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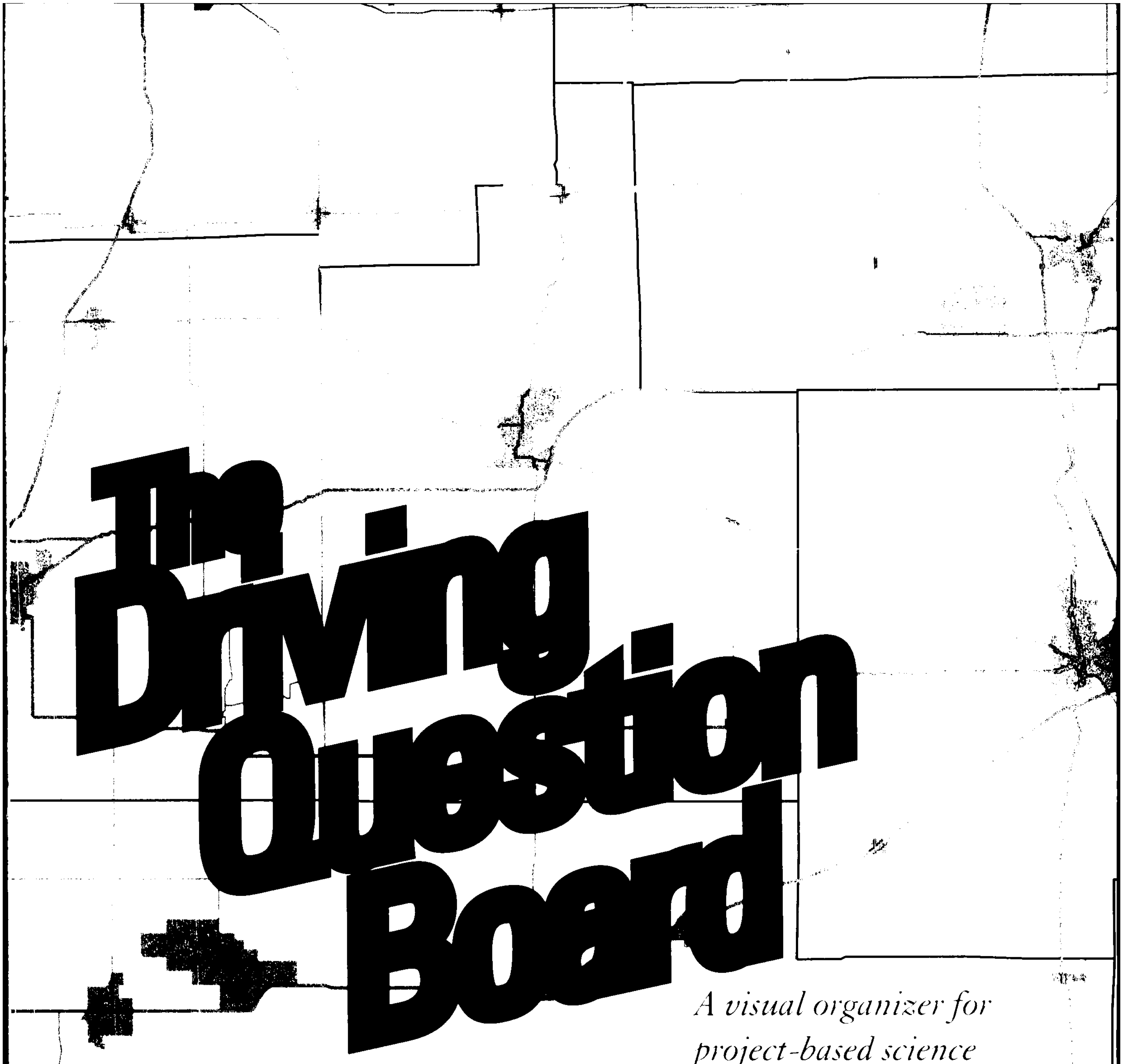
The Science Teacher; Nov 2008; 75, 8; ProQuest Education Journals
pg. 33



The Driving Question Board

A visual organizer for project-based science

Ayelet Weizman, Yael Shwartz, and David Fortus

"It was helpful to keep track of questions we had at the beginning so we knew what we were trying to find out." With these words, a student described the value of using a Driving Question Board (DQB) in a project-based science (PBS) unit. This instructional tool is designed to support inquiry and project-based learning by organizing and focusing students' questions and linking them to content learning goals. We have used this tool in both physics and chemistry classes, but it can be used with any subject matter. This article describes the purpose and process of the DQB.

