Toward NGSS Design:

EQuIP Rubric for Science
Detailed Guidance

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Introduction

The Educators Evaluating the Quality of Instructional Products [(EQuIP) Rubric for Science] provides criteria by which to measure the alignment and overall quality of lessons and units with respect to the Next Generation Science Standards (NGSS). The EQuIP rubric and review process can be used to:

1. review existing lessons and units to determine what revisions are needed;
2. provide constructive criterion-based feedback and suggestions for improvement to developers;
3. identify examples and models of instructional materials for teachers' use within and across states; and
4. inform the development of new lessons, units, and other instructional materials.

First developed in 2014 by Achieve and NSTA, the EQuIP Rubric has supported thousands of educators and instructional materials developers to design materials that support students in building toward proficiency on the standards. The NextGenScience EQuIP reviewers and the Peer Review Panel have used the EQuIP Rubric to review hundreds of science units and lessons, providing valuable feedback to developers and educators.

Although the rubric can be accessed or used by any educator or developer, effective use of the rubric requires a deep understanding of both the standards and the rubric criteria themselves. To support designers and users of science instructional materials to more effectively use the EQuIP Rubric, NextGenScience developed this new resource, *Toward NGSS Design: EQuIP Rubric for Science Detailed Guidance*. This resource unpacks each of the 19 EQuIP Rubric criteria, providing details, explanations, and external references related to each criterion. The detailed guidance in this resource will help support educators and developers see what it looks like to meet each criterion, creating a common vision of the most important features of instructional materials designed for today's science standards.

What is included?

For each EQuIP criterion, this resource includes:

- the criterion itself from EQuIP v3.0;
- a detailed description of the criterion; and
- an explanation of features of instructional materials that fully meet the criterion.

In addition, the final part of this document lists several resources related to each EQuIP criterion that can be used for additional learning.

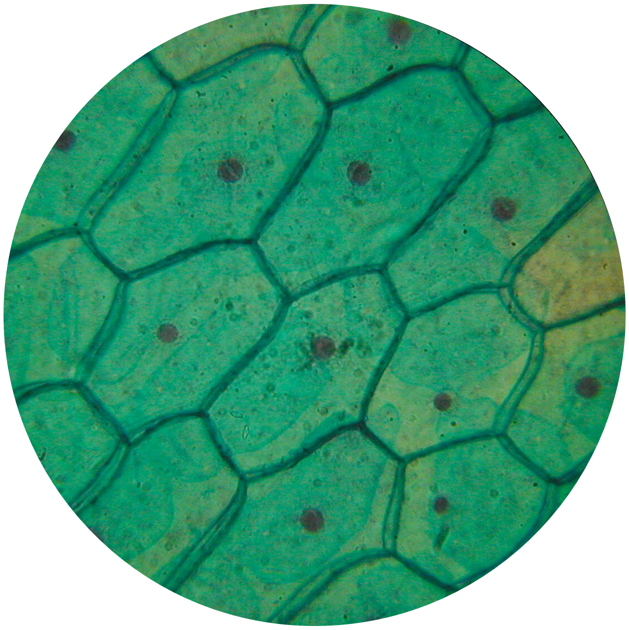
How should this resource be used?

As with the EQuIP rubric itself, this resource is intended to support those who develop, review, select, or use instructional materials by helping create a common vision of high-quality materials that are designed for the NGSS. It can be used as a tool to support conversation and collaboration among educators who are building understanding of high-quality materials or developers who are determining priorities for designing new materials. This document is not intended to be a stand-alone tool that someone without extensive background and deep understanding of the NGSS and the EQuIP rubric could pick up and apply to the review of instructional materials.

To support students with meeting the goals outlined by today's science standards, it is important to design or select materials that fully meet as many EQuIP criteria as possible. However, it may not be feasible for any one unit to include all the features of full NGSS design for every criterion. Design and review teams can use the guidance in this document to help determine strengths and weaknesses in NGSS design and therefore what kinds of supplemental supports would be most important to add for classroom use.

How shouldn't this resource be used?

- **Restrictions on instructional models or structures.** There are many different models, structures, and methods instructional materials could use to meet each of the EQuIP criteria. The descriptions in this guide are intended as illustrative examples, not to limit or dictate design decisions.
- **Limits to the descriptions of high-quality materials.** Like the EQuIP rubric itself, this document focuses on the features of high-quality materials that are specific to the shifts in the NGSS when described at the unit or lesson level. There are other general features of high-quality design not specific to NGSS shifts as well as considerations for the design of full curricular programs that are **not** measured by EQuIP.
- **Additional EQuIP criteria.** Although more details are described in this document than in the EQuIP rubric itself, this document does not add any requirements or go beyond the scope of the EQuIP rubric. Each existing criterion is simply "unpacked." This is similar to the analogy described in the *NGSS Evidence Statements* Front Matter:



"Imagine sliding a plant cross-section under a microscope; this will allow you to see greater detail and to develop a deeper understanding about how the component parts work together to make up the full plant. However, seeing this magnified view does not change the fundamental properties of the plant, nor does it give the plant new functions."

Criterion I.A: Making Sense of Phenomena or Designing Solutions to Problems

Making sense of phenomena and/or designing solutions to a problem drive student learning.

i. **Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem solving.**

ii. **The focus of the lesson is to support students in making sense of phenomena and/or designing solutions to problems.**

iii. **When engineering is a learning focus, it is integrated with developing disciplinary core ideas from physical, life, and/or earth and space sciences.**

Criterion Description

This criterion is focused on whether student sense-making of the phenomena or student designing of solutions is *the reason* for the students to learn from the student's perspective. The criterion requires not only a driving phenomenon or problem, but a close match between the learning objectives and the phenomenon or problem. This includes having a close match between science Disciplinary Core Idea (DCI) learning objectives and a focus problem to solve; engineering DCIs are not used independently as learning objectives in materials designed for the NGSS.

In the NGSS, phenomena are defined as "observable events that occur in the universe and that the reviewers can use our science knowledge to explain or predict" and problems are defined as "situations somebody wants to change." Phenomena can include discrepant events, but not all phenomena are necessarily immediately surprising and compelling to students without facilitation. According to the document *Using Phenomena in NGSS-Designed Lessons and Units*, "students might not be intrigued by an everyday phenomenon right away because they believe they already know how or why it happens. It takes careful teacher facilitation to help students become dissatisfied with what they can explain, helping them discover that they really can't explain it beyond a simple statement such as 'smells travel through the air' or a vocabulary word, such as 'water appears on cold cans of soda because it condenses.'"

The presence of a phenomenon or problem is not enough. The following are common examples of when the phenomenon or problem is **not** driving the learning:

- *The Hook*: the phenomena and problems are just used as a "hook," where they draw in the learner but are then explained by the teacher.
- *The Application*: lessons are focused on acquiring knowledge and at the end of the learning, students apply the learning to explain a phenomenon.

- *The Bookend*: The phenomenon or problem is used as a hook, then a series of learning happens that is related to the phenomenon but doesn't involve making sense of the phenomenon and then finally at the end of the unit the students apply their learning to the phenomenon or to solving a problem — a combination of both The Hook and the Application.

- *The Existential:* The phenomenon or problem presented are not actually phenomena or problems (e.g., materials describe the topic of "energy", or the factoid "sharks are more ancient than dinosaurs" as a phenomenon, or the performance task "build a tall structure with marshmallows and toothpicks" as a problem, etc.).

CONNECTIONS TO OTHER CRITERIA

Other EQuIP criteria focus on other aspects of a quality phenomenon/problem. Whether or not the three dimensions are integrated in sense-making and problem solving is addressed in I.C. Whether or not the phenomenon/problem results in a *relevant and authentic learning experience for students* is addressed in II.A.

What Does This Look Like In Materials?

Student-centered focus on phenomena or problems

- The materials are organized so that students figuring out a central phenomenon, a series of related phenomena, and/or designing a solution to a problem *drives learning*. Instruction is focused on supporting students to better make sense of the phenomenon or design a better solution to a problem.

- Students regularly return to the phenomena or problems to add layers of explanation or iterate on solutions based on learning, or regularly build on what they have learned from smaller phenomena or problems to explain a broader science topic.

Close match between the phenomena/problems and the student learning objectives throughout the materials

- Almost all of the student learning in the three dimensions targeted by the materials is in service of students making sense of phenomena or designing solutions to a problem.

Consistent student-driven learning over time

- Student questions or prior experiences related to the phenomena and problems consistently *create an explicit need*, from the students' perspective, for the students to engage in learning throughout the materials.

- Materials provide structured support for teachers to draw out student questions and prior experiences related to the phenomena and problems and to use these connections to motivate student learning when each new phenomenon or problem is introduced.

- Students have frequent opportunities to feel as if they are driving the learning sequence through their questions and emerging understanding.

When multiple phenomena and/or problems are used

- Phenomena and/or problems are clearly connected to each other in a logical way from the students' perspective and build on each other coherently.

When students are designing solutions to problems (with or without connections to ETS DCIs)

- Students use grade-appropriate science ideas (DCIs from life, Earth, or physical sciences) to solve the engineering problem and these DCIs are included as part of the learning objectives in the instructional materials.
- The way that the materials support students to engage in the engineering design process results in students demonstrating new understanding of the targeted science ideas.

MATERIALS THAT SUPPORT MAKING SENSE OF PHENOMENA AND DESIGNING SOLUTIONS TO PROBLEMS…

…LOOK *LESS* LIKE THIS:	…LOOK *MORE* LIKE THIS:
Topics (e.g., "photosynthesis") or tasks (e.g., "build a solar powered phone charger") are used to focus learning in the materials.	True phenomena (e.g., "a tree grows from a tiny seed") or problems (e.g., "I'm stuck in the middle of the desert and my phone is dead") are used to motivate student learning.
Explaining phenomena and designing solutions are not a part of student learning or are presented separately from "learning time" (e.g., used only as a "hook" or engagement tool, used only for enrichment or reward after learning, only loosely connected to a DCI, etc.).	The **purpose and focus** of the materials are to support students in making sense of phenomena and/or designing solutions to problems. The entire instructional sequence drives toward this goal.
Phenomena or problems are brought into the lesson after students develop the science ideas so students can apply what they learned.	The **development** of science ideas is anchored in explaining phenomena or designing solutions to problems.
Driving questions are given to students.	Teachers are supported to facilitate discussions such that student questions, prior experiences, and diverse backgrounds related to the phenomenon or problem can be used to drive the learning and the sense-making or problem solving, from the students' perspectives.
The lesson tells the students what they will be learning.	The lesson provides support to teachers and students for connecting students' own questions to the targeted materials.
A different, unrelated phenomenon or problem is used to start every lesson.	If multiple phenomena and/or problems are used, they are explicitly connected together and build on each other.
Engineering lessons focus on trial-and-error activities or following step-by-step instructions that don't require science or engineering knowledge.	Engineering lessons require students to acquire and use elements of DCIs from physical, life, or Earth and space sciences together with elements of DCIs from engineering design (ETS) to solve design problems.

