Profiles in Science

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The BSCS Center for Professional Development compiled Profiles in Science—A Guide to NSF-Funded High School Instructional Materials, second edition, because we believe that the quality of instructional materials matters in the learning process for students and in the teaching process for teachers. As one of our colleagues so aptly expressed:

Before implementing well-designed instructional materials, I thought my role as a teacher was to take the textbook ... and create a curriculum.

Now, I don’t want to be a curriculum writer. I want to teach—to do the art of teaching.

Profiles in Science, second edition, provides updated profiles on instructional materials designed to help high school science teachers in grades 9–12 focus on “the art of teaching” and student learning. The instructional materials described in this document were developed originally with funding from the National Science Foundation (NSF), and thus have undergone field testing and critical review during their development. The developers of these materials based their work on the National Science Education Standards (NRC, 1996) and Benchmarks for Science Literacy (AAAS, 1993); consequently, these materials are truly “standards based.” The profiles were derived from the instructional materials themselves and checked for accuracy by the developers and publishers of the materials. Profiles in Science includes only those materials designed to be semester-long or full-year programs; we did not include NSF-funded modules or units.

Within Profiles in Science, the instructional materials are organized by discipline—earth science, physical science, life science, and integrated science. There is also a section for materials that are currently under development.

The purpose of Profiles in Science is to help those involved in the review and selection of instructional materials for high-school science become familiar with high-quality, research-based instructional materials. This document is intended to be a source of general information about NSF-funded instructional materials; it is not a source of evaluative data or critical analysis of the materials. Each profile includes the following information:

- a brief overview of the primary goals and principles of the materials;
- a listing of the program’s content by module/unit and chapter;
- a description of the instructional approach;
- information about the alignment with national standards;
- a brief description of the various components offered, including kits and equipment suppliers;
- methods used for assessing student learning;
- information about professional development opportunities; and
- contact information for the developer and the publisher of the materials.

The information included in this document was as accurate as possible at the time of publication. Please contact the developer or publisher of the instructional materials for more detailed information and for examination copies of the instructional materials.

References

Profiles in Science is available on the BSCS website as a downloadable pdf file. You may download, at no cost, one or all of the profiles from the BSCS website: www.bscs.org/Profiles.
Why should I consider *Profiles in Science*?

- Are you interested in a standards-based approach to improving student learning in science?
- Are you looking for ways to incorporate research-based instructional strategies, such as science as inquiry, into your science classroom?
- Would you like to create a classroom environment that promotes learning in science for all students?
- Do you need to generate discussion about the process of curriculum selection and implementation in your school or district?

If you answered yes to any of these questions, then *Profiles in Science* can help you find just the right program to meet your needs.

First, *Profiles in Science* offers the initial information you need in one place, which will save you time in searching for developers and publishers of high-quality high school science programs.

Second, *Profiles in Science* allows you to compare programs before you invest the time and effort in ordering and reviewing the instructional materials.

Third, *Profiles in Science* serves as an excellent awareness tool for teachers, administrators, parents, and other stakeholders who might not be familiar with standards- and inquiry-based instructional materials.

How might I use *Profiles in Science*?

- Engage teachers and administrators in a dialogue about the important features of high-quality instructional materials.
- Increase the awareness of NSF-funded high school instructional materials in all science disciplines.
- Compare instructional materials within a specific science discipline.
- Look across science disciplines and consider materials that might complement each other when offered as part of a comprehensive high school science program.
- Generate interest in standards-based instructional materials among colleagues, parents, and the larger community.
- Provide a basis for comparing current high school instructional materials with NSF-funded materials.

However you choose to use *Profiles in Science*, we hope you find the information valuable as you seek to improve the learning and teaching of science. If you decide to contact developers and/or publishers of the instructional materials, please mention that you learned about the materials through *Profiles in Science*, from the BSCS Center for Professional Development.
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<td>138</td>
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<td>10–12</td>
<td>SEPUP (D) University of California, Berkeley (D) Lab-Aids, Inc. (P)</td>
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BSCS and Professional Development

In 2008, BSCS will celebrate its fiftieth year of providing leadership in science education. As one of several research-based curriculum studies created in 1958 by the National Science Foundation, BSCS became a leader in the development of innovative curricula that provide opportunities for students to learn science by doing science through inquiry.

