Massachusetts CURATE Project: *Cu*rriculum *Ra*tings by *Te*achers

Science and Technology/Engineering Rubric

Rubric

Domain: Standards Alignment		
Criterion	**Indicator**	**Evidence**
1. Scope and Progression *Note:* This rubric was developed for the CURATE project, which evaluates materials that have previously been reviewed for alignment to college- and career-ready standards. If using this rubric to review materials not already screened for some degree of standards alignment, consider adding or expanding indicators to ensure a comprehensive	**a. Materials' expectations align to grade-level standards:** ● **Disciplinary Core Ideas are addressed at appropriate levels.** ● **Science and Engineering Practices are addressed at appropriate levels.** ● **Massachusetts-specific standards are addressed (e.g., technology/ engineering in K-8).**	The Massachusetts learning standards for science are nearly identical to the Next Generation Science Standards (NGSS), for which Amplify Science was specifically designed from the ground up. To ensure alignment with the additional content that is unique to the Massachusetts standards, we offer a set of Massachusetts companion lessons for teachers to use in conjunction with their Amplify Science units. Please see details of the alignment here. Complete descriptions of the standards addressed in a given unit are provided in that unit's Standards and Goals resource, located in the Unit Guide area of the Teacher's Guide.

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evaluation.	**b. Materials facilitate coherent progressions of learning within and across grade levels:** • **Concepts build on one another.** • **Students take increasing responsibility for practices.**	Amplify Science units bundle and sequence the performance expectations within each grade level to support the development of deep and coherent understanding. There are also opportunities to revisit ideas across grade levels when that provides an opportunity to deepen or extend understanding. To help teachers determine how each unit contributes to a student's developing understanding of scientific/engineering concepts and practices, comprehensive information is included in the Unit level support available in the print and digital Teacher's Guide ("Standards and Goals"). As an example of the coherence Amplify Science facilitates across grade levels, below we show how, across the K–5 grade span, units are designed to support increasingly complex reasoning about the ideas that matter cycles and energy flows through ecosystems: • In kindergarten, students develop an understanding that animals and plants have needs that they must meet in the place they live. In the **Needs of Plants and Animals** unit, students learn that even without directly contacting plants and animals, humans can impact a place in ways that make it easier or more difficult for living things to meet their needs. • In grade 2, students build on these ideas and deepen their understanding of interdependence. In the **Plant and Animal Relationships** unit, students consider that, just as animals need plants in order to eat to survive, plants need animals to get to a place with water and sunlight so they can survive. • In grade 5, students add to their understanding as they investigate more complex ecosystems in the **Ecosystem Restoration** unit. Students figure out that the food relationships they have learned about are necessary because food supplies the matter and energy that all organisms need to grow and thrive. Plants can make their own food from water and air by using energy from the sun, and students trace the path of matter and energy through an ecosystem. Students add to their understanding of interdependence as they learn that while animals depend on plants, plants also need the nutrients that decomposers release into the soil to help them make food. In addition, Amplify Science units are designed to facilitate the Gradual Release of Responsibility–there is an emphasis on teacher modeling and direction at the beginning of the unit, but much of the scaffolds that existed earlier in the unit are thoughtfully and meaningfully removed as the unit progresses. For example, in Lesson 1.6 of the grade 4 **Earth's Features** unit, students are introduced to the features of a scientific argument in a discourse routine called Evidence Circles. Students receive evidence and have small group discussions about how the evidence supports the claim that Desert Rocks National Park used

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		to be underwater. Afterwards, with input from the students, the teacher models writing a scientific argument about what Desert Rocks National Park was like in the past. The Evidence Circles discourse routine continues to be used throughout the unit, with less and less instruction from the teacher. Ultimately, in Lessons 4.5, students engage in Evidence Circles to discuss new evidence about Desert Rocks Canyon and Keller's Canyon and work together to make a claim about why more rock layers were exposed in Desert Rocks Canyon. This prepares them for writing a scientific argument on their own, which serves as Part 2 of the End-of-Unit Assessment.

2. Approach to Instruction	**a. Materials use anchoring phenomena to build student understanding:** ● **Student questions and experiences drive learning.** ● **Understanding and explaining phenomena are the goals of learning.** ● **Phenomena connect concepts purposefully.**	In each Amplify Science unit, students are asked to inhabit the role of a scientist or engineer in order to figure out scientific phenomena through a 21st century, real-world problem context. Over the course of the unit, students collect and make sense of evidence from multiple sources and through a variety of modalities, ensuring that they have multiple vehicles through which to develop and articulate their understanding of each phenomenon. As the class progresses through their lessons, students move back and forth from first-hand investigation and inquiry to secondhand analysis and synthesis, formulating an increasingly complex explanation to help them solve the problem at hand. Each unit also provides students with opportunities to apply what they have learned to solve new problems and/or use newly-learned practices in different contexts. Evidence: ● **Needs of Plants and Animals** unit (kindergarten): Students assume the role of scientists helping a group of children to explain why there are no more monarch caterpillars in a community garden that was converted from a field which once had caterpillars. At the end of the unit, students recommend a plan to redesign the garden in such a way that it accommodates the needs of both humans and monarch caterpillars. ● **Waves, Energy, and Information** unit (grade 4): Students take on the role of marine scientists investigating how bottlenose dolphin mothers and their calves use patterns of sound to communicate across distances. To learn about important characteristics of sound and how sound travels through materials, students engage with several models of sound waves, as well as informational text and first-hand investigations with sound, to learn how sound waves travel at the particle level and how a sound's volume and pitch correspond to the amplitude and wavelength of the sound wave. In the last chapter of the unit, students broaden their understanding of patterns in communication by investigating the patterns that humans use to communicate across distances.