Click here for more reading and resources related to this criterion.

Criterion I.B: Three Dimensions

Builds understanding of multiple grade-appropriate elements of the science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs) that are deliberately selected to aid student sense-making of phenomena and/or designing of solutions.

i. **Provides opportunities to *develop and use* specific elements of the SEP(s).**

ii. **Provides opportunities to *develop and use* specific elements of the DCI(s).**

iii. **Provides opportunities to develop and use specific elements of the CCC(s).**

Criterion Description

This criterion is focused on whether students are using and developing elements of each of the three dimensions, whether those elements are grade appropriate, and whether those elements support students to make sense of phenomena and/or design solutions to problems. The criterion requires specific places in materials that can be pointed to where students are clearly developing or using a particular grade-appropriate element of the standards. However, this doesn't mean that students should be explicitly told what element they are learning. The intent here is not for students to be able to recite the elements of each dimension but rather to ensure the materials are designed for students to use all three dimensions.

It is most helpful to users of materials when there is a clear alignment between the material's claims about what students are learning and evidence in the materials themselves. Below are a few related common pitfalls to avoid:

- **Overclaiming elements.** Some materials may claim that students will learn a large number of SEP, CCC, and DCI elements within a single unit without clarifying which elements are really prior learning that are simply applied, which elements are only briefly introduced to be more fully developed in a later unit, and which long and complex elements are only partially used or developed. This kind of overclaiming commonly happens with ETS DCIs, which are often claimed even when students only apply engineering practices.

- **Below grade-level design.** All three dimensions include learning progressions, so student expectations are not the same

CONNECTIONS TO OTHER CRITERIA

This criterion does not depend on whether the dimensions are integrated, which is discussed in I.C. This criterion also connects to II.B, which looks for evidence of helping teachers understand intended learning progressions, whereas evidence of students actually learning the three dimensions is collected here.

What's the difference between "using" and "developing" elements? For all three dimensions, students continuously apply, or "use" their prior learning. This could be learning from prior grade bands or earlier in the same unit. In order to progress in their proficiency, though, students also need to learn, or "develop" new elements or parts of elements.

between elementary and high school. Grade-appropriate elements of the three dimensions are sometimes claimed when students only use elements from a lower grade level. For example, middle school students are sometimes only asked to *identify cause and effect*, which only meets the expectation for the K–2 grade band. Closely examining the differences between the different grade bands in the charts in [NGSS Appendices E, F, and G] can help to determine the grade-appropriateness of the student performance.

- **Mismatch between elements in Performance Expectations and evidence in lessons.** Materials might also build toward performance expectations (PEs) but not the individual elements that make up the PEs. This is not itself a pitfall if the full PE is not claimed, as instruction does not have to pair the three dimensions in the same way that the PEs do since PEs describe expectations for the end of a grade level or grade band. For example, materials could demonstrate some progress toward a PE by only addressing one of those three dimensions in instruction. However, materials sometimes indicate that PEs are fully developed without supporting student use or development of the three dimensions of those PEs.

How many times do students need to use a certain grade-level-specific element? The three dimensions are considered somewhat differently. Students are expected to build competence in SEP and CCC elements throughout a grade band, which requires repeated exposure and use of elements in a variety of contexts over the years. However, students often have only one set of instructional materials in which to build full competence in DCI elements. If that is the case, it is important for students to have opportunities to develop deep understanding of the targeted DCI elements within that single unit.

What Does This Look Like In Materials?

Students develop and use grade-appropriate elements of all three dimensions to make sense of phenomena or design solutions to problems

- There is a close match between the SEP, CCC, and DCI elements that are claimed and evidence of their development and use in the materials.
- Students use the SEP, CCC, and DCI elements that are listed as key learning objectives in service of making sense of phenomena or designing solutions to problems.
- Students are supported to develop deep competence in specific elements such that they could be applied to more than one context. For SEPs, this could look like the teacher introducing the concept of comparing different types of data sets (e.g., self-generated, archival, etc.), or the class figuring out the important parts to consider in planning an investigation. For CCCs, this could look like the class figuring out how patterns can be useful, or the teacher facilitating students to think explicitly about why it is useful to compare different kinds of systems.
- There are sufficient SEP, CCC, and DCI elements and time that students are engaged in the elements for the length of the materials. For example, a very long unit of instruction that only supports students to develop proficiency in one element from each dimension might not sufficiently prepare students to be able to develop all of the elements by the end of the grade band.

- If below- or above-grade-level elements are claimed, there's a clear explanation for why they're outside the students' grade level. For example, it could be appropriate for materials to review and apply elements from the prior grade level if they are clearly labeled as review and distinguished from new targeted learning objectives.

MATERIALS THAT SUPPORT BUILDING UNDERSTANDING OF THE THREE DIMENSIONS…

…LOOK *LESS* LIKE THIS:	…LOOK *MORE* LIKE THIS:
Materials list many elements as learning objectives because they are introduced or partially used in the materials.	Materials explicitly distinguish between elements that are fully used, elements that are partially used, elements that are fully developed, and elements that are partially developed.
Materials focus only on developing students' DCI understanding.	Materials help students build proficiency in elements of all three dimensions.
The lessons focus on oversimplified definitions of the SEP or CCC names (e.g., "asking questions", "cause and effect", etc.) when supporting students to use these dimensions.	Lessons focus on helping students build or use **specific grade-appropriate elements** of SEPs and CCCs (from NGSS Appendices F and G) to help explain phenomena or solve problems throughout the learning process.
Materials don't make CCCs explicit to students. For example, students write an explanation about a phenomenon but aren't asked to include information about how causal relationships relate to their explanation.	Materials require students to explicitly use the CCC elements to make sense of a phenomenon or to solve a problem. For example, the materials prompt students to discuss a causal relationship as part of their explanation about a phenomenon.
A single element of each dimension shows up in a two-month-long unit.	The number of elements that students use and develop in the materials is appropriate for the length of the unit, such that all grade band targets could be reached by the end of the grade band.

Click here for more reading and resources related to this criterion.

Criterion I.C: Integrating the Three Dimensions

Student sense-making of phenomena and/or designing of solutions requires student performances that integrate elements of the SEPs, CCCs, and DCIs.

Criterion Description

This criterion is focused on materials showing clear evidence of two things:

- Grade-appropriate elements of the three dimensions are used together (integrated) *throughout the learning process***.**
- This integration is in service of figuring out something about the phenomena or solving part of the problem.

Ideally, students have opportunities to experience this kind of three-dimensional learning in every lesson and with all learning objectives.

Student three-dimensional performances do not have to align with any particular NGSS PE, as PEs describe expectations for the end of a grade level or grade band. For example, a three-dimensional performance in a lesson could integrate grade-specific parts of complex elements that are not yet fully developed, such as only the underlined parts of this Grade 3–5 CCC element: Substructures have shapes and parts that serve functions. Three-dimensional performances could also integrate elements that support instructional goals but don't match the SEP, CCC, or DCI categories used in a PE, such as using a Planning and Carrying Out Investigations SEP element in a lesson to help build toward a PE that measures an Analyzing and Interpreting Data SEP element.

CONNECTIONS TO OTHER CRITERIA

This criterion overlaps somewhat with I.A. It also connects to I.B but focuses less on a match between claims and evidence. Here, the three-dimensional performances may not align exactly with the three dimensions specified in the materials or in any particular NGSS PE. III.A can also seem very similar to this criterion, but it focuses on individual student artifact creation whereas classroom or group activities also count as evidence for I.C.

What Does This Look Like In Materials?

Learning is integrated

The three dimensions rarely appear in isolation and are generally learned in tandem, with each dimension supporting understanding of the others.

Integration to support sense-making over time

There are *numerous events* where students are expected to figure something out (a phenomenon) or solve part of a problem in a way that requires a grade-appropriate element of each of the three dimensions *working together*. For example, if when students construct an explanation of a phenomenon using a DCI, they are unable to fully explain the phenomenon without the use of the targeted CCC element, that is evidence that all three dimensions are required for the sense-making. This can include classroom or group activities that do not result in individual student artifacts.

MATERIALS THAT SUPPORT INTEGRATION OF THE THREE DIMENSIONS…	
…LOOK *LESS* LIKE THIS:	**…LOOK *MORE* LIKE THIS:**
Students learn the three dimensions in isolation from each other (e.g., a separate lesson or activity on science methods or skills followed by a later lesson on science knowledge, front-loading DCI acquisition followed by application with SEPs, etc.).	Students learn elements from multiple dimensions in tandem, such as using partial understanding of an SEP element to help begin developing understanding of a DCI element, and along the way developing more knowledge about and proficiency with the SEP element.
The expected learning in the three dimensions is only loosely connected to the phenomenon or problem.	The three dimensions work together to help students explain a phenomenon or design solutions to a problem.
Students would be able to explain the phenomenon without using or developing a CCC.	All three dimensions are **necessary** for sense-making and problem solving.

Click here for more reading and resources related to this criterion.

Criterion I.D: Unit Coherence

Lessons fit together to target a set of performance expectations.

i. **Each lesson builds on prior lessons by addressing questions raised in those lessons, cultivating new questions that build on what students figured out, or cultivating new questions from related phenomena, problems, and prior student experiences.**

ii. **The lessons help students develop toward proficiency in a targeted set of performance expectations.**

Criterion Description

This criterion is focused on unit coherence in student experiences. In a coherent unit, each lesson builds on each other, resulting in an evolving understanding of science ideas and concepts needed to explain the phenomenon or design a solution to a problem. This *building on* is motivated by questions and experiences that create a coherent path to learning **from the student's perspective**.

Note that any three-dimensional learning objectives meet the second sub-criterion, three-dimensional objectives don't need to exactly match specific NGSS PEs as long as they are grade level appropriate. In this case, it is especially helpful if the materials explicitly describe how they work together with other units to build toward the NGSS PEs. For example, they might say something like: "this unit fully covers the DCI from this PE, but different SEPs were used as they were more appropriate for the instructional materials. As such, students should have opportunities to use the SEP associated with the PE in another learning experience."

CONNECTIONS TO OTHER CRITERIA

This criterion differs from the first sub-criterion of I.A in that I.A includes a focus on student-generated questions **driving sense-making**, whereas in I.D, the focus is on building coherence over time, **linking lessons together**. One way (but not the only way) to build coherence is by asking questions that are then answered in subsequent lessons, and the questions can be generated or provided by either the students or the teacher. I.D also differs from II.F in that I.D focuses on student experiences whereas II.F focuses on teacher supports.

What Does This Look Like In Materials?

