Report on the Review of the South Carolina Science Academic Standards

SC EDUCATION OVERSIGHT COMMITTEE

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Approved by the
Education Oversight Committee
June 11, 2012

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 belief in lifelong learning. Academic standards are used to focus schools and districts toward higher performance by aligning the state assessment 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 59-18-350(A) of the Education Accountability Act, the Education Oversight Committee (EOC) and the State Board of Education are responsible for reviewing South Carolina's standards and assessments to ensure that high expectations for teaching and learning are being maintained.

> The State Board of Education, in consultation with the Education Oversight Committee, shall provide for a cyclical review by academic area of the state standards and assessments to ensure that the standards and assessments are maintaining high expectations for learning and teaching. At a minimum, each academic area should be reviewed and updated every seven years. After each academic area is reviewed, a report on the recommended revisions must be presented to the Education Oversight Committee and the State Board of Education for consideration. After approval by the Education Oversight Committee and the State Board of Education, the recommendations may be implemented. However, the previous content standards shall remain in effect until approval has been given by both entities. As a part of the review, a task force of parents, business and industry persons, community leaders, and educators, to include special education teachers, shall examine the standards and assessment system to determine rigor and relevancy.

In March of 2012, the EOC activities under the cyclical review of the South Carolina Science Academic Standards were completed. This document presents recommendations for modifications to the 2005 South Carolina Science Academic Standards from the Education Oversight Committee. These recommendations were compiled under the advisement of three review teams: a national review team of science educators who have worked with national or other state organizations; a parent, business, and community leaders' team drawn from various geographical areas in South Carolina; and a team of educators and parents of students with disabilities and students with limited English proficiency. At the same time that these three committees were meeting, the State Department of Education assembled a team of SC science educators from around the state to review the standards.

It is important to note that the adopted South Carolina Science Academic 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 belief in the achievement of all students. The Education Oversight Committee intends to enhance the work of school level educators and, ultimately, to ensure that all students are knowledgeable and capable.

I. CYCLICAL REVIEW PROCESS

The review of the South Carolina Science Academic Standards began with focus on the accomplishment of goals articulated in the Education Accountability Act (EAA) of 1998. The law, as amended through 2008, 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 Standard Operating Procedures for the Review of Standards (SOP) agreed upon by the State Department of Education (SDE) and the Education Oversight Committee (EOC) during the summer 2003 were followed for this review. A time line established during the fall of 2011 outlined the time frame in which the required review teams were to review the standards adopted in 2005 by the end of spring 2012. The SOP also outlines the steps to be taken to revise the current standards should the completion of the reviews indicate that revision is needed.

A. CRITERIA DESCRIPTIONS

The South Carolina Science Academic Standards Review Process followed by all four review teams emphasized the application of the criteria addressing comprehensiveness/balance, rigor, measurability, manageability, and organization/ communication. SDE representatives, district and university curriculum leaders, and 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 the four review panels: (1) leaders in the discipline drawn from across the nation; (2) science educators from South Carolina's education community; (3) special educators from the South Carolina's education community; and (4) parents, business representatives, and community leaders.

CRITERION ONE: COMPREHENSIVENESS/BALANCE
The criterion category for Comprehensiveness/Balance is concerned with how helpful the South Carolina Science Academic 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 Science content, that is, what all students should know and be able to do in science by the time they graduate. The criterion includes consideration of the following areas:

- The standards address essential content and skills of science;
- The standards are aligned across grades as appropriate for content and skills;
- The standards have an appropriate balance of the content and skills needed for mastery of each area in science; and
- The standards reflect diversity (especially for ethnicity and gender) as appropriate for the subject area.

CRITERION TWO: RIGOR
This criterion calls for standards that require students to use thinking and problem-solving skills that go beyond knowledge and comprehension. Standards meeting this criterion require students to perform at both national and international benchmark levels.

- Standards should focus on cognitive content and skills (not affect);

- Standards should be developmentally appropriate for the grade level;
- Standards should include a sufficient number of standards that require application of learning (application, analysis, synthesis, and evaluation);
- Standards should be informed by the content and skills in national and international standards; and,
- Standards should be written at a level of specificity that will best inform instruction for each grade level.

CRITERION THREE: MEASURABILITY
Knowledge and skills presented in the standards are assessable for school, district and state accountability. The primary element of measurability is:

- The content and skills presented in the standards should be assessable (are observable and demonstrable).

