The Importance of Performing 3D Assessments with NGSS

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Introduction

The *Next Generation Science Standards* (NGSS) take a new approach to science education that reflects the needs of our changing world. The standards have three components or dimensions: Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts. These standards promote the idea that science education is no longer about what students know, but rather about how they can incorporate knowledge and skills to meet explicit Performance Expectations.

NGSS asks that students be able to integrate all science disciplines, engineering principles, and a variety of practices in order to solve comprehensive problems and/or explain phenomena. As a result, "science" now represents what students can do with information, and is no longer conceived of as a static collection of facts.

In order to assess understanding in this new model, assessments should be three-dimensional and integrate the practices with Crosscutting Concepts as students learn new core ideas. When rigorous performance assessments are developed at the start of a unit, teachers can work backwards to determine what knowledge and skills are necessary in order for all students to meet those expectations.

About the NGSS

The *Next Generation Science Standards* were written over the course of two years with the cooperation of national organizations, higher education, industry experts, and state leaders. The foundation of this work was the National Research Council publication *A Framework for K–12 Science Education* in 2012. What makes NGSS unique in the world of science education is the profound pedagogical shift from science being a collection of facts and lower-level cognitive tasks to science being a process of learning through application of the practices and making connections among all disciplines of science.

The standards have clearly defined Performance Expectations for each grade level that describe what students should be able to do. In order to accomplish those tasks, students must use the Science and Engineering Practices (Dimension 1), while recognizing Crosscutting Concepts applicable to all areas of science (Dimension 2), and understanding Disciplinary Core Ideas relevant to a specific discipline of science (Dimension 3).

A rationale for this approach is provided in *A Framework for K–12 Science Education:*

"Standards and performance expectations that are aligned to the framework must take into account that students cannot fully understand scientific and engineering ideas without engaging in the practices of inquiry and the discourses by which such ideas are developed and refined. At the same time, they cannot learn or show competence in practices except in the context of specific content." (p. 218).

How to Read the NGSS

In order to understand what three-dimensional assessments are, it is first important to understand how to read the *Next Generation Science Standards* (www.nextgenscience.org) to identify each dimension.

When looking at the standards, the top box (color-coded white) shows Performance Expectations. This is the most important component of the standards because it clearly explains what students must be able to do in order to demonstrate mastery. In fact, some states consider the Performance Expectations to be the "official" standards, since all students are held accountable to these requirements. However, schools ultimately decide the type of instruction that is necessary so that all students can meet the Performance Expectations. When unit planning, it is important to consider differentiated instruction, scaffolding, project and problem-based learning, inquiry, design of experiment, etc.

Beneath Performance Expectations are three foundation boxes that are color-coded blue, orange, and green. The foundation boxes represent the three dimensions of the *Next Generation Science Standards*. When instruction is focused on these boxes, students should be able to meet the Performance Expectations.

The left box (color-coded blue) represents Science and Engineering Practices. Each Performance Expectation is numbered, and there is a corresponding designation for the appropriate practices students will need to employ in order to meet expectations. Students will typically be using more than one practice in a task, because all practices are highly interconnected.

The middle Disciplinary Core Ideas (DCI) box (color-coded orange) represents the science content that students will need to know in order to meet a particular Performance Expectation. Again, the DCIs correspond to particular Performance Expectations, although schools may incorporate additional content to meet the needs of their student population. DCIs focus on the major essential scientific ideas.

The right Crosscutting Concepts box (color-coded green) is also aligned to Performance Expectations. These concepts apply to all disciplines of science and help students make connections between the sciences and essential concepts.

Developing 3D Assessments

Three-dimensional (3D) assessments are tasks that incorporate the use of Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts simultaneously. Because three-dimensional assessments are complex in nature, they cannot be carried out in their entirety as a traditional multiple-choice test within one class period. These types of assessments must be created with careful thought and planning, and their design should take place before beginning a unit of study. By starting a unit with clearly determined outcomes, it is then possible to help students meet their learning goals by working backwards to develop a learning path based on their individualized needs.

