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**Report on the Review of the
Science
High School Course Standards**

Physical Science & Biology

March 2002



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INTRODUCTION

The South Carolina Education Accountability Act of 1998 establishes an accountability system for public education that focuses on improving teaching and learning so that students are equipped with a strong foundation in the four primary academic disciplines and a strong commitment to lifelong learning. Academic standards are used to focus schools and districts toward higher performance by aligning the state assessments to those standards. The implementation of quality standards in classrooms across South Carolina is dependent upon systematic review of adopted standards, focused teacher development, strong instructional practices, and a high level of student engagement. Pursuant to Section 59-18-310 of the Education Accountability Act, the State Board of Education, through the State Department of Education, is responsible for developing end of course tests for gateway courses in English/language arts, mathematics, science, and social studies for grades nine through twelve. Section 59-18-320 requires the Education Oversight Committee to review and approve the assessments before any assessment is fully implemented. It also requires the Education Oversight Committee to be active in the development of any new standards and assessments developed by the South Carolina State Board of Education.

“Any new standards and assessments required to be developed and adopted by the State Board of Education, through the Department of Education, must be developed and adopted upon the advice and consent of the Education Oversight Committee.”

In the summer and fall of 2001, The State Department of Education developed curriculum standards for two high school science benchmark courses – physical science and biology. The standards were adaptations of the standards for grades nine through twelve from the South Carolina Science Curriculum Standards adopted by the State Board of Education in 2000. This document presents recommendations for modifications to the Science High School Course Standards for Physical Science and Biology from the Education Oversight Committee. These recommendations were compiled under the advisement of three review teams: a national review team of science educators representing national or other state organizations; a parent, business, and community leaders team drawn from various geographical areas in South Carolina; and, a special educator team drawn from the various school districts in South Carolina. Prior to the meetings of these three committees, the State Department of Education disseminated the Course Standards to educators around the state for review.

It is important to note that the adopted South Carolina Science High School Course Standards represent the work of many educators, and that this review of the standards was undertaken to identify ways in which their work could be strengthened and supported. The Education Oversight Committee expresses its appreciation to those educators and commends their utilization of national source documents and their commitment to the achievement of all students. The Education Oversight Committee intends that its work further their work and, ultimately, ensure that all students are knowledgeable and capable.

I. REVIEW PROCESS

The review of the South Carolina Science High School Course Standards began with focus on the accomplishment of goals articulated in the Education Accountability Act (EAA) of 1998. The legislation specifies: “The standards must be reflective of the highest level of academic skills with rigor necessary to improve the curriculum and instruction in South Carolina’s schools so that students are encouraged to learn at unprecedented levels and must be reflective of the highest level of academic skills at each grade level.” (Article 3, 59-18-300)

The South Carolina Science High School Course Standards Review Process emphasized the application of the criteria addressing comprehensiveness/balance, rigor, measurability, manageability,

and organization/communication. State Department of Education representatives, district and university curriculum leaders, and Education Oversight Committee (EOC) staff collaborated to identify the standards review criteria. Decisions on the criteria to be used were based on a comprehensive review of professional literature, and the goals for the standards review as specified in the Education Accountability Act of 1998. The identified criteria were each applied through three screens: (1) leaders in the discipline drawn from across the nation; (2) parent, business, and community leaders representing geographic regions of South Carolina; and, (3) special education teachers and specialists representing school districts throughout the state. Science educators from across the state reviewed the standards through the State Department of Education.

A. CRITERIA DESCRIPTIONS

The South Carolina Science High School Course Standards Review Process followed by the three review teams emphasized the application of the criteria addressing comprehensiveness/balance, rigor, measurability, manageability, and organization/communication. State Department of Education representatives, district and university curriculum leaders, and Education Oversight Committee (EOC) staff collaborated to identify the standards review criteria. Decisions on the criteria to be used were based on a comprehensive review of professional literature, and the goals for the standards review as specified in the Education Accountability Act of 1998. The identified criteria were each applied through three screens: (1) leaders in the discipline drawn from across the nation; (2) parent, business, and community leaders representing geographic regions of South Carolina; and, (3) special educators from South Carolina's education community.