CRITERION FOUR: MANAGEABILITY
This criterion applies to instructional feasibility, that is, whether the complete set of science standards at a particular grade level can reasonably be taught and learned in the class time allotted during one year. The primary element of manageability is:

- The number and scope of the standards for each grade level should be realistic for teaching, learning, and student mastery within the academic year.

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 and by teachers, curriculum developers, and assessment writers. Organization includes the following components:

- The content and skills in the standards should be organized in a way that is easy for teachers to understand and follow;
- The format and wording should be consistent across grades;
- The expectations for student learning should be clearly and precisely stated for each grade; and,
- The standards should use the appropriate terminology of the field but be as jargon free as possible.

B. PANEL MEMBERSHIP

The EOC's cyclical review of the 2005 South Carolina Science Academic Standards was conducted by the following three panels during February and March 2012.

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 in part on *The State of the State Standards 2012* from the Fordham Institute, *International Standards Benchmarking Report* (2010), *A Framework for K-12 Science Education* (2012), *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads* (2011), *Surrounded by Science: Learning Science in Informal Settings* (2010), and *Project 2061* (1989)

along with additional current research documents, classroom experiences, knowledge of students' developmental stages and an understanding of expectations for student learning in the area of science. Members of the team received the materials for the review in early January and received communications concerning the process of the review through March. After an independent review period, the members of the panel participated in a telephone conference call that produced through consensus, a set of findings listed later in this document. Members of the National Review Panel included:

- Dr. Melanie Cooper, Department of Engineering and Science Education, Clemson University
- Dr. Robert T. Dillon, Jr., Associate Professor, Department of Biology, College of Charleston
- Dr. Bert Ely, Professor of Biological Sciences, University of South Carolina
- Dr. Ursula Goodenough, Professor of Biology, Washington University, St. Louis, MO
- Dr. Lawrence S. Lerner, Professor Emeritus, Department of Physics and Astronomy, California State University, Long Beach, CA
- Dr. Christine Lotter, Associate Professor, Instruction and Teacher Education, Department of Education, University of South Carolina
- Dr. James Wanliss, Department of Physics and Computer Science, Presbyterian College

The EOC contacted all school district superintendents and instructional leaders in the state as well as EOC members for nominations to the following panels. Approximately 162 names were provided to the EOC. First, the Science Parent/Business/Community Leader Review Task Force was composed of twenty one parents, business representatives and community leaders. Task force members provided individual responses to the standards review and attended a one-day session on March 30, 2012 conducted by Kay Gossett, EOC review coordinator and Melanie Barton, Interim Director of EOC. The task force reached consensus on insights and specific recommendations about the 2005 South Carolina Science Academic Standards. Members of the task force included:

Libby Baker, Pageland
George Brown, Hemingway
Patricia Caldwell, Newberry
Rose Choice, Estill
Dave Coggins, Spartanburg
Mike Fair, Columbia
Adrian Grimes, Summerville
Jennifer Hawthorned, Monks Corner
Hugo Linares, Greer
Edward Lott, Florence
Collette McBride, Salters
Robert McClinton, Greenwood
Jerome McCray, Bishopville
Jordana Megonigal, Greer
Robert Oliver, Pinewood
Scott Owens, Horatio
Angela Peters, Orangeburg
Khushru Tata, Columbia
Mike Taylor, Batesburg-Leesville
Jamie Thon, Summerville
Kim Williams-Carter, Clinton

The Community/Business panel represented policymakers, clergy, engineers, organization leaders, state educators, industry representatives, and business leaders.

Each school district also was invited to recommend members of their respective special education communities to the Science Special Education and English Language Learners Review Task Force. Twenty seven special education teachers, English Language Learners teachers and parents participated in the cyclical review process. After reviewing the science standards according to the cyclical review criteria, the task force members attended a one day

meeting on March 26, 2012 facilitated by Kay Gossett, EOC review coordinator and Melanie Barton, Interim Director of EOC. The task force through discussion determined a series of findings and recommendations about the 2005 South Carolina Science Academic Standards. Members of the task force included:

