SCASS SCIENCE PROJECT
Consensus Guidelines for Science Assessment

A framework and set of criteria to guide the SCASS Science assessment development process.

Council of Chief State School Officers

State Collaborative on Assessment and Student Standards (SCASS)

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Consensus Guidelines for Science Assessment

Background: SCASS Science Project

SCASS was established to help develop state-of-the-art assessment tools and reform strategies as a means of informing and improving science education

To address States' growing need for thorough and authentic information regarding student performance in science, the Council of Chief State School Officers (CCSSO) initiated the State Collaborative on Assessment and Student Standards (SCASS) Science Education Assessment Project. Established in 1992, this multi-state consortium pooled expertise and resources to apply State Content Standards and the emerging *National Science Education Standards* (NSES) (NRC, 1995) as well as other landmark documents such as the *Benchmarks for Science Literacy* (AAAS, 1993) to develop state-of-the-art assessment tools and reform strategies as a means of informing and improving science education in member states. Development of the products and services was based on member states' common vision for science education and assessment which borrowed heavily from the state and national science education reform recommendations. The consortium continues to develop new assessment tools for member states as well as strategies to use them effectively. A brief description of the materials produced as part of the SCASS Science Project may be found at the end of this document.

Purpose: Consensus Guidelines

The "guidelines" outline the parameters to guide Assessment Development

One primary goal of the SCASS Science project is to develop assessment tools which may be used by member states to monitor student performance at the state level and to assist local educators in the assessment of students in a manner consistent with emerging state and national reform recommendations. This document, the *Consensus Guidelines for Science Assessment* outlines the parameters that guide the SCASS assessment development. The *Guidelines* are *not* designed to guide curriculum development nor describe the philosophical underpinnings of the project.

Assessment Products

The SCASS Science assessments, focused on the concepts and principles embedded in the *Guidelines,* are designed to collect data about what students know and can do in science through:

Portfolios

SCASS Science portfolios provide an opportunity for students to reflect on, write about, and display their work to demonstrate their achievement and proficiency in science. The work samples that students choose to include as part of their portfolio represent their achievement in four areas essential to science: Depth of Understanding, Evidence of Inquiry, Relevance to Society, and Communication.

Long-term Investigations

Multi-week investigations or performance tasks allow students an opportunity to gain a deeper understanding of a particular science concept. These long term investigations, such as an exploration of the factors that produce acid rain and its resulting effects, focus on concepts central to science and frame them in an investigative manner which requires students to explore the topic, conduct research either in the laboratory, field, or literature, and present their findings in a relevant context (such as producing the results from the acid rain investigation as recommendations to a governmental agency).

Hands-on Performance Activities

Hands-on performance activities or events provide an on-demand means of assessing students' interaction with, and manipulation of, materials. These 45 minute tasks allow students the opportunity to interact with materials and then write about the topic investigated to demonstrate their understanding of the concepts behind the activity. An elementary performance event, for example, might require students to observe and categorize the properties of a sample of rocks, and then explain this information in terms of the rock cycle and 'change over time'.

Integrated Essay Questions

Integrated essay questions allow students an opportunity to demonstrate their understanding of the unifying concepts and themes of science. A high school essay question might, for example, require students to discuss the interdependence of the carbon dioxide and oxygen cycles in the context of establishing a space station.

Short Constructed Response Items

Short constructed response items allow students to demonstrate their understanding of science concepts, such as the forces and changes in the Earth systems that would produce a specific rock layer pattern.

Conceptual Selected-Response Items

Selected response questions, which focus on important contextualized science concepts rather than specific isolated facts, allow students to demonstrate the breadth of their knowledge. For example, a constructed response question might provide a graph of predator and prey populations over time and require the student to select the correct explanation of the dynamic interaction of the two populations.

Assessment items include both independent sets as well as "modules" which consist of a collection of conceptual selected response items, short constructed response items, and essay questions that focus on a single integrated theme or content topic. Recognizing the limitation of on-demand assessments with regard to complete science assessment, the SCASS Science project developed long term investigations and portfolios to better allow students to demonstrate their understanding and achievement in applied science and problem solving.

Focus of the Assessments

SCASS Science Assessments are developed to reflect scientific habits of mind, use of reliable evidence, informed decision-making, and relevant conceptual science content.

To ensure that the assessments are authentic and provide meaningful results, member states made strong recommendations that the assessment tools developed by the SCASS Science project incorporate scientific methods and habits of mind, everyday experiences, and a focus that scientific understanding is essential for informed decision-making. Central to the methods of constructing meaning and understanding the nature of science is the notion of scientific inquiry -- a process that includes asking questions and making observations, planning and conducting experiments, interpreting and analyzing data, drawing conclusions based on reliable evidence, and communicating new ideas. Scientific habits of mind are an important aspect of scientific understanding, and are woven through all of the activities developed by this project. Learning about science in the context of relevant, everyday situations empowers students to become effective problem-solvers and decision-makers, and the SCASS Science assessments provide such a context to encourage students to succeed in making meaning of science.

