to 2 points) and maintenance (up to 2 points).

*Diagram/Photo/Schematic*

- \_\_\_ Image is clear, not pixilated (up to 3 points).
- \_\_\_ Includes description and orientation for observer; explains what is shown in picture simply, for someone not informed or seeing it for the first time (up to 4 points).

*Graph*

- \_\_\_ Graph is appropriate for data.
- \_\_\_ Axes are labeled appropriately.
- \_\_\_ Scale is appropriate.
- \_\_\_ Data shown are documented with references.

**Style 2. Fiction report** (points are for each of 3 items)

- \_\_\_ Uses imagery and imagination (up to 3 points).
- \_\_\_ Fictional details are mixed with facts (up to 3 points).
- \_\_\_ Length is appropriate (up to 3 points).

**Style 3. Persuasion report**

- \_\_\_ Experiment questions are answered (up to 2 points per question).
- \_\_\_ Includes a diagram (up to 3 points).
- \_\_\_ Each description is clear (up to 3 points each).
- \_\_\_ Argument is logical (up to 4 points).

**References** (all styles)

- \_\_\_ Includes more than one source (up to 2 points per source).
- \_\_\_ Each listing is in the appropriate format for the type of source it is (up to 2 points for each correctly formatted source).

**Student self-evaluation/checklist** (to be completed individually for each OEQ and turned in with student's work)

- \_\_\_ I've read all the directions.
- \_\_\_ I've asked questions when I didn't understand directions.
- \_\_\_ My diagram has all of the required elements.
- \_\_\_ My graph has appropriate axis labels\_\_\_, scale\_\_\_, and data selection\_\_\_.
- \_\_\_ My work in the fiction report is full of imagery, real and imagined.
- \_\_\_ In our persuasion report, I supported each fact with evidence.

## Integrating skills across disciplines

Our interdisciplinary team works on building active learners who can self-evaluate their progress in learning basic skills and processes. We strive to show that our different disciplines have similar skill sets: skills that help our students become lifelong learners. Inquiry and the writing process are matched in this unit (Figure 2 shows the overlap in our skill set). Writing OEQs helps students build expertise in several skills.

By early spring, when we start a solar system exploration unit, students have developed the thinking skills, science process skills, and communication skills to write their OEQs using different styles. On the first day of this unit, three open-ended questions and the scoring guide are handed out to students. With this OEQ assignment, we integrate three different writing styles: *description*, *fiction*, and *persuasion*. *Description* writing combines facts with knowledge and is a lower-order thinking skill. *Fiction* writing is a higher-order style of writing; students have to synthesize knowledge to create fiction. *Persuasion* is another writing style that uses higher-order thinking skills—students have to present arguments using evidence in a logical manner. These three OEQs parallel the investigations, activities, and explorations that make up this unit (Harris-Freedman 1994).

## Teaching strategies

### *Time for practice, feedback, and mentoring*

By the time our students are given the solar system assignment in the spring, they have completed at least four different OEQ assignments, each one focused on a different level of thinking skill and writing style. (For more on OEQs and how to design them, see *Open-Ended Questioning: A Handbook for Teachers* [Harris 1994]). This

**FIGURE 2** A comparison of skills across disciplines

	Comparative lifelong learning skills	Inquiry processes	Writing processes
1	Gathering information and focusing on an idea or topic	Hypothesizing (asking questions)	Brainstorming
2	Researching	Gathering evidence and information	Composing
3	Synthesizing of data	Making charts and graphs and writing explanations	Editing
4	Communicating findings	Presenting findings	Publishing

Note: Steps 2 and 3 are recursive; you can bounce between them several times as you work toward step 4.

unit's assignment combines three of the styles they have already completed. Students have to apply their knowledge to new settings and practice presenting scientific information using three different styles. Students work on this throughout the unit. It takes students a different amount of time for each question. Lower-order thinking skills take less time; higher-order skills and problem solving take more time. The amount of time depends on the general knowledge level of the students and when during the unit activities they are given time to work on their responses. Students enjoy that the assignment is open ended because there is some flexibility to choose a topic that interests their group (see Activity Worksheet).

Through this assessment, students receive more feedback and mentoring than usual, because there are two teachers grading student work: I provide science-content feedback and our language arts teacher provides communication-skills feedback.

#### Peer review

In addition to instructor feedback, students offer each other peer feedback in study lab groups. (At the beginning of each unit, students are assigned to study lab groups [three to five students per group] for that unit.) Starting at the beginning of the school year, students are taught to be positive peer reviewers who listen to each other and ask clarification questions. They are not allowed to give negative feedback or make judgmental

statements. Some appropriate peer-review questions for the solar system assignment include the following: Am I too wordy? Am I too vague? Can you understand my graph? Are my photos and diagrams clear and not too pixilated? Is my evidence credible? I do most of the peer-review modeling by asking questions and listening to students during the course of the unit (Harris-Freedman 1999, p. 5–7). For more information on peer review, visit the National Council of Teachers of English website, [www.ncte.org/prog/writing](http://www.ncte.org/prog/writing).

#### Presenting OEQs in class

The opening PowerPoint for this unit, Solar System Exploration, describes many of NASA's enterprises, including the International Space Station (ISS). I ask questions to start students thinking about the concepts and topics that will make up this

unit. When I get to the ISS part of the presentation, I ask, "What would it be like to work on, build parts for, provide ground support to, or coordinate work for the ISS?" Our discussion is very lively.

I pass out the OEQs (see Activity Worksheet) right after our opening discussion. Students write due dates for drafts and final versions in their calendars, and we discuss the assignment and the scoring guide. As the unit progresses, there are class activities and explorations that provide students with opportunities to investigate and gather data that pertain to the completion of the three OEQs. We spend class time and homework time searching the web for appropriate information. About halfway through the unit, students turn in a draft that goes to the ELA teacher. These are graded and returned to students. Students work on their final papers to be turned in at the dates set at the end of the unit.

This assignment is easily differentiated. Separate the three open-ended questions into individual assignments and allow students to pick one. For a higher grade, they would complete two, and for the highest grade, they would complete all three. The same scoring guides apply to each iteration.

#### Finishing this assignment

Students turn in drafts according to set due dates and self-evaluate each time they turn in a draft. The language arts teacher grades for literacy skills, and I grade

## Activity Worksheet: OEQ writing directions

### Writing the description report

**Prompt:** You are a part of the NASA ISS team. The U.S. Senate Appropriations Committee has asked your committee to provide information about the workings of the ISS. Choose one ISS system or experiment and prepare a report for the Senate committee. What is the current status on this system or experiment? What data are available? Download any available photos or drawings of the system or the experiment.

**Directions for writing:** Prepare a graph of resources used for this system over time. If you have chosen an experiment to describe, what data have been/are being collected? Graph results and explain findings in writing.

### Writing the fiction report

**Prompt:** Pretend that the members of your lab group are background researchers for the radio station WKRP/Cincinnati. They want to run a series on a day in the life of someone who works on or supports the work on the ISS—people such as research associates, assembly integration and verification mechanics (who put the ISS together), satellite engineers (payload or platform), communications officers (ground and station), programmers, astronauts, or scientists.

**Directions for writing:** Write three one-minute scripts that can be read on the radio. Remember that one spoken minute

is about 250 written words. Choose a person who works on or supports the ISS and research their job requirements. Write your story in the form of a scientist's daybook, which would have information about their daily tasks, what challenges and problems they faced, who helped them solve those problems (if they were solved), what they ate, and who they worked with. Extra credit will be given for submitting podcasts.

### Writing the persuasion report

**Prompt:** The chair of the NASA ISS Earth Enterprise has advertised for new experiments to be performed onboard the station. For a listing of current experiments, see [www.nasa.gov/mission\\_pages/station/science](http://www.nasa.gov/mission_pages/station/science). Your group has an experiment that it would like to propose, and you need to convince the committee to pick your experiment. Be precise and clear in your description.

**Directions for writing:** Prepare a report on your proposed ISS experiment, including as much information as you can. Make sure you answer these questions: What do you want to do? Where has it been done before? How long will the experiment last? What materials are needed? Draw a picture of your experimental setup. What is the mass of the experimental materials? What kind of scientist will you need to conduct your experiment? What other resources will you need for your experiment? Please provide data tables for the collection of data.

for science content. (The language arts teacher gets an earlier draft and I receive the final draft.) The checklist scoring guide (Figure 1) makes it easy to award points and for student groups to revise if they are not satisfied with their scores. Students do group work, but turn in individual papers for the description assignment. The fiction and persuasion OEQs receive a group grade.

Once the description and persuasion assignments are in and graded, the products of the assignment should be posted for sharing. We display several photographs of the ISS, the radio shows are read aloud, and the podcasts are played in class (see Activity Worksheet). For extra credit, groups may give an oral presentation to convince the NASA ISS *Earth Enterprise* (the rest of the class) to choose their experiment.

### References

Erwin, J.C. 2004. *The classroom of choice: Giving students what they need and getting what you want*. Alexandria, VA: Association for Supervision and Curriculum Development.

Harris-Freedman, R.L. 1994. *Open-ended questioning: A handbook for educators*. Menlo Park, CA: Addison-Wesley.

Harris Freedman, R.L. 1999. *Science and writing connections*. Parsippany, NJ: Pearson Education, Inc.

### Resources

ISS—[www.nasa.gov/mission\\_pages/station/science](http://www.nasa.gov/mission_pages/station/science)

ISS work timelines—[www.nasa.gov/mission\\_pages/station/timelines](http://www.nasa.gov/mission_pages/station/timelines)

Latest news on the ISS—[www.nasa.gov/mission\\_pages/station/main](http://www.nasa.gov/mission_pages/station/main)

National Council of Teachers of English—[www.ncte.org/prog/writing](http://www.ncte.org/prog/writing)

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