Although BSCS has provided professional development for science teachers and other science educators throughout its 50-year history, the organization has recently expanded its mission to provide greater resources and services in professional development through the BSCS Center for Professional Development. BSCS believes, and research supports, that the sustained implementation of standards-based curriculum, especially those that engage students in scientific inquiry, can transform the learning and teaching of science. To be successful, however, curriculum implementation must be supported by high-quality, ongoing professional development.

The BSCS Center for Professional Development provides professional development opportunities that guide districts through a process of effective curriculum reform, from learning about science as inquiry in the classroom to analyzing instructional materials through the AIM process to building department-, school-, and district-wide professional learning communities. The mission of the BSCS Center for Professional Development is to provide learning opportunities for science teachers and other science educators that transform their thinking and practice resulting in more rigorous, inquiry-based learning opportunities for science students.

One of the hallmarks of the BSCS Center for Professional Development is the BSCS National Academy for Curriculum Leadership (NACL). Through the NACL, BSCS helps schools and school districts build leadership capacity to sustain the implementation of standards-based instructional materials in all science disciplines, such as those described in Profiles in Science.

Interested? See the following page for more information about the NACL.
The BSCS National Academy for Curriculum Leadership (NACL) is a rich, in-depth three-year professional development experience for district leadership teams. Through the NACL, school and district leadership teams build on their capacity to design, implement, and sustain an effective high school science education program using inquiry-based instructional materials.

Why the NACL? Because . . .

- Science curriculum matters
- Teaching and learning matter
- Leadership matters
- Professional development matters

Research shows that for students to achieve success in science, they need inquiry-based curriculum aligned with standards and high quality teachers prepared to teach the content.

The NACL works because of its . . .

- Annual events and technical assistance over three years
- Research-based design
- Implementation of standards-based curricula
- Committed leadership teams that represent their districts
- Focus on developing professional learning communities with teachers and administrators working together
- Capacity building and ability of leadership teams to use the NACL processes, tools, and strategies throughout their districts

We invite you to join BSCS as a member of NACL. Together we can improve science education through curriculum leadership.

For more information, please contact us at nacl@bscs.org or call 719.531.5550 ext. 119.
NACL Model for Curriculum Implementation

Curriculum implementation is a complex process and involves several stages. The NACL Model for Curriculum Implementation provides a “road map” and some helpful ideas for schools and districts to consider before engaging in the process.

**Awareness: Laying the Foundation for Change**

In the first stage of the process, a school or district

- builds the awareness that high-quality, inquiry-oriented instructional materials matter in the learning process for students;
- initiates the development of leadership capacity through forming school- and district-based leadership teams; and
- establishes the need for change based on school and district data on student achievement, course enrollment, and teacher capacity.

**Selection: Making Evidence-Based Decisions**

In the second stage of the process, a school or district

- applies an evidence-based process for evaluating and piloting instructional materials which serves as a professional development strategy prior to implementation;
- develops common understandings among teachers about the characteristics of high-quality, inquiry-oriented instructional materials; and
- builds consensus during the decision-making process by establishing selection criteria based on research and the needs of students and teachers in the district.

**Scaling Up: Designing Support for Implementation**

In the third stage of the process, a school or district

- designs a transformative professional development program that supports the implementation of high-quality, inquiry-oriented instructional materials;
- incorporates a variety of professional development strategies and evaluation tools; and
- builds the local “improvement infrastructure” that will provide ongoing support within the system for effective implementation.

