California Integrated Science Grade 8
Cited CCCs and their Bullets[1]

PATTERNS In grades 6-8, students recognize that macroscopic patterns are related to the nature of microscopic and atomic-level structure. They identify patterns in rates of change and other numerical relationships that provide information about natural and human designed systems. They use patterns to identify cause and effect relationships, and use graphs and charts to identify patterns in data.

- **Patterns can be used to identify cause and effect relationships. (MS-ESS1-1), (MS-LS4-2)**
- **Graphs, charts, and images can be used to identify patterns in data. (MS-PS4-1), (MSLS4-1), (MS-LS4-3)**

CAUSE AND EFFECT: MECHANISM AND PREDICTION In grades 6-8, students classify relationships as causal or correlational and recognize that correlation does not necessarily imply causation. They use cause and effect relationships to predict phenomena in natural or designed systems. They also understand that phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

- **Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-3), (MS-PS2-5), (MS-ESS3-4)**
- **Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-4), (MS-LS4-5), (MS-LS4-6)**

SCALE, PROPORTION, AND QUANTITY In grades 6-8, students observe time, space and energy phenomena at various scales using models to study systems that are too large or too small. They understand phenomena observed at one scale may not be observable at another scale and that the function of natural and designed systems may change with scale. They use proportional relationships (e.g., speed as the ratio of distance traveled to time taken) to gather information about the magnitude or properties and processes. They represent scientific relationships through the use of algebraic expressions and equations.

- **Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1-3), (MS-ESS1-4)**
- **Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1)**

[1] Crosscutting Concept in grey (Energy and Matter) is not cited in California Integrated Grade 8 Performance Expectations.

SYSTEMS AND SYSTEM MODELS In grades 6-8, students understand that systems may interact with other systems; they may have sub-systems, and be part of larger complex systems. They can use models to represent systems and their interactions – such as inputs, processes, and outputs – and energy, matter and information flows within systems. They also learn that models are limited in that they only represent certain aspects of the system under study.

• Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-PS2-1), (MS-PS2-4), (MS-PS3-2), (MS-ESS1-2)

ENERGY AND MATTER

STRUCTURE AND FUNCTION In grades 6-8, students model complex and microscopic structures and systems and visualize how their function depends on the shapes, composition, and relationships among its parts. They analyze many complex natural and designed structures and systems to determine how they function. They design structures to serve particular functions by taking into account properties of different materials and how materials can be shaped and used.

• Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function. (MS-LS3-1)

• Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS4-2), (MS-PS4-3)

STABILITY AND CHANGE In grades 6-8, students explain stability and change in natural or designed systems by examining changes over time and considering forces at different scales, including the atomic scale. Students learn that changes in one part of a system might cause large changes in another part. Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms, and stability might be disturbed by either sudden events or gradual changes that accumulate over time.

• Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale. (MS-PS2-2)

Dr. Art's CCC Recommendations for California Integrated Grade 8

NOTE: Please read "Dr. Art's Overview Grade Span 6-8 CCC Recommendations" before reading the recommendation for this grade level.

NGSS in K-5 features a strong emphasis on both **Patterns** and **Cause and Effect**. These two CCCs work well together since humans are hard wired to perceive patterns in phenomena and to try to explain the patterns in terms of what might be causing them. The 6-8 Grade Span Overview recommends in each grade level an emphasis on patterns that readily connect with causal relationships. In Integrated Grade 8, students experience patterns and infer causal relationships in diverse contexts such as strength of electric and magnetic attractions (MS-PS2-3 and MS-PS2-5), changes in traits within populations (MS-LS4-4 and MS-LS4-6), and environmental impacts of human populations and consumption (MS-ESS3-4).

An important **Cause and Effect** CCC bullet states that "Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation." The only citation in Integrated 6-8 for this bullet occurs in Integrated Grade 6. It could be both relevant and helpful to review in Integrated Grade 8 the distinction between causation and correlation.

As described in the 6-8 Grade Span Overview, both testing and predicting can help distinguish between causation and correlation. The full title of the causal CCC is **Cause and Effect: Mechanism and Prediction**. With respect to prediction, the CCC bullet "Cause and effect relationships may be used to predict phenomena" is cited three times in Integrated Grade 8. Another relevant bullet that is also cited three times advises that "phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability." Students may expect cause and effect relationships to be "all or none," but this bullet can help them have more realistic expectations about the results from testing cause and effect relationships in complex systems. See also in Dr. Art's Overview of the 6-8 Grade Span the related discussion of how "mechanism" can provide evidence whether a relationship is causal or not.

The 6-8 Grade Span Overview document also recommends that in each middle school grade level, students experience the CCC of **Scale, Proportion, and Quantity**. The main cited bullet states: "Time, space and energy phenomena can be observed at various scales using models to study systems that are too large or too small." The three solar system Performance Expectations in Integrated Grade 8 (MS-ESS1-1, MS-ESS1-2, and MS-ESS1-3) offer students multiple opportunities to experience how the space aspect of Scale can facilitate their investigations and understandings. Similarly, the geological time Performance Expectation (MS-ESS1-4) provides insight into the time aspect of scale. One key stumbling block to understanding natural selection/evolution is that our sense of time is miniscule compared with many millions of years. It is hard for humans to appreciate how very long periods of time enable changes that seem impossible to creatures who live a mere 100 years.

The 6-8 Grade Span Overview document also recommends that in each middle school grade level, students experience the CCC of **Systems and System Models** and also connect that CCC with at least one of the three other "systems thinking" CCCs. Note that the Scale bullet cited in the previous paragraph advises using models to study systems that are too large or too small. This modeling is further reinforced by the fact that both MS-ESS1-1 and MS-ESS1-2 begin with "develop and use a model." MS-PS3-2 also begins with "develop a model," in this case to describe how the amount of potential energy in a system changes when the arrangement of interacting objects changes.

Systems modeling in Integrated Grade 8 can readily connect with the CCC of **Structure and Function** in the physical science of waves and transmission of information. Students can develop and use a wave model of light to explain brightness, color, and the frequency-dependent bending of light at a surface between media (MS-PS4-2). They also utilize understandings of structure and function to investigate various modes of information transfer to support the claim that digitized signals are a more reliable way to encode and transmit information (MS-PS4-3).

Note that Integrated Grade 8 does not include any citations for the CCC of **Energy and Matter**. Of course Grade 8 students have many opportunities to investigate and understand interactions involving matter and energy, particularly with respect to the motions of objects and Newton's Laws.