- All the lesson themes and content are sequenced coherently and explicitly from the student's perspective.
- The lessons work together to provide sufficient opportunities for students to build proficiency in **all** of the targeted learning (e.g., targeted NGSS PEs) for all three dimensions.
- Each lesson builds directly on prior lessons and makes the links between lessons explicit to the students. This includes:
  - As students move through the unit, part of what they figure out is used as the next question(s) to pursue.
  - Students have regular opportunities to engage in asking questions based on what they have learned so far in the unit and revisit their questions in subsequent lessons.
- In subsequent lessons, students answer relevant questions unanswered by the sense-making opportunities in previous lessons. Investigations are focused on students answering these questions by connecting evidence from the investigations/information collection to science ideas and concepts. It is not just the teacher answering the questions, and students don't only read about or watch videos that give answers.
- *When the questions are generated by students*, it's fine to have support for teachers to focus student thinking and facilitate the questions toward a goal set of questions — the unit doesn't need to focus on whatever the students want to investigate.

MATERIALS THAT SUPPORT UNIT COHERENCE…

…LOOK *LESS* LIKE THIS:	…LOOK *MORE* LIKE THIS:
Lessons fit together in ways that are only apparent to the teacher.	Lessons are sequenced logically in a way that is coherent from the students' perspectives; students can see how what they are trying to figure out or solve in one lesson builds on previous lessons and fits into the larger goal for the unit.
Students only have opportunities to build toward some of the stated learning goals.	Students are supported to build toward all of the three-dimensional learning goals
Questions that arise from one investigation are not revisited or are only revisited at the end of the unit.	Questions that arise from one investigation are used as the focus of the next investigation.

Click here for more reading and resources related to this criterion.

Criterion I.E: Multiple Science Domains

When appropriate, *links are made across the science domains of life science, physical science, and Earth and space science.*

i. **Disciplinary core ideas from different disciplines are used together to explain phenomena.**

ii. **The usefulness of crosscutting concepts to make sense of phenomena or design solutions to problems *across science domains* is highlighted.**

Criterion Description

This criterion is focused on links between multiple science domains. However, it is different than most other criteria as linking multiple science domains (life, Earth, physical) through DCIs may not be necessary. The phenomenon or problems used in the lesson or unit determines whether including multiple science domains would be helpful or necessary. If students can make sense of the phenomenon or solve the problem using only one science domain, then using DCIs or partial DCIs from multiple science domains is not necessary. If the phenomenon or problem *requires* multiple domains in order for students to explain or solve it, then multiple domains should be included to meet the criterion. Therefore, the criterion is really about seeing whether there are obvious opportunities to link multiple science domains. For the purposes of this criterion, ETS DCIs are not considered to be a science domain, and physics and chemistry are both counted as part of one science domain — physical science.

The sub-criterion about CCCs is meant to emphasize the purpose of CCCs as thinking frames that can be applied across domains. These thinking skills can only deeply be taught as such if they are made explicit as a concept that is helpful in different domains. Note that crosscutting concept links would not necessarily have to be made to multiple dimensions within the same unit. Links could be made to prior learning.

What Does This Look Like In Materials?

DCI links

- If the unit focuses on **one** science domain, **either:**
    - The phenomena or problem driving the learning *can be fully addressed* within that domain.

      OR

    - The related science domains relevant to the explanation or solution are identified as prerequisite learning.

- If the unit focuses on **more than one** science domain, it clearly conveys to students how ideas from different domains together are required to explain the phenomenon or design the solution to the problem.

CCC links

Grade-appropriate elements of CCCs are explicitly used to make connections across science domains. This could include domains not used in the unit. For example, students figuring out a chemistry phenomenon could be reminded of when they previously used a specific Systems element to think about Biological systems.

MATERIALS THAT SUPPORT MULTIPLE SCIENCE DOMAINS…	
…LOOK *LESS* LIKE THIS:	**…LOOK *MORE* LIKE THIS:**
The one science domain used in the unit is not sufficient for a grade-appropriate explanation of the phenomenon or solution to the problem.	If one science domain is used, it can fully address the problem or phenomena in the unit.
Multiple science domains are used in different parts of the unit and students are not prompted to think about how the ideas connect to one another.	Multiple science domains are used in different parts of the unit and students can clearly see how the ideas from different domains connect and are all required to explain the phenomenon or design the solution to the problem.
Crosscutting concept use across science domains, such as how systems interact in both physical sciences and life sciences, is not explicitly pointed out to students.	The way the same element of a cross-cutting concept can be used together with different science domains to make sense of different phenomena is explicitly discussed.

Click here for more reading and resources related to this criterion.

Criterion I.F: Mathematics and English Language Arts (ELA)

Provides grade-appropriate connection(s) to the Common Core State Standards in Mathematics and/or ELA and Literacy in History/Social Studies, Science, and Technical Subjects.

Criterion Description

This criterion is focused on connections between science and other subjects. One of the shifts of the NGSS is to make explicit connections to mathematics and ELA/Literacy. Instructional materials designed for the NGSS would ideally not only recognize these kinds of connections between science and other disciplines, but also design learning in a way that reinforces and builds on these connections, supporting learning in each of the disciplines and deepening students' sense-making and problem solving. The NGSS themselves list some possible connections that could be made between science and mathematics or ELA/Literacy, but these particular connections are not required or exhaustive.

Note that connections can be made to mathematics and ELA standards that are up to one grade band below the targeted science grade level, but not to standards that are above the targeted science grade level. This means that 6th grade science materials can use upper elementary (grades 3–5) ELA and mathematics content but should not include 7th grade content.

What Does This Look Like In Materials?

- Materials explicitly state the mathematics and ELA standards that are used in the unit and support students to see the connections between content areas. This can include, but does not require, students actually developing the ELA or mathematics along with the science.
- Literacy and mathematics skills expected are not above students' grade level, although prior learning can be used and reinforced.
- **Whenever students read or write in a unit**, ELA connections are listed even if they are below grade level (e.g., grade 9 students using grade 8 ELA/Literacy standards).
- **Wherever a reasonable match exists to the science or engineering subject matter** (e.g., where mathematics could aid in sense-making or problem solving), mathematics concepts are explicitly incorporated into lessons such that students use them to explain or help understand the scientific concepts, phenomena, or results.

- All students use reading skills, at a grade-appropriate level, to develop understanding of scientific concepts and results, supporting their sense-making and problem solving. Related reading materials go beyond textbooks and include at least two of the following formats:
    - o fictional or narrative stories;
    - o news articles;
    - o journal articles;
    - o infographics; and
    - o websites of scientific entities.
- Students use writing skills to explain and communicate their understanding of the scientific concepts, results, and phenomena. Writing assignments are varied in structure and purpose.
- Students have multiple opportunities for speaking and listening to peers in a variety of formats and scenarios (e.g., diverse partners, small group, formal presentations, technology-enhanced, etc.).

MATERIALS THAT SUPPORT CONNECTIONS TO MATHEMATICS AND ENGLISH LANGUAGE ARTS…	
…LOOK *LESS* LIKE THIS:	**…LOOK *MORE* LIKE THIS:**
Science learning is isolated from related learning in mathematics and ELA; or there are places where students could have used mathematics or ELA/Literacy to strengthen their sense-making (e.g., by graphing or developing a mathematical model) but these disciplines are not used.	Students learning is connected to use and learning of mathematics and ELA and students see where these disciplines are useful within their sense-making and problem solving.
Students have limited opportunities to read, speak, or write to learn.	Students' reading, writing, speaking, and listening skills are developed as an integral part of sense-making and problem solving.
Student reading materials are limited to textbooks or textbook-like explanatory texts.	Student reading materials include several different formats, such as narrative stories, news articles, journal articles, infographics, and websites of scientific entities.

Click here for more reading and resources related to this criterion.

Criterion II.A: Relevance and Authenticity

Engages students in authentic and meaningful scenarios that reflect the practice of science and engineering as experienced in the real world.

i. Students experience phenomena or design problems as directly as possible (firsthand or through media representations).

ii. Includes suggestions for how to connect instruction to the students' home, neighborhood, community, and/or culture as appropriate.

iii. Provides opportunities for students to connect their explanation of a phenomenon and/or their design solution to a problem to questions from their own experiences.

Criterion Description

This criterion is focused on whether there is sufficient evidence that the phenomena, problems, and classroom activities are set up in a way that authentically connects with every student's life. This could happen in many ways, such as providing multiple related phenomena that are place-based and providing teacher support to adjust which one is used to make the learning more local or relevant to students. It could also happen by helping students connect a phenomenon or problem from different locations to experiences in their own lives, even if the phenomenon or problem is not based in their region. Students are all different and come to class with different prior experiences and ways of understanding the world. This criterion asks for evidence that materials are explicitly designed to support students to see the connections between their lives and cultures and the phenomena, problems, and activities used during the lessons.

CONNECTIONS TO OTHER CRITERIA

Phenomena and/or problems are evaluated for whether they drive student learning and are grade-level appropriate in I.A. In contrast, this criterion focuses on whether they authentically connect with students' lives.

What Does This Look Like In Materials?

- The phenomena, problems, and classroom activities used are engaging to students and reflect grade-appropriate, realistic scenarios that **students are authentically motivated to figure out or solve**. Problems to solve are grounded in compelling issues that affect people's lives — either students' own lives or the lives of others they can relate to.

- Students can relate to the phenomenon, problem, and activity, and materials provide opportunities for students to reflect on how figuring out the phenomenon or problem is important to someone — whether themselves or someone they can relate to.

- Students experience the phenomenon or problem as directly as possible — firsthand or through media representations.
- Students have **multiple** opportunities to connect the phenomena they figure out or problems they solve to their own prior experiences, community, or culture.
- The materials provide support to teachers for connecting instruction to all students’ homes, neighborhoods, communities, and cultures as appropriate, with a particular emphasis on making connections for students from underserved communities. This could include providing flexibility to enable adaptations to fit students’ local contexts, including reminders to seek out and make use of the funds of knowledge that students bring to school from their homes and communities throughout the learning process, and supporting student agency to apply learning in their own communities.
- The materials provide support to teachers for anticipating and handling topics that are potentially sensitive, controversial, or difficult to discuss for certain students or populations of students (e.g., when students connect phenomena related to genetics to traits in their own families).
- Teachers are supported to cultivate student questions and ideas that connect to students’ experience, community, or culture.

MATERIALS THAT SUPPORT RELEVANCE AND AUTHENTICITY…

…WILL LOOK *LESS* LIKE THIS:	**… WILL LOOK *MORE* LIKE THIS:**
Teachers tell students about an interesting phenomenon or problem in the world.	Students **directly experience** (preferably firsthand, or through media representations) a phenomenon or problem.
The phenomena or problems don’t seem to be connected to the real world. For example, students might think a classroom demonstration of a collapsing coke can is interesting but might not think it is relevant to the real world until they see a collapsing tanker.	The phenomena and problems are authentic and meaningful to a range of student backgrounds and interests. Students can clearly see how the phenomena and problems are relevant to them or to others they can relate to, and therefore why learning the science and engineering necessary to explain the phenomenon or solve the problem is relevant.
The lesson focuses on examples that some of the students in the class understand.	The lesson uses examples that are accessible to all students and provides support to teachers for ensuring that students fully understand all examples and contexts.
Teacher materials focus on disciplinary content delivery without providing support to help teachers understand, value, and build on the experiences and knowledge that students bring to the classroom.	Teacher materials focus on connecting instruction to the students' homes, neighborhoods, communities, and cultures as appropriate, and provide multiple opportunities for students to connect their learning to questions and ideas from their own funds of knowledge.