**Sustainability: Monitoring the Capacity for Reform**

In the fourth and final stage of the process, a school or district

- improves the capacity of the system to move forward and provide continuous improvement for teaching and learning by developing site-based leadership;
- monitors and adjusts interventions based on data that document student learning, teaching practice, formative classroom assessment, professional development support, and system infrastructure and capacity;
- sustains effective professional development using strategies such as examining student work, collaborative lesson study, and action research; and
- bases professional development on data of teachers’ attitudes about, abilities to use, and understanding of new instructional materials.
Characteristics of Reform-Oriented Instructional Materials

The instructional materials described in this publication were developed to be consistent with the vision of science education suggested in reform documents such as the National Science Education Standards (NRC, 1996), Benchmarks for Scientific Literacy (AAAS, 1993), and Designing Mathematics or Science Curriculum Programs (NRC, 1999). These documents describe high-quality, reform-oriented instructional materials as being standards based, inquiry based, and grounded in contemporary research on learning and teaching. These documents also suggest that quality instructional materials be guided by carefully developed conceptual frameworks and informed by thoughtful and comprehensive field-testing. Since we are suggesting that the instructional materials in this publication look different from traditional materials, it is important for us to first clarify what some of the distinguishing characteristics are before describing the materials themselves.

Reform-oriented instructional materials are standards based in that their science content, instructional approach, and assessment optimize student learning as described in the Standards.

The science content included in the National Science Education Standards (NSES) encompasses important aspects of recent science education reform. Specifically, the NSES suggest that the design of instructional materials reflect a change in emphasis.

<table>
<thead>
<tr>
<th>Less Emphasis On</th>
<th>More Emphasis On</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowing scientific facts and information</td>
<td>Understanding scientific concepts and developing abilities of inquiry</td>
</tr>
<tr>
<td>Studying subject matter disciplines for their own sake</td>
<td>Learning subject matter disciplines in the context of inquiry, technology, science in personal and social perspectives, and history and nature of science</td>
</tr>
<tr>
<td>Separating science knowledge and science process</td>
<td>Integrating all aspects of science content</td>
</tr>
<tr>
<td>Covering many science concepts</td>
<td>Studying a few fundamental science concepts</td>
</tr>
<tr>
<td>Implementing inquiry as a set of processes</td>
<td>Implementing inquiry as instructional strategies, abilities, and understandings to be learned</td>
</tr>
</tbody>
</table>

Adapted from the National Science Education Standards (NRC, 1996)

In addition, standards-based instructional materials often provide assessments that are consistent with the content in the standards as well as other teacher-support resources. In general, the resources provided in the instructional materials are intended to help teachers use effective teaching strategies to create learning environments conducive to the development of scientific reasoning abilities and a conceptual understanding of the content described in the Standards. The NSES assessment may be different from that of more traditional science instruction.
### Standards-Based Teaching and Assessment

<table>
<thead>
<tr>
<th>Less Emphasis On</th>
<th>More Emphasis On</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focusing on student acquisition of information</td>
<td>Focusing on student understanding and use of scientific knowledge, ideas, and inquiry processes</td>
</tr>
<tr>
<td>Asking for recitation of acquired knowledge</td>
<td>Providing opportunities for scientific reasoning, discussion, and debate among students</td>
</tr>
<tr>
<td>Assessing scientific knowledge</td>
<td>Assessing scientific understanding and reasoning</td>
</tr>
<tr>
<td>Assessing what is easily measured</td>
<td>Assessing what is most highly valued</td>
</tr>
</tbody>
</table>

Adapted from the *National Science Education Standards* (NRC, 1996)

Reform-oriented instructional materials are inquiry-based and support inquiry as a teaching strategy, as well as the abilities to do and the understandings about science as inquiry.

Inquiry-based instructional materials are designed to support inquiry as a strategy for teaching science concepts. That is, the materials are intended to help teachers as they engage students in the formulation and pursuit of scientifically oriented questions. Using inquiry as a teaching strategy requires substantial changes in instructional emphases.

