Implementing the NM STEM Ready! Science Standards

Planning Instruction through Curriculum Adaptation

October 25, 2018

Patricia Carden, Math Specialist

Shafiq Chaudhary, Math & Science Specialist

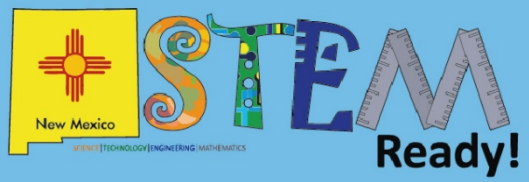
Christopher N. Ruszkowski
Secretary of Education

Goals

- Identify effective strategies for planning instruction for the NM STEM Ready! science classroom

- Understand how planning and curriculum adaptation support students in sense making

NM STEM Ready! Science Standards

NGSS
+
New Mexico 6
Specific Standards
=


science standards

Together, the NGSS in their entirety, plus the New Mexico 6 specific standards comprise the NM STEM Ready! science standards.

Christopher N. Ruszkowski
Secretary of Education

What is a NM STEM Ready! science standard?

Students who demonstrate understanding can:

3-PS2-1. **Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.** [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.] [*Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Science investigations use a variety of methods, tools, and techniques.

Disciplinary Core Ideas

PS2.A: Forces and Motion

- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.)

PS2.B: Types of Interactions

- Objects in contact exert forces on each other.

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships are routinely identified.

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:

K.PS2.A ; **K.PS2.B** ; **K.PS3.C** ; **5.PS2.B** ; **MS.PS2.A** ; **MS.ESS1.B** ; **MS.ESS2.C**

Common Core State Standards Connections:

ELA/Literacy -

RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. *(3-PS2-1)*

W.3.7 Conduct short research projects that build knowledge about a topic. (3-PS2-1)

W.3.8 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. (3-PS2-1)

Mathematics -

MP.2 Reason abstractly and quantitatively. *(3-PS2-1)*

MP.5 Use appropriate tools strategically. *(3-PS2-1)*

3.MD.A.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. *(3-PS2-1)*

Christopher N. Ruszkowski
Secretary of Education

What is a NM STEM Ready! science standard?

who demonstrate understanding can:

2-1. **Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.** [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.] [*Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Science investigations use a variety of methods, tools, and techniques.

Disciplinary Core Ideas

PS2.A: Forces and Motion

- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.)

PS2.B: Types of Interactions

- Objects in contact exert forces on each other.

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships are routinely identified.

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:

K.PS2.A ; **K.PS2.B** ; **K.PS3.C** ; **5.PS2.B** ; **MS.PS2.A** ; **MS.ESS1.B** ; **MS.ESS2.C**

Common Core State Standards Connections:

ELA/Literacy -

RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. *(3-PS2-1)*

W.3.7 Conduct short research projects that build knowledge about a topic. (3-PS2-1)

W.3.8 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. (3-PS2-1)

Mathematics -

.P.2 Reason abstractly and quantitatively. *(3-PS2-1)*

Use appropriate tools strategically. *(3-PS2-1)*

Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multi… to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker … measurement scale) to represent the problem. *(3-PS2-1)*

Christopher N. Ruszkowski
Secretary of Education

Reading a Standard

MS-PS1-3 **Gather and make sense of information to describe that synthetic materials comes from natural resources and impact society.** [Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] *[Assessment Boundary: Assessment is limited to qualitative information.]*

MS-PS1-3 **Gather and make sense of information to describe that synthetic materials comes from natural resources and impact society.** [Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] *[Assessment Boundary: Assessment is limited to qualitative information.]*

Science and Engineering Practice
Disciplinary Core Idea

MS-PS1-3 **Gather and make sense of information to describe that synthetic materials comes from natural resources and impact society.** [Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] *[Assessment Boundary: Assessment is limited to qualitative information.]*

Science and Engineering Practice
Crosscutting Concept

3-Dimensional Learning

Student Performance Expectation (PE)

Science & Engineering Practices (doing science)

Disciplinary Core Ideas (facts)

Crosscutting Concepts (connecting science)

Adapted from NSTA

* NEXT GENERATION SCIENCE STANDARDS is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards was involved in the production of, and does not endorse, this product.

