Elaboration and Unpacking of the CCCs

Grade 8, Measurement Target 2	Students are able to develop and interpret models and use mathematical representations and scientific information to make claims about how waves transfer energy and information through various materials.	
	Patterns	**Structure and Function**
CCCs[1]	• Graphs and charts can be used to identify patterns in data. **(MS-PS4-1)**	• 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)** • Structures can be designed to serve particular functions. **(MS-PS4-3)**
Essential Knowledge and Skills	**MS-PS4-1** • Graphs can be used to represent and identify patterns such as direct and inverse relationships. • The unit rate can be interpreted as the slope of a graph for a proportional relationship. • Charts can be used to represent and identify patterns such as direct and inverse relationships. • Images can be used to represent and identify patterns.	**MS-PS4-2 and MS-PS4-3** • Structures can be designed to serve different functions. • The relationship between structure and function may be reciprocal. **MS-PS4-3** • The design of a structure must be based on the properties of its materials. • The design of a structure must be based on its shape. • The design of a structure must be based on how it will be used. • Structure does not always determine function. • Different structures can have the same or similar functions.
Evidence of a High Level of Performance	• Students can reason using multiple sources of information (e.g., graphs, charts, and images) to draw conclusions based on patterns in data.	• Students can apply knowledge of macroscopic and microscopic properties of materials to design a structure to serve a particular function.

[1] These are the primary Crosscutting Concepts associated with the Performance Expectations for this Measurement Target. Additional Crosscutting Concepts Building to the PEs can be found on the website for the Next Generation Science Standards.

Relationships to Practices[2]	• Recognizing patterns in data and seeing relationships between variables. • Recognizing patterns is a large part of working with data. • Patterns are identified best using mathematical concepts. • Patterns in rates of change and other numerical relationships provide information about natural and human designed systems.	• A sense of scale is necessary to know what properties and what aspects of shapes or materials are relevant at a particular magnitude or in modeling particular phenomena. • Modeling complex and microscopic structures and systems and visualizing how their function depends on the shapes, composition, and relationships among its parts. • To communicate findings clearly and persuasively may include an analysis of complex structures and systems to describe how they function.
Prerequisite Knowledge and Skills	• Ability to use patterns to identify cause and effect relationships, and use graphs and charts to identify patterns in data • Ability to identify patterns in rates of change and other numerical relationships	• Ability to model complex and microscopic structures and systems and visualize how their functions depend on the shapes, composition, and relationships among their parts • Ability to design structures to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used
Student Challenges	• Middle school students tend to invoke personal experiences as evidence to justify a particular hypothesis. They seem to think of evidence as selected from what is already known or from personal experience or second-hand sources, not as information produced by experiment. [1] Most sixth graders can judge whether evidence is related to a theory, although they do not always evaluate this evidence correctly. [2] When asked to use evidence to judge a theory, students of all ages may make only theory-based responses with no reference made to the presented evidence. Sometimes this appears to be because the available evidence conflicts with the students' beliefs. [3]	

[1] Roseberry, A., Warren, B., Conant, F. (1992). Appropriating scientific discourse: Findings from language minority classrooms. *Journal of the Learning Sciences, 2*, 61-94.

[2] Kuhn, D., Amsel, E., O'Loughlin, M., Beilin, H. (1988). *The development of scientific thinking skills.* London: Academic Press.

[3] Kuhn, D., Amsel, E., O'Loughlin, M. (1988). *The development of scientific thinking skills.* London: Academic Press.

[2] These are meant to be examples; not an exhaustive list of connections to the practices. Additional Practices Building to the PEs can be found on the website for the Next Generation Science Standards.