The driving question

Most PBS units use a driving question to create "a meaningful, defined problem space that provides intellectual challenge for the learners" (Singer, Marx, and Krajcik 2000). The driving question contextualizes the content of a project-based unit and provides students the opportunity to connect it to their personal experiences. A driving question is a rich, open-ended question that uses everyday language to make connections with students' authentic interests and curiosities. The question cannot be solved immediately, but requires a series of investigations that can be done in or around the classroom over several weeks. (**Note:** Typically, the driving question is chosen carefully by the teacher, after consulting with other teachers, students, and science educators.)

The open-ended nature of the driving question creates a challenge, since students may have difficulty recognizing the relevant science principles that are needed to answer it. The tool described here was developed in response to this challenge, as an instructional strategy used to facilitate students' learning.

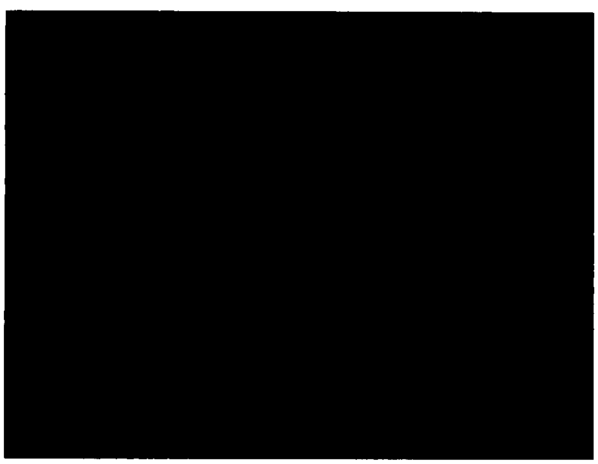
What is the DQB?

The DQB is a large poster board that presents the driving question, which is surrounded by subquestions that are the foci of different sections in the PBS unit. These in turn are surrounded by questions posed by students. The DQB is jointly constructed by students and the teacher at the very start of the unit (and modified as necessary throughout the unit).

First, the teacher presents the driving question through an anchoring activity—an exciting activity or real-world example that is used to engage students. Then, following this intriguing observation, students generate questions that interest them and that they think will help them make sense of both the anchoring activity and the driving question. This creates a common base for "science talk" that will serve the class as a community of learners (Wenger 1998). Working in groups, students write their questions down on "sticky notes." After these questions have been written, the teacher then presents the subquestions, which are categories representing the main learning goals of the unit. Students use these categories to organize their questions. After they have finished, a representative of each group posts the student questions on the board, or on a temporary poster, under the relevant category. A whole-class discussion then leads to some of the questions being merged, re-categorized, or deleted. At the end of this lesson, the teacher takes the temporary poster or collects the notes from the board (after making a photo or drawing of the notes' locations).

FIGURE 1

The physics unit driving question as it appears in the anchoring activity.



The teacher then prepares the actual DQB to be posted in the classroom during the next lesson. It should include both the driving question and students' sorted questions around categories (or subquestions). Although the structure of the DQB is set by the prechosen driving question and learning goals, the specific questions under each category, the order of the questions, and the evolving DQB are unique to each class, created and designed by students and their teacher. The teacher simply finalizes the work that was done by students. The sorted questions remain on the board in the order students suggested, and are referred to during relevant lessons.

At the beginning and end of each relevant lesson, the teacher revisits the DQB and makes connections between the various activities and the driving question. The class may focus on specific student questions that relate to specific activities, review questions that have already been answered and those that are still open, or post additional student questions that may arise later on in the unit.