Performance Expectations

ARE

- Guidance for what students should be able to do and understand
- Specifications for assessments

ARE NOT

- Learning goals for students
- Instructional strategies for students
- Tests for students

Adapted from Bybee (2013) and Krajcik (2014)

Shifting from "Learning About" to "Figuring Out"

Three key ideas:

1. Core ideas: Shift away from too much content at a surface level to *focus on in-depth development of core ideas.*
2. Practices: Developing explanations through investigation to make sense of phenomena.
3. Coherence: Science learning is a *logical progression* in which learners build ideas over time and between science disciplines.

Adapted from Reiser, 2013

Shifting from "Learning About" to "Figuring Out" (*continued*)

- Students using the science and engineering practices are "figuring out" an explanation or solving a problem
  - Application of science knowledge
- Practices mean students should know *why* they are doing an activity

Adapted from Reiser (2013; 2014a,b)

Strategies for Planning Instruction

- Phenomena
- Backwards Design
- Curriculum Adaptation
- Bundling Standards
- Storylines

Which of these planning strategies are you currently using?

Strategies for Planning Instruction

- Phenomena
- **Backwards Design**
- **Curriculum Adaptation**
- Bundling Standards
- Storylines

Backwards Design

1. Identify the learning outcomes.
2. Determine the evidence for learning.
3. Plan instruction to facilitate the outcomes.

Adapted from Wiggins and McTighe, (2008)

Curriculum Adaptation

- “Refers to a purposeful effort to bring existing materials into alignment with new visions for science learning by adding to, adapting, or transforming those materials” (Debarger *et al*, 2016, p 4).

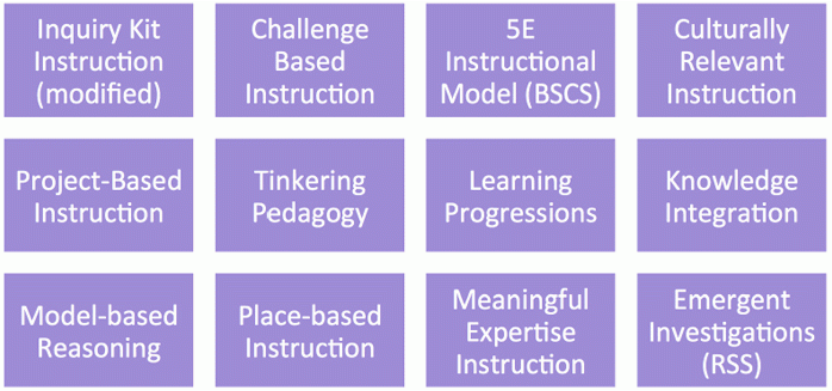
Why Adapt Curriculum?

- The development and phasing in of curriculum aligned to the NM STEM Ready! Science Standards will take time.
- “Instructional units on topics that are included in the standards for a grade level should be adapted to focus around student learning experiences that engage students in the science and engineering practices” (NRC, 2015, p 54).

Curriculum Adaptation

Instructional Model

- NGSS and the underlying NRC Framework do not say anywhere that there is only one instructional approach for engaging students in the practices.
- Practice-based instructional models engaging students in three-dimensional learning.



Adapted from Institute for Science Math Education. (n.d.)

Curriculum Adaptation

Screening for Alignment with NGSS

1. What DCIs would this lesson/unit address?
2. Are students engaged in the science and engineering practices?
3. Does the unit involve *figuring out* rather than *learning about?* Look for…
   - students being able to experience concepts before vocabulary introduction.
   - opportunities for teachers to identify what students know and can do.

Adapted from Reiser (2014a, b) and Bybee (2013)

Curriculum Adaptation

Screening for Alignment with NGSS (cont.)

4. Do the materials include DCIs? SEPs? CCCs?
5. Are the DCIs, SEPs, and CCCs integrated?
6. Opportunities to connect to the CCSS?
7. Grade-level alignment?