		Spinning Earth unit (grade 1): Students assume the role of sky scientists, helping a young boy named Sai who lives in a place near them understand why the sky looks different to him than to his grandma when they talk on the phone. Students record, organize, and analyze observations of the sun and other sky objects as they look for patterns and make sense of the cycle of daytime and nighttime. Finally, students investigate why the lengths of daytime and nighttime change throughout the year, drawing conclusions about seasonal differences of daytime and nighttime. In addition to figuring out and explaining phenomena, each year of Amplify Science K–5 has a unit that is focused on engineering design in which students apply science principles in order to design functional solutions, and iteratively test those solutions to determine how well they meet specific criteria. Students develop their understanding of science ideas from investigation and text, and apply them in designing a solution to an engineering problem. They then evaluate their solutions to see how well they meet a set of criteria for quality. Evidence: **Properties of Materials** unit (grade 2): Students take on the role of glue engineers and use engineering design practices to create a glue for use at their school. They conduct hands-on investigations to observe properties of a variety of possible glue ingredients and learn how certain materials respond to heating and cooling; they engage in digital card sorts to apply their understanding of how properties of ingredients affect properties of mixtures; and they search for useful information about each ingredient in the unit's reference book. Over the course of the unit, students conduct tests that yield quantifiable results, graph their data, analyze and interpret results, and then use that evidence to iteratively design a series of glue mixtures, each one better than the one before. By the end of the unit, students are able to speak knowledgeably about their choices and argue for how a particular glue mixture best meets their design goals, with evidence from a variety of sources. **Environments and Survival** unit (grade 3): Students assume the role of biomimicry engineers studying a population of grove snails to understand how the snails' traits influence their survival in a changing environment. At the end of the unit, students use their newfound understanding of how the traits of organisms affect their survival in order to help the engineering firm design a robot that aims to mitigate the effect of an environmental change. **The Earth System** unit (grade 5): The cities of East Ferris and West Ferris are located on different sides of a mountain on the fictional Ferris Island. East Ferris is having a water shortage while West Ferris is not. As water resource engineers, students learn about the Earth system to help figure out what is causing the water shortage problem and design possible solutions, including freshwater collection systems and proposals for using chemical reactions to treat wastewater.

	b. Materials purposefully and effectively integrate Science and Engineering Practices (SEP) with Disciplinary Core Ideas (DCIs): ● **SEPs are used for specific, content-driven purposes.** ● **SEPs are used for investigating, sense-making, and critiquing.**	Amplify Science's real-world problems provide relevant, 21st-century contexts through which students will investigate different scientific phenomena and develop a deeper understanding of Disciplinary Core Ideas (DCIs), acquire more experience with Science and Engineering Practices (SEPs), and observe the interconnectedness of various science disciplines through the Cross-Cutting Concepts (CCCs). The Amplify Science curriculum developers at UC Berkeley's Lawrence Hall of Science crafted each unit, chapter, and lesson with the following questions in mind: What do we want students to figure out (what DCI or part of a DCI)?; How do we want them to figure it out? (what scientific and engineering practice will they engage in to figure it out); and what crosscutting concept can scaffold students' understanding and connect it to other ideas about the natural world that they have learned? This resulted in a curriculum that incorporates a strategic, well balanced integration of the three dimensions. In order to help teachers recognize the three dimensional structure of every unit, chapter, and lesson, each unit contains a color-coded "3-D Statement" document that makes the integration clear (blue= SEP; orange= DCI; green= CCC). The 3-D Statement for each lesson is also available to teachers within the "Standards" section of that Lesson Brief. Evidence: 3-D statements from the **Light and Sound** unit (grade 1) include: ● **Unit Level:** Students investigate and construct explanations about how light and sound can be used to create solutions for a puppet-theater company (cause and effect). Students apply what they learn in order to design solutions to create shadow scenery and sound effects for a puppet-theater show. (patterns) ● **Chapter level:** Chapter 2, "How do we make a dark area in bright puppet show scene?"- Students investigate and construct explanations about the effect that some materials can have in blocking light from getting to a surface (cause and effect; patterns). ● **Lesson level:** Lesson 3.4 , "Planning and making our stencils"- Students make diagrams of their proposed solutions for stencils that will project a puppet-show scene that enables all, some, or no light to pass through (cause and effect). 3-D statements from the **Balancing Forces** unit (grade 3) include: ● **Unit Level:** Students are challenged to explain how a floating train works in order to reassure nervous citizens. To solve the mystery, students plan and conduct investigations, analyze patterns in data (patterns), and obtain information about magnetic force, gravity, and balanced and unbalanced forces. Students write explanations and create physical models and diagram models to show why the train's vertical motion is stable at times and changes at times (stability and change).