Kyle Blankenship, Aiken
Sharon Jackson, Anderson 4
Lauren McClellan, Anderson 5
Wanda Coleman, Barnwell 29
Robin Boyleston, Barnwell 45
Rachel Amey, Charleston
Nicole Adams, Charter Schools
Melissa Cruse, Dorchester 2
Mary Atkins, Hampton, 2
Marie Fernandez, Jasper
Casey Spain, Laurens 56
Carla Stegall, Lexington 1
Emmylou Todd, Lexington 2
Debra Hall, Lexington 3
Pauline Morris, Marlboro
Cheryl Parr, Newberry
Liana Calloway, Orangeburg 3
Juliett Stoute-White, Orangeburg 5
Sandy Frazier, Richland 1
Teisha Hair, Spartanburg 2
Teresa Brown, Spartanburg 3
Sharon Glenn, Spartanburg 6
Vaughn Vick, Spartanburg 7
Albertha Bannister, Sumter
Barbara Greene, Williamsburg
Susan Conrad, York 3
Carmen Belei, York 3

The State Department of Education also gathered a panel of science educators from around the state to review the SC science standards. This group consisted of classroom teachers from all grade levels, university professors, curriculum specialists, administrators, and State Department of Education personnel. Meeting in March and April 2012, the state department's review team followed the same criteria as the three review teams conducted by the EOC and reached consensus on their recommendations.

C. THE STANDARDS DOCUMENT

The 2005 South Carolina Science Academic Standards are organized by grade levels for grades kindergarten through the eighth grade to include discipline areas of life science, earth science, and physical science and five high school core areas: physical science, biology, chemistry, physics, and earth science. An overview describing specific subject matter and themes is provided on the first page of the standards' document for each grade and high school core area.

http://ed.sc.gov/agency/pr/standards-and-curriculum/documents/sciencestandardsnov182005_001.pdf.

The statements of the academic standards themselves are newly constructed. Each standard is now stated as one full sentence that begins with the clause "The student will demonstrate an understanding of …" and goes on to specify the particular topics to be addressed by that standard. The area from which each of the content standards is drawn is specified in parenthesis immediately following the statement of the standard. Following each of the academic standards are indicators, which are intended to help meet teachers' needs for specificity. The main verbs in the indicators are taxonomic – that is, they identify specific assets of the cognitive process as described in the revised Bloom's Taxonomy. The term *including* appears frequently in parenthetical statements in the science indicators to introduce a list of specifics that are intended to clarify and focus the teaching and learning of the particular concept.

In addition to the content standards, each grade and high school core area has a separate scientific inquiry standard, with indicators that are now differentiated across grade levels and core ideas. The skills, processes, and tools specified in the scientific inquiry indicators are also embedded in the content standards and indicators wherever appropriate.

Fifth Grade Example:

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.3 Plan and conduct controlled scientific investigations, manipulating one variable at a time.

The State Department of Education developed a curriculum support document providing in-depth content information, prerequisite skills and prior knowledge needed for the content after the State Board of Education adoption of these standards.

II: ISSUE WITH THE STANDARDS PRIOR TO THE REVIEW

As stated earlier, South Carolina Science Academic Standards are well-regarded by national experts and has been the model for standards development in many other states. However, the reality of the science standards is found in the student performance results. Unfortunately, too few students have reached the expectations set for them causing us to determine issues to be addressed as the current standards are reviewed. The following table documents the percentage of students scoring Not Met, Met and Exemplary on the Palmetto Assessment of State Standards (PASS) test in science in 2011. The percentage of students scoring Not Met on the PASS science exam fluctuates from a low of 28.3 percent in seventh grade to a high of 39.2 percent in third grade. By law, the student performance levels are defined accordingly:

> Not Met means that the student did not meet the grade level standard;
> Met means that the student met the grade level standard; and
> Exemplary means that the student demonstrated exemplary performance in meeting the grade level standards. (Section 59-18-900)

Table 1
2011 PASS Science, % of Students Scoring:

Grade	Number of Test Takers	Not Met	Met	Exemplary
03	26,828	39.2	36.8	24.0
04	55,006	29.1	54.8	16.0
05	27,683	35.1	46.5	18.5
06	27,018	35.1	50.5	14.4
07	53,464	28.3	44.7	27.0
08	25,952	29.9	33.2	36.9

Source: South Carolina Department of Education, http://ed.sc.gov/data/pass/2011/.