NGSS Lesson Screener

Adapted from Bybee (2013)

Curriculum Adaptation

Instructional Sequence

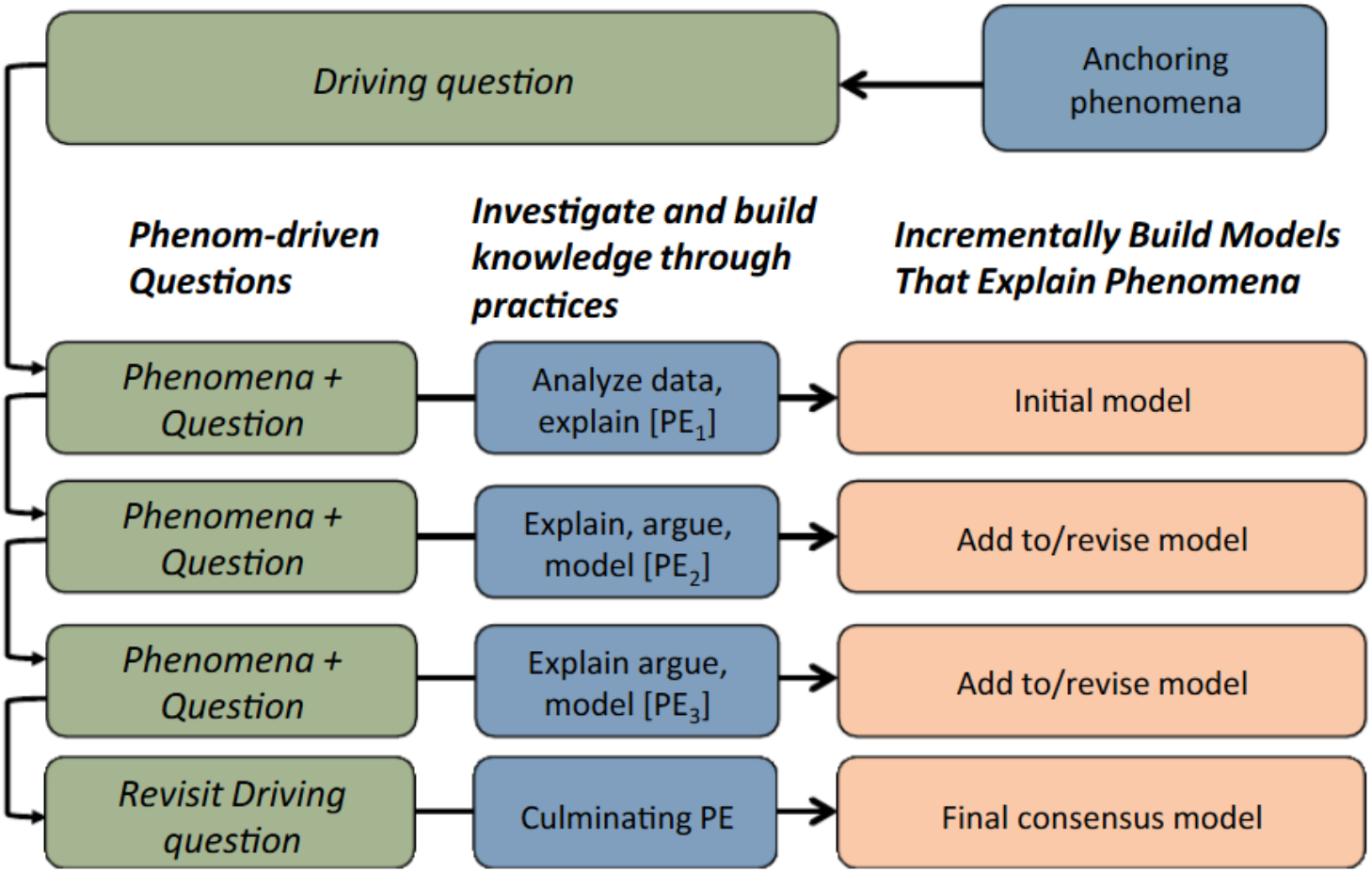
An instructional sequence should:

- provide for different forms of interaction among learners and teachers.
- allow for a variety of teaching strategies.
- integrate three dimensions.
- allow adequate time and opportunities for learners to formulate understandings of DCIs, SEPs, and CCCs.

Adapted from Bybee (2013)

Curriculum Adaptation

Guiding questions for adapting instruction (cont.)