Click here for more reading and resources related to this criterion.

Criterion II.B: Student Ideas

Provides opportunities for students to express, clarify, justify, interpret, and represent their ideas and to respond to peer and teacher feedback orally and/or in written form as appropriate.

Criterion Description

This criterion is focused on students negotiating new understandings by clarifying their own ideas and comparing to their peers' ideas or ideas encountered in the learning experience(s). For this to be successful, there have to be appropriate, accessible, and culturally-affirming ways for students to communicate their thinking and there need to be feedback loops, from the teacher and peers as appropriate, to help them clarify their thinking. Sometimes, but not always, the elicitation of student ideas is intentionally organized as an opportunity to measure student learning.

What Does This Look Like In Materials?

Student ideas are clarified, justified, and built upon

- The teacher has enough support to act as an expert facilitator to draw out individual student ideas and multiple perspectives in an identity-affirming way. The support is specifically customized to the lesson materials.
- The classroom discourse includes explicitly expressing, clarifying, and justifying student reasoning.
- The students have opportunities to share ideas with peers directly, to elicit ideas from others, and to use others' ideas to improve or change their own thinking.

CONNECTIONS TO OTHER CRITERIA

When elicitation of student ideas is done in a way that elicits responses from all students individually, this criterion overlaps somewhat with III.A, III.B, and III.E.

The feedback portion of this criterion also overlaps somewhat with III.F. That criterion focuses on opportunities for students to **apply feedback related to targeted learning objectives** from one assessment to improve performance in the next assessment. Whereas, II.B focuses more on opportunities for students to provide peer feedback and to receive and reflect on feedback related to their thinking and reasoning.

- The students are supported to communicate their ideas in ways that are meaningful to them and respectful of their cultures. This can include multiple modes of discourse and the initial expression of ideas in vernacular language or students' homes languages.

Artifacts show evidence of students' reasoning and changes in their thinking over time

- Student artifacts include elaborations, reasoning, and reflection and show how students' reflective thinking has changed over time. Descriptions of student thinking may be written, oral, pictorial, kinesthetic, or models.

Students receive feedback and revise their thinking accordingly

- Supports are provided to guide constructive feedback to students from both the teacher and peers. The feedback is based on displayed student thinking related to the classroom task and is framed to support improvement in how students reason about the phenomenon or problem.

- Students have opportunities to reflect on and respond to the feedback they receive, when appropriate, using multiple modalities of expression.

MATERIALS THAT SUPPORT STUDENT IDEAS…

…LOOK *LESS* LIKE THIS:	…LOOK *MORE* LIKE THIS:
The teacher is positioned as the central figure in classroom discussions.	Students are positioned as the central focus of classroom discussions through teacher facilitation directions, and discourse focuses on explicitly expressing and clarifying student reasoning. Students have frequent opportunities to share ideas and feedback with each other directly and to use others' ideas to improve or change their own thinking.
Student artifacts only show answers without reasoning or elaboration.	Student artifacts include elaborations — which may be written, oral, pictorial, kinesthetic — of reasoning behind their answers, and show how students' thinking has changed over time.
The teacher's guide focuses on what to tell the students.	The teacher's guide provides supports for eliciting student ideas and giving feedback on student thinking.
Only one style of discourse (e.g., full class oral discussions, shouting out "correct" answers, etc.) is considered acceptable in the classroom, and only some students feel comfortable contributing their ideas.	All students are supported to make productive contributions to classroom discourse in a variety of ways.

Click here for more reading and resources related to this criterion.

Criterion II.C: Building Progressions

Identifies and builds on students' prior learning **in all three dimensions,** ***including providing the following support to teachers:***

i. **Explicitly identifying prior student learning expected for all three dimensions; and**

ii. **Clearly explaining how the prior learning will be built upon.**

Criterion Description

This criterion is focused on two areas as described in the sub-criteria language: identifying 1) what learning students are expected to come in with for all three dimensions, and then explaining 2) how this learning will be added to during instruction. To meet this criterion, materials would need to **explicitly** identify the expected learning and communicate a plan for how that learning will be enhanced during the outlined learning experiences. This includes identifying students' alternate conceptions and supporting learning that moves students toward more scientifically aligned ideas. These alternate conceptions can exist in all three dimensions, so support to build on and adjust these prior ideas is likewise necessary for all three dimensions.

CONNECTIONS TO OTHER CRITERIA

This criterion focuses on teacher supports — specifying intended learning progressions. Evidence of students actually learning the three dimensions is collected for I.B, and evidence of the progression of SEP learning and independence is collected for II.G.

A common pitfall associated with this criterion is describing a progression of learning for only one of the three dimensions — often just the DCIs. Instead, this criterion asks for this kind of progression information to be described for all targeted learning for each of the three dimensions, specified at the level of individual elements of each dimension.

What Does This Look Like In Materials?

- The materials explicitly state the expected level of prior proficiency students should have **with individual elements** of all three dimensions for the core learning in the materials. For example, the materials could say "Students should already be familiar with the general ideas of cause-and-effect relationships but are not yet expected to understand that causes generate observable patterns." In the first unit of a grade band, this could be accomplished by simply stating that students are expected to begin the unit with proficiency in all elements from the previous grade band.

- A progression of learning toward the targeted elements of all three dimensions is clearly described for teachers for each section of the materials. For example, "In Lesson 1, students observe examples of cause-and-effect relationships generating patterns, and in Lesson 2 they are facilitated to realize they can use the concept of 'patterns' to describe these observations."
- Learning progresses logically throughout the materials. For example, if full PEs or elements are stated as prior knowledge, learning in the materials does not repeat that prior content unless explicitly stated as review. Similarly, students are not suddenly expected to proficiently use a full SEP element that wasn't listed as prior knowledge.
- Explicit support is provided to teachers to clarify adult understanding of the potential alternate conceptions that they, or their students, may have while building toward students' three-dimensional learning, along with guidance for how to help students negotiate their understandings (vs. telling students they are wrong). For example, students or teachers might initially think that raw data is evidence, or might think their perceptions (e.g., the size of stars) are infallible sources of data. Note, however, that alternate conceptions do not have to be immediately corrected. They can be considered and reconsidered throughout the learning cycle, supporting student thinking in ways that value their funds of knowledge and different life experiences.

MATERIALS THAT SUPPORT BUILDING PROGRESSIONS…

…LOOK *LESS* LIKE THIS:	…LOOK *MORE* LIKE THIS:
The lesson content only builds on students' prior DCI learning, helping them develop more sophisticated DCI understanding.	The lesson content builds on students' prior learning in all three dimensions, helping them build more sophisticated understanding in each targeted learning objective.
The lesson does not include support to teachers for identifying students' prior learning, or assumes all students have the same prior learning.	The lesson provides explicit support to teachers for identifying individual students' prior learning and accommodating different entry points.
Targeted learning objectives are listed in the materials without information about how students will reach these objectives.	A learning progression for each targeted element of all three dimensions is coherently mapped out for the entire instructional materials program, helping teachers see the expected path of student growth from their prior understanding to the learning outcomes for each element.
The lesson assumes that students are starting from scratch in their understanding of any particular element of the three dimensions.	The lesson explicitly builds on students' foundational knowledge and practice from prior grade levels for all three dimensions.

Click here for more reading and resources related to this criterion.

Criterion II.D: Scientific Accuracy

Uses scientifically accurate and grade-appropriate scientific information, phenomena, and representations to support students' three-dimensional learning.

Criterion Description

This criterion is focused on determining whether all learning — including all three dimensions as well as content that is not included in the three dimensions of the standards (e.g., the concept of friction, which is not a part of a DCI but might be important for making sense of a phenomenon) — is scientifically accurate and does not lead to alternate conceptions. One common pitfall is when materials emphasize inaccurate ideas about the nature of science, such as that students should try to "prove" their hypotheses, or that there is a single scientific method.

What Does This Look Like In Materials?

All science ideas and representations included in the materials — including content related to all three dimensions as well as content that is not included in the three dimensions of the standards — are accurate. This does not mean, however, that students should not be encouraged to express, consider, and reconsider scientifically inaccurate ideas as they are learning. For example, teachers might present students an inaccurate or incomplete model of a phenomenon and ask the students to evaluate it.

MATERIALS THAT SUPPORT SCIENTIFIC ACCURACY…

…LOOK *LESS* LIKE THIS:	…LOOK *MORE* LIKE THIS:
Student-facing materials use confusing or misleading language, such as not distinguishing between the common English meaning of "argument" and the scientific practice of argumentation.	Student facing materials have precise, grade-appropriate wording to help students scaffold their understanding of concepts in all three dimensions, avoiding creating misconceptions.
Students lose points or receive negative feedback for expressing scientifically inaccurate ideas early in the learning process.	Students are encouraged to express their scientific ideas and to continually examine and re-examine the ideas in light of new evidence.

Click here for more reading and resources related to this criterion.

Criterion II.E: Differentiated Instruction

Provides guidance for teachers to support differentiated instruction by including:

i. **Appropriate reading, writing, listening, and/or speaking alternative (e.g., translations, picture support, graphic organizers, etc.) for students who are English learners, have special needs, or read well below grade level;**

ii. **Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations; and**

iii. **Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.**

Criterion Description

This criterion is focused on evidence that the lessons and units are for ALL students and ALL teachers. This goes beyond only looking for translations, picture support, graphic organizers, etc., which are the focus of the first sub-criterion. The full criterion also asks for evidence that materials have been explicitly designed using Universal Design for Learning (UDL) principles, including providing extra support through access to alternate phenomena and opportunities to represent thinking through a variety of modalities. Supports in materials are ideally explicit such that all teachers would recognize them.

One common pitfall in materials is providing supports that are only focused on student understanding of DCIs rather than student understanding of all three dimensions. To meet this criterion, differentiated supports are provided to help ensure all students can engage equitably in sense-making and problem solving using the three dimensions. Materials that do not fully meet this criterion also often provide generic supports for an instructional program in general and rely on the teacher to figure out when to add in the supports and how to modify them to fit with a specific activity.

Although this criterion is always essential, it takes on an even greater significance as students transition to NGSS-designed instruction. Many students may not have had opportunities to develop all the prior learning expected if their classes did not teach much science or did not incorporate SEPs and CCCs into instruction in previous years. To help address this issue, robust teacher guidance can be included in materials, indicating how the learning experience could be adapted or scaffolds could be added to support all students *where they are* in their current understanding of each of the three dimensions.

