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An Introduction to Formative Assessment Classroom Techniques (FACTs)

WHAT DOES A FORMATIVE ASSESSMENT-CENTERED CLASSROOM LOOK LIKE?

In a primary classroom, students are having a "science talk" to decide which organisms illustrated on a set of cards are called "animals." After using a *Card Sort* strategy to group the cards as "animals" and "not animals," the teacher encourages the students to develop a rule that could be used to decide whether an organism is an animal. The students share their ideas, openly agreeing or disagreeing with their peers. The teacher records the ideas that are most common among students and notes the reasoning students use. She notices many students think animals must have fur or legs and that humans are not animals and makes note of this to address in the next lesson. She then gives students an opportunity to regroup their cards, using the rule they developed as a class. She listens carefully as students explain their reasoning based on the "animal rule" they developed. The teacher adds new cards to the *Card Sort*. Some students decide they need to revise the rule to fit the new cards. The teacher probes deeper to find out why some students revised their thinking.

In an intermediate classroom, students use a *P-E-O Probe* to predict and explain whether the mass of an ice cube in a sealed ziplock bag will increase, decrease, or stay the same after it melts. Using the *Human Scatterplots* technique, the teacher quickly sees that students differ in their predictions and confidence in their answer. She then provides them with an opportunity to discuss their prediction and the justification for it in small groups. The teacher listens carefully and notes the preconceptions students bring to the problem, particularly concepts they may have encountered previously, such as ice floating, that seem to muddle their understanding of the conservation-of-matter phenomenon of ice melting. After students have had an opportunity to explain their thinking about what would happen to the mass of the ice cube after it melts, the teacher provides an opportunity for students to test their ideas by observing and recording the mass of an ice cube in a sealed ziplock bag before and after it melts. She notices how some students are starting to rethink their ideas. The class then comes together to discuss and reconcile their findings with their original predictions and ideas. The students use *Scientists' Ideas Comparison* to examine their new thinking and compare how closely their current ideas match the scientific explanation.

In a middle school classroom, the teacher uses a *Familiar Phenomenon Probe* to uncover students' explanations for the phases of the moon. Using the *Sticky Bars* strategy to anonymously display students' ideas, the teacher and the class could instantly see that most students believed the phases of the moon were caused by the shadow of the Earth on the moon. Knowing that this would be a difficult idea to change, the teacher designs a lesson that involves the students in constructing a model to visually see for themselves how the position of the moon in relation to the Earth and the sun results in the different moon phases. After students experience the model, they revisit their original explanations and have an opportunity to revise them. The next day, students are given a task of researching lunar eclipses. They work in small groups with *Whiteboards* to illustrate and explain the difference between an eclipse and a new moon. Students share their *Whiteboard* ideas and get feedback from the class and teacher regarding the differences in representing the two sun-Earth-moon phenomena. At the end of the lesson, students use *I Used to Think . . . But Now I Know* to reflect on their original explanation for the phases of the moon and describe how comparing the model of an eclipse with the model of a moon phase helped them better understand both phenomena.

In a high school chemistry class, small groups of students are using *A & D Statements* to discuss and reconcile their different ideas about the claim, "The mass of an iron object decreases as it rusts." One student who agrees with the claim is trying to persuade her classmates to consider her idea that rust is like a mold that eats and breaks down iron, causing it to lose mass. Another student who disagrees with the claim argues that the air is combined with the iron to make rust, which would add mass. Each group is trying to come up with a consensus idea and explanation to share with the class along with a method to test its idea. The teacher circulates among groups, probing further and encouraging argumentation. Students write a *Two-Minute Paper* at the end of class to share their thinking with the teacher and describe what they need to do next to test their ideas. The teacher uses this information to prepare for student inquiry the next day.

What do all of these classroom snapshots have in common? Each of these examples combines formative assessment techniques with instruction for a specific teaching and learning purpose. Often it is hard to tell whether a particular technique or strategy serves an instructional, assessment, or learning purpose since they are so intertwined. Students are learning while at the same time the teacher is gathering valuable information about their thinking that will inform instruction and provide feedback to students on their learning.