### Changing Emphases to Promote Inquiry

<table>
<thead>
<tr>
<th>Less Emphasis On</th>
<th>More Emphasis On</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities that demonstrate and verify science content</td>
<td>Activities that investigate and analyze science questions</td>
</tr>
<tr>
<td>Investigations confined to one class period</td>
<td>Investigations over extended periods of time</td>
</tr>
<tr>
<td>Process skills out of context</td>
<td>Process skills in context</td>
</tr>
<tr>
<td>Getting an answer</td>
<td>Using evidence and strategies for developing or revising an explanation</td>
</tr>
<tr>
<td>Science as exploration and experiment</td>
<td>Science as argument and explanation</td>
</tr>
<tr>
<td>Individuals and groups of students analyzing and synthesizing data without defending a conclusion</td>
<td>Groups of students often analyzing and synthesizing data after defending conclusions</td>
</tr>
<tr>
<td>Doing few investigations in order to leave time to cover large amounts of content</td>
<td>Doing more investigations in order to develop understanding, ability, values of inquiry and knowledge of science content</td>
</tr>
<tr>
<td>Concluding inquires with the result of the experiment</td>
<td>Applying the results of experiments to scientific arguments and explanations</td>
</tr>
<tr>
<td>Private communication of student ideas and conclusions to the teacher</td>
<td>Public communication of student ideas and work to classmates</td>
</tr>
</tbody>
</table>

Adapted from the *National Science Education Standards* (NRC, 1996)
Inquiry-based instructional materials typically encourage students to develop their own methods for collecting, analyzing, and evaluating scientific data. In addition, students using these materials learn by collaboratively developing, justifying, communicating, and evaluating scientific explanations. Inquiry-based instructional materials also prompt students to think about the nature of scientific inquiry, such as how scientists use evidence and logic to establish and revise knowledge. Therefore, in addition to providing discipline-specific science content, inquiry-based instructional materials aim to help students develop both the abilities to do and understandings about scientific inquiry. Examples of abilities and understandings of inquiry are provided in the table below.

### Examples of Science as Inquiry from the National Science Education Standards

<table>
<thead>
<tr>
<th>Abilities to do Inquiry</th>
<th>Understandings about Inquiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students identify questions that can be answered through scientific investigations.</td>
<td>Scientists’ work involves asking and answering questions and comparing answers with what scientists already know about the world.</td>
</tr>
<tr>
<td>Students design and conduct scientific investigations.</td>
<td>Scientists in different scientific domains employ different methods, core theories, and standards to advance scientific knowledge and understanding.</td>
</tr>
<tr>
<td>Students develop descriptions, explanations, predictions, and models based upon evidence.</td>
<td>Scientists construct explanations that emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.</td>
</tr>
<tr>
<td>Students communicate scientific procedures and explanations.</td>
<td>Two ways that scientists evaluate the explanations proposed by other scientists are by examining evidence and identifying faulty reasoning.</td>
</tr>
</tbody>
</table>

Adapted from the National Science Education Standards (NRC, 1996)

Reform-oriented instructional materials are grounded in contemporary research on learning and teaching.

The book, How People Learn (NRC, 2000), synthesized a large body of research on learners and learning and on teachers and teaching. From this research, several key findings emerged that are summarized in the table below.

### Key Findings from How People Learn

- Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information that are taught, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom.

- To develop competence in a science discipline, students must (a) have a deep foundation of usable knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application.

- 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.

Adapted from How People Learn (NRC, 2000)
When the design of instructional materials is informed by contemporary research findings, such as those discussed in *How People Learn*, the resulting materials tend to share several common characteristics: a) teaching suggestions and numerous student prompts intended to elicit preconceptions and prior knowledge, b) an emphasis on conceptual understanding, higher order thinking, and sensitivity to the processes of knowledge construction, and c) prompts that encourage students to reflect and evaluate their own emerging understanding of science concepts.

**Reform-oriented instructional materials are based on a carefully developed conceptual framework.**

A conceptual framework describes the outcomes (usually content standards or benchmarks) and performance assessments that guide the development of instructional materials. When instructional materials are based on a carefully developed conceptual framework, the content presented in the materials tends to be comprehensive, consistent, and presented in a manner that is logical, coherent, and developmentally appropriate (for examples of how conceptual frameworks can be used to develop quality instructional materials, see AAAS, 2000; BSCS, 1993).

**Reform-oriented instructional materials are revised as a result of thoughtful and comprehensive field testing.**

Instructional materials that have been revised as a result of thoughtful and comprehensive field testing are likely to reflect an enhanced understanding of the needs of both students and teachers. Field-tested materials tend to reflect an understanding of a) how diverse learners might achieve the intended outcomes, b) the prior understandings students should have to progress coherently through the content, c) the understandings that teachers will need to possess or develop to facilitate student learning, and d) the resources (for example, time, materials, facilities) necessary to implement the instructional materials.