Assessment Framework

Based on the NSES and Project 2061 philosophies, four facets to guide the development of the assessment products were identified.

The following assessment framework consists of ideas, themes, and content based on the frameworks of member states, as well as the NSES and Project 2061 *Benchmarks*. Four facets that guide all item development and ensure that exercises reflect relevant, contextualized concepts rather than isolated facts are herein referenced as:

- **Themes**
- **Subject Areas**
- **Dimensions of Knowing and Inquiring about Science**
- **Overarching Influences**

Themes

For the purpose of the SCASS Science Project, five interdisciplinary themes that are common to the science frameworks of most of the SCASS members are used to guide the development of assessments. The themes are essential, unifying concepts that help to link the disciplines of science and explain observations of natural phenomena. The themes include:

Themes are used to contextualize the assessments and help link science content and natural phenomena in meaningful ways.

Constancy and Change

includes ways in which natural systems regulate and respond to internal and external stimuli, such as stability, equilibrium, conservation, and symmetry; and various forms of change that help explain punctuated events in natural and long-term trends, such as cycles, evolution and population trends. For example, students might be asked to explain how changing environmental factors lead to speciation over time.

Patterns

refers to the relationships of properties that help to interpret data, explain natural phenomena, and make predictions. For example, students might be asked to explain how the patterns of motion of celestial bodies influence the time and position that they become visible from Earth.

Systems and Interactions

is any collection or organization of parts that function or interact together, that have some influence on one another, and appear to constitute a unified whole. For example, students might be asked to discuss the ensuing changes in a local ecosystem after a river floods.

Models, Scale, and Measurement

refers to conceptual, physical, and mathematical representations, tools or technologies that help to explain or explore scientific processes at different levels of organization or degrees of magnitude. For example, students might investigate the drag forces on a toy boat in a large tank of water, and then explore how their findings relate to actual drag forces felt by boats at sea.

Form and Function

describes the relationship between the size, shape, or structure of objects and the function that the structure (atomic, chemical, anatomical, etc.) performs. For example, students might investigate the relationships between plant structure and the corresponding sunlight and nutrient needs.

Subject Areas

The four broad subject areas that guide the conceptual development of assessment tools include: Life Science, Physical Science, Earth and Space Science, and Coordinated Science. The content is intended to focus on the core, essential ideas within science, and does not represent an exclusive or exhaustive list of topics.
To demonstrate their understanding of life science concepts, students might be asked to:

Life Science

Life science focuses on the study of the structure, properties, and interactions of living organisms, including characteristics of organisms, reproduction and life cycles, populations and ecosystems, regulation and behavior, and evolution and adaptation.

To demonstrate their understanding of life science concepts, students might be asked to:

- trace the environmental factors that changed and led to the extinction of a species
- explore the patterns of growth in cell reproduction and how they differ in cancerous cells
- examine the impact of various organisms on the environment
- represent the interactions of organisms in a community through a food web
- or explain how the structure of DNA impacts genetics and heredity

Physical Science

Physical science focuses on the study of the structure, properties, and interactions of materials, including forces and motion, light, energy, electricity and magnetism, atomic structure, and chemical reactivity.

To demonstrate their understanding of physical science concepts, students might be asked to:

- explore conservation of energy and mass
- explain how atomic structure relates to physical and chemical properties and placement within the periodic table
- investigate the relationships between velocity, acceleration, and resistance for various moving objects
- demonstrate how microscopic molecular actions can produce macroscopic forces such as air pressure in a balloon
- or discuss the microscopic and macroscopic factors that energy retention depends on.

Earth/Space Science

Earth and space science focuses on the study of the structure, properties, and interactions of the subsystems of Earth and of our solar system, including the atmosphere, the lithosphere, energy in Earth's systems, and the evolution of the solar system.

To demonstrate their understanding of earth and space science concepts, students might be asked to:

- trace the evidence of geologic change through fossils and rock patterns
- explore seasonal differences in various climatic conditions
- examine the Sun's influence on the planets in our Solar System and the factors that support life on Earth but not elsewhere
- model the Earth's core and explain how the varying materials influence surface phenomena
- or relate land characteristics to the land formations they support.

Coordinated Science

Coordinated science focuses on the study of the structure, properties, and interactions of the integrated living and non-living systems.

To demonstrate their understanding of coordinated science concepts, students might be asked to:

- explore how energy is transferred from the sun to both living and non-living systems
- relate patterns of climates to characteristics of the land, flora, and fauna
- trace the effects of acid rain on geological systems and ecological communities
- investigate the efficiencies and implications of using various sources of energy in small and large scale applications
- or explain the impact of water's chemical structure on biological, chemical, and geological systems.