Sample artifacts—the products of student investigations and research—that were created in class (or photos of three-dimensional models and other artifacts that are too large for the DQB) are hung next to the questions to which they are related. Student artifacts could include answers to specific DQB questions that were generated in class, diagrams, or a consensus model. During the instructional sequence, students complete a series of investigations, each time returning to the DQB with new knowledge until eventually they are able to explain the entire anchoring phenomenon and answer the driving question.

If students ask questions that are not related to the learning goals, these questions can be listed in a separate category, or "parking lot." The teacher can choose to address these remaining questions at the end of the unit using other resources, use the questions for a new project, or let students know that they will address these questions in later studies.

The DQB is used while teaching a guided-inquiry and learning goals–driven curriculum, in which all students are engaged in the same project. (**Note:** For more on this approach, see Krajcik, McNeill, and Reiser 2008, and Singer, Marx, and Krajcik 2000). The DQB is a useful organizing tool not only for project-based classes or curriculum units, but also for any inquiry-based instruction, and even for more traditional classes.

What is the DQB's purpose?

There are four main reasons to use a DQB:

1. It provides explicit connections between the various activities and the context set by the driving question.

2. It helps organize learning and focus on specific content topics by showing where students have been, what they have learned and done along the way, and where they will be going—serving as a kind of "road map."
3. It scaffolds the practice of asking questions.
4. Since it is created by students, it can provide them with a sense of ownership and help to develop a community of learners.

Making connections

The DQB supports both the context of the investigation (created by the driving question) and the scientific concepts being presented. It serves as a visual reminder and organizer for both teachers and students. Both the driving question and the DQB allow students to draw upon previous knowledge (e.g., from home, media, former studies, and personal experiences), and make connections between prior knowledge and newly learned concepts. It also helps to create a coherent story out of many small instances and experiments in a class.

The structure of the DQB (i.e., subquestions centered around the driving question) helps students recognize the connections between smaller ideas, which are investigated through activities in the learning sequence, and the main driving question. By focusing on specific DQB categories, the teacher helps students focus their learning on different content ideas. In addition, taking a big, complex question and breaking it down into manageable subquestions makes it easier for students to see the connections and use the investigations to answer them.

Getting organized

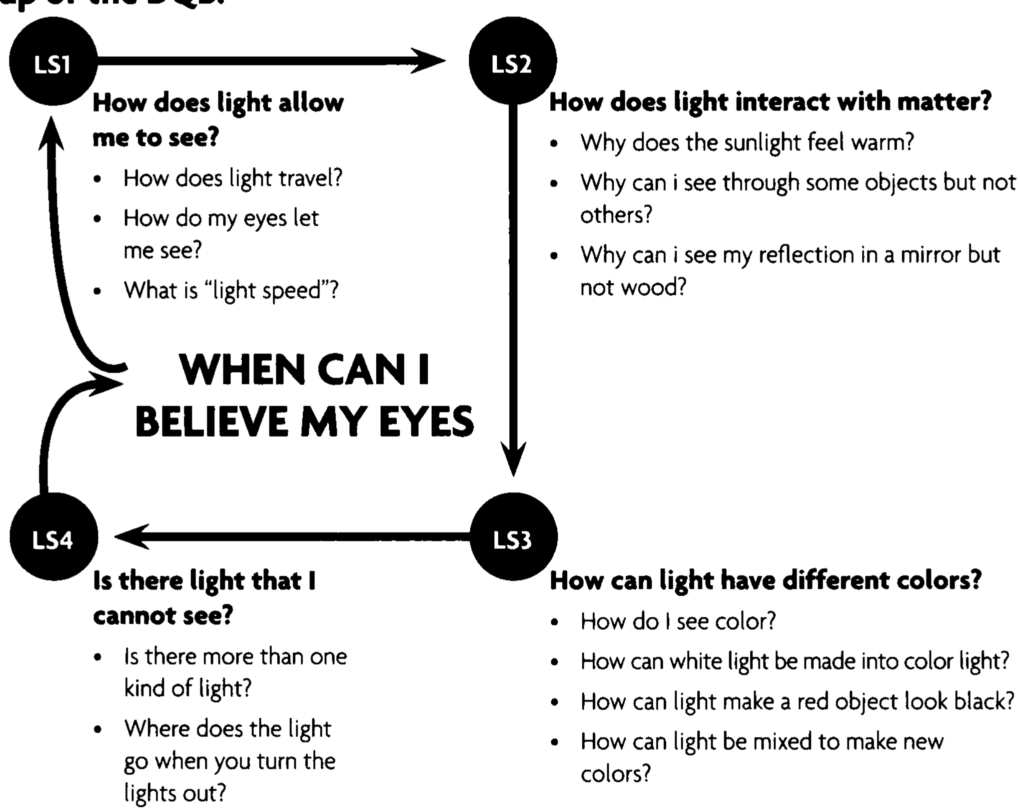
Similar to concept maps, the DQB serves as a tool for organizing students' knowledge, starts from students' initial knowledge base, and assists in connecting and synthesizing ideas. However, the DQB is *not* a representation of students' abstract ideas on a topic (as it is in concept maps), but rather a reflection of the inquiry process, representing steps in the investigation and including physical as well as cognitive products.