Adapted from Reiser (2014a, b)

Curriculum Adaptation

Overview

- Identify the anchoring phenomena/question students are working towards explaining
- List the pieces of knowledge (big ideas) will students investigate to fully explain the phenomena/question
- Logically order lessons to build student coherence
- Integrate practices/screen lessons for alignment

Considerations

- It is not possible to attend to all curriculum lessons/units at once.
- Follow a backwards design process to adapt curriculum.
- Work with a team of teachers, if possible.

Adapted from Institute for Science Math Education. (n.d.).

Resources

- NM STEM Ready! Science Resources page
- NGSS In Practice-Tools and Processes
- NGSS Lesson Screener

Curriculum Adaptation

- *Translating the NGSS for Classroom Instruction* by Rodger Bybee
- STEM Teaching Tool 5
- *Adapting Curriculum Materials to Align with NGSS: Grades K-5; 6-12*

Instructional Models

- STEM Teaching Tool 4

Next Steps

Next Webinar:

End of November 2018 - Planning Instruction: Bundling Standards/Storyline

Professional Learning:

Please visit the Math and Science Bureau's Professional Learning page; registration for Making Sense of SCIENCE is upcoming.

References

- Brown, K., Burditt, T., Cerwin, K., Clark, J., Cochrane, C., DiRanna, K., …Topps, J. (n.d.). *Criteria for selecting useful phenomena* [Web log post]. Retrieve from https://sites.google.com/site/sciencephenomena/criteria.
- Bybee, R. W. (2013). *Translating the NGSS for Classroom Instruction*. National Science Teachers Association.
- Debarger, A. H., Penuel, W. R., Moorthy, S., Beauvineau, Y., Kennedy, C. A., & Boscardin, C. K. (2016). Investigating Purposeful Science Curriculum Adaptation as a Strategy to Improve Teaching and Learning. *Science Education, 101*(1), 66-98. doi:10.1002/sce.21249
- Cerwin, K., DiRanna, K., Grace, J., LaFontaine, P., Ritchie, S., Sheriff, J., . . . Iveland, A. (2018). *Next Generation Science Standards in Practice: Tools and Processes Used by the California NGSS Early Implementers* (pp. 1-74, Rep.). CA: WestEd.
- Institute for Science Math Education. (n.d.). Using curriculum adaptation as a strategy to help teachers learn about NGSS and developing aligned instructional materials : StemTeachingTools. Retrieved July 12, 2018, from http://stemteachingtools.org/brief/5
- Institute for Science Math Education. (n.d.). Are there multiple instructional models that fit with the science and engineering practices in NGSS? (Short answer: Yes): StemTeachingTools. Retrieved July 12, 2018, from http://stemteachingtools.org/brief/4
- Joseph Krajcik, Susan Codere, Chanyah Dahsah, Renee Bayer & Kongju Mun (2014) Planning Instruction to Meet the Intent of the Next Generation Science Standards, Journal of Science Teacher Education, 25:2, 157-175, DOI: 10.1007/s10972-014-9383-2
- National Research Council. 2015. *Guide to Implementing the Next Generation Science Standards*. Washington, DC: The National Academies Press. https://doi.org/10.17226/18802.Retrieved July 12, 2018, from https://www.nap.edu/read/18802/chapter/7.

References

- National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.
- NSTA. (n.d.). Designing Units and Lessons. Retrieved July 6, 2018, from http://ngss.nsta.org/designing-units-and-lessons.aspx
- Pruitt, S. L. (2014). The Next Generation Science Standards: The Features and Challenges. *Journal of Science Teacher Education, 25*(2), 145-156. doi:10.1007/s10972-014-9385-0
- Reiser, B. J. (2014a). *Adapting Curriculum Materials to Align with NGSS: Grades K-5. CPS*
- Reiser, B. J. (2014b). *Adapting Curriculum Materials to Align with NGSS: Grades 6-12. CPS*
- Reiser, B. J. (2014c). *Designing coherent storylines aligned with NGSS for the K12 classroom.* National Science Education Leadership Association, Boston, MA
- Reiser, B. J., Novak, M., & Furnagalli, M. (2015). *NGSS storylines: How to construct coherent instructional sequences drive be phenomena and motivated by student questions. Illinois* Science Education Conference 2015, Tinley Park, IL
- Wiggins, G. P., & McTighe, J. (2008). *Understanding by design*. Alexandria, VA: Association for Supervision and Curriculum Development.