		Chapter level: Chapter 4, "Why does the train float, even though gravity is acting on it?"- Students gather evidence to support the claim that two forces can act on an object at once. They discover how balanced forces can make an object's motion stable (stability and change) by planning and conducting investigations and obtaining information by reading. **Lesson level:** Lesson 3.4, "Modeling and Explaining the Falling Train"- Students use mathematical thinking as they create diagram models of forces that change the motion of several objects. They create physical models and write explanations about what causes the train to fall (cause and effect). 3-D statements from the **Waves, Energy, and Information** unit (grade 4) include: **Unit Level:** Using physical and computer models to observe and analyze patterns (patterns), students figure out how sound travels as a wave (energy and matter). They apply that knowledge to explain how dolphins in the fictional Blue Bay send and receive signals underwater when separated (energy and matter) and how humans encode, send and receive patterns of information for efficient communication across distances (patterns; scale proportion and quantity). **Chapter level:** Chapter 1, "How does a mother dolphin communicate with her calf across a distance?"- Students use models to investigate waves and how sound travels (patterns, energy and matter). They figure out that sound energy travels as a wave from a source to a listener (patterns, energy and matter). Students create initial Sound Diagrams, and the class constructs an initial scientific explanation about how a mother dolphin uses sound to communicate underwater with her calf across a distance (energy and matter; scale proportion and quantity) **Lesson level:** Lesson 4.3, "Communicating with Codes"- Students use the Code Communicator Tool to encode and image in binary code (patterns) and design a plan to communicate the image across a distance (patterns, energy and matter).
	c. Materials purposefully and effectively integrate literacy and math in service of science: **Reading and writing science-specific texts are used to interpret and explain science concepts.**	Amplify Science provides instructional support for literacy, and provides instructions on how to read scientific texts, write scientific explanations and arguments from evidence, and engage in scientific discourse. - Reading: In Amplify Science, students don't simply "read the text and answer the questions that follow." Rather, students are always approaching their readings with a purpose in mind, from looking for pieces of evidence to support their scientific argument, to asking and recording questions as they read through the text. Evidence: **Animal and Plant Defenses** unit (grade 1): In Lesson 2.1, students are led in a Shared Reading of the book *Tortoise Parts,* with the express purpose of gathering information about how tortoises do what they need to do to survive. Using the strategy of

	● **Math is used as a tool to help students interpret and explain science concepts.**	visualizations to make sense of the structures in the text, students become acquainted with the idea that animals use specific body parts to meet their survival needs. ○ **Modeling Matter** unit (grade 5): In Lesson 2.3, students read the book *Solving Dissolving*, a fictional text about a brother and sister who make lemonade. The teacher first models making inferences with the first few pages of the text. As students read the book with partners, they make inferences about the text, using the images as well as the text to help them understand what they are reading. After reading the book, students record two observations made in the text as well as inferences that they made while reading. Students discuss the models used in the text and how they contribute to an overall understanding of the text. ○ **Changing Landforms** unit (grade 2): In Lesson 2.3, students are introduced to a new Investigation Question (*How could water change a landform even though landforms are made of hard rock?*), and participate in a Partner Reading of the informational text *What's Stronger? How Water Causes Erosion,* with the specific purpose of gathering evidence related to the question. The lesson concludes with a class discussion about different examples of landforms and how water can change them, using the book as reference. ● Writing: In addition to vocabulary development, students will engage in a variety of writing activities, from quick reflection activities that start the class, to end of chapter scientific explanations, and finally, end of unit scientific arguments. Evidence: ○ **Inheritance and Traits** unit (grade 3): The pre-unit assessment in Lesson 1.1 is a writing assignment intended to reveal students' initial understanding of the unit's content. Later, in Lesson 1.7, after groups review gathered data, the class works together to write their first scientific explanation to answer the Chapter 1 Question: *Why are wolves different even though they are all the same species?* This allows the teacher to model the scientific practice of constructing explanations. Throughout the unit, students will continue to engage in writing scientific explanations, and will do so with increasing independence. Ultimately, in Lesson 3.6, students construct a final written explanation about why the wolf they have been studying is medium in size. ○ **Energy Conversions** unit (grade 4): In Lesson 1.6, students are introduced to the vocabulary word *evidence,* then get practice with the concept by writing a response to the prompt, "*Look at the picture of the Ergstown subway on page 17. Name at least two forms of energy that you see evidence of. What is your evidence?"* At the end of the lesson, students work in pairs to gather additional evidence for a claim and write their first argument of the unit. Each subsequent chapter also concludes with a written scientific argument.

