Inquiry learning is an excellent way for students to get actively involved in science. It is essential that while inquiry learning is in progress, teachers continuously elicit students’ conceptions and take action to move students toward learning goals (Black and Wiliam 1998; Bell and Cowie 2001; Duschl 2003).

The informative questioning cycle
During inquiry activities, teachers need to ensure their students are making progress toward learning goals. The informative questioning cycle can help teachers and students achieve these goals through simple techniques that can redirect and improve the quality of students’ learning while it is in progress. The informative questioning cycle assists the teacher in making students’ thinking explicit so the teacher can help students develop deeper understanding. The teacher begins by eliciting a response from students that reveals the state of the students’ understanding. Next, the teacher recognizes the response by reflecting it back to the student or asking another follow-up question. The third step involves taking some form of action to help the student move toward the essence of the activity or concept. The process can be thought of as a cycle to reflect the ongoing nature of informative questioning throughout inquiry activities.

Setting and aligning learning goals
Science inquiry units, like all other instruction, should have an ultimate goal to focus daily activities. Conversely, each daily activity should contribute in some way to reaching the...
ultimate goal. The goals for an activity can consist of learning about a concept, such as density, or developing a process skill, such as using a balance or constructing a graph properly.

A useful analogy for thinking about daily activity goals is the preparation of food. Different ingredients are combined together because of their individual flavors, and the flavors of these ingredients together create the taste of the dish. Similarly, each activity in an inquiry unit must have an essence that, when combined with those from other activities, contributes to the ultimate instructional goal.

To determine what the essence of an activity might be, a teacher may ask: What will students need to know and be able to do at the end of the unit? What are the concepts and skills students need to acquire during each of the activities to reach the goal? If a certain activity does not contribute to the ultimate goal, the teacher should question why it is being included. While competencies that satisfy the criteria for the ultimate goal are not developed in a single activity, the contribution of each activity toward the ultimate goal should be clearly understood for each classroom activity.

Eliciting student responses

Eliciting questions serve the purpose of drawing out what students know and are able to do, and to help them learn how to share this information in an inquiry activity. Although teachers already use questions of this style, we suggest their purpose be changed to increase their informative potential. Asking students to provide evidence for an explanation, to share
predictions based upon previous experiences, and to describe patterns in their data are all ways that the teacher can elicit students’ thinking. Figure 1 includes a list of eliciting questions. Teachers should use the list as a source of suggestions, tailoring the questions to fit their own activities.

Eliciting questions may be used at any point in a lesson. For example, the teacher may use eliciting questions to determine students’ prior knowledge when introducing a new activity, or to focus class discussion around an important concept at the conclusion of an investigation. In some cases the teacher may choose to develop eliciting questions in advance by writing them into a lesson plan. At other times, such as when the students are collecting data, the eliciting questions may be more spontaneous and responsive to what the students are doing at a given time.

**Recognizing student responses**

Once teachers have successfully elicited students’ responses, they can acknowledge what the student has said in some way. Recognizing students’ responses makes clear the students’ contribution during whole class conversations or small group work and allows students to agree or disagree with what the teacher or other students have said. It should go beyond repeating students’ words verbatim; rather, teachers should incorporate the student’s comment into the ongoing classroom discussion (O’Connor and Michaels 1993), or rephrase the comment so that the student can acknowledg-
goal (Sadler 1989). There are a number of strategies teachers can employ in this final step (Figure 3).

**Informative questioning as assessment for learning**

In the context of inquiry, telling students whether their responses are right or wrong focuses them on whether they have the correct answer, rather than allowing them to explore how they are coming to know what they know (Duschl 2003). Teachers should avoid the pattern of asking a question, receiving a response from a student, evaluating the answer, and moving quickly to the next question. The targeted actions possible in the informative questioning cycle can help students to understand more clearly how they are thinking about concepts and processes and to lead them to reach inquiry learning goals. A sample conversation incorporating the entire cycle is provided in Figure 4. The sample is based upon the investigation “Sinking and Floating Objects” from the Foundational Approaches to Science Teaching curriculum (Pottenger and Young 1992), in which students are provided with a collection of sinking and floating objects and are asked to determine if it is possible to predict the volume of water a floating object will displace if its mass is known.

Informative questioning helps the teacher become aware of the students’ thinking and provides a basis for action. Practicing informative questioning is practicing high quality informal formative assessment, which improves student learning. We have evidence that teachers using informative questioning had students who performed better on several types of formative embedded assessments (e.g., predict-observe-explain, open-ended questions) and summative assessments (e.g., performance assessments, predict-observe-explain, open-ended questions) aligned with the learning goals of their curriculum (Ruiz-Primo and Furtak 2004).

**References**


**FIGURE 4** Sample learning conversation that demonstrates informative questioning during small group work.

<table>
<thead>
<tr>
<th>Ms. Yin’s example</th>
<th>Role of question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ms. Yin: Can you predict the displaced volume of this floating object now that its mass is known?</td>
<td>Making a prediction (eliciting)</td>
</tr>
<tr>
<td>Rich: I think that displaced volume will be about the same.</td>
<td>Asking Rich to provide evidence (eliciting)</td>
</tr>
<tr>
<td>Ms. Yin: How do you know? Can you show me some evidence from your graph that supports your prediction?</td>
<td>Asking Rich to provide an example (eliciting)</td>
</tr>
<tr>
<td>Rich: I’m not sure. I don’t see anything.</td>
<td>Revoicing Rich’s statement, noticing that Rich seems to understand the essence of the activity, but does not generalize from one object to the trend on the graph (recognizing)</td>
</tr>
<tr>
<td>Ms. Yin: Can you give me an example from your data table?</td>
<td>Promoting argumentation (acting)</td>
</tr>
<tr>
<td>Rich: Well, I have this container of sand, and it floated. Its mass is 11.84 grams, and it displaced 12 ml of water.</td>
<td></td>
</tr>
<tr>
<td>Ms. Yin: So Rich, you’re telling me that the volume of displaced water is equal to the mass in this container of sand, based upon the data you collected in the activity?</td>
<td></td>
</tr>
<tr>
<td>Rich: Yeah.</td>
<td></td>
</tr>
<tr>
<td>Ms. Yin: Okay Rich, you’re telling me the relationship for this one object. Ayita over here is saying something else—I heard her say a few minutes ago that the graph shows that mass and displaced volume are equal for all objects. Rich, why don’t you use your graph to see whether you agree or disagree?</td>
<td></td>
</tr>
</tbody>
</table>