What Does This Look Like In Materials?

- Materials explicitly clarify how they anticipate the needs of students who might struggle with any of the three dimensions within a particular activity. This is coordinated with a range of specific individualized and customized learning strategies to support learners with specific needs.

- The materials provide multiple and varied individualized learning strategies that support three-dimensional sense-making throughout a majority of the materials, including specific guidance for all of the critical learning steps (e.g., activities that serve as major components of building progressions for key learning objectives).

- Differentiation strategies explicitly clarify how they address the needs of all of the following groups of students. All groups are not necessarily supported in every activity, but they are supported when an obvious need arises (e.g., reading supports during activities that require reading) and at least once while developing each targeted learning outcome:
    - Emerging multi-lingual students who are still learning English;
    - Learners with special needs. This could include representations accessible to color-blind students, tactile engagement in activities, and flexible timing;
    - Learners who read well below grade level;
    - Struggling students; and
    - Students who have already met the performance expectation(s) or who have high interest in the subject matter and are ready to develop deeper understanding in any of the three dimensions. Supports for these students could include applying learning in new contexts (e.g., transfer phenomena) or through the lenses of different CCC elements or could include extending to learning from the next grade level, such as the next level SEP element in a learning progression (e.g., grade 5 students extending to prioritize criteria).

- The materials provide examples and guidance that support reading, writing, listening, and speaking alternatives (e.g., translations, picture support, graphic organizers, non-linguistic, etc.).

- Supports such as related phenomena or multiple modalities are provided throughout the materials for students who are struggling to meet performance expectations or any one of the three dimensions, with guidance on how to determine their understanding at that point in the lesson and how the suggested supports will help students demonstrate progress toward each element of the three dimensions that is targeted as a learning objective.

- Suggestions are provided for adaptations if students begin the lesson with significantly higher or lower levels of prior proficiency than expected for the grade level in any of the three dimensions.

MATERIALS THAT SUPPORT DIFFERENTIATED INSTRUCTION…	
…LOOK *LESS* LIKE THIS:	**…LOOK *MORE* LIKE THIS:**
Materials separate out lessons or activities for students with different abilities or home languages.	Materials provide a common learning sequence for all learners, ensuring students with diverse needs and abilities can access instruction.
Materials provide limited ways of meeting learning goals, such as reading about topics, listening to lectures and note-taking, and following written directions to complete labs.	Materials provide multiple access points and modalities for students to learn (e.g., students can use argumentation and evidence-based discourse to develop scientific understanding rather than simply reading for understanding, students can use modeling to make sense of phenomena and problems and to make thinking visible in ways that are less dependent on English language proficiency, etc.).
Teacher materials only offer minimal or non-context specific support for differentiation (e.g., providing a separate document about differentiation that is not connected to or referred to in the lesson materials).	Teaching materials include detailed guidance describing how individual students with a variety of needs can be supported to access and engage in each specific learning activity.
Differentiation supports are provided to help students access DCI-related learning only.	Differentiation supports are provided to help students access learning for all targeted learning objectives, including all three dimensions and their use together.

Click here for more reading and resources related to this criterion.

Criterion II.F: Teacher Support for Unit Coherence

Supports teachers in facilitating coherent student learning experiences over time by:

i. Providing strategies for linking student engagement across lessons (e.g., cultivating new student questions at the end of a lesson in a way that leads to future lessons, helping students connect related problems and phenomena across lessons, etc.); and

ii. Providing strategies for ensuring student sense-making and/or problem solving is linked to learning in all three dimensions.

Criterion Description

This criterion is focused on 1) whether or not teacher materials provide sufficient supports to facilitate coherent and explicit links between student sense-making of phenomena or designing of solutions and their learning in all three dimensions over time, and 2) whether or not teachers are supported with guidance, strategies, and routines that reinforce or establish the coherence from the students' perspective addressed in Criterion I.D. This second sub-criterion emphasizes the guidance provided to the teacher, as opposed to directly to students through student materials or presentation slides, to support this coherence.

CONNECTIONS TO OTHER CRITERIA

Evidence about coherence from the student perspective (e.g., in student-facing materials) is collected in I.D.

What Does This Look Like In Materials?

- Guidance and support are provided for how to recognize what students figure out in a lesson, what questions are left unanswered, and what new questions could be answered in the next investigation.
- Frequent guidance or tools are provided to teachers to support linking student engagement across lessons. For example, guidance may be provided to:
    - help teachers gather and gently push for student questions that will be answered in subsequent lessons;
    - support navigation routines that help make the connections between lessons explicit to students;
    - modify the discussion at the beginning of an activity to ensure that students see how it connects to what they just figured out in the previous activity; or
    - frame a discussion in ways that forecast that it will be returned to in future lessons.

- Strategies are provided to support the teacher as they help students connect phenomena across lessons.
- Throughout the unit, teacher guidance and strategies are provided to ensure that students see their learning in all three dimensions as coherently linked to the progress they make toward explaining phenomena or designing solutions to problems. For example, the teacher support could help students see how what they learn about using CCCs is relevant to the sense-making

MATERIALS THAT HELP TEACHERS SUPPORT UNIT COHERENCE…

…LOOK *LESS* LIKE THIS:	…LOOK *MORE* LIKE THIS:
Only teachers are supported to see how lessons fit together.	Teachers are supported to help students see how lessons fit together.
Students see their three-dimensional learning as separate from their sense-making or problem solving.	Students see how their learning for each targeted learning objective works in service of sense-making or problem solving.
Students are prompted to ask questions in one lesson but there is no teacher guidance to connect these questions to future lessons and these questions are never revisited.	Through teacher facilitation, students develop curiosity about the learning that is planned for future lessons, and ask questions that are then answered in subsequent lessons.

Click here for more reading and resources related to this criterion.

Criterion II.G: Scaffolded Differentiation Over Time

Provides supports to help students engage in the practices as needed and gradually adjusts supports over time so that students are increasingly responsible for making sense of phenomena and/or designing solutions to problems.

Criterion Description

This criterion is focused on whether there is a *change* in how independently students use SEP elements from the beginning to the end of the unit. This involves identifying levels of scaffolding provided for students at different points in the unit and determining whether the scaffolding and supports for students are reduced later in the unit in comparison with the early lessons.

- One aspect of this is helping ensure that over time, students build toward ownership and proficiency in the practices. For example, a teacher may provide students enough scaffolding that the students are only *independently* responsible for using an SEP element from a prior grade band in early lessons, but by the end of the unit students might be expected to demonstrate the element at a grade-appropriate level.
- Another aspect of this criterion is whether the supports and scaffolds provided to students are customized to different student needs, including guidance about when to reduce scaffolds for individual students.

This criterion also asks for evidence that there is a match between targeted learning objectives and those that are developed by students during the learning experience. If only one SEP element is targeted as a learning objective, then this criterion would only require evidence in students building some proficiency and independence of that one SEP element.

CONNECTIONS TO OTHER CRITERIA

This criterion may overlap somewhat with II.C in that both include an emphasis on development of specific elements of the SEPs. II.C describes the planning aspect of this progression (i.e., whether the plan is communicated to teachers) whereas this criterion focuses on guidance throughout the activities for ensuring that all students are supported to develop their proficiency and increase their independence in using the SEP elements that are targeted as learning objectives.

What Does This Look Like In Materials?

- Teacher supports are provided to help **all students,** including those with special needs and abilities and emerging multilingual students, explicitly build an understanding and proficiency in specific elements of the SEPs over time through a variety of approaches over the course of the unit.

- Scaffolding is explicitly reduced over time for use of *nearly all SEP elements stated as targeted learning objectives***,** supporting students to become more independent in their use of the SEP elements over the course of the learning experience. This might include:

    - Engaging in the practice as a class or assigning specific roles in small groups in early lessons while transitioning to independent use of the practice in later lessons; and

    - Gradually reducing scaffolds throughout the unit.

- Teacher materials provide guidance for where and when to add and remove supports to move students toward independently knowing when to use and demonstrating proficiency with the SEPs.

MATERIALS THAT SUPPORT SCAFFOLDED DIFFERENTIATION OVER TIME...

...LOOK *LESS* LIKE THIS:	...LOOK *MORE* LIKE THIS:
Teachers only have enough guidance to support ”average” students with developing SEP elements.	Teachers have guidance to identify needs of each individual student as they develop proficiency and independence in SEP elements.
Scaffolding for student use of SEPs looks the same throughout the unit or increases without evidence for why earlier levels of scaffolding should be brought back in, such as suddenly giving students a CER template to fill in after they have been independently engaging in argument using explicit CER components.	Scaffolding gradually decreases throughout the learning process as students show evidence that they successfully use the SEP element with each prior level of scaffolding. For example, students decrease use of CER templates over time as they are increasingly expected to show evidence of claims, evidence, and reasoning in their arguments independently.
Materials list several targeted SEP learning objectives but only one element is scaffolded and developed in the learning experiences.	**All targeted learning objectives** are supported with scaffolding that gradually decreases to support student learning and independence.

Click here for more reading and resources related to this criterion.

Criterion III.A: Monitoring 3-D Student Performances

Elicits direct, observable evidence of three-dimensional learning; students are using practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions.

Criterion Description

This criterion is focused on materials providing opportunities for students to demonstrate that they have reached or exceeded all targeted learning objectives. Here, opportunities for monitoring student performance are not restricted to only something that is labeled as an assessment in materials. Any artifact that demonstrates that students are using grade-appropriate elements of the three dimensions to show what they have figured out about a phenomenon or problem can count toward the evidence that materials meet this criterion.

An artifact is something a teacher, administrator, or parent could pick up and use later as evidence of learning. This could include teacher notes about individual student responses to class discussion, or videos taken of student performances. *Artifacts do not have to be written or drawn by a student.*

This criterion also looks at whether, when formal assessment tasks are used in materials, they:

1. primarily focus on figuring out aspects of phenomena and problems;
2. require students to sense-make or problem solve using the three dimensions targeted as learning objectives: and
3. provide all students with equitable opportunities to show what they know. Note that no particular item format is required. Multiple choice questions might be part of a phenomenon-focused, three-dimensional task, and open-ended questions might only assess one dimension.

CONNECTIONS TO OTHER CRITERIA

Having clear evidence from some kind of student artifact and using this evidence to monitor student learning are the major differences between Category I criteria and this criterion. For example, I.C also asks for evidence that students are engaged in all three dimensions to explain a phenomenon or solve a problem but would count classroom or group activities as evidence whereas individual student artifacts, whether recorded by the student or the teacher, are required for III.A.

Some common pitfalls related to formal assessment tasks include:

- Tasks are not regularly driven by a phenomenon or problem scenario — they're either about topics or just a collection of questions that are focused on some aspect of the three dimensions of the standards but without sense-making or problem solving being necessary.

- Questions can be answered simply by going through a previously learned procedure or by restating an idea that was learned in the lesson — confirmatory, not sense-making.