Each of these snapshots gives a brief glimpse into the different techniques teachers use to promote student thinking, uncover students' ideas, and use information about their students' progress in learning to improve their instruction. The teaching strategies in these snapshots are just a few of the 75 formative assessment classroom techniques (FACTs) described in Chapter 4, along with the underpinnings described in Chapters 1 through 3, that will help you understand and effectively use formative assessment. While you may be tempted to skip ahead and go directly to Chapter 4 to find FACTs you can use in your classroom, you are encouraged to read the preceding chapters. By having a firm knowledge base about the purposes and uses of formative assessment, as well as considerations for their use before you select a FACT, the image and implementation of formative assessment in your classroom will be sharper and more deliberately focused.

WHY USE FACTS?

Every day, science teachers are asking questions, listening carefully to students as they explain their ideas, observing students as they work in groups, examining student writing and drawings, and orchestrating classroom discourse that promotes the public sharing of ideas. These purposeful, planned, and often spontaneous teacher-to-student, student-to-teacher, and student-to-student verbal and written interactions involve a variety of assessment techniques. These techniques are used to engage students in thinking deeply about their ideas in science, uncover the preexisting ideas students bring to their learning that can be used as starting points to build upon during instruction, and help teachers and students determine how well individuals and the class are progressing toward developing scientific understanding.

"Assessment for learning is any assessment for which the first priority in its design and practice is to serve the purpose of promoting pupils' learning. It thus differs from assessment designed primarily to serve the purposes of accountability, or of ranking, or of certifying competence" (Black & Harrison, 2004).

The 75 science formative assessment classroom techniques, FACTs, described in this book are inextricably linked to assessment, instruction, and learning. The interconnected nature of formative assessment clearly differentiates the types of assessments we call assessments *for* learning from assessments *of* learning—the summative assessments used to measure and document student achievement. Although it is important to recognize that summative assessments can also be used formatively, they tend to be more formal in nature, tend to be given at an endpoint of instruction, and usually involve grading or other means of determining proficiency. Figure 1.1 describes the different types and purposes of assessment in the science classroom. Note that diagnostic assessment becomes formative assessment when the information is used by the teacher to improve teaching and learning. For example, a teacher can collect data in response to a probing question in order to identify the commonly held ideas students have about a phenomenon. But, if the data are not used to inform teaching and learning, then it is merely a diagnosis without action. In a medical context, this would be analogous to the sick patient who goes to the doctor and is diagnosed with a medical condition. To go beyond the diagnosis, the doctor would use the information collected diagnostically to design the best course of treatment so that the patient's health would improve.

Each FACT described in Chapter 4 is a type of question, process, or activity that helps to provide teachers and students with information about their factual, conceptual, and procedural understandings in science. These formative assessment techniques inform teaching by allowing the teacher to continuously gather information on student thinking and learning in order to make data-informed decisions to plan for or adjust instructional activities, monitor the pace of instruction, identify potential

Figure 1.1 Types and Purposes of Assessment

Diagnostic—To identify preconceptions, lines of reasoning, and learning difficulties.

Formative—To inform instruction and provide feedback to students on their learning.

Summative—To measure and document the extent to which students have achieved a learning target.

NOTE: Diagnostic assessment becomes formative when the assessment data are used to inform instruction.

misconceptions that can be barriers as well as springboards for learning, and spend more time on ideas that students struggle with. Formative assessment is also used to provide feedback to students, engaging them in the assessment of their own and their peers' thinking and learning. In addition to informing instruction and providing feedback, many of the formative assessment techniques included in this book initiate the use of metacognitive skills and promote deeper student thinking.

The FACTs described in this book are designed to be easily embedded into classroom instruction. They are primarily used to assess *before and throughout* the learning process, rather than at an endpoint of instruction (except for reflection). Their main purpose is to improve student learning and opportunities to learn through carefully designed instruction. They are not used for the summative purpose of accountability—measuring and reporting student achievement. The versatility of the techniques described accommodates a range of learning styles and can be used to differentiate instruction and assessment for individuals and groups of students. FACTs can be used to spark students' interest, surface ideas, initiate an inquiry, and encourage classroom discourse—all assessment strategies that promote learning rather than measure and report learning. A rich repertoire of FACTs enables learners to interact with assessment in multiple ways—through writing, drawing, speaking, listening, physically moving, and designing and carrying out investigations. Figure 1.2 lists a variety of purposes for using FACTs in the science classroom.

> "When data are used by teachers to make decisions about next steps for a student or group of students, to plan instruction, and to improve their own practice, they help *inform* as well as *form* practice; this is *formative assessment*. When data are collected at certain planned intervals, and are used to show what students have achieved to date, they provide a *summary* of progress and are *summative assessment*" (Carlson, Humphrey, & Reinhardt, 2003, p. 4).