		○ **Spinning Earth** unit (grade 1): In Lesson 1.5, students draw and write (using Word Rings) about what two friends see in the sky, and use that information to determine if they live in the same place. The teacher then introduces Interpretation Language Frames and leads students in a Shared Writing about why the sky looks different to Sai than it does to his grandma when they talk on the phone. Teachers record the sentences that students orally compose and then invite students to read these sentences aloud together to consolidate their understanding of the explanations. In the final Shared Writing of the unit, which occurs in Lesson 5.2, the teacher guides students to synthesize their ideas and compose an answer to the Chapter 5 Question: *Why was it nighttime for Sai when he called his grandma during the winter?* ● Vocabulary: Developing a robust scientific vocabulary is an important aspect of our approach to literacy development. For each unit, a carefully selected set of conceptually important words has been identified, and students get repeated exposure to these words through multiple modalities: reading, writing, listening, and student-to-student talk. Evidence: ○ **Needs of Plants and Animals** unit (Kindergarten): In Lesson 1.1, teachers use a specific vocabulary routine with students to introduce the word *scientist*. In the exercise, students get the opportunity to hear, see, and say the word, and then connect the word to a student-friendly definition. This routine provides a consistent way to introduce and practice new words as students encounter focal vocabulary throughout the unit. ○ **Balancing Forces** unit (grade 3): In Lesson 1.2, students are introduced to the words *force* and *evidence.* First, students engage in a hands-on activity in which they use blocks and everyday materials to explore different ways that one object can push or pull on another object. To build on this experience, the teacher leads a discussion to help students make sense of the class data, defining *force* and guiding students to figure out what *evidence* of a *force* might be from their investigation. ○ **Weather and Climate** unit (grade 3): In Lesson 1.2**,** students are introduced to the word *data.* First, students engage in a hands-on activity in which they explore how to measure rainfall in a way that allows them to compare different amounts of rain. The discussion that teachers lead afterwards codifies the word *data* for students, enabling them to make the connection that the information they recorded in their notebooks is, in fact, *data.* The word continues to be used throughout the unit, such as in Lesson 3.3, when students engage in student-to-student discussion about what they observed in weather data that spans 50 years and 3 locations. ● Discourse: Students in Amplify Science have numerous opportunities for structured student-to-student discourse, with low-stakes and high-stakes opportunities to share ideas, use newly acquired vocabulary, and craft oral scientific arguments. Evidence:

		○ **Vision and Light** unit (grade 4): Students participate in a Think-Pair-Share routine to reflect on questions about light receptors and vision. This routine allows students to quickly develop ideas about what they are learning and to discuss those ideas. Think-Pair-Share in Amplify Science is especially beneficial for English learners and other students who may feel reluctant to speak in front of the whole class without preparation. ○ **Light and Sound** unit (grade 1): In Lesson 1.3, students participate in a Shared Listening routine in which they think about and discuss the question: *What is another light source that you know of that we did not see on our Light-Source Hunt?* The teacher explains that each partner will have a turn being the speaker and the listener, but that each student can only fulfill one role at a time, and provides language frames to get them started. The Shared Listening routine is used throughout the unit, and is designed to provide students with multiple opportunities to think on their own and then discuss their ideas with a partner as a way to clarify, refine, add to, or change their understanding. ○ **Earth's Features** unit (grade 4): In Lesson 1.1, students share what they already know and what questions they have about rocks and fossils, first with a partner then with the whole class, in order to activate prior knowledge and to motivate learning. Teachers emphasize to students that it is okay to not be totally sure of their thinking; that thinking about a topic before students start investigating can help make it easier for them to learn new information. Students responses in the discussion are recorded on an Anticipatory Chart, which will be revisited throughout the unit to give students a chance to reflect on what they have learned about rocks and fossils. Math connections are also incorporated into the curriculum. Teacher Support Notes within activities that provide especially fruitful opportunities for math extensions offer instructional suggestions that help to emphasize math further. Evidence: ● **Plant and Animal Relationships** unit (grade 2): In Lesson 1.3, students are introduced to their Investigation Notebooks and use them to record information from the text, *My Nature Notebook.* As a math extension, the Teacher Support Tab of the Instructional Guide suggests, *"to give students practice making bar graphs and analyzing data, have them use the data table on page 15 of My Nature Notebook. Working in pairs, invite students to each make one bar graph. One student should make a bar graph to represent the growth of the young oak tree while the other makes a bar graph that represents the growth of grass. Partners can then describe their graphs to each other. Ask them how the height of the young oak tree and grass have changed*

		over time [...]. The purpose of this activity is to give students practice analyzing and interpreting data using bar graphs." ● **Pushes and Pulls** unit (Kindergarten): In Lesson 1.4, students install launchers into their Box Models to get pinballs to start moving. As a math extension, the Teacher Support tab of the Instructional Guide includes the suggestion that teachers, *"Engage students in a discussion about the different shapes. Start by asking students to identify the shapes and describe what they see. They will likely identify that the box is shaped like a rectangle, and they will describe its sides. Deepen the conversation by asking students to analyze the shapes. Ask questions such as 'Why do you think the Box Model is shaped like a rectangle?' 'What would happen if we made a pinball machine that is a different shape?' or 'What would be different if we turned the machine sideways?' Repeat this line of questioning with other shapes that students identify with the Box Models [...]. The purpose of thinking in this way is to provide students with experience using informal language as they analyze and compare different sizes and orientations of two- and three-dimensional shapes."* ● **Sunlight and Weather** unit (Kindergarten): In Lesson 2.2, students record the temperature data they collected outside on the Class Playground Temperature chart. As a math extension, the Teacher Support tab of the Instructional Guide suggests, *"Once the class has added data to the Class Playground Temperature Chart, consider inviting students to compose evidence-based results statements using the data. These statements allow students to practice reading graphs to make better sense of the information the graph conveys. For instance, students could say, "We had 6 mornings that were cold." More sophisticated statements might say, "There were 3 more very warm playground surfaces then there were cold playground surfaces." If time allows consider recording students' statements underneath the graph as a way to support the connection between oral and written language."*