Dimensions of Knowing and Inquiring about Science

The dimensions of knowing and inquiring about science through which depth of understanding of science is developed, are not intended to be discrete, sequential, or hierarchical, and are separated into the following four categories:

...observe, collect, organize, classify, measure...

Acquiring Scientific Knowledge

includes observing, collecting, and organizing data; measuring; reading graphs and charts; classifying; and asking questions. To demonstrate their ability to acquire scientific knowledge, students might be asked to make detailed and accurate observations about the physical structures of several plant samples, produce a graphical representation of a given set of temperatures over time for a boiling pot of water, or classify rock samples based on their observable properties.

...interpret, analyze, recognize...

Using Scientific Knowledge

includes interpreting, inferring, analyzing, and recognizing patterns and trends in data; manipulating variables; and making decisions. To demonstrate their ability to use scientific knowledge, students might be asked to explain the relationship between time of year and fish population when given the number of fish in a particular lake each month over a three year period, determine meteorological patterns from a given set of temperature data and precipitation observations, or predict the characteristics of the next generation of flowers based on the characteristics of the current generation.

...develop, evaluate, generalize, design, conduct...

Extending Scientific Knowledge

includes developing models, drawing conclusions, analyzing and evaluating information; generalizing; designing and conducting experiments; making predictions; and applying knowledge to new situations. To demonstrate their ability to extend scientific knowledge, students might be asked to investigate the factors that affect energy absorption by various materials, use information from previous space travels to prepare a plan to sustain life in a space station, or explain how the results of a hands-on investigation of the factors affecting the rate of corrosion in metals can be used to evaluate the danger that corroding sunken ships might leak fuel and oil into local ecosystems.

Knowing Scientific Content

...know, demonstrate, understand...

includes knowing and understanding basic information considered to be part of a core content. To demonstrate their knowledge of scientific content, students might be asked to explain the components and interactions of the human body systems, demonstrate how random mutations lead to change in a species, or discuss conservation of energy and mass in chemical reactions.

Overarching Influences

Finally, the overarching influences that help provide a relevant context for the assessments are:

Historical Perspectives

...evaluate ideas, compare theories...

Reflections of science as a dynamic process, with new discoveries and technologies, scientific theories, models, and ideas that change with time. To demonstrate their understanding of the historical perspectives of science, students might be asked, for example, to evaluate various theories of dinosaur extinction such as Alvarez's meteor theory.

Social and Personal Perspectives

...discuss implications, apply understanding...

Illustrations of the importance of science in everyday life, emphasizing the connections between scientific knowledge and real-world problems, including such things as health and environmental science. To demonstrate their understanding of the social and personal perspectives of science, students might be asked, for example, to discuss the implications of the dwindling supplies of fossil fuels.

Nature of Science

...explore, inquire, question...

An emphasis on science as a process, including such things as habits of mind and the process by which scientific inquiry occurs. To demonstrate their understanding of the nature of science, students might be asked, for example, to complete a long term investigation to determine the factors that promote plant growth that not only requires them to design an initial investigation, but also requires them to react to the data as the investigation progresses and revise the investigative plans and data interpretation as time passes.

Science and Technology

...outcomes, benefits, implications...

An understanding that advances in technology have changed how we view the natural world. Also reflecting on how science has resulted in many of the advances in technology that we take for granted. To demonstrate their understanding of science and technology, students might be asked, for example, to discuss the implications of the discovery of the structure of the atom.

All assessments, which are developed for elementary, middle, and high school, reflect these four facets or dimensions.

Additional Resources

- **Portfolio**

  As previously mentioned, Portfolio assessment has been developed to provide an opportunity for students to demonstrate understanding of science over an extended period of time, and to make science meaningful in whatever manner they personally can. Further explanation of the goals, format, and components to the SCASS Science Portfolio can be found in the *SCASS Science Portfolio Teacher and Student's Guide* and *SCASS Science Portfolio Implementation Guide*.

- **Measures of the Enacted Curriculum**

  To provide a more complete picture of the status of science education and reform for member states, teacher and student surveys, which complement the SCASS Science Assessments, were created to provide descriptions of the curriculum as it is taught in the classroom, monitor the effects of reform, and provide a means for diagnosing problem areas in classroom content related to student achievement. A paper entitled "*SCASS Science Assessment, Measures of the Enacted Curriculum*" describes the use of surveys and data regarding science content, classroom practices, and student achievement to inform instruction.

- **Outreach**

  Additional explanatory documents and an introductory video tape explain the basic characteristics including the benefits of performance assessment.

  Brochures to explain the overall goals and products of the SCASS Science project as well as the ongoing Portfolio Implementation Guide in member states.

References

American Association for the Advancement of Science (1993). *Benchmarks for Science Literacy*. New York: Oxford University Press

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SCASS Science Consensus Matrix