1. **Determine which Performance Expectation(s) will be assessed.**
   The first step to developing a 3D assessment is to look at the Performance Expectations. Since the Performance Expectations are specified at the middle and high-school level in the NGSS, there is no significant difference in the approach to developing these assessments at each level. Crosscutting Concepts and Science and Engineering Practices are the same for all grade levels, yet the degree of expected mastery differs. As a result, using the Performance Expectations and resources available at the *Next Generation Science Standards* website will guide the development of meaningful, higher order assessments.

2. **Organize Practices, Core Ideas, and Crosscutting Concepts.**
   The next step is to organize the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts that relate to the targeted Performance Expectation. As stated above, each Performance Expectation has three corresponding dimensions. These three dimensions together are what students are expected to know and do in order to meet standards.

   Prior to the development of the *Next Generation Science Standards,* teachers typically designed units based on what students should know, which is analogous to using only the DCIs to guide instruction. As a result of NGSS, the Performance Expectations now guide unit development, and learning occurs through the application of Science and Engineering Practices and Crosscutting Concepts.

3. **Connect to Phenomena.**
   After clearly identifying what students should do in order to meet the Performance Expectations, it is then possible to link the associated learning to phenomena. This can be done either in the form of an essential question or an actual problem-based learning task that requires students to design and build a solution to a specified problem. To answer the question or solve the problem, students are required to apply the previously identified three dimensions. How they answer the question or carry out the learning task that addresses the phenomenon is the assessment piece.

4. **Decide how students will meet the assessment goals.**
   Once the frame around a phenomenon is established, teachers must decide how students will meet the established goals as 3D assessment tasks. Typically, this is accomplished with a combination of tasks including experimentation, writing prompts, argumentation, close reading, inquiry-based investigations, project-based learning, journaling, simulations, modeling, or designing and building.

Since the *Next Generation Science Standards* require all students to meet expectations, it is important to determine at this stage if specific supports are needed for students based upon individual academic struggles, learning disabilities, or language barriers. The standards do not dictate how students must meet expectations, but rather define what the expectations are. Teachers have the freedom, flexibility, and responsibility to find ways to ensure that all students can reach mastery. This is why 3D assessments will look different for different students.

5. **Establish grading criteria.**
   Finally, once the paths to standards mastery have been developed, clearly defined grading criteria must be established. Typically, this is accomplished with a well-constructed rubric that can show if a student has met the expectations, exceeded expectations, or has not yet met the expectations.

   These days digital tools make it entirely possible for students to look up any information they don't know the very moment they need to know it. However, simply knowing the facts will not help students learn to think scientifically. Students must work throughout grades K–12 to develop the critical thinking and practices necessary to apply information and solve problems in a new way. This is why NGSS places such a strong focus on performance tasks and 3D assessments as opposed to traditional "content only" tests that mainly require memorization.

   As educators, it is imperative that skills are consistently assessed in order to make certain that students are college- and career-ready. By developing 3D assessments prior to beginning a new unit, teachers can structure their classrooms in a manner that promotes daily integration of Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas. That type of classroom environment fosters the development of lifelong skills.

Resources for Teachers and Parents

The *Next Generation Science Standards* website provides *Instruction and Assessment Supports*. This section of the website will be helpful for teachers as they begin to develop 3D assessments in their classrooms, and also for parents as they begin to understand the shifts in science education and assessment their children will experience.

Assessment Supports are text and video resources that can help unpack the standards. Resources include:

- Evidence statements that specifically identify measurable outcomes to meet Performance Expectations
- Sample classroom tasks that provide examples of three-dimensional learning
- Examples for how teachers can "bundle" performance expectations together and logically structure tasks for each grade band

- A guide to phenomena to help educators make appropriate connections
- NGSS Storylines and NGSS Appendices that provide additional examples of what learning should look like, clarify standards, and model implementation
- *NGSS For All Students,* which provides case studies and standards-based classroom strategies for diverse student populations

Conclusion

N*ext Generation Science Standards* immerse students in hands-on learning and critical thinking rather than simply testing their abilities to memorize facts and perform low-level tasks. These new standards require K–12 educators to approach lessons with careful planning to meet Performance Expectations.

Three-dimensional assessment tasks allow teachers to see a student's thinking at work, which can reveal how well learners are understanding and integrating Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts. Therefore, teachers should challenge themselves to develop 3D assessments prior to every lesson to ensure their students are making appropriate connections and are developing the scientific skills to be college- and career-ready.

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