Introduction To High School Science Course Standards

The South Carolina Science Curriculum Standards, adopted by the State Board of Education in January 2000, were developed from the National Science Education Standards and were organized in the same way as the national standards—that is, into the major areas of inquiry, life science, physical science, and Earth science. Other areas of the National Science Education Standards (nature of science, technology, history of science, and science in social and personal perspectives) were integrated into these four major areas. The K–8 standards are grade-level specific, as this is a requirement of the South Carolina Education Accountability Act. The need to develop course-specific standards was recognized by the writing team for the state science standards. However, because of limited time and resources, the high school standards team believed this would be a logical next step in the standards development process. In addition, high school teachers have asked for further clarification of the intent of the very broad science standards. Thus, the idea for the development of High School Science Course Standards, Objectives, and Activities was born. The intended audience for this document is the high school science teacher. However, administrators can also use the document to make informed district-level and state-level curriculum and assessment decisions.

In September 2000, the project was announced and a call for team members was extended. The development team was selected, and the project began with the first meeting in January 2001. The High School Science Course Standards, Objectives, and Activities document is based on the January 2000 science standards, and all science standards are addressed in at least one of the course guides. *We have not developed any new standards.* Since the South Carolina Science Curriculum Standards were intended to convey what all students should know and be able to do in order to become scientifically-literate citizens, some topics for chemistry and physics were not included but could have been under the existing standards. Thus, for chemistry and physics, standards now have been expanded to include knowledge above basic scientific literacy. Chemistry and physics teachers should take note of the fact that the course guides for these areas build on the foundation laid in a strong ninth-grade physical science course. The South Carolina Department of Education requires that all students have the opportunity to learn the physical science course standards by the end of the tenth grade year.

How is this document organized? Each set of course standards begins with a course description that can be used in your course registration guides distributed to students in late winter. Depending on your unique situation, you may want to add information to these general descriptions, especially for honors or Advanced Placement courses or for courses that may have an additional focus (for example, Earth/Environmental Science). The preface to each course guide gives additional information about the intent and focus of the course and any prerequisites. Inquiry is essential to the study of science. It is the way we learn science and acquire new information. Inquiry must be the method by which science content is learned. This message is conveyed at the beginning of each set of

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course standards. Safety is always of primary consideration in science instruction. High school teachers who have not already participated in the Lab Safety and Tools CD-ROM workshop[1] should do so at their earliest convenience. In the chart for each course, the code used (for example, IV.A.1.a) refers to the actual South Carolina science curriculum standard being referenced. The science standard is stated in the next column, followed by the performance objective or competency. The writing team has defined an objective (competency) as an observable student behavior, one which a teacher can easily monitor and use to gauge student understanding and progress in learning science or engaging in inquiry. Suggested activities and labs are suggestions. Others are certainly possible and encouraged. High school science teachers are welcome to send additional activities, and we will post them on the SDE Web site (www.sctlc.com).

The vision of the writing team is that the High School Science Course Standards, Objectives and Activities document will provide the basis for greater consistency and opportunity to learn in course offerings across the state, clear up misconceptions in regard to the state science standards, and provide the information needed to create inquiry-based, rigorous, and exciting science courses at the high school level. It is hoped that High School Science Course Standards will put all high school teachers on the same page with respect to interpretation of the standards, observable student behaviors while learning the standards, and appropriate activities that the teacher should plan in order to provide opportunity to learn for all of our students. Schools struggling to raise the level of education will have access to these blueprints of what each science course should be like.

How can this document be used? District and school curricula, instruction, and assessment should reflect these standards and objectives. Classroom instruction, units of study, and learning experiences should reflect the suggestions made in the activity column, although other activities are encouraged. State-level assessment should be based on the South Carolina Science Curriculum Standards and High School Science Course Standards. The course standards should not limit assessment but should better inform the PACT test item developers and the PACT item reviewers of the intent of the science standards at the high school level. High School Science Course Standards can serve as the basis for the development of the end-of-course test for physical science and biology. The state science standards, used along with this document, will provide the basis for the evaluation and selection of instructional materials. Professional development for high school teachers is clearly informed by this document.

What other documents will be developed to assist teachers? Activities, labs, demos, other resources identified in this document will be clearly described and placed on the SDE Web site. Links from this document to Web sites with complete lesson plans, activities, and other resources will be provided. We would also like to develop a list of basic science materials that are absolutely essential to the effective teaching of high school science.

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Will other high school science course standards, objectives, and activities be developed? Yes. Additional science course standards will be developed as the State Department of Education receives funding to do so. Others that we would like to develop include environmental science, marine science, applied physics, anatomy and physiology, astronomy, and integrated science.