**Summary**

The instructional materials described in this publication are designed to be consistent with current science curriculum reform efforts. Specifically, reform-based instructional materials can be characterized by

- aligning closely with standards;
- emphasizing inquiry abilities, understandings, and teaching strategies;
- supporting research-based implications for learning and teaching science;
- presenting content in a coherent way; and
- representing a tested product for students and teachers.

However, since *Profiles in Science*, is not a source of evaluative data or critical analyses of these instructional materials, it is for you to determine the degree to which these instructional materials address and incorporate the characteristics presented.

**References**


At a Glance

Active Physical Science combines two of our most popular proven programs to form a single physical science course that meets both state and national requirements. This comprehensive course is composed of two units: Active Physics and Active Chemistry, with a total of 12 chapters. The curriculum was developed using an instructional strategy that combines guided-inquiry and whole class instruction with appropriate content.

Active Physical Science is the first and only project-based inquiry program that enables students of all learning levels to embrace fundamental concepts of both physics and chemistry. Students are introduced to these concepts on an appropriate basis as they explore issues that deal with sports, transportation, the home, roller coasters, atomic structure, special effects, educational games, and chemistry shows. Each chapter is independent of any other chapter, so the subjects can be taught in any order.

Active Physical Science was written by a dedicated team of physicists, chemists and high school teachers and supported by prominent technical editors, educational technology specialists, cognitive scientists, and mathematics curriculum specialists. The two units composing Active Physical Science meet nationwide frameworks and have been developed with the National Science Education Standards (NSES) in mind. The materials are written for use by all students, including special education and honor students.

Instructional Design

Each Active Physical Science chapter begins with a Scenario, a realistic event or situation the student might actually have experienced or can imagine participating in at home, in school, or in the community. A Chapter Challenge is then presented where students are given a problem they will be expected to solve or complete using knowledge they will gain in the chapter.
The Chapter Challenge is the heart and soul of *Active Physical Science*. Each *Active Physical Science* activity begins with a What Do You Think? question that elicits students’ prior understandings. Eliciting prior understandings helps teachers learn what their students think about the topic and engages students in thinking about the goal of inquiry to be addressed in the Physics Talk (or Chem Talk) section of the activity, which summarizes the physics principles and includes equations where appropriate.

After students complete the activity, they will relate it to the larger Chapter Challenge in the Reflecting on the Activity and the Challenge section. The activity concludes with a Physics To Go (or Chemistry to Go) assignment that provides additional questions and problems to be completed outside of class. The Chapter Assessment is the return to the Chapter Challenge. Students are able to review the chapter as they discuss the synthesis of the information into the required context of the challenge. The Science You Learned section provides students with a sense of accomplishment and serves as a quick review of all that was learned in the preceding weeks.

As students work together in small groups, they acquire the knowledge and information needed to address the series of challenges presented through the chapter scenarios. The curriculum encourages students to use the same set of inquiry processes as scientists. The Activities associated with each chapter introduce relevant events, scenarios, and real-life challenges that are pertinent to the student’s everyday life. The curriculum follows the five-stage learning cycle model: Engage, Explore, Explain, Elaborate, and Evaluate.

**Standards Alignment**

*It’s About Time* provides a chart on its Web site that correlates *Active Physical Science* to the NSES. A correlation chart is also found within the *Teacher’s Edition*. *Active Physical Science* was designed and developed to provide teachers with instructional strategies that model the science teaching standards. The program facilitates learning while developing students as self-directed learners. It also engages teachers in an ongoing assessment of their teaching and students’ understanding. Other content standard strengths include science as inquiry and the unifying concepts and processes. Correlation of the content standards addressing science and technology and science in personal and social perspectives is dependent on the actual chapter used.
Components

The Student Text, three-volume Teacher’s Edition, teacher resources, Active Physical Science Kits, and videos are all available from the publisher.