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Criterion	**Indicator**	**Evidence**
3. Accessibility for Students *Note:* While no one set of materials can serve all students'	**a. Materials provide for varied means of accessing content, helping teachers meet the diverse needs of students**	Amplify Science is rooted in the research-based approach of Do, Talk, Read, Write, Visualize. This learning approach has students engaging with SEPs, figuring out DCIs, and noticing and reflecting upon CCCs in thoughtful, structured activities for each lesson. ● **DO:** "Do" means collecting firsthand evidence. This can include conducting hands-on investigations, making observations of a video clip, or collecting data using a digital simulation, all of which can then be used as evidence in formulating a convincing scientific argument.

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needs, they should strongly support teachers tasked with doing so. Standard II of the [MA model teacher evaluation rubric]() sets expectations for teaching all students.	**with disabilities and those working above or below grade level.**	● **TALK:** Student-to-student discourse is a key indicator of a productive learning environment, and talking is a key modality for instruction in an Amplify Science class. This is more than just partner activities or group work (though there is plenty of that, too). For example, reading activities are followed by a student-to-student discussion where students share their insights and questions with each other and with the whole class. Through talking and developing a collaborative environment, students feel comfortable asking questions of each other, challenging assumptions, and learning from each other. ● **READ:** Science articles, written by the Lawrence Hall of Science, serve multiple purposes: they help students make connections between science concepts and real-world contexts; provide students with secondhand data to analyze; and model science practices, showing real scientists in action. Students also learn to read actively, with explicit instruction on how to record their questions, seek evidence from text, and monitor their understanding as they read. ● **WRITE:** Students in Amplify Science have frequent opportunities to write in order to help them reflect and make sense of what they are learning. Across the program students learn how to express their scientific thinking by leveraging evidence and using relevant vocabulary as they apply their thinking to writing. Frequent reflective writing help students to gain a deepening understanding of the genres of scientific arguments and explanations, both of which embody the foundation of scientific understanding and expression. ● **VISUALIZE:** Through a combination of sims, media, hands-on activities, readings, and digital and physical models, students are empowered to visualize scientific phenomena in ways never possible before. In the classroom, these modalities manifest themselves through carefully designed activities with students planning and conducting investigations, engaging in computational thinking, evaluating information, asking questions and defining problems, analyzing and interpreting data, crafting visual models, and formulating scientific arguments based on evidence they have collected — all through the lens of their investigations of real-world problems. Evidence: ● In the Grade 5 unit **Modeling Matter**, students start Chapter 2 by **doing** a hands on activity in order to obtain, evaluate, and communicate information (SEP 8) about ingredients to be used in a salad dressing. In the next lesson, they **do** observations using a digital simulation (SEP 2) and **talk** to each other about patterns they recognized in the simulation. In the third lesson, they will **read** a book about a boy named Diego, who uses models and **visualizations** to help his little

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		sister Maya understand dissolving. In the book, Diego also draws models for Maya (SEP 2), so that she can connect what is happening at the molecular scale with what she is observing at the macro scale. In the fourth lesson, students create similar models to construct an explanation (SEP 6) about dissolving, and then **write** a scientific explanation to explain solubility. The variety of multimodal activities that are included in Amplify Science, such as the above, provide students with the opportunity to dive deeply into understanding science ideas, make science exciting to students and allow for *all* students to have the benefit of multiple opportunities to access rich science content.
	b. Materials provide for varied means of demonstrating learning, helping teachers meet the diverse needs of students with disabilities and those working above or below grade level.	As outlined above, Amplify Science is rooted in the research-based Do, Talk, Read, Write, Visualize approach. This learning approach presents students with multiple modalities to both figure out the unit's scientific phenomena and articulate their understanding. For example: ● Student-to-student discourse is a key indicator of a productive learning environment, and talking is a key modality for instruction in an Amplify Science class. This is more than just partner activities or group work. For example, reading activities are followed by a student-to-student discussion where students share their insights and questions with each other and with the whole class. Through talking and developing a collaborative environment, students feel comfortable asking questions of each other, challenging assumptions, and learning from each other. Evidence: ○ **Ecosystem Restoration** unit (grade 5): In Lesson 1.8, students draw upon what they have been learning about how matter moves through an ecosystem to explain why plants are key for the health of the animals in the project area. This activity, an Evidence Circle, engages students in small-group, student-led discussions about one or more claims. The goal of Evidence Circles is for students to discuss how evidence supports a claim and to gain practice connecting different pieces of evidence together to make a strong argument. Evidence Circles also provide an opportunity for students to collaboratively reason through ideas and practice using the language of argumentation. Students gain more practice with the Evidence Circle routine later in the unit, in Lesson 2.7 and 3.6. ○ **Balancing Forces** unit (grade 3): Lesson 1.2 includes a "Think-Pair-Share" Routine. In it, students reflect on a series of questions about the unit's anchoring phenomenon of magnetic levitation trains, thinking about how the trains rise off the tracks, float, and fall back down to the tracks. They then share their thoughts with a partner and discuss each other's ideas.

