BSCS 5E Instructional Model

The guided inquiries in this book are designed using the BSCS 5E Instructional Model, commonly referred to as the 5E model (or the 5Es). Developed by the Biological Sciences Curriculum Study (BSCS), the 5E model is a learning cycle based on a constructivist view of learning. Constructivism embraces the idea that learners bring with them preconceived ideas about how the world works. According to the constructivist view, "learners test new ideas against that which they already believe to be true. If the new ideas seem to fit in with their pictures of the world, they have little difficulty learning the ideas … if the new ideas don't seem to fit the learners' picture of reality then they won't seem to make sense. Learners may dismiss them … or eventually accommodate the new ideas and change the way they understand the world" (Colburn 2003, p. 59). The objective of a constructivist model, therefore, is to provide students with experiences that make them reconsider their conceptions. Then, students "redefine, reorganize, elaborate, and change their initial concepts through self-reflection and interaction with their peers and their environment" (Bybee 1997, p. 176). The 5E model provides a planned sequence of instruction that places students at the center of their learning experiences, encouraging them to explore, construct their own understanding of scientific concepts, and relate those understandings to other concepts. An explanation of each phase of the BSCS 5E model—*engage, explore, explain, elaborate,* and *evaluate*—follows.

Engage

The purpose of this introductory stage, *engage,* is to capture students' interest. Here you can uncover what students know and think about a topic as well as determine their misconceptions. Engagement activities might include a reading, a demonstration, or other activity that piques students' curiosity.

Engage: Mrs. Custis generates curiosity about coral reefs by inviting students to interact with the text during a read-aloud ("Over in the Ocean," Chapter 11).

explore

In the *explore* stage, you provide students with cooperative exploration activities, giving them common, concrete experiences that help them begin constructing concepts and developing skills. Students can build models, collect data, make and test predictions, or form new predictions. The purpose is to provide hands-on experiences you can use later to formally introduce a concept, process, or skill.

Explore: Mrs. Quill challenges her students to design a roller coaster ("Roller Coasters," Chapter 14).

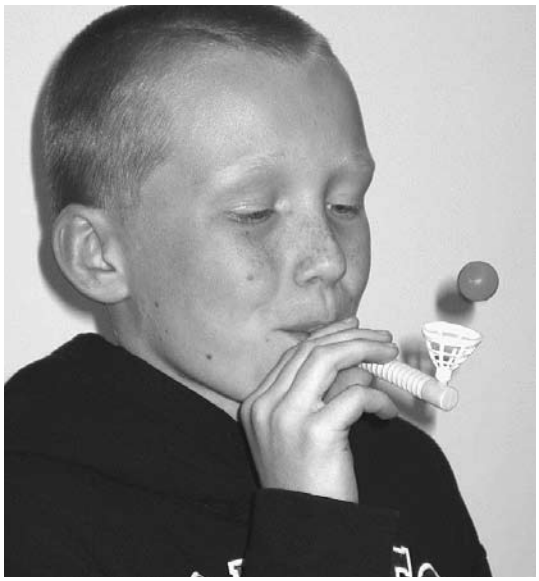
explain

In the *explain* stage, learners articulate their ideas in their own words and listen critically to one another. You clarify their concepts, correct misconceptions, and introduce scientific terminology. It is important that you clearly connect the students' explanations to experiences they had in the *engage* and *explore* phases.

Explain: Students in Miss Calpin's class create posters to help them explain which objects were attracted to a magnet ("That Magnetic Dog," Chapter 13).

elaborate

At the *elaborate* point in the model, some students may still have misconceptions, or they may understand the concepts only in the context of the previous exploration. Elaboration activities can help students correct their remaining misconceptions and generalize the concepts in a broader context. These activities also challenge students to apply, extend, or elaborate upon concepts and skills in a new situation, resulting in deeper understanding.



Elaborate: A student applies his understanding of risks and benefits by testing toys ("Imaginative Inventions," Chapter 19).

evaluate

In the *evaluate* phase, you evaluate students' understanding of concepts and their proficiency with various skills. You can use a variety of formal and informal procedures to assess conceptual understanding and progress toward learning outcomes. The evaluation phase also provides an opportunity for students to test their own understanding and skills.

Although the fifth phase is devoted to evaluation, a skillful teacher evaluates throughout the 5E model, continually checking to see if students need more time or instruction to learn the key points in a lesson. Ways to do this include informal questioning, teacher checkpoints, and class discussions. Each lesson in *More Picture-Perfect Science Lessons* also includes a formal evaluation such as a written quiz or poster session. These formal evaluations take place at the end of the lesson. A good resource for more information and practical suggestions for evaluating student understanding throughout the 5Es is *Seamless Assessment in Science: A Guide for Elementary and Middle School Teachers* by Abell and Volkmann (2006).

Evaluate: A student shows what he has learned about sun safety.

Cycle of Learning

The 5Es are listed above in linear order—engage, explore, explain, elaborate, and evaluate—but the model is most effective when you use it as a cycle of learning as in Figure 4.1 (p. 32).

Each lesson begins with an engagement activity, but students can reenter the 5E model at other points in the cycle. For example, in "Wiggling Worms," Chapter 10, students *explore* the characteristics of earthworms. Then they *explain* their earthworm observations and compare them to their classmates'. Next, the students reenter the *explore* phase by performing an experiment to find out if worms prefer damp or dry places. Moving from the *explain* phase back into the *explore* phase gives students the opportunity to add to the knowledge they have constructed so far in the lesson by participating in additional hands-on explorations.