Regardless of geographic area, type of school, diversity of student population, science discipline, and grade level science teachers teach in, every teacher shares the same goal. That goal is to provide the highest quality instruction that will ensure that all students have opportunities to learn the concepts and skills that will help them become science-literate students and adults. Formative assessment provides ongoing opportunities for teachers to elicit students' prior knowledge; identify the ideas they struggle with, accommodate, or develop as they engage in the process of learning; and determine the extent to which students are moving toward or have reached scientific understanding at an appropriate developmental level. FACTs help teachers continuously examine how students' ideas form and change over time as well as how students respond to particular teaching approaches. This information is constantly used to adjust instruction and refocus learning to support each student's intellectual growth in science.

Figure 1.2 Twenty Purposes for Using FACTs

- Activate thinking and engage students in learning
- Make students' ideas explicit to themselves and the teacher
- Challenge students' existing ideas and encourage intellectual curiosity
- Encourage continuous reflection on teaching and learning
- Help students consider alternative viewpoints
- Provide a stimulus for discussion and scientific argumentation
- Help students recognize when they have learned or not learned something
- Encourage students to ask better questions and provide thoughtful responses
- Provide starting points for student investigations and idea exploration
- Aid formal concept development and transfer
- Determine if students can apply scientific ideas to new situations
- Differentiate instruction for individuals or groups of students
- Promote the use of academic language in science learning
- Evaluate the effectiveness of a lesson
- Help students develop self-assessment and peer assessment skills
- Give and use feedback (student to student, teacher to student, and student to teacher)
- Encourage social construction of ideas in science
- Inform immediate or later adjustments to instruction
- Encourage and include participation of all learners
- Increase comfort in making one's own ideas public

HOW DOES RESEARCH SUPPORT THE USE OF FACTS?

The seminal report from the National Research Council, *How People Learn: Brain, Mind, Experience, and School* (Bransford, Brown, & Cocking, 1999), has significantly contributed to our understanding of how students learn science. This understanding has implications for what is taught in science, how science is taught, how science learning is assessed, and how to promote deeper understanding in science. Three core principles from this report strongly support the use of FACTs in the science classroom.

> **Principle 1:** If their [students'] initial understanding is not engaged, they may fail to grasp new concepts and information presented in the classroom, or they may learn them for purposes of a test but revert to their preconceptions (Bransford et al., 1999, p. 14).

This principle supports the use of FACTs as a way to elicit the prior ideas students bring to the classroom, making their thinking visible to themselves, their peers, and the teacher. Students do not begin science learning as blank slates waiting to be filled with knowledge. By knowing in advance the ideas students have already formed in their minds, teachers can design targeted instruction and create conditions for learning that take into account and build upon students' preconceived ideas. Students' own ideas and the instructional opportunities that use them as springboards provide a foundation on which formal concepts and skills in science can be developed. As students engage in learning experiences designed to help them develop scientific understandings, teachers keep their fingers on the pulse of students' learning, determining when instruction is effective in helping students revise or refine their ideas and make midcourse corrections as needed.

> **Principle 2:** To develop competence in an area of inquiry, students must (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application (Bransford et al., 1999, p. 16).

This principle points out the importance of factual knowledge but cautions that knowledge of a large set of disconnected facts is not sufficient to support conceptual understanding. Several of the FACTs described in Chapter 4 not only provide strategies for teachers to assess students' knowledge of facts and understanding of concepts but actually promote thinking that supports understanding. This thinking and the feedback students receive during the learning process help support the development of a conceptual framework of ideas. Teachers use the information on students' thinking to design opportunities that will help move students from novice learners to deeper, conceptual learners who can draw upon and retrieve information from their framework. As concept development is monitored, reinforced, and solidified, formative assessment techniques are also used to determine how well students can transfer their new knowledge and skills from one context to another.

> **Principle 3:** A "metacognitive" approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them (Bransford et al., 1999, p. 18).

John Flavel, a Stanford University psychologist, coined the term *metacognition* in the late 1970s to name the process of thinking about one's own thinking and learning. Since then, cognitive science has focused considerable attention on this phenomenon (Walsh & Sattes, 2005). Several FACTs described in this book promote the use of metacognitive strategies for self-regulation of learning. These strategies help students monitor their own learning by helping them predict outcomes, explain ideas to themselves, note areas where they have difficulty understanding scientific concepts, activate prior knowledge and background information, and recognize experiences that help or hinder their learning. White and Frederickson (1998) suggest that metacognitive strategies not be taught generically but rather be embedded into the subject matter that students are learning. The FACTs that support metacognition are designed to be seamlessly embedded into the science learning experiences that target students' ideas and thinking in science. They provide opportunities for students to have an internal dialogue that mentally verbalizes their thinking, which can then be shared with others.