A concern found in reviewing the SC science standards revolves around the breadth of the standards versus the depth. National science standards and input from state science educators provided the content to be included in the 2005 science standards. The science standards provide a wealth of content to be learned from kindergarten through high school. All science content is considered important because science builds on prior background knowledge. In order for students to obtain a true understanding of science concepts, a determination needs to be made as to what content is essential for the students to be successful in their school careers as well as in the work careers

Another concern deals with how students learn science best. In order to grasp an understanding of science concepts and skills, students must be engaged in science. Currently, inquiry standards are separate from the content standards in all grades and high school courses. In order for students to be sufficiently prepared for post-secondary science work, students must move beyond recall and memory-work in the science classes. They must be engaged in the "doing" of science. Science must promote current science practices, modern science content, and an infusion of the most current technological instruments.

III: FINDINGS

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

A: COMMENDATIONS

1. The SC science standards are well-written and highly regarded. According to *The State of State Science Standards 2012* by the Fordham Institute, South Carolina has "produced a set of workmanlike standards of consistent, high quality." In this review of the science standards, Fordham Institute granted South Carolina an A- grade for providing "science standards that are clear and succinct, but that also outline most of the essential K-12 content that students need to learn."

   http://www.edexcellencemedia.net/publications/2012/2012-State-of-State-Science-Standards/2012-State-of-State-Science-Standards-FINAL.pdf.

2. The standards are consistent across grade levels and increase in appropriate complexity. The standards develop appropriately through advancing grades with clear and logical progression.

3. The science standards are clearly written using Bloom's verbs that show the level of performance required of students; thus, they are observable and assessable.

4. The standards are informed by content and skills in national standards developed in 1996 and additional science education research documents from the early 2000's.

5. The standards are easy to follow and user friendly for teachers. A logical progression is followed throughout the standards, building science concepts from grade to grade and defining what students should know.

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6. The science support document provides teachers with additional content and instructional information. The standards are presented clearly and are linked to support documents, providing for teachers specific details of the content and clarifying what students should know and be able to do.

   http://ed.sc.gov/agency/pr/standards-and-curriculum/Science.cfm

B: CONCERNS COMMON TO ALL REVIEW PANELS

1. SC must improve the learning of science by going deeper rather than broader with standards.
2. Students do not appear to be appropriately prepared for postsecondary education as reflected by state and national evaluators of the science standards. This may be a result of a shallow understanding of science content due to the number of standards or even from the lack of student engagement in learning science.
3. SC should use the most recent and relevant information when amending the standards which includes the new science framework as well current research on international science standards.
4. The standards must be incorporate engineering and real-life applications.
5. Inquiry must be integrated with the content standards to bring meaning to science.

C: ADDITIONAL FINDINGS OF THE NATIONAL REVIEW TEAM

1. The standards provide clear content and skills learning objectives from the early grades through high school but are based on prior research from the 1990's. Current emphases in more recent national and international research is on the use of key core ideas in developing science standards and a focus on combining content and practices to make it explicit what it is that students should be able to know and do. In a recent publication, *A Framework for K-12 Science Education* (NRC 2012), national science experts recognize that *"although the existing national documents on science content for grades K-12 (developed in the early to mid-1990s) were an important step in strengthening science education, there was much room for improvement. Not only has science progressed, but the education community has learned important lessons for 10 years of implementing standards-based education, and there is a new and growing body of research on learning and teaching in science that can inform a revision of the standards and revitalized science education."*

2. Use of big core ideas in the standards would decrease the scale of standards and indicators and allow depth of content to be the focus, not the breadth. Standards using "recall, summarize, know, etc…." should be removed and combine these ideas to formulate higher level standards.

3. Revisit the use of Bloom's taxonomy in the standards which is not intuitive to teachers. Use performance verbs that say exactly what science knowledge students should have.

4. For teachers to successfully implement the standards, the learning progressions must be made clearer and show teachers how to integrate content and practices in performance.

5. Inquiry skills can only enhance student learning if they are meaningfully linked to content. The current separate inquiry skills need to be integrated into the content standards to ensure inclusion of science practices into the knowledge of science.

6. The science indicators and support documents should be revised to include engineering terminology and make engineering instruction more explicit.

7. Assessment needs to align with the level of thinking wanted from students in order for true instructional change to occur. Move away from multiple choice tests which measure lower level learning from students.

8. Based on the need to assess student performance in science, investigate the use of adaptive computer assessments that incorporate simulations and critical thinking applications needed to assess the higher level standards.