The traditional roles of the teacher and student are virtually reversed in the 5E model. Students take on much of the responsibility for learning as they construct knowledge through discovery, whereas in traditional models the teacher is responsible for dispensing information to be learned by the students. Table 4.1 shows actions of the teacher that are consistent with the 5E model and actions that are inconsistent with the model.

In the 5E model, the teacher acts as a guide: raising questions, providing opportunities for exploration, asking for evidence to support student explanations, referring students to existing explanations, correcting misconceptions, and coaching students as they apply new concepts. This model differs greatly from the traditional format of lecturing, leading students step-by-step to a solution, providing definite answers, and testing isolated facts. The 5E model requires the students to take on much of the responsibility for their own learning. Table 4.2 (p. 33) shows the actions of the student that are consistent with the 5E model and those that are inconsistent with the model.

Using Children's Picture Books in the 5Es

Both fiction and nonfiction picture books can be valuable components of the 5E model when placed strategically within the cycle. We often begin lessons with a fiction book to pique students' curiosity or motivate them to want to learn more about a science concept. For example, Chapter 6 ("Bubbles") begins with a story about a young boy

Table 4.1 The BSCS 5Es Teacher

	What the teacher does	
	CONSISTENT **with the BSCS 5E model**	***INCONSISTENT*** **with the BSCS 5E model**
engage	• Generates interest and curiosity • Raises questions • Assesses current knowledge, including misconceptions	• Explains concepts • Provides definitions and conclusions • Lectures
explore	• Provides time for students to work together • Observes and listens to students as they interact • Asks probing questions to redirect students' investigations when necessary	• Explains how to work through the problem or provides answers • Tells students they are wrong • Gives information or facts that solve the problem
explain	• Asks for evidence and clarification from student • Uses students' previous experiences as a basis for explaining concepts • Encourages students to explain concepts and definitions in their own words, then provides scientific explanations and vocabulary	• Does not solicit the students' explanations • Accepts explanations that have no justification • Introduces unrelated concepts or skills
elaborate	• Expects students to apply scientific concepts, skills, and vocabulary to new situations • Reminds students of alternative explanations • Refers students to alternative explanations	• Provides definite answers • Leads students to step-by-step solutions to new problems • Lectures
evaluate	• Observes and assesses students as they apply new concepts and skills • Allows students to assess their own learning and group process skills • Asks open-ended questions	• Tests vocabulary words and isolated facts • Introduces new ideas or concepts • Promotes open-ended discussion unrelated to the concept

Adapted from *Achieving Scientific Literacy: From Purposes to Practices* (Bybee 1997).

Table 4.2 The BSCS 5Es Student

	What the student does	
	CONSISTENT **with the BSCS 5E model**	***INCONSISTENT*** **with the BSCS 5E model**
engage	• Asks questions such as, "Why did this happen? What do I already know about this? What can I find out about this?" • Shows interest in the topic	• Asks for the "right" answer • Offers the "right" answer • Insists on answers and explanations
explore	• Thinks creatively, but within the limits of the activity • Tests predictions and hypotheses • Records observations and ideas	• Passively allows others to do the thinking and exploring • "Plays around" indiscriminately with no goal in mind • Stops with one solution
explain	• Explains possible solutions to others • Listens critically to explanations of other students and the teacher • Uses recorded observations in explanations	• Proposes explanations from "thin air" with no relationship to previous experiences • Brings up irrelevant experiences and examples • Accepts explanations without justification
elaborate	• Applies new labels, definitions, explanations, and skills in new but similar situations • Uses previous information to ask questions, propose solutions, make decisions, design experiments • Records observations and explanations	• "Plays around" with no goal in mind • Ignores previous information or evidence • Neglects to record data
evaluate	• Demonstrates an understanding of the concept or skill • Answers open-ended questions by using observations, evidence, and previously accepted explanations • Evaluates his/her own progress and knowledge	• Draws conclusions, not using evidence or previously accepted explanations • Offers only yes-or-no answers and memorized definitions or explanations • Fails to express satisfactory explanations in his/her own words

Adapted from *Achieving Scientific Literacy: From Purposes to Practices* (Bybee 1997).

who uses a magic bubble maker to blow bubbles in all kinds of shapes … a kangaroo, a snake, and a cat, and so on. This read aloud during the engage phase sets up the question, "Are all free-floating bubbles round?" and is followed by an investigation to find out. A storybook, however, might not be appropriate to use during the explore phase of the 5Es in which you want students to take part in hands-on concrete experiences.

You should also avoid using books too early in the learning cycle that contain a lot of scientific terminology or "give away" information students could discover on their own. It is important for students to have opportunities to construct meaning and articulate ideas in their own words before being introduced to scientific vocabulary. Nonfiction books, therefore, are most appropriate to use in the explain phase only after students have had these opportunities. For example, in the explain phase of Chapter 13 ("That Magnetic Dog"), students first develop and share their own hypotheses about why certain objects are attracted to magnets. Then, students compare their hypotheses to the information presented in the nonfiction book *Magnetic and Nonmagnetic.* They are also introduced to the terms *magnetic* and *nonmagnetic* at this point.

Thoughtful placement of fiction and nonfiction picture books within the BSCS 5E Instructional Model can motivate students to learn about science, allow them to evaluate their findings in the light of alternative explanations, and help them understand scientific concepts and vocabulary without taking away from the joy of discovery.

References

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