Evidence from the research studies described in *How People Learn* (Bransford et al., 1999) indicates that when these three principles are incorporated into instruction, assessment, and learning, student achievement improves. This research is further supported by the metastudy described in *Assessment for Learning* (Black et al., 2003), which makes a strong case, supported with quantitative evidence, for the use of formative assessment to improve learning, particularly to raise the achievement levels of students who have typically been described as low performers.

CLASSROOM ENVIRONMENTS THAT SUPPORT FORMATIVE ASSESSMENT

In addition to contributing to our understanding of how students learn science, *How People Learn* (Bransford et al., 1999) has changed our view of how classroom environments should be designed that support teaching and learning. These characteristics relate directly to classroom climates and cultures where the use of FACTs is an integral part of teaching and learning. These environments include the following:

Learner-Centered Environment. In a learner-centered environment, teachers pay careful attention to the knowledge, beliefs, attitudes, and skills students bring to the classroom (Bransford et al., 1999, p. 23). In a learner-centered classroom, teachers use FACTs before and throughout instruction, pay careful attention to the progress of each student, and know at all times where their students are in their thinking and learning. All ideas, whether they are right or wrong, are valued in a learner-centered environment. Learners come to value their ideas, knowing that their existing conceptions that surface through the use of FACTs provide the beginning of a pathway to new understandings.

Knowledge-Centered Environment. In a knowledge-centered environment, teachers know what the goals for learning are, the key concepts and ideas that make up the goals, the prerequisites upon which prior and later understandings are built, the types of experiences that support conceptual learning, and the assessments that will provide information about student learning. In addition, these goals, key concepts and ideas, and prerequisite learnings can be made explicit to students as well so they can monitor their progress toward achieving understanding (Bransford et al., 1999, p. 24). The knowledge-centered environment uses FACTs to understand students' thinking in order to provide the necessary depth of experience students need to develop conceptual understanding. It looks beyond student engagement and how well students enjoy their science activities. There are important differences between science activities that are "fun" and those that encourage learning with understanding. FACTs support a knowledge-centered environment by promoting and monitoring learning with understanding.

Assessment-Centered Environment. Assessment-centered environments provide opportunities for students to surface, examine, and revise their thinking (Bransford et al., 1999, p. 24). The ongoing use of FACTs makes students' thinking visible to both teachers and students and provides students with opportunities to revise and improve their thinking and monitor their own learning progress. In a formative assessment-centered environment, teachers identify problem learning areas to focus on. They encourage students to examine how their ideas have changed over the course of a unit of study. Having an opportunity to examine their own ideas and share how and why they have changed is a powerful moment that connects the student to the teaching and learning process.

"An important feature of the assessment-centered classroom is assessment that supports learning by providing students with opportunities to revise and improve their thinking" (Donovan & Bransford, 2005, p. 16).

Community-Centered Environment. A community-centered environment is a place where students learn from each other and continually strive to improve their learning. It is a place where social norms are valued in the search for understanding, and both teachers and students believe that everyone can learn (Bransford et al., 1999, p. 25). Within this environment, FACTs are used to promote intellectual camaraderie around discussing and learning ideas in science. A science community-centered environment that uses FACTs encourages the following:

- Public sharing of all ideas, not just the "right answers"
- Safety in academic risk taking
- Shared revision of ideas and reflection
- Questioning and clarification of explanations
- Discussions with peers and use of norms of scientific argumentation
- Group and individual feedback on teaching and learning

A classroom "ecosystem" with these four overlapping environments is a place where students and teachers both feel part of an intellectual learning community that is continuously improving opportunities to teach and learn. It is a place where students and teachers thrive. It is a place where the connections between assessment, teaching, and learning are inseparable.

CONNECTING TEACHING AND LEARNING

Imagine the following scenario. Two friends are talking about their pets. One friend says that he taught his dog how to ride a skateboard. The other friend pulls out his skateboard and waits for the dog to ride it. After encouraging the dog to ride the skateboard with no luck, his friend says, "I said I taught him how to ride a skateboard. I didn't say he learned it." Without the effective use of formative assessment, teaching science to children can be like teaching your dog to ride a skateboard.