9. Review the standards for redundancy such as found in the population and ecology sections and other areas.

10. The standards need to be checked for consistency in wording and review glossary terms for accuracy.

11. To address diversity in the standards, the standards could state "using appropriate examples that include a variety of cultures, genders, and ethnicities…." to build connections between curriculum and students' cultures especially in standards that address human impact on the environment.

12. Introduce some basic concepts earlier (ex. Move DNA to 7th grade) which would free more time to focus on genetic engineering and more cutting edge genetic applications in biology.

13. Physiology content is lacking and needs to be included throughout the upper grades. For example, physiology has strong coverage in the seventh grade standards; nothing appears after that year on this important topic and is completely omitted from high school biology materials.

14. All standards must be treated equally. Only once in the standards is the phrase "critically analyze" found which is in B-5.6 on biological evolution. Recommendations made during the review of the 2005 SC standards included using the phrase in additional indicators to Standard B-5. Most of the recommendations were not accepted leaving standard B-5 slightly weaker than any other science standard in the K-12 curriculum.

15. Chemistry standards do not reflect how chemistry is practiced by modern chemists. Students taught in this manner will merge with a surface level understanding of chemistry that will not be useful to them in future studies.

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

1. The world is changing at an ever-increasing pace, especially as it relates to issues taught through science and an ongoing review seems necessary to keep pace with the changes. The review would prioritize what is best to teach during the limited time available.

2. The standards/indicators need to address the rapid changes in science-based careers and prepare students to be adaptable to fit jobs that have not been created at this time.

3. Engineering based scientific argument and engineering skills need to be added and connected to the science standards.

4. Math is a critical component in learning science concepts and practices. Science and Common Core math should be aligned for appropriate learning opportunities.

5. Emphasis needs to be placed on technology beginning in early grades and continuing through high school. Knowledge of different technological instruments is essential to the understanding of science.

6. Content and skills should be written into one document to appropriately inform instruction. Incorporating science practices and content with scientific concepts will make expectations much clearer.

7. An essential part of science is laboratory based. An active laboratory component can provide engagement and motivation for science leading to extended interest in post-secondary education and careers. Schools must be provided the resources and equipment for a viable science laboratory focus.

8. Measurability of the science standards are constrained by use of standardized tests.

9. Instructional time for science needs to be mandated in order for adequate time to be allocated to science.

10. Standards are necessary to ensure that all SC students are receiving the same basic education but the key to improved student performance is execution of the standards. Teachers who teach science without a science background will hinder successful implementation of the standards.

E. ADDITIONAL FINDINGS OF THE TEACHERS AND PARENTS OF STUDENTS WITH DISABILITIES (SPED) AND ENGLISH LANGUAGE LEARNERS (ELL)

1. The number of application standards needs to be increased to address diversity among the student population. By integrating inquiry standards in with the content standards, SPED and ELL students would gain from the hands on approach to learning.

2. The standards document needs a simplified continuum of standards added to inform teachers, especially SPED and ELL teachers, of the prerequisite skills and application level of the standards across grade levels.

3. The relationship between the science standards and other content areas needs to be investigated. A cross over document would benefit SPED and ELL teachers in thematic or integrated instruction.

4. Standards sometimes contain verbiage that can be confusing. More specific language which uses explicit and direct words as well as words that do not have multiple meanings is needed by instructors of and students with disabilities or language limitations.

5. More inquiry skills need to be built into the standards to support the use of hands on learning for SPED and ELL students. These students especially need additional examples, models, and visuals to be used in the standards.

6. Performance based assessments which allow students' drawings to indicate understanding could be used to assess students. Current assessments are not appropriate for mainstream, ELL, or special education students.

7. Some standards are not repeated often enough while others are taught only once at a specific grade level. The standards need to be built on a progression of learning to meet the needs of students of all abilities.

8. Science should make connections to the "real world." There is a need to explain "why" students are being instructed on these standards and "how" they will be relevant to the students now and in the future and is particularly beneficial to students with disabilities.

9. There is a need for more examples and visuals within the standards instruction highlighting the cultural diversity and disabled population found in the community, families, state, nation, and world.

F: CRITERIA-BASED FINDINGS AND RECOMMENDATIONS

Listed below are the specific findings based on the criteria presented earlier in this report. Findings were reached by the National Review Panel, the Parent/Business/ Community Review Panel and the Special Education/English Language Learners Review Panel. The complete Criteria description may be found on pages 2 and 3 of this document.