CRITERION ONE: COMPREHENSIVENESS/BALANCE

The criterion for Comprehensiveness/Balance is concerned with how helpful the South Carolina Science High School Course Standards document is to educators in designing a coherent curriculum. The criterion is directed at finding evidence that the standards document clearly communicates what constitutes appropriate content for high school physical science and biology courses; that is, what all students should know and be able to do in these courses by the end of the course. The criterion includes consideration of the following areas:

- The standards are substantially aligned with national and international science standards;
- The internal organization of the standards is explicit in the progression of complexity of ideas within each specific subject area;
- There is evidence of appropriate content coverage;
- The grade-level placement of the Course Standards is developmentally appropriate;
- Adequate coverage of the major ideas is given to each area;
- There is increasing complexity of these ideas within each area; and
- There is even distribution of ideas across topics, i.e., avoidance of overemphasis on certain topics to the exclusion of others.

CRITERION TWO: RIGOR

This criterion calls for standards that require students to use thinking and problem-solving skills that go beyond *ad hoc* knowledge and comprehension. Standards meeting this criterion require students to perform at a level consistent with both national and international benchmarks.

- Rigor is achieved by meeting standards that explicitly identify the ideas and the levels of complexity for a particular grade level; and
- Students are brought gradually to an understanding that many science concepts are essential in everyday living.

CRITERION THREE: MEASURABILITY

Knowledge and skills presented in the standards are assessable with respect to school, district and state accountability. Elements of measurability include the following:

- Course Standards express observable and demonstrable activities and achievements;
- Standards are presented using the recommended terminology of the field; and
- Educators and parents understand specifically what students are to know and be able to do.

CRITERION FOUR: MANAGEABILITY

This criterion applies to instructional feasibility; that is, whether the complete set of Course Standards for a particular science course can reasonably be taught and learned in the class time allotted for a one credit course. A format commonly agreed upon is that approximately 80% coverage of the intended curriculum is reasonable, allowing for student mastery of content. Elements of manageability include the following:

- The total number of standards is reasonable for one course;
- The degree of difficulty of the standards assigned to the course is appropriate;
- The standards are stated clearly and succinctly; and
- The standards are devoid of unnecessary repetition.

CRITERION FIVE: ORGANIZATION/COMMUNICATION

The Organization/Communication criterion category stipulates that the expectations for students are to be clearly written and organized in a manner understandable to all audiences, including teachers, curriculum developers, and assessment writers. Organization includes the following components:

- Standards, topics, and skills are well ordered and not redundant;
- Standards that appear in more than one course specify distinctly different aspects, areas of emphasis, or overall depth;
- Format and terminology are consistent;
- Expectations for student learning are precisely stated for each course and across courses;
- Appropriate terminology of the field is used; and
- The document is as jargon-free as possible.

B. PANEL MEMBERSHIP

This review of the South Carolina Science High School Course Standards was conducted by the following three panels during January 2002.

The national review team members consisted of recognized leaders in science education, who have participated in the development/writing of national and state science standards. As national leaders on science standards, all have reviewed a number of state science standards. Comments and

recommendations included in this document are based on the National Science Education Standards 1997, classroom experiences, knowledge of students developmental stages and understanding of expectations for student learning in the area of high school science. Members of the team received the materials for the review in early December 2001 and participated in a telephone conference call that provided them instruction in the process of the review. After an independent review period, the members of the panel met in Columbia and over a two-day period produced through consensus a set of findings listed later in this document. Members of the National Review Panel included:

- Phyllis Barnhart, West Virginia Department of Education
- Lawrence S. Lerner, California State University, Long Beach
- Ann-Courtney Miller, Consultant, late of the University of North Carolina-Charlotte

Each school district was invited to recommend members of its community to serve as members of the Science High School Course Standards Parent/Business/Community Leader Review Panel. Eleven parents, business representatives and community leaders participated in the review process. Review panel members attended a one-half day information session in early January conducted by Paul Horne of the staff of the Education Oversight Committee. The review panel reconvened in mid-January and through discussion reached consensus on insights and specific recommendations about the Science High School Course Standards. Members of the review panel were:

David Avery, Bennettsville	Ulis Byrd, Jr., Laurens	Elizabeth T. Higgins, Greer
Anita Husbands, Greenwood	Uwe Klauck, Ware Shoals	Sharon Langdale, Summerville
Steve A. Love, York	Clarence Mahoney, Camden	Kay R. McMillan, St. George
Philip J. North, Easley	Jerry Wigfall, Jr., Holly Hill	

Each school district was also invited to recommend members of its special education community to the Science High School Course Standards Review Panel. Eighteen special education teachers and specialists participated in the review process. Review panel members also attended a one-half day information session in early January conducted by Paul Horne of the staff of the Education Oversight Committee. The review panel reconvened in mid-January and through consensus provided insights and specific recommendations about the Science High School Course Standards. Members of the review panel were:

Barbara Anderson, Columbia	Denny Bailey, Blackville	Frances Bowers, Elloree
Susan Conrad, Rock Hill	Carol Gallman, Gaffney	Rose Infinger, Sumter
Gwen Jeffords, Florence	Fannie Lanon, Sumter	Susan Layton, Lugoff
Linda Mack, Newberry	Elaine McGee, Anderson	Robin O'Brien, Sumter
Pat Phillips, Mullins	Tobie Presler, Rock Hill	Kimberly W. Shelton, Laurens
Janie Sweet, Union	Georgia H. Walker, Sumter	Charles Wall, Sr., Dorchester

The State Department of Education disseminated the Course Standards at the annual conference of science educators in early November 2001, and placed the standards on the State Department of Education web site to gather feedback from state educators. While teachers and other people who have reviewed the Course Standards via the internet or in other ways have not been provided with the criteria used by the other three groups, they have provided meaningful and important reaction to the documents.

C. THE STANDARDS DOCUMENT

The Science High School Course Standards are divided into two courses: Physical Science and Biology. Both courses are typically offered to students in the ninth grade, though Physical Science has been dropped from the curriculum in some districts in South Carolina. Each course is subdivided into a section on Inquiry and a section containing specific content material to be covered.

II: FINDINGS

The discussion below summarizes reviews of panel members, and presents consensus findings and examples for each criterion.

A: FINDINGS ON THE COURSE STANDARDS COMMON TO ALL REVIEW PANELS

1. A decision must be made on whether both science courses are to be taken by all students, and if so, in what sequence, prior to the implementation of the standards and their subsequent assessments. If Physical Science is not to be required for all students, then the standards for Physical Science and Biology will need to be different than if all students have to take Physical Science.
2. The science standards must be aligned with the mathematics standards to ensure that students have acquired the necessary mathematics background to achieve the science standards.
3. The historical perspective in science needs to be presented throughout the high school Course Standards. The standards should include key historical milestones for the various topics outlined in the standards.
4. Many of the items to be covered are not clearly written, especially in the Biology courses standards. Items needing clarity need to be revised.
5. There are important topics missing from each course. Simple machines and gravity are omitted from the Physical Science Course Standards, and classical biology topics, such as entomology, botany, and zoology, are missing from the Biology Course Standards.
6. Some subjects are treated sketchily or unevenly; examples are electromagnetism, mass, energy and momentum conservation, heat energy, modern evolutionary theory, and human evolution.
7. Many of the verbs used to describe what the student should know and/or be able to do are descriptive of lower cognitive levels. Where possible, verbs should be substituted that describe higher levels of achievement.
8. There is a concern over manageability. Both courses are rigorous and cover a lot of material. Manageability is connected to two issues: have the students received instruction based on the standards in grades K-8, and are all students to take both courses?
9. A definition or explanation of what a "Laboratory" course means is needed.
10. The National Science Education Standards should be followed as closely as possible. Where the national standards are vague the Course Standards should provide specific clarification as to what the student is supposed to learn.
11. All standards should be reviewed by a specialist in assessment and revised as necessary to make all standards assessable.
12. The standards need additional items that connect science, in general, and these courses specifically, to everyday life application. Many of the national standards that provide the connection have been omitted from the Course Standards.