- Rote knowledge (e.g., restating a DCI, formulas, memorized/expected procedures, etc.) is sufficient to answer the questions posed to students.

- Assessments *connect* to multiple dimensions, but only **require** one dimension at a time to answer questions successfully. For example, students might be given a model of a food web, but questions can be answered simply by restating their understanding of DCIs related to food webs instead of needing to use the model. Similarly, students might be given data tables about a scientific idea but only need to be able to interpret the tables to answer the questions — not needing to pull on any DCI understanding.

- Assessments require all three dimensions, but only DCIs are used at a grade-appropriate level. For example, middle school students might be asked to list causes of a phenomenon, but not to use any of the middle school-level CCC elements related to Cause and Effect.

What Does This Look Like In Materials?

Formal tasks in the materials are driven by well-crafted phenomena- and problem-based scenarios that are able to elicit rich student performances

- Most scenarios are rich, based on specific, real-world, puzzling events, instances, or problems to solve, and require grade-appropriate three-dimensional performances to address.

- Most tasks are focused on sense-making, in contrast to representing or communicating previously learned material without applying it to a phenomenon or problem. Tasks do this by requiring student reasoning to connect their existing understanding and abilities (assumed, based on the target of the assessment) to new information (provided by the scenario or previous investigations) to construct new understanding of the scenario presented — and thus demonstrate knowledge-in-use. This new understanding could be in the form of a claim, hypothesis, prediction, model, question, explanation, argument, etc.

Student performances produce artifacts of integrating the three dimensions in service of sense-making or problem solving

- Materials routinely elicit direct, observable evidence that students are integrating the three dimensions in service of sense-making or problem solving in varied ways.

- Student artifacts that require grade-appropriate elements of all three dimensions to be used together are used frequently, including to evaluate targeted learning objectives. Many of these artifacts may be from group activities if there is evidence that the teacher has recorded evidence from individual students (e.g., through video or notes).

Students routinely produce artifacts with evidence of using the grade-appropriate elements of SEPs, CCCs, and DCIs that are targeted as learning objectives

- A substantial portion of the tasks **require** students to use grade-appropriate elements of each of the three dimensions to successfully respond to prompts.

- Each targeted SEP, CCC, and DCI element is routinely used in service of sense-making in contrast to just stating the idea of a CCC or DCI, using the mechanics of an SEP, or using the SEP to represent previously learned information/processes.

- The focus of SEP, CCC, and DCI elements in the major assessments — formative and summative — within a unit is on the distinguishing features of those elements at that grade band. For example, the difference between the Grade 3–5 CCC element "Energy can be transferred in various ways and between objects" and the Grade 6–8 CCC element "The transfer of energy can be tracked as energy flows through a designed or natural system" is the emphasis on tracking energy. Therefore, the idea that energy transfers can be tracked could be part of the focus of a Grade 6–8-level assessment.
- There's a close match between SEP, CCC, and DCI elements that are intended to be assessed in each item and the evidence of those elements being **required** to respond to each prompt posed to students.
- There's a close match between the SEP, CCC, and DCI elements identified as key learning objectives in the unit and the elements that are assessed in the unit overall.
- For DCIs, tasks across a lesson or unit focus on comprehensively eliciting the major point/intent of the DCIs that are learning objectives in the lesson or unit. The intent here is to make sure that opportunities for students to show their thinking aren't focused on minutia but are also eliciting deep conceptual understanding across the full scope of the DCIs that are learning objectives.

MATERIALS THAT SUPPORT MONITORING OF THREE-DIMENSIONAL STUDENT PERFORMANCES…

…LOOK *LESS* LIKE THIS:	…LOOK *MORE* LIKE THIS:
Teachers infer that if students can correctly answer a question, they must have understood and used all three dimensions to formulate that correct answer.	Teachers deliberately seek out student artifacts that show direct, observable evidence of using **all three dimensions** of the NGSS at a grade-appropriate level.
Tasks measure only one dimension at a time (e.g., separate items for measuring SEPs, DCIs, and CCCs) focusing only on students' abilities to remember information or demonstrate a skill.	Some tasks require that students integrate all three dimensions as part of the learning performance, applying them to explain phenomena or design solutions to problems.
The focus is only on getting the "right" answer to explain the phenomenon.	The focus is on using student sense-making of phenomena or designing of solutions as a window into student understanding of all three dimensions of the NGSS.
Students experience a disconnect between their assessment prompts and their sense-making focus in class, such as having a completely different context or having a lower level of rigor.	Students see assessments as connected to what and how they're learning. Assessments are similar in style and context to student learning activities.

Click here for more reading and resources related to this criterion.

Criterion III.B: Formative

Embeds formative assessment processes throughout that evaluate student learning to inform instruction.

Criterion Description

This criterion is focused on whether 1) there are opportunities that are called out as formative in materials, and 2) those opportunities include support for next steps. Formative assessments are not discrete assessment opportunities alone, but rather processes that are embedded throughout instructional materials.

While there is a tendency to think of formative assessments as pre-tests and post-tests, exit tickets, etc., these are not inherently formative nor are they, alone, sufficient to be considered examples of formative assessment. To be formative, the questions “what does this tell me?” and “what do I do next?” have to be addressed for either the teacher or the student — or ideally for both the teacher and the student. Some key elements for the “formative” aspect of formative assessment include:

- **Interpretation guidance.** This ideally includes a range of possible student responses, how these should be interpreted relative to both previous instruction and learning objectives, and possible ideas for instruction to help students continue developing their thinking in meaningful ways.
- **Instructional next steps that may adjust direction but continue moving all students forward, rather than focusing on “reteaching” or remedial steps.** These instructional next steps might be found in rubrics and teacher materials and might be tied to specific formative assessment opportunities in the lesson — in contrast to generic formative assessment strategies typically included in front matter.
- **Formative assessments embedded as part of learning.** Instructional tasks, in which students are generating individual or group artifacts (e.g., discourse, models, etc.), might be good formative assessment opportunities *if they clearly support **both** students and teachers in taking the appropriate next steps.*
- **Small grain-size.** Formative assessments do not all have to involve multiple grade-appropriate elements or even entire single elements. However, they should ideally be connected to meaningful learning objectives. Over the course of the lesson or unit, the goal is for formative assessments to support all three dimensions and their use together.
- **Focused on important learning checkpoints.** When students are developing complex ideas and proficiencies in a stepwise process, it is helpful to check in with them at each important learning step along the way rather than waiting until the final step to learn that they are missing some foundational understanding.
- **Connections to issues of equity and access.** It is important that formative assessments include support for adjusting instruction based on individual student needs rather than only on the needs of the majority of the class. This allows every student the opportunity to learn.

What Does This Look Like In Materials?

Materials include explicit, frequent, and varied supports for formative assessment processes

- The materials include opportunities for formative assessment that are called out explicitly and that occur multiple times within each lesson, including for all activities that are central to the learning progressions for each learning objective.
- Most formative assessment opportunities are accompanied by clear guidance for the teacher of how to modify instruction based on varied student responses. Rubrics or teacher materials include supports for informing instruction and for student self-assessment based on a range of possible student responses or levels of student proficiency.
- Formative assessments take varied forms and are frequently built directly into instructional sequences rather than existing as a separate "assessment."

Formative assessment processes routinely provide varied support for student thinking across all three dimensions

- Formative assessments are tied to grade-appropriate elements of all three dimensions, and clearly build from student engagement with the dimensions. For example, student engagement with an SEP element as part of an instructional task could be called out and supported as a formative assessment opportunity. This could be supported by sample student responses that show levels of student use of each dimension.

Formative assessment processes routinely attend to multiple aspects of student equity

- Formative assessments attend to issues of student equity and access regularly by including culturally and linguistically responsive strategies to help elicit, interpret, and respond to student thinking related to the learning objectives. These might include providing multiple ways for students to demonstrate their thinking, such as writing, drawing, and oral presentations.
- Support is provided to attend to students' individual levels and needs in formative assessments. For example, the teacher could be reminded to look for individual students who might need more help even if all of the other students are ready to move on.

MATERIALS THAT SUPPORT FORMATIVE ASSESSMENT…	
…LOOK *LESS* LIKE THIS:	**…LOOK *MORE* LIKE THIS:**
Assessments provide data on student proficiency at a certain point of instruction but don't contribute to ongoing learning.	Formative assessment processes are embedded into instruction and provide suggestions for how to adjust instruction as necessary.
All students are required to demonstrate their thinking in the same way (e.g., writing), limiting the opportunity for some students to fully demonstrate their understanding.	Students are offered choice of modality (e.g., write or draw your ideas) to demonstrate their thinking, ensuring all learners have the opportunity to demonstrate their knowledge.
Teachers are only supported to reteach DCI concepts that most of the class didn't understand.	Teachers are supported to adjust instruction based on individual student difficulties with **all three dimensions and their use together,** such as using suggestions for learning activities for a range of student responses related to each dimension.
Formative assessments only require students to demonstrate their understanding of DCIs.	Formative assessment opportunities are included for assessing students' thinking in each of the three dimensions — separately and together.

Click here for more reading and resources related to this criterion.

Criterion III.C: Scoring Guidance

Includes aligned rubrics and scoring guidelines that provide guidance for interpreting student performance along the three dimensions to support teachers in a) planning instruction and b) providing ongoing feedback to students.

Criterion Description

This criterion is focused on scoring guidance that supports the learning process. Scoring guidance supports teachers, students, and possibly parents in monitoring student progress along a continuum toward the ultimate learning goals of the materials. This kind of guidance provides the connection between the assessment activity, the targeted three-dimensional learning objectives, and the learning experiences students have previously had. It ideally includes all grade-appropriate elements of the dimensions being assessed and provides guidance for how to interpret a range of student performance in each of the dimensions as well as their integration and use in sense-making or problem solving. Scoring guidance might vary based on the type (summative, formative, degree of transfer) and the format (written test, model revision, group project, etc.) of the assessment.

Note that "scoring guidance" **does not necessarily need to include guidance on assigning scores (letter grades or numbers).** The emphasis for this criterion is on building an understanding of where students are so the teacher is equipped to help them progress. This includes collecting enough information to enable effective and targeted feedback to be given to individual students.

What Does This Look Like In Materials?

- Assessment targets — for grade-appropriate elements of all dimensions being assessed and their use together — are clearly stated and incorporated into the scoring guidance. Note that the assessment targets might include those from a different grade level if accompanied by an explanation, such as when they're used for students who need extra scaffolding before they engage with grade-level material.

- Scoring guidance focuses on performance objectives without referencing unrelated skills (e.g., grammar, handwriting, English fluency, etc.).

- Explicit guidance is provided for teachers to interpret student progress and for students to interpret their own progress in relation to both the instructional materials (e.g., the activity) as well as the standards, elements, parts of elements, **and** learning performances that are targeted as learning objectives.