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Inquiry Standards Are to Be Woven throughout All Science Courses

A major objective of science instruction is to promote scientific thinking. One way to accomplish this in the laboratory is to avoid giving too much direction in experimentation. The ultimate goal would be for students to design their own experiments, including purposes, hypotheses, procedures, data collection and analysis, and conclusions. A good way to lead students to this level of thinking is to begin with experiments that have clearly defined goals but no clearly defined procedures or equipment lists. Laboratory time must then be focused on solving problems and analyzing the components of a well-designed investigation. Much of what is performed is called "guided inquiry." Inquiry is not an isolated unit of instruction and should be embedded throughout the content areas.

The nature of science and technology are incorporated within this area.

A. Identify Questions and Concepts that Guide Scientific Investigations
   Experimental design should demonstrate logical connections between a knowledge base and conceptual understanding.
   1. Formulate a testable hypothesis based on literary research and previous knowledge.
   2. Identify and select experimental variables (independent and dependent) and controlled conditions.

B. Design and Conduct Investigations
   Prior knowledge about major concepts, laboratory apparatus, laboratory techniques, and safety should be used in designing and conducting a scientific investigation.
   1. Design a scientific investigation based on the major concepts in the area being studied.
   2. Select and use appropriate instruments to make the observations necessary for the investigation, taking into consideration the limitations of the equipment.
   3. Identify technologies that could enhance the collection of data.
   4. Select the appropriate safety equipment needed to conduct an investigation (e.g., goggles, aprons).
   5. Suggest safety precautions that need to be implemented for the handling of materials and equipment used in an investigation.
   6. Describe the proper response to emergency situations in the laboratory.
   7. Conduct a laboratory investigation with repeated trials and systematic manipulation of variables.
   8. Identify possible sources of error inherent in an experimental design.
   9. Organize and display data in usable and efficient formats, such as tables, graphs, maps, and cross sections.
   10. Draw conclusions based on qualitative and quantitative data.

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11. Discuss the impact of sources of error on experimental results.
12. Communicate and defend the scientific thinking that resulted in conclusions.

C. Use Technology and Mathematics to Improve Investigations and Communications

Scientific investigations can be improved through the use of technology and mathematics. While it is acknowledged that the "system international" or SI system is the accepted measurement system in science, opportunities to use the English System are encouraged.

1. Select and use appropriate technologies (e.g., computers, calculators, Calculator Based Laboratories (CBL) to enhance the precision and accuracy of data collection, analysis, and display.
2. Discriminate between data that may be valid or anomalous.
3. Select and use mathematical formulas and calculations to extend the usefulness of laboratory measurements.
4. Draw a "best fit" curve through data points.
5. Calculate the slope of the curve and use correct units for the value of the slope for linear relationships.
6. Calculate interpolated and predict extrapolated data points.
7. Perform dimensional analysis calculations.

D. Formulate and Revise Scientific Explanations and Models Using Logic and Evidence

Scientific explanations and models are developed and revised through discussion and debate.

1. Construct experimental explanations or models through discussion, debate, logic, and experimental evidence.
2. Develop explanations and models that eliminate bias and demonstrate the use of ethical principles. (Relates to Science in Social and Personal Perspectives)
3. Revise explanations or models after review.

E. Recognize and Analyze Alternative Explanations and Models

Scientific criteria are used to discriminate among plausible explanations.

1. Compare current scientific models with experimental results.
2. Select and defend, based on scientific criteria, the most plausible explanation or model.

F. Communicate and Defend a Scientific Argument

Experimental processes, data, and conclusions should be communicated in a clear and logical manner.

1. Develop a set of laboratory instructions that someone else can follow.
2. Develop a presentation to communicate the process and conclusion of a scientific investigation.

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G. Understandings about Scientific and Technological Inquiry

Historical scientific knowledge, current research, technology, mathematics, and logic should be the basis for conducting investigations and drawing conclusions.

1. Analyze how science and technology explain and predict relationships.
   a. Defend the idea that conceptual principles and knowledge guide scientific and technological inquiry.
   b. Explain how historical and current scientific knowledge influences the design, interpretation, and evaluations of investigations.
      1) Discuss the reasons scientists and engineers conduct investigations.
      2) Defend the use of technology as a method for enhancing data collection, data manipulation, and advancing the fields of science and technology.
      3) Explain how mathematics is important to scientific and technological inquiry.
      4) Explain why scientific models and explanations need to be based on historical and current scientific knowledge.
      5) Understand that scientific explanations must be logical, supported by the evidence, and open to revision.

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