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		○ **Changing Landforms** unit (grade 2): In Lesson 3.4, students engage in the Building on Ideas discourse routine, where one partner begins an explanation and the second partner repeats their explanation and builds upon it (then partners switch for a second question). ● Students in Amplify Science have frequent opportunities for both low- and high-stakes writing in order to help them reflect on and make sense of what they are learning. From quick Warm Ups that start each class, to numerous formative assessment opportunities, to end-of-unit summative assessment writing assignments, students are learning how to express their scientific arguments in writing using evidence, vocabulary, and proper structure. Evidence: ○ **Environments and Survival** unit (grade 3): In Lesson 1.5, students are introduced to the genre of scientific explanation writing, and to several guidelines for writing explanations. THe class works together to help the teacher write a scientific explanation for the Chapter 1 Question: *Why are the snails with yellow shells not surviving well?* As the unit progresses, students are expected to take on more and more aspects of composition, ultimately writing their own scientific explanation in Part 1 of the End-of-Unit Assessment in Lesson 3.4 ○ **Properties of Materials** unit (grade 2): In Lesson 1.8, students gain experience writing and supporting a design argument with appropriate evidence. This is the second argument students will have written in the unit so far using the Providing Evidence template. This activity therefore provides a good opportunity for a formative assessment of students' ability to construct an argument by supporting their claims with evidence. ○ **The Earth System** unit (grade 5): In Lesson 2.2, students engage in a hands-on investigation, then observe, record, and make sense of the results through writing and drawing. ● Physical materials and digital and paper "modeling tools" empower students to create, and later revise, visualizations of their understandings of key scientific phenomena at critical points in the curriculum. Evidence: ○ **Animal and Plant Defenses** unit (grade 1): In Lesson 2.3, students make the first in a series of models to explain animal and plant defenses. Partners explore the reference book to observe how animals and plants use their structures to not be eaten. Students reflect on what they observed in the reference book before using a ball of clay, a comb, and a variety of materials to model how animals and plants might use their structures to defend themselves. The teacher demonstrates how to draw a model structure in the Investigation Notebook and how to use a Word Ring to label the drawing. Then, students

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		choose one of their model structures to draw and label in their notebooks. The teacher introduces the scientific practice of modeling and uses a chart to record what the class learned from each model they created. ○ **Modeling Matter** unit (grade 5): In Lesson 3.5, after observing an emulsifier, students make initial nanovision drawings of what they think is happening to the molecules of oil, vinegar, and lecithin to create a stable mixture. Drawing these models helps students think through and make visible their current mental models of how emulsifiers work. In Lesson 3.6, pairs of students work together to use the digital Modeling Matter Diagramming Tool to revise their initial hand-drawn models of an emulsifier. Pairs then swap models and evaluate one another's models based on how well the models represent what the class has learned. ○ **Earth's Features** unit (grade 4): The Formation Modeling Tool activity in Lesson 1.6 allows students to show their understanding about how fossils form inside sedimentary rock. This digital model requires students to synthesize the ideas they have constructed about how a fossil forms over time and how sediment settles, piles up, compacts, and cements to form a rock layer. Students will revisit the digital Modeling Tool to demonstrate their increasingly sophisticated understanding of rock formation in Lessons 3.2 and 4.4.
	c. Materials help teachers ensure that students at various levels of English proficiency have access to grade-level content, cognitively demanding tasks, and opportunities to develop academic language in English.	The aim of Amplify Science is for **all** students to develop a deep understanding of science concepts as well as facility with practices that are essential to the work of scientists and engineers. In fact, the program was designed with the knowledge that a wide array of student experiences, knowledge, and capabilities exist in every classroom, and that every student has the right and the ability to succeed in science. Amplify Science therefore provides a rigorous yet accessible curriculum designed with broad access in mind, and includes suggestions for strategic modifications by teachers to meet the needs of their students. Every lesson of Amplify Science includes a Differentiation Brief that provides suggestions specifically for supporting English Learners. The Differentiation Brief points out activities that could pose linguistic challenges for ELs or reduce their access to science content, and suggests supports and modifications accordingly. Suggestions include linguistic supports to bolster students' understanding of science content, supports for engaging with science texts, ideas for helping students participate in discussions, multiple ways students can express their ideas in writing, and more.