B: FINDINGS RELATED TO THE COURSE STANDARDS COMMON TO ALL REVIEW PANELS

1. Adequate laboratory facilities and working laboratory equipment must be provided at each high school.
2. Teachers must be provided appropriate professional development related to the implementation of the Course Standards.
3. School districts must develop appropriate curriculum guides based on the standards.
4. Instructional materials to implement all of the standards must be made available to all students.
5. The end-of-course test implications on the school report cards and the guidelines for implementation and administration of the tests must be determined prior to the implementation of the Course Standards.
6. The material covered by the science standards in grades K-8 must be taught to all students to provide the needed foundation of knowledge for student success in both courses.
7. All college and university pre-service programs must be made aware of the Course Standards and should utilize them in courses of instruction for science teachers.

C: ADDITIONAL FINDINGS OF THE NATIONAL REVIEW TEAM

1. The Course Standards should address the significant linkages between the physical sciences of earth and space science and the biological sciences..
2. The major themes outlined in the National Science Education Standards should be addressed in both courses. The Inquiry section of each course addresses the theme of Models, but themes such as Systems and Change, Evolution, Constancy, and Form and Function are covered only minimally or not at all.
3. The course title for Physical Science should be changed. A more appropriate title may be "Integrated Physics/Chemistry."
4. The Science High School Course Standards should prepare the students for the possibility of administration of NAEP at the twelfth grade.
5. Earth Science standards should be addressed in the benchmark courses.
6. Standards developed for the courses Physical Science and Biology should not be repeated in higher level courses such as Chemistry, Physics, and Biology II. The higher-level courses should build on previously taught knowledge.

D. ADDITIONAL FINDINGS OF THE PARENT/BUSINESS/COMMUNITY LEADER REVIEW PANEL

1. The Inquiry sections of the Course Standards are well written and comprehensive.
2. The standards require the students to conduct investigations in order to learn the material.

3. The student/teacher ratio should be reasonable, perhaps 20:1, but must ultimately be based on available lab space and lab safety.
4. The blueprint for instruction should be issued at the same time as the Course Standards.
5. The Course Standards should make explicit use of the SI (metric) system.
6. Vectors should be included in the Physical Science Course Standards, and the ethics of genetic engineering should be included in the Biology Course Standards.
7. Business/industry and the community at large should be involved in the implementation of the Course Standards.
8. Professional development on the Course Standards and what is expected of both students and teachers in the courses should be provided for administrators and guidance counselors.

E. ADDITIONAL FINDINGS OF THE SPECIAL EDUCATION REVIEW PANEL

1. The standards are comprehensive, challenging and understandable.
2. Accommodation guidelines should be developed and distributed at the same time as the Course Standards. Specific skills that are critical to the mastery of the material must be outlined in the accommodation guidelines.
3. The specific goals of both courses must be realistic for special education students.
4. The use of calculators in the courses must be specifically defined.
5. Instructional materials must be available for all students.
6. Additional laboratory supervision should be available for classes with special education students.
7. Professional development concerning learning styles should be provided for all school personnel.
8. Accommodation guidelines must take TIME into consideration. TIME includes time in class, time to complete work, and all other accommodations given special education students in this area.
9. A glossary of content vocabulary should be developed for use by special education teachers.
10. The Biology Course Standards should be aligned with the Applied Biology course expectations.

F: CRITERIA-BASED FINDINGS AND RECOMMENDATIONS

Listed below are the specific findings based on the criteria presented earlier in this report. Findings reached by the National Review Team are marked "N", those reached by the Parent, Business, Community Leader Task Force are marked "P", and those reached by the Special Educator Task Force are marked "S". Findings reached by all three groups are marked "ALL".