    - There is sufficient guidance to support students with understanding the learning objectives in a grade-appropriate way, and allowing them to track their own progress, even if they're not given a formal self-assessment to complete.

- The progress students track does not have to be “learning objectives” in teacher form (e.g., a listing of the standards), but rather could be in terms that are relevant to them (e.g., part of a performance rubric).

- A range of student responses, not just exemplar responses, and interpretation guidance are described to support teachers. This could include sample student work (e.g., models, drawings, etc.) or expected student responses.
- All major assessment opportunities (e.g., exit tickets, major formative assessment opportunities, all summative assessments, etc.) include scoring or feedback guidance for teachers.
- Scoring guidance tools provide the teacher with enough information to enable:
    - Modification of instruction; and
    - Provision of ongoing targeted feedback to individual students.

MATERIALS THAT SUPPORT SCORING GUIDANCE…

…LOOK *LESS* LIKE THIS:	…LOOK *MORE* LIKE THIS:
Providing only the “correct” answers to assessment prompts.	Identifying what a range of student performance for each assessment task looks like from partial to complete proficiency.
Focusing primarily on DCI-related scoring guidance.	Including explicit guidance on levels of student understanding and proficiency for all three dimensions and their use together.
When only science standards are learning targets, scoring rubrics penalize grammatical or spelling errors.	Scoring rubrics assign value to student use of the three dimensions for sense-making and problem solving, and teachers are supported to provide feedback (rather than scoring) for issues outside of the learning objectives, such as grammatical errors.
Only the final summative assessment includes scoring guidance.	Scoring guidance is provided for major formative assessments (e.g., student discussions, progress trackers, exit tickets, etc.) and summative assessments.
Only teachers receive guidance to interpret student progress.	Both teachers and students are supported to interpret student progress over time.

Click here for more reading and resources related to this criterion.

Criterion III.D: Unbiased Tasks/Items

Assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.

Criterion Description

This criterion is focused on whether the tasks or items for measuring student learning are sensitive to the variety of students in the nation's classrooms. This includes whether the materials use grade-appropriate text, provide tasks that do not assume all students know culturally-specific knowledge, and allow students to demonstrate learning through a variety of modalities. Ideally, materials also leverage students' funds of knowledge within assessment opportunities, such as by helping students make connections between assessment scenarios and their own experiences and allowing them to use their home languages, familiar dialects, and preferred modality to express their thinking.

What Does This Look Like In Materials?

Multiple modes of communication

- Vocabulary and text volume in student assessments are grade-level appropriate and text in tasks is frequently accompanied by other methods (e.g., visual representations, graphs, video, etc.) of communicating the expectations for student performance.

Supports success for all students

Task representations or scenarios:

- Are fair, unbiased, and refrain from assuming students know culturally specific information;
- Support teachers to be aware of the limitations of the scenario for reaching all students, including when the materials are designed for a specific geographic area; and
- Provide appropriate on-ramping for students to engage with and attend to the appropriate parts of the task. This includes providing potential scaffolds to make sure that students have the background they need to be successful with the task, such as additional contextual information when an idea might be unfamiliar to students.

Multiple modalities and student choice

- Communicating Expectations: Tasks use multiple modalities to present information to students in meaningful ways, capitalizing on what is communicated best by each modality — not just the exact same information in two different formats.
- Expected Responses: There is structured variety in the modalities expected for student responses (e.g., talking about their learning, creating visual representations, writing short and more complex answers, etc.), and use of different modalities is balanced (e.g., not relying mostly on writing with only one opportunity for sharing orally).
- The materials include at least one significant task that provides students with a choice of responses across multiple modalities.

MATERIALS THAT USE UNBIASED TASKS/ITEMS…

…LOOK *LESS* LIKE THIS:	…LOOK *MORE* LIKE THIS:
Contexts or content in task scenarios is unfamiliar or inaccessible to some students.	Guidance is provided for teachers to ensure each student can fully understand and access task scenarios, and task scenarios make connections to student background knowledge and interests to make the task more engaging and interesting for students.
Tasks are heavily dependent on the ability to read and write academic English.	Tasks provide opportunities for students to express their thinking through many different modalities as well as to choose which modality works best for them.
All student expectations are communicated orally. Student facing materials do not communicate expectations in other modalities.	Student expectations are communicated in a variety of ways to ensure all students understand exactly what the task is asking them to do.

Click here for more reading and resources related to this criterion.

Criterion III.E: Coherent Assessment System

Includes pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.

Criterion Description

This criterion is focused on how the assessments within a unit, including pre-, formative, summative, and self assessments, create a system of assessments that work together to measure the intended student learning across the materials. The coherent nature of the assessment system — how the different assessments work together to measure the three-dimensional learning objectives — drives this criterion and is more important than whether or not each of the specific types of assessments listed in the criterion are included in the unit.

CONNECTIONS TO OTHER CRITERIA

This criterion is connected to III.A and III.B, which address three-dimensional performance tasks and support for formative assessment respectively but goes beyond these criteria to focus on how the various assessments work together.

Assessment system coherence does not require a clear map, text or visual, that describes where pieces are measured, although such information would be helpful to teachers and administrators. This criterion also does not require that every assessment be three dimensional. However, over the course of the materials, the variety of assessments ideally provides the teacher and student feedback about the degree to which the intended three-dimensional learning is accomplished.

Assessment system coherence doesn't predicate that tasks or items must be found in sections labeled "assessment." Any student artifacts that are being produced by *all* students can be evaluated as part of the assessment system. However, open discussion that doesn't intentionally draw out responses from all students would not be strong evidence for this criterion or other criteria in Category III.

What Does This Look Like In Materials?

Matches three-dimensional learning objectives

- Assessments are connected to learning objectives and require students to apply grade-appropriate elements of the three dimensions to make sense of phenomena and/or solve problems.
- The assessment of the three dimensions proportionally matches up with the learning objectives. For example, there aren't five CCC elements as learning objectives with only two tasks attempting to measure them all.

Pre-, formative, summative, and self-assessment

- All four of the assessment types mentioned in the criterion are present, and assessment opportunities are found throughout the learning experience. Formal pre-assessment may not be essential if teacher materials ideally address connections to student learning in prior units from the same school year, although materials help the teacher determine what initial ideas and experiences students bring to the class from their own backgrounds.

Coherent three-dimensional assessment system rationale is clearly described

- The assessment purpose and rationale are coherent across the materials and are explicitly described for all three dimensions, including how the different types of assessment, including informal assessment opportunities, work together to provide regular feedback:
    - to teachers to inform instruction; and
    - to students to inform learning.

MATERIALS THAT USE A COHERENT ASSESSMENT SYSTEM…	
…LOOK *LESS* LIKE THIS:	**…LOOK *MORE* LIKE THIS:**
Assessment tasks are only at the end of the learning experience to grade student performance or there is only one type of assessment (e.g., summative assessment).	Various forms of assessment are used throughout the learning experience to continually monitor and support growth in student performance.
There are many more learning objectives listed than are assessed.	All targeted learning objectives, in all three dimensions and their use together, are assessed with more than one assessment type at different times during the learning experience.
Teachers do not have guidance to see how the different assessments fit together to provide a full picture of changes in student performance over time.	Teachers are supported to understand how student performance in each assessment fits together to reflect student learning across the unit.

Click here for more reading and resources related to this criterion.

Criterion III.F: Opportunity to Learn

Provides multiple opportunities for students to demonstrate performance of practices connected with their understanding of disciplinary core ideas and crosscutting concepts and receive feedback.

Criterion Description

At first read, this criterion might seem to be about the development of the practices through multiple learning activities. However, it is actually focused on students having multiple opportunities to demonstrate their growing proficiency in the targeted learning objectives. Students engage in multiple performances with each as an opportunity for them to demonstrate learning — in each claimed element and for three-dimensional claims — over the course of the unit and receive feedback that supports their learning process.

This criterion also asks for evidence that students have adequate opportunities to apply feedback from prior activities that will help them progress in their learning and then demonstrate their progress at a later time. Therefore, the multiple opportunities to demonstrate their learning are iterative, with growth opportunities in between. For example, for the learning that is the focus of the unit, you would want to see at least 1) learning opportunities, 2) an assessment opportunity, 3) feedback and more learning opportunities, and 4) another assessment opportunity. However, it would not be useful for the second, and subsequent, assessment opportunities to be identical to the first on which students received feedback. Otherwise, students might be able to produce the "correct" performance without having full proficiency. However, the assessment opportunities should be related enough to assess the same targeted element(s).

CONNECTIONS TO OTHER CRITERIA

This criterion looks at feedback in a different way than does II.B. II.B looks at opportunities for students to receive and reflect on feedback related to their thinking and ideas about phenomena or problems, whereas III.F focuses on opportunities for students to apply feedback related to targeted learning objectives from one assessment **to improve performance in the next assessment.** This criterion also looks for a close match between targeted learning objectives and the feedback students receive.

What Does This Look Like In Materials?

Multiple, interconnected opportunities over time

- For all targeted learning objectives for each of the three dimensions and their use together, there are multiple student performances that provide students with iterative opportunities, not including pre-assessment, to demonstrate their progress towards full proficiency over time.

Multi-modal feedback loops

- Students receive multi-modal feedback from their teacher and peers.
- Feedback focuses on improving student performance for all key claimed learning in each of the three dimensions.
- Students have opportunities to use their feedback to construct new learning and improve their performance in preparation for the next assessment opportunity.

MATERIALS THAT SUPPORT STUDENTS' OPPORTUNITIES TO LEARN…

…LOOK *LESS* LIKE THIS:	…LOOK *MORE* LIKE THIS:
Prompts to provide feedback come only at the end of an instructional unit.	Teacher **and** peer feedback is prompted throughout the learning experience, so students have ample time to apply the feedback before further assessments.
Prompts about providing feedback focus on student behavior or compliance.	Teacher and peer feedback prompts focus on student performance related to the learning objectives and sense making.
Some targeted learning objectives are only the focus of one activity and assessment.	All targeted learning objectives are included in more than one activity and assessment such that students have opportunities to develop and improve their performance over time.

Click here for more reading and resources related to this criterion.

Helpful resources for understanding and applying the criteria

The resources below provide additional background information related to each criterion.

Criterion I.A: Making Sense of Phenomena or Designing Solutions to Problems

- Achieve, Next Gen Science Storylines, and STEM Teaching Tools. (2016). Using Phenomena in NGSS-Designed Lessons and Units. Retrieved from https://www.nextgenscience.org/resources/phenomena.

- Penuel, W. R., & Bell, P. (2016). Qualities of a Good Anchor Phenomenon for a Coherent Sequence of Science Lessons. STEM Teaching Tools Initiative, Institute for Science + Math Education. Seattle, WA: University of Washington. Retrieved from http://stemteachingtools.org/brief/28.

- NSTA. (2017). Criteria for Evaluating a Phenomenon. Retrieved from https://static.nsta.org/ngss/docs/Criteria%20for%20Evaluating%20a%20Phenomenon.pdf.