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		In addition, more generally, English Learners were given particular thought and attention during the development of the entire Amplify Science curriculum. To read more about how particular care was taken to ensure English Learners had equitable access to rich science learning, "English Learners" section of the Amplify Science Program Guide. Finally, developed in conjunction with Spanish experts and classroom teachers, Amplify Science provides Spanish language components across our curriculum. These materials were designed to mirror the English versions in quality and format so that English learners have an equal opportunity to develop a deep understanding of science concepts as well as facility with practices that are essential to the work of scientists and engineers. Spanish resources are available in 3 useful formats: ● First, the Teacher Spanish license gives teachers access to a button that enables them to toggle back and forth between seeing Spanish and English in their Amplify Science accounts. When in Spanish mode, teachers can: ○ Download PDFs of all classroom wall materials, copymasters, assessments, and more ○ Use Spanish projections in class ○ See all model teacher talk in Spanish ○ Access digital versions of the student books and articles in Spanish ● Second, Spanish Print Kits provide hard-copy, translated versions of all student-facing materials such as student books, copymasters, print materials, assessments, and notebooks. ● Last, Student Spanish Licenses are available. These licenses allow students to access Spanish versions of all student resources, including lesson instructions, student books, vocabulary, assessments, and simulations. Audio in videos, as well as in the read aloud functionality within the books, is also translated. When their students have the Spanish licenses, teachers can assign students to a particular language, or they can choose to give students the ability to toggle between English and Spanish as needed.
	d. Materials include questions and tasks that affirm and value diverse identities, backgrounds, and perspectives.	Across all units of Amplify Science, students encounter profiles of scientists of a wide variety of ethnic and racial backgrounds, and of different ages and genders. Care has been taken to reflect diverse backgrounds in both the selection of real scientists and engineers to feature, as well as in the portrayal of fictional characters in student books and media. For example: ● **Light and Sound** unit (grade 1): The book *Let's Test!* follows two young children who test several different shade devices for their lemonade stand before finding the perfect one. Both the

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		children and their lemonade customers at the end of the book reflect a diverse, multicultural community. ● **Sunlight and Weather** unit (kindergarten): Students consult a reference book called *Handbook of Models*, which shows a diverse collection of real scientists who use models, including an African-American man, Asian-American men, a European-American woman, and an Arab-American woman. ● **Ecosystem Restoration** unit (grade 5): Students read the book *Walk in the Woods*, which follows a soil scientist named Asmeret Asefaw Berhe, who is an African-American woman. Many other examples abound throughout every unit of Amplify Science. This was important to the curriculum's developers, because when students see people in top science and engineering roles who look like them or who may have had similar life experiences, they can imagine themselves in similar futures. In addition, the program features real-world phenomena in a variety of places around the world, including: Mexico, Costa Rica, the Philippines, and India, providing students from those countries with a natural connection to the activities they conduct in the curriculum.
4. Usability for Teachers *Note:* Materials should strongly support teachers in their everyday work. Standard I of the MA model teacher evaluation rubric defines expectations for teachers related to curriculum, planning, and assessment.	**a. Lessons and tasks advance student learning with clear purpose.**	In conjunction with the iterative process of Do, Talk, Read, Write, Visualize, each successive lesson in a unit furthers student understanding of the phenomena they are investigating, as well as the targeted Performance Expectations, in a structured and considered way through the use of something we call "Progress Builds." Progress Builds, or PBs, define levels in the increasingly complex explanation of a unit's anchoring phenomenon that students should be constructing over the course of the unit. Each PB level integrates and builds upon the knowledge and skills from lower levels. In this way, the unit's Progress Build provides teachers and students with a clear roadmap for *how* understanding of the unit's anchor phenomenon is expected to deepen and develop over the course of the unit's learning experiences. The Amplify Science curriculum was constructed to inspire a deep knowledge of the NGSS—not merely touching upon each standard, but truly allowing for a depth of coverage in a variety of modalities for each. Progress Builds are an innovative way to ensure all students develop this deep understanding by aligning instruction and assessment around focused, meaningful, standards-based learning goals. Because PBs carefully consider not only the knowledge students are likely to have at the beginning of a sequence of instruction, but also how those learning experiences will position students for success with future learning opportunities, PBs support a consistent and coherent approach to a single unit of instruction. Structured by the PB, students' explanations of phenomena in each Amplify Science unit

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		build over time through the accumulation of evidence from their investigations within a unit. As students engage in this evidence-gathering, they work toward increasingly sophisticated explanations that evolve with new evidence. Evidence: See below for examples of Progress Build levels, given for one unit. Note how each description of a given PB expands on the one that came before it to include deeper, more sophisticated concepts: **Balancing Forces** unit (grade 3): ● Progress Build Level 1: A force is a push or pull that acts between two objects. ○ Description: A force is a push or pull exerted on an object. When something starts or stops moving, that is evidence of a force. Forces always act between two objects. ● Progress Build Level 2: Forces can be touching or non-touching. ○ Description: A force is a push or pull exerted on an object. When something starts or stops moving, that is evidence of a force. Forces always act between two objects. **Forces can be touching or non-touching. Gravity is a non-touching force that acts between Earth and all other objects. Magnetic force is a non-touching force that acts between magnets and some other metal objects.** ● Progress Build Level 3: More than one force can act on an object at the same time. When those forces are balanced, a still object will remain still; when those forces are unbalanced, the object will start to move. ○ Description: A force is a push or pull exerted on an object. When something starts or stops moving, that is evidence of a force. Forces always act between two objects. Forces can be touching or non-touching. Gravity is a non-touching force that acts between Earth and all other objects. Magnetic force is a non-touching force that acts between magnets and some other metal objects. **More than one force can act on an object at a time. If the forces are in opposite directions and of the same strength, the forces are balanced, and a nonmoving object will not start to move. If the forces are in the opposite directions and are not of the same strength, the forces are unbalanced, and the object will move in the direction of the stronger force.**
	b. Materials support teachers with suggested classroom routines and	The teacher's Instructional Guide in Amplify Science provides clear step-by-step instructions and ready-to-use slide decks for each lesson, with teacher support notes and possible student responses for activities within the lessons. Furthermore, every lesson includes a Differentiation Brief that gives teachers specific suggestions on making that particular lesson impactful for their own students. The Differentiation Brief describes what is built into the lesson to support diverse learning needs; highlights