1. Comprehensiveness/Balance

Findings	Recommendations
<ul style="list-style-type: none"> • Need to be explicit about choice and use of verbs. ALL • The Biology Course Standards are too focused on Cellular Biology. ALL • The Physical Science Course Standards omit simple machines and gravity. ALL • Overall, the documents are comprehensive and are based on the National Science Education Standards. ALL • The Course Standards in science should be aligned with the state mathematics standards. ALL • Skills critical to student mastery need to be outlined. S 	<ul style="list-style-type: none"> • Revise the verbs used to raise the cognitive level expectations of the students. ALL • Add entomology, zoology, botany and other aspects of biology to the course. ALL • Add simple machines and gravity to the Physical Science Course Standards. ALL • Look to the <u>National Science Education Standards</u> for any missing standards and for guidance on including higher order thinking standards. ALL • Align the science standards with the mathematics standards. ALL • Determine the critical skills for mastery and publish along with the Course Standards. S

2. Rigor

Comments	Recommendations
<ul style="list-style-type: none"> • Rigorous, though some standards are written in a manner that makes them not measurable ALL • Instruction in grades K-8 must be based on the current Science Standards and the standards must be taught by all teachers. ALL • 	<ul style="list-style-type: none"> • Look to <u>National Science Education Standards</u> for guidance on writing measurable standards. N

3. Measurability

Comments	Recommendations
<ul style="list-style-type: none"> • As written, most statements are measurable; however, there is concern that some of the standards are not measurable as written. ALL • Format of many statements leads to recall types of measurement items. ALL 	<ul style="list-style-type: none"> • Ensure that all expectations are measurable. ALL • Ensure that a variety of ways to measure knowledge and skills are included in the standards. ALL

4. Manageability

Comments	Recommendations
<ul style="list-style-type: none"> • Course Standards are manageable only if adequate standards-based instruction has been given in grades K-8. ALL • Adequate laboratory facilities and working laboratory equipment must be provided at each high school. ALL • Instructional materials to implement all of the standards must be made available to all students. ALL • Prevent overlap with higher-level science courses. N 	<ul style="list-style-type: none"> • Instruction in grades K-8 must be based on the current Science Standards and the standards must be taught by all science teachers. ALL • Eliminate overlap in higher-level courses. N

5. Organization and Communication

Comments	Recommendations
<ul style="list-style-type: none"> • Clarity is needed in many standards. ALL • Define the meaning of laboratory course. ALL • Basic document needs supporting piece on vocabulary. S • Found to be jargon free; appropriate use of terminology; consistent wording across document. ALL 	<ul style="list-style-type: none"> • Revise standards where needed for clarity. ALL • Add a minimum percentage of time in laboratory settings to the course description. ALL • Develop a vocabulary list for special education teachers. S

III. EOC RECOMMENDATIONS

The recommendations that are listed below are based on the detailed review of the South Carolina Science High School Course Standards and are supported by the evidence and detailed comments that appear in the criteria-based and individual task force findings included in this report.

1. The Course Standards should be revised to include the historical perspective in science for many standards.
2. The Physical Science Course Standards should be revised to include a section on simple machines and should include a discussion on gravity.
3. The Biology Course Standards should be revised to reduce the focus on cellular biology and to include other topics in biology such as botany, zoology, and/or entomology.
4. Revise the Course Standards to make all standards measurable.

5. The verbs used in the Course Standards should be revised to raise the cognitive level of learning.
6. Define the meaning of "laboratory" course.
7. Revise the Course Standards where needed to provide greater clarity.
8. Align the science standards with the mathematics standards.
9. The ongoing implementation of these revised standards must be accompanied by:
 - Changes in state assessment so that what is assessed is aligned with what is to be taught;
 - A determination prior to implementation of the standards regarding whether both courses are to be taken by all students, in what sequence, and in what grade(s);
 - An intensive set of professional development activities that broaden both awareness of and capacity to implement these standards for both teachers and administrators;
 - An intensive effort to provide adequate laboratory facilities and working laboratory equipment to implement the standards;
 - The purchase of appropriate instructional materials to implement the Course Standards;
 - An intensive effort to instruct pre-service teachers based on the content of the standards; and
 - Development of supplemental/support documents and materials for use in the classroom to assist teachers in instructing students towards learning the standards; this would include an adaptability document for special education teachers.