Student Text

Active Physical Science combines two proven programs—nine chapters from Active Physics with three chapters from Active Chemistry—to form a core physical science course. The chapters are divided into the following sections:

- **Scenario**—begins the chapter with a realistic event or situation in science.
- **Challenge**—presents students with the problem they will be expected to solve.
- **Criteria**—explains how students will be graded.
- **Goals**—presents students with a list of goals for completing science inquiry.
- **What Do You Already Know?**—encourages students to share their understanding.
- **Investigate**—students participate in experiments, fieldwork, or search the Internet.
- **Reading Sections**—provides text, illustrations, and photographs for greater conceptual insight.
- **Reflecting on the Activity and the Challenge**—prompts students to consider how inquiry helps solve the challenge.
- **Science to Go**—questions students on key principles and concepts introduced.
- **Inquiring Further**—deepens students’ thinking of new concepts and skills.
- **Stretching Exercises**—challenges students with in-depth problems, questions, and exercises.
- **Chapter Assessment**—asks students to complete the challenge they were presented at the beginning of the chapter (using the activities as a guide).
- **Science You Learned**—lists science terms, principles, and skills from the chapter.
- **Physics at Work**—features real people in real jobs, demonstrating how the principles learned are being applied everyday, everywhere.

Teacher’s Edition

The Teacher’s Edition is a three-volume set, offering the following features:

- **Perforated and three-hole punched**—allows individual customizing.
- **Introduction to Active Physical Science**—provides an outline of the ten “Big Ideas” as well as goals and expectations for the program. Also offers additional notes on what teachers can expect to happen in the classroom and some hints for managing collaborative group learning and organizing materials and supplies.
- **Chapter Overviews**—provides an outline of the themes and specific content of each chapter. Also includes an extensive list of materials and sample assessment rubrics for the Chapter Challenges and key components of the curriculum design.
- **Activity Prefaces**—offer background information on the physics and chemistry content being taught, plus a careful guide through all of the preparations. Sample answers for all questions, including the Think About It questions, are included, as are correlations to the NSES.
- **Reproducible Pages**—including blank data tables and copymasters of key diagrams and maps that appear in the Student Text.

The Teacher’s Edition also includes assessments, evaluation criteria, scientific content, graphs, and diagrams.

Software

- **Constructing Physics Understanding (CPU) for Active Physics CD-ROM**—enables students to build powerful visual models of abstract phenomena such as nature of matter, light waves, and magnetic and electrical forces (60 simulation activities).
- **Spreadsheet Software**—may be used in conjunction with the student modules to increase student participation and learning.

Videos

Videos capture students’ attention while exploring a variety of the physics topics. It’s About Time offers a
Professional Development

Materials
Web-based teacher enhancement for the curricula is available at the Active Physical Science Web site. The Internet site supports the adoption and implementation of the programs. Each Active Physical Science chapter has its own Web page, and each activity includes background information about major topics covered.

Assessment
For the culmination of each chapter, students are required to demonstrate the usefulness of their newly acquired knowledge by adequately meeting the challenge posed in the chapter introduction. The Chapter Challenge forms the focus of chapter activities and content as well as the final assessment. The final Chapter Challenge assessment asks students to tie together all they have learned throughout the activities. Teacher assessment tools are included with the student print materials, such as sample assessment rubrics for the Chapter Challenges, key components of each activity, and chapter tests. The Reflecting on the Activity, Physics to Go, Chem to Go and Stretching Exercises also provide additional assessment opportunities.

Professional Development
It’s About Time is committed to working with school systems to assist in the process and help implement our standards-based programs. The publisher provides a full range of professional development services. The Professional Development Department will work with each district to design a customized implementation plan that addresses each district’s unique needs.

Equipment Suppliers
The hands-on materials necessary to do each of the Active Physical Science activities have been specially designed and packaged. It’s About Time’s Kit Division will work with each school or district closely to plan a package that will fit their needs. The publisher also offers training sessions for the instructional staff on various topics related to equipment and its use in the classroom. Many items in the kits are custom-made, and items can be purchased as group kits or individually. Each kit is designed to serve 28–35 students.