Scaffolding questions

Asking questions is not always easy for students. In traditional learning, the teacher asks the questions and students provide the answers. In inquiry-based learning, asking questions is one of the major practices students must develop. The DQB is used to scaffold students in developing this practice. A motivating anchoring activity serves as a trigger for generating questions. By sorting

FIGURE 2

The setup of the DQB.



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the questions into categories, students learn to focus their questions, connect them to the main ideas, and vary the type and level of questions they ask. As a result, students are able to ask more and better questions (e.g., not only questions about facts, but also ones that require higher level–thinking skills such as synthesis and analysis).

Imparting ownership

Because students are responsible for generating questions, collecting data, and developing the answers through inquiry, they develop ownership of their learning. This is visually reflected by presenting their common concepts and artifacts on the DQB as a community. Therefore, the DQB is a unique product of each class, depending on the background, experience, and creativity of students and their teacher. This characteristic of the DQB is strengthened with time, when relevant artifacts created in class and answers to the main questions are posted near or on the DQB.

FIGURE 3

Sample DQB questions.

These questions were generated by students in the physics unit and organized around specific subquestions formed by the teacher.

How does light allow me to see?

- How does light help me see the hidden message in the dark?
- How does light affect our eyes?
- How do our pupils know when to change size when light is seen?
- How far can light travel?
- How is light made?

How does light interact with matter?

- How does light interact with organisms?
- How does light conduct heat?
- How does light pass through a molecule?
- Can a lightbulb melt the snow?

How can light have different colors?

- How do the filters make the letter appear?
- What is red light?
- Can dogs see in color?
- What causes people to be colorblind?
- How does a prism separate light to form a rainbow?

Is there light that I cannot see?

- Is light dangerous?
- How many types of light are there?
- Is there any light in a collapsed star?
- Why are some animals' eyes able to see other light?

The way the DQB is used may vary from one teacher to another, or among different classes and grade levels. Some students may need more scaffolding than others in generating questions; others may not need the teacher's support to make connections between activities and learning goals. Some teachers may decide to review the questions, make them higher level, or sort them in a different way later in the unit. Some students may need less scaffolding or faster removal of the scaffolds, and others may only need a glance at the DQB to make connections on their own.

Examples from two PBS units

The first DQB example is drawn from the pilot of a physics unit on light (Fortus et al. 2006). (**Note:** The pilot was used with middle school students, but the DQB tool is generic and can easily be used in high school physical science classes as well.) The driving question for this unit is "When can I believe my eyes?"

In the first lesson, the driving question is presented through the anchoring phenomenon (Figure 1, p. 34), which provides an experience that both engages students and provides a common reference for the classroom community. A "secret message" is printed in red and green letters on a black background. When illuminated with red or green light, only vowels or consonants appear. Only when illuminated with white light is the entire message visible. After observing the anchoring phenomenon, students generate questions about it and about light in general. The teacher then presents four main questions, representing categories that are drawn from the four main ideas of the unit:

1. How does light allow me to see?
2. How does light interact with matter?
3. How can light have different colors?
4. Is there light that I cannot see?