> "Learning can and often does take place without the benefit of teaching—and sometimes even in spite of it—but there is no such thing as effective teaching in the absence of learning" (Angelo & Cross, 1993, p. 3).

Teaching without learning can happen in science classrooms. The unfortunate truth is, even with what one perceives as his or her most engaging activity or best teaching moments, instruction can result in little or no gain in conceptual understanding if the time is not taken to find out students' initial preconceptions, ascertain their readiness to learn, monitor their learning to uncover any conceptual difficulties that can be addressed during instruction, and provide opportunities for feedback and reflection.

Even our brightest students can "learn" science for the purpose of passing a test but then quickly revert back to their misconceptions. Gaps often exist between what was taught and what students actually learned. Frequently, these gaps do not show up until after students have been summatively assessed through end-of-unit, district, or state assessments. At that point, it is often too late to go back and modify the lessons, particularly when assessments given months and even years later point out the gaps in student learning.

To stop this inefficient cycle of backfilling the gaps, teachers need better ways of determining where their students are in their thinking and understanding prior to and throughout the instructional process. Students need to be actively involved in the assessment process so that they are learning through assessment as well as providing useful feedback to the teacher and other students. Good formative assessment practices raise the quality of classroom instruction and promote deeper conceptual learning. Formative assessment ultimately empowers both the teacher and the student to make the best possible decisions regarding teaching and learning.

Linking assessment, instruction, and learning does not merely involve adding some new techniques to teachers' repertoire of strategies. The purposeful use of FACTs, on a continuous basis, provides much more—it organizes the entire classroom around learning and informs ways teachers can provide more effective learning experiences based on how their own students think and learn. Formative assessment can be used formally or informally, but it is always purposeful. The FACTs teachers use and the actions they take based on the information they have gained can be immediate, the next day, over the course of a unit, or even shared with and used by teachers who will have the same students the next year. If information about student learning is collected but not used as feedback for the teacher or student to take action on that will improve teaching or learning, then it is not formative. It becomes information for information's sake. For example, using a FACT to find out if students have misconceptions similar to the commonly held ideas noted in the research literature is interesting and important in and of itself. However, just knowing students have these ideas does not make this a formative assessment activity. It is the collecting of this information and the decisions made as a result of carefully examining the data that gives it the distinction of formative assessment and connects teaching to learning.

"Formative assessment isn't just about strategies to ascertain current knowledge—formative happens after the finding out has taken place. It's about furthering student learning during the learning process" (Clarke, 2005, p. 1).

MAKING THE SHIFT TO A FORMATIVE ASSESSMENT-CENTERED CLASSROOM

Formative assessment requires a fundamental shift in our beliefs about the role of a teacher. In a formative assessment-centered classroom, teachers interact more frequently and effectively with students on a day-to-day basis, promoting their learning (Black & Harrison, 2004). This interaction requires the teacher to step back from the traditional role of information provider and corrector of misconceptions in order to listen to and encourage a range of ideas among students. The teacher takes all ideas seriously, whether they are right or wrong, while helping students talk through their ideas and consider evidence that supports or challenges their thinking. During such interactions, the teacher is continuously thinking about how to shape instruction to meet the learning needs of their students and build a bridge between their initial ideas and the scientific understandings all students need to achieve.

"Even though teachers routinely gather assessment information through homework, quizzes, and tests, from the students' perspective, this type of information is often collected too late to affect their learning. It is very difficult to 'de-program' students who are used to turning in homework, quizzes, and tests, getting grades back, and considering it 'over and done with'" (Angelo & Cross, 1993, p. 7).

The teacher also plays a pivotal role in connecting assessment to students' opportunities to understand how science is conducted in the real world. Providing opportunities for students to make discoveries through their own investigations and authentic testing of ideas often surfaces new ideas and scientific ways of thinking. The provision of opportunities to speak, write about, and draw to organize thinking about such discoveries helps give rise to the students' view of science as an enterprise that values curiosity and personally meaningful insight (Shapiro, 1994).

Traditionally, science teachers were considered the providers of content that students then learned—teachers teach content and, as a result, students learn. The role of the teacher in a formative assessment-centered classroom is more of a facilitator and monitor of content learning. The teacher's role expands to helping students use strategies to understand how well they are learning. As a result, students become more conscious of the learning process itself and take greater responsibility for their own learning.