Criterion One: Comprehensiveness/Balance
Findings/Recommendations

1. *The standards reflect essential science content and skills.*
2. *The standards should address the low level standards and redundancy in the content across grade levels in an effort to reduce the number of standards.*
3. *The standards need to reflect current research in science education and how students learn.*
4. *The standards should include current people of note and engineering.*

Criterion Two: Rigor
Findings/Recommendations:

1. *Indicators are written at a low level of Bloom's Taxonomy (cognitive demand) and needs to move to the application level (or higher).*
2. *Currently the inquiry standards are separate and need to be integrated into the content standards.*
3. *Develop a means for spiraling standards across grade levels to increase rigor.*
4. *The standards are informed by content and skills in national standards but should include recent research on incorporating science practices into the standards.*
5. *Balance the specificity of standards within and across standards.*

Criterion Three: Measurability
Findings/Recommendations:

1. *Indicators are written so that they are easily understandable and assessable. Use of high level performance verbs (cognitive demand) in the standards will allow for assessments items at a higher level.*
2. *Investigate adaptive computer assessments capable of assessing high level standards for students of all abilities.*

Criterion Four: Manageability
Findings/Recommendations:

1. *The numbers of standards should be reduced to allow for more in-depth teaching and depth of student understanding.*
2. *An adequate amount of time needs to be given to science instruction.*

Criterion Five: Organization/Communication
Findings/Recommendations:

1. *The format is easy to understand and follow for all teachers.*
2. *Consider using themes or disciplines for organization which will lead to integration of standards and content areas.*
3. *Currently, teachers are using the standards as check-off lists instead of understanding the value of using activities to integrate the standards.*
4. *The standards need to be checked for consistency of wording.*

IV. EOC RECOMMENDATIONS

The EOC stands firmly behind the premise that students must learn science at the highest level in order to be prepared for college and successfully compete in careers today and those to be created in the future. The recommendations that are listed below are based on the detailed review of the South Carolina Science Academic 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. According to national and international research, science standards should be built upon key core ideas in science; limiting the breadth of "good to know" content and focusing on the depth of the standards for increased student understanding. Limit the number of key

ideas explored each year while increasing their depth and revisiting the concepts periodically.

2. Decreasing the scale of standards and indicators of standards allows for removal of "recall" standards by combining the ideas to formulate higher level standards. By using explicit performance verbs, a progression of learning is established from grade to grade providing all students with exactly what it is that students should be able to do.

3. Science is innately an activity based content area. Students are more engaged and motivated through hands-on opportunities. The inquiry standards must be integrated into the science standards to ensure inclusion of science practices in instruction.

4. As standards are written at a higher level, assessments must appropriately measure the performance of students at higher levels. New adaptive computer assessments that incorporate simulations and critical thinking applications are needed to adequately measure these standards.

5. Science should make connections to the "real world." There is a need to explain to students of all ability levels "why" students are being instructed on the standards and "how" they will be relevant to all students now and in the future. Therefore teachers must be aware how modern science is addressed in the work world.

6. Alignment of standards with other content areas is greatly needed. In elementary grades, teachers face the dilemma of more content to be taught in a given year than there is time. In all grades, math is a critical component of learning science concepts and practices. Cross-over documents need to be developed to align standards for appropriate learning opportunities.

7. Engineering skills and technology are integral components of modern science education. Deliberate inclusion of these skills and materials into the standards should be addressed.

8. Attention should be given to teacher preparation for all teachers instructing in the science areas. The key to improved science performance is execution of the standards. Teachers who teach science without a science background hinder successful implementation of the standards. Efforts should be made to work closely with post-secondary science educators in providing a student based instructional model for pre-service opportunities.

9. The ongoing implementation of these revised standards must be accompanied by:
    a. Changes in state assessment to reflect that what is assessed is aligned with what is to be taught;
    b. Sample demonstrations of what students should be able to do based on the explicit standards for assessment purpose;
    c. An intensive set of professional development activities for both teachers and administrators that broaden both awareness of and capacity to implement these standards and includes video examples of science activities;
    d. Widespread encouragement and support to adopt newer curriculum materials that are better aligned with the content and process standards; and
    e. Development of supplemental/support documents and materials for use in the classroom to assist teachers in instructing all students towards learning the

stands; this would include a curriculum guide and an adaptability document for special education teachers and teachers of English Language Learners.