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	structures (e.g., grouping strategies).	potential challenges teachers should be aware of; and provides specific strategies for differentiating instruction. The Differentiation Brief contains the following sections: ● **Embedded Supports for Diverse Learners:** Every unit is designed with diverse learners in mind, with the goal of providing rigorous yet accessible science instruction. Each lesson is intentionally planned to provide multiple entry points for students, and to enable all students to be successful with all of the activities. This section of the Differentiation Brief highlights the scaffolds already embedded within the lesson so that teachers can take advantage of the power of these carefully designed activities. ● **Potential Challenges in This Lesson:** This section of the Differentiation Brief highlights aspects of the lesson that may present particular cognitive, linguistic, or social challenges for students. ● **Specific differentiation strategies for English Learners (ELs)**: This section of the Differentiation Brief points out activities that could pose linguistic challenges for ELs or reduce their access to science content, and suggests supports and modifications accordingly. Suggestions include linguistic supports to bolster students' understanding of science content, supports for engaging with science texts, ideas for helping students participate in discussions, multiple ways students can express their ideas in writing, and more. ● **Specific differentiation strategies for students who need more support:** Every lesson includes ways for teachers to support those students who are struggling or who have special needs. These additional scaffolds are to be used entirely at the discretion of the teacher, and provide targeted suggestions tailored for the activities in that particular lesson. ● **Specific differentiation strategies for students who need more challenge**: Every lesson has ways for a teacher to expand upon the lesson, or go beyond the scope of what is expected in that lesson. This section of the Differentiation Brief provides suggestions that allow students to engage with content more deeply, explore the material with a new purpose, pursue more independent research on a topic, and more.
	c. Pacing is reasonable and flexible; the curriculum can be implemented effectively within a typical school year.	Each course of Amplify Science K-5 consists of 3 or 4 units, with each unit containing 22 lessons. Grade K–1 lessons are written for 45-minute sessions, and Grades 2–5 for 60-minute sessions. Taught as designed, this works out to 66 lessons per year for Grades K-2 (or an average of approximately 2 lessons per week) and 88 lessons per year for Grades 3-5 (or an average of approximately 2.75 lessons per week). Given the wide range of time devoted to science at the elementary level throughout districts and schools, and of time allotted for a class session, we designed Amplify Science K–5 for flexible use. For example, all lessons are broken into activities with suggested time allotments for each. This helps provide guidance for how to break up a lesson, if needed, so it can fit within the time frames that a teacher has.

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		A suggested scope and sequence is provided for each grade level, which can be found on the Amplify Science Program Guide site.
	d. Materials include informal and formal assessments that help teachers measure learning and adjust instruction.	The assessment system for each Amplify Science unit is designed to provide teachers with actionable diagnostic information about student progress toward the learning goals for the unit. Assessment of unit learning goals is grounded in the unit's Progress Build, which describes how student understanding is likely to develop and deepen through engagement with the unit's learning experiences. The assessment system includes formal and informal opportunities for students to demonstrate understanding and for teachers to gather information throughout the unit — all while giving teachers flexibility in deciding what to score and what to simply review. Built largely around instructionally embedded performances, these opportunities encompass a range of modalities that, as a system, attend to research on effective assessment strategies and the NRC Framework for K–12 Science Education. The variety of assessment options for Amplify Science include: ● **Pre-Unit assessment (formative):** These assessments make use of discussion, modeling, and written explanations to gauge student knowledge prior to starting a unit and form a baseline from which to measure growth over the course of the unit. ● **On-the-Fly assessment (formative):** Designed to provide regular information to the teacher with minimal impact on instructional time, these embedded assessments leverage the formative opportunities in the learning experience students are already engaged in. Each On-the-Fly assessment includes guidance on what to look for in student activities or products of student work, and offers suggestions on how to adjust instruction accordingly or respond to assessment information. ● **Self-assessment (formative):** Once per chapter, students are given a brief opportunity to reflect on their own learning, ask questions, and reveal ongoing wonderings about unit content. Students respond to a consistent set of prompts each time, ensuring that their own progress is visible to them. ● **Critical Juncture assessment (formative):** Usually occurring at the end of each chapter and designed to assess students' understanding of a level of the Progress Build, these signify a point at which student understanding of content is crucial before moving on, ensuring they are well positioned for success in ensuing instruction