In a formative assessment-centered classroom, students learn to play an active role in the process of learning. They learn that their role is not only to actively engage in their own learning but to support the learning of others as well. They come to realize that learning has to be done *by* them—it cannot be done *for* them. They learn to use various FACTs that help them take charge of their own learning and assess where they stand in relation to identified learning goals. When they know what the learning target is, they use metacognitive skills along with peer and self-assessment strategies that enable them to steer their own learning in the right direction so they can take responsibility for it (Black & Harrison, 2004).

"The role of the learner is not to passively receive information, but to actively participate in the construction of new meaning" (Shapiro, 1994, p. 8).

Standards and learning goals have a significant impact on what teachers teach and students learn. Developing content knowledge that includes important scientific facts, conceptual ideas, skills of science, and habits of mind is at the center of science teaching and learning. As a result, teaching, assessing, and learning must take place with a clear target in mind. Standards should not become a checklist of content to be taught and assessed. Rather, they inform thinking about content as an interconnected cluster of learning goals that develop over time. By clarifying the specific ideas and skills described in the standards and articulated as learning goals, teachers are in a better position to uncover the gap between students' existing knowledge or skill and the knowledge or skill described in the learning goal. As a result, they are better able to monitor that gap as it closes (Black et al., 2003). While a particular FACT may determine the approach that teachers take to uncover students' ideas and modify instruction accordingly, the fundamental ideas and skills students need to learn remain the same. The focus of teaching and learning is on meeting goal-oriented learning needs rather than delivering a set of curricula at an established pace or teaching a favorite activity that does little to promote conceptual understanding.

Identifying and targeting learning goals is not the sole purview of the teacher. In a formative assessment-centered classroom, teachers share learning goals with students. This may involve breaking them down into the key ideas students will learn. Awareness of the goals and key ideas for learning helps students see the bigger picture of learning and make connections to what they already know about science concepts.

Another major shift that happens in a formative assessment-centered classroom is the recognition of the importance of students' ideas. Traditional instruction involved the passing on of information from the teacher or the instructional materials, with little thought given to building on students' existing conceptions. Students form many of their ideas in science before they ever formally encounter them in the classroom. These ideas come from previous school and life experiences and often conflict with the science understandings teachers are trying to develop. These preformed ideas are referred to in a variety of ways, including naive ideas, misconceptions, facets of understanding, partial understandings, commonly held ideas, or alternative conceptions. In this book, they will be referred to generically as *misconceptions,* although the term does not necessarily imply that the idea is completely incorrect. In some cases, misconceptions include partially formed correct ideas, but they are not yet put together in a way that is scientifically correct. It is important to recognize that these misconceptions have the following general characteristics (Connor, 1990):

> Putting one's ideas forward allows an opportunity for students to experience uncertainty and cognitive dissonance—the first step in building a bridge between students' ideas and scientific knowledge.

They form early, often before school begins, and continue lifelong.

They are subtle and can easily be missed by teachers who are unaware of them.

They are separable. Students retain their personal ideas even though they might give "school answers."

They are persistent, even after being disproved.

They are highly personal—each student sees experiences or draws conclusions from his or her point of view and constructs a personal meaning.

They appear to be incoherent to the teacher but make a lot of sense to the student.

A constructivist approach to teaching and learning posits that students' existing ideas make a difference to their future learning, so effective teaching needs to take these existing ideas into account. Research indicates that misconceptions held by students persist into adulthood if they are left unconfronted and unchallenged (Carre, 1993). However, this does not simply imply that misconceptions are a bad thing and must be confronted on the spot as "wrong ideas." Rather than immediately correcting misconceptions when they surface, teachers should gather information that may reveal how misconceptions can be used as starting points for instruction. Starting with students' ideas and monitoring their progress as they are guided through activities that help them recognize when their ideas no longer work for them and need to be modified or changed is the essence of an idea-focused, formative assessment classroom that promotes conceptual change.

As you gain a deeper understanding of the purposes and uses of formative assessment, you may find yourself reshaping techniques or developing new ones. You might find that some techniques work better than others depending on the scientific idea being assessed or the nature of the learners in your classroom. Many of the FACTs described in Chapter 4 may be new to you; others may be ones you use routinely. Regardless of how you use the FACTs or your familiarity with them, one important implication for the science classroom stands out—formative assessment provides an effective way for teachers to create classrooms that reflect current research on learning and provide greater opportunities for all students to achieve deeper levels of learning.