- NGSS Lead States. (2013). NGSS Appendix I: Engineering Design in the NGSS. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press. Retrieved from https://www.nextgenscience.org/sites/default/files/Appendix%20I%20-%20Engineering%20Design%20in%20NGSS%20-%20FINAL_V2.pdf.

Criterion I.B: Three Dimensions

- The full elements of the three dimensions:
  - **SEPs:** NGSS Lead States. (2013). NGSS Appendix F: Science and Engineering Practices in the NGSS. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press. Retrieved from https://www.nextgenscience.org/sites/default/files/resource/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf.
  - **CCCs:** NGSS Lead States. (2013). NGSS Appendix G: Crosscutting Concepts. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press. Retrieved from https://www.nextgenscience.org/sites/default/files/resource/files/Appendix%20G%20-%20Crosscutting%20Concepts%20FINAL%20edited%204.10.13.pdf.
  - **DCIs:** NSTA. (2013). Disciplinary Core Ideas in the Next Generation Science Standards (NGSS) Final Release. Retrieved from https://static.nsta.org/ngss/20130509/MatrixOfDisciplinaryCoreIdeasInNGSS-May2013.pdf.

- **Summaries of the DCIs to highlight key differences between grade bands:** NGSS Lead States. (2013). NGSS Appendix E: Disciplinary Core Idea Progressions. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press. Retrieved from https://www.nextgenscience.org/sites/default/files/resource/files/AppendixE-ProgressionswithinNGSS-061617.pdf.

- The Framework for K–12 Science Education:
  - **SEPs:** National Research Council. (2012). Chapter 3 — Dimension 1: Scientific and Engineering Practices. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/13165/chapter/7.
  - **CCCs:** National Research Council. (2012). Chapter 4 — Dimension 2: Crosscutting Concepts. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/13165/chapter/8.
  - **DCIs:** National Research Council. (2012). Chapter 5 — Dimension 3: Disciplinary Core Ideas. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/13165/chapter/9
- National Academies of Sciences, Engineering, and Medicine. (2019). Chapter 5: How Teachers Support Investigation and Design, p. 144. *Science and Engineering for Grades 6–12: Investigation and Design at the Center*. Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/25216/chapter/7#144.
- Summit for Examining the Potential for Crosscutting Concepts to Support Three-Dimensional Learning Conference Proceedings. (2018). Retrieved from https://curry.virginia.edu/sites/default/files/uploads/resourceLibrary/CCC%20Summit%20Proceedings_5.8.19.pdf.

Criterion I.C: Integrating the Three Dimensions

- National Research Council. (2012). Chapter 9: Integrating the Three Dimensions. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/13165/chapter/14.
- Krajcik, J. (2015). *Three-Dimensional Instruction: Using a New Type of Teaching in the Science Classroom*. ScienceScope. Retrieved from https://mydigitalpublication.com/publication/?m=&l=1&i=276015&view=articleBrowser&article_id=2292808&ver=html5.

Criterion I.D: Unit Coherence

- National Academies of Sciences, Engineering, and Medicine. (2019). Chapter 5: How Teachers Support Investigation and Design, p. 142. *Science and Engineering for Grades 6–12: Investigation and Design at the Center*. Washington, DC: The National Academies Press. https://www.nap.edu/read/25216/chapter/7#142.
- Nordine, J., Krajcik, J., Fortus, D., & Neumann, K. (2019). Using Storylines to Support Three-Dimensional Learning in Project-Based Science. *Science Scope, 42*(6). Retrieved from https://www.nsta.org/science-scope/science-scope-february-2019/using-storylines-support-three-dimensional-learning

Criterion I.E: Multiple Science Domains

- National Research Council. (2012). Chapter 2: Guiding Assumptions and Organization of the Framework, p. 26. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/13165/chapter/5#26
- National Research Council. (2014). Chapter 2: Assessments to Meet the Goals of the Framework, p. 37. *Developing Assessments for the Next Generation Science Standards.* Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/18409/chapter/4#37.
- National Academies of Sciences, Engineering, and Medicine. (2019). Chapter 5: How Teachers Support Investigation and Design, p. 144. *Science and Engineering for Grades 6–12: Investigation and Design at the Center*. Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/25216/chapter/7#144

- Summit for Examining the Potential for Crosscutting Concepts to Support Three-Dimensional Learning Conference Proceedings. (2018). Retrieved from https://curry.virginia.edu/sites/default/files/uploads/resourceLibrary/CCC%20Summit%20Proceedings_5.8.19.pdf.

Criterion I.F : Mathematics and English language arts (ELA)

- National Academies of Sciences, Engineering, and Medicine. (2018). Chapter 3: Developing and Selecting Instructional Materials for the NGSS, p. 28. *Design, Selection, and Implementation of Instructional Materials for the Next Generation Science Standards: Proceedings of a Workshop*. Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/25001/chapter/4#28.

- NGSS Lead States. (2013). NGSS Appendix L: Connections to the Common Core State Standards for Mathematics. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press. Retrieved from https://www.nextgenscience.org/sites/default/files/resource/files/Appendix-L_CCSS%20Math%20Connections%2006_03_13.pdf.

- NGSS Lead States. (2013). NGSS Appendix M: Connections to the Common Core State Standards for Literacy in Science and Technical Subjects. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press. Retrieved from https://www.nextgenscience.org/sites/default/files/resource/files/Appendix%20M%20Connections%20to%20the%20CCSS%20for%20Literacy_061213.pdf.

- NSTA. (2012). *Making Connections to Common Core*. Retrieved from https://ngss.nsta.org/making-connections-common-core.aspx.

- Hill, L., et al. (2019). What does subject matter integration look like in elementary instruction? Including science is key! STEM Teaching Tools Initiative, Institute for Science + Math Education. Seattle, WA: University of Washington. Retrieved from http://stemteachingtools.org/brief/62.

- National Governors Association Center for Best Practices, Council of Chief State School Officers. (2010). Common Core State Standards. National Governors Association Center for Best Practices, Council of Chief State School Officers, Washington D.C. Retrieved from http://www.corestandards.org/.

Criterion II.A: Relevance and Authenticity

- National Academies of Sciences, Engineering, and Medicine. (2018). *How People Learn II: Learners, Contexts, and Cultures*. Washington, DC: The National Academies Press. https://doi.org/10.17226/24783.

- National Research Council. (2012). Chapter 2: Guiding Assumptions and Organization of the Framework, p. 28. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/13165/chapter/5#28.

- NGSS Lead States. (2013). NGSS Appendix D: Case Studies. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press. Retrieved from https://www.nextgenscience.org/appendix-d-case-studies.

- Penuel, W. R., & Bell, P. (2016). Qualities of a Good Anchor Phenomenon for a Coherent Sequence of Science Lessons. STEM Teaching Tools Initiative, Institute for Science + Math Education. Seattle, WA: University of Washington. Retrieved from http://stemteachingtools.org/brief/28.

- Bell, P., Morrison, D., & DeBarger, A. (2015). How to launch STEM investigations that build on student and community interests and expertise. STEM Teaching Tools Initiative, Institute for Science + Math Education. Seattle, WA: University of Washington. Retrieved from http://stemteachingtools.org/brief/31.

- Bell, P., et al. (2018). How to avoid possible pitfalls associated with culturally responsive instruction. STEM Teaching Tools Initiative, Institute for Science + Math Education. Seattle, WA: University of Washington. Retrieved from http://stemteachingtools.org/brief/53.

Criterion II.B: Student Ideas

- National Research Council. (2012). Chapter 10: Implementation: Curriculum, Instruction, Teacher Development, and Assessment, p. 252. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/13165/chapter/15#252.

- Bacolor, R., et al. How Can I Get My Students to Learn Science by Productively Talking with Each Other? STEM Teaching Tools Initiative, Institute for Science + Math Education. Seattle, WA: University of Washington. Retrieved from http://stemteachingtools.org/brief/6.

- Chowning, J., & Peterman, T. (2015). Beyond the Written C-E-R: Supporting Classroom Argumentative Talk about Investigations. STEM Teaching Tools Initiative, Institute for Science + Math Education. Seattle, WA: University of Washington. Retrieved from http://stemteachingtools.org/brief/17.

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- Michaels, S., & O'Conner, C. (2012). *Talk Science Primer*. TERC. Retrieved from https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf.

- Wiggins, G. (2012). Seven Keys to Effective Feedback. *Educational Leadership, 70*, 10–16. Retrieved from http://www.ascd.org/publications/educational-leadership/sept12/vol70/num01/Seven-Keys-to-Effective-Feedback.aspx

Criterion II.C: Building Progressions

- National Research Council. (2012). Chapter 2: Guiding Assumptions and Organization of the Framework, p. 33. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/13165/chapter/5#33

- National Research Council. (2012). Chapter 2: Guiding Assumptions and Organization of the Framework, p. 26. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/13165/chapter/5#26

- National Research Council. (2014). Chapter 2: Assessments to Meet the Goals of the Framework. *Developing Assessments for the Next Generation Science Standards*, p. 37. Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/18409/chapter/4#37

- National Research Council. (2014). Chapter 2: Assessments to Meet the Goals of the Framework. *Developing Assessments for the Next Generation Science Standards*, p. 44. Washington, DC: The National Academies Press. Retrieved from https://www.nap.edu/read/18409/chapter/4#44.

- **SEPs:** NGSS Lead States. (2013). NGSS Appendix F: Science and Engineering Practices in the NGSS. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press. Retrieved from https://www.nextgenscience.org/sites/default/files/resource/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf.

- **CCCs:** NGSS Lead States. (2013). NGSS Appendix G: Crosscutting Concepts. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press. Retrieved from https://www.nextgenscience.org/sites/default/files/resource/files/Appendix%20G%20-%20Crosscutting%20Concepts%20FINAL%20edited%204.10.13.pdf.

- **DCIs:** NGSS Lead States. (2013). NGSS Appendix E: Disciplinary Core Idea Progressions. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press. Retrieved from https://www.nextgenscience.org/sites/default/files/resource/files/AppendixE-ProgressionswithinNGSS-061617.pdf.

- NGSS Lead States. (2013). NGSS Appendix K: Model Course Mapping in Middle and High School for the Next Generation Science Standards. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press. Retrieved from https://www.nextgenscience.org/sites/default/files/resource/files/Appendix%20K_Revised%208.30.13.pdf.

Criterion II.D: Scientific Accuracy

- National Research Council. (2012). *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: The National Academies Press. Retrieved from https://doi.org/10.17226/13165.

- NGSS Lead States. (2013). NGSS Appendix H: Understanding the Scientific Enterprise: The Nature of Science in the Next Generation Science Standards. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press. Retrieved from https://www.nextgenscience.org/sites/default/files/resource/files/Appendix%20H%20-%20The%20Nature%20of%20Science%20in%20the%20Next%20Generation%20Science%20Standards%204.15.13.pdf.

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