Students then sort their questions into the four categories. Figure 2 (p. 35) shows the set up of the DQB presented in the teachers' guide (Fortus et al. 2006), while Figure 3 presents actual student questions.

The second example is a DQB created in a chemistry unit aimed at developing a particulate view of matter (Krajcik et al. 2006). This is facilitated by investigating the driving question "How can I smell things from a distance?"

In the pilot class, after experiencing how a strong (but harmless) smell spread through their classroom (i.e., the anchoring activity), students were asked to make a list of all the times they had smelled an odor that day. Then they were asked to raise questions related to their list. Some resulting questions included

- "I smelled the metal smell of coins in my hand—do metal odors behave differently than other odors?"
- "How do 'air fresheners' work?"
- "Why can dogs smell better than us?"

Later on, after learning how odors travel in air, more scientific questions were added, such as: "If a material is odorless, does that mean that no part of it breaks off to become a gas, or could it be that we just do not detect it?"

Students' questions were then sorted into categories defined by teacher-created questions that characterize the main topics of the unit:

- How does an odor get from the source to my nose?
- What makes one odor different than the other?
- How can a material change so that you can smell it?

Throughout the chemistry unit, the use of the DQB is similar to that of the physics unit. Therefore, we believe the DQB can be used with any subject matter, making it a general tool to support project-based learning.

FIGURE 4

Sample interview responses.

Make connections	"It helped to refer back and remember what we were talking about." "It is kind of hard to understand [the project] if you spread it out, and with the DQB, you connect [the ideas] together so it is easier."
Focus learning	"It helped me understand the questions that we are trying to answer in doing an activity and focus on it." "The teacher presented [the DQB] in order to keep students' minds focused on the questions we wanted to learn, instead of asking random questions that have nothing to do with the light unit."
Break questions	"It helped to talk about groups of questions instead of one big question and take one subquestion at a time." "Without the DQB, it would be harder to understand, because it broke questions into smaller ones so we can understand more."
Other	"Without DQB I would probably understand less because it is kind of a guideline of what we are doing." "DQB helped because in my mind, it is easier to understand pictures than words."

What do students say?

During enactments of these units, a sample population of 13 students was asked the following interview questions:

- What was the purpose of the DQB?
- Did it help you understand the main ideas?
- Would the unit be the same without it?

Students from various schools acknowledged the importance and value of the DQB. They believed it helped them to better understand the science concepts, focus their learning on the main questions, break big questions into subquestions, and organize things without jumping between subjects, making it easy to relate one thing to another. The categories helped students understand the activities and questions in each lesson. See Figure 4 for sample student answers.

Conclusion

The DQB is a tool that provides explicit connections between PBS activities and the driving question, organizes and focuses learning, helps students break big questions into smaller ones, and gives them a sense of ownership. The DQB was found to be helpful for both teaching and learning in inquiry-based units. For teaching, it is a visual road map that helps organize the unit and make its structure visible to all. For students, it supports learning science content, understanding the purpose of the various activities in the unit, and constructing and applying the scientific practice of asking questions. ■

Acknowledgment

The research reported here was supported in part by the National Science Foundation (ESI-0439352 and ESI-0227557). Any opinions expressed in this work are those of the authors and do not necessarily represent those of the funding agency.

References

Fortus, D., D. Grueber, J. Nordine, J. Rozelle, C. Schwarz, and A. Weizman. 2006. *Seeing the light: Can we believe our eyes?* East Lansing, MI: Michigan State University.

Krajcik, J., S. Dalpe, M. Heitzman, J. Merritt, A. Rogat, and Y. Shwartz. 2006. *How can I smell things from a distance?* Ann Arbor, MI: University of Michigan.

Krajcik, J., K.L. McNeill, and B.J. Reiser. 2008. Learning-goals driven design model: Developing curriculum materials that align with national standards and incorporate project-based pedagogy. *Science Education* 92: 1–32.

Singer, J., R.W. Marx, and J.S. Krajcik. 2000. Constructing extended inquiry projects: Curriculum materials for science education reform. *Educational Psychologist* 35(3): 165–178.

Wenger, E. 1998. *Communities of practice: Learning, meaning, and identity.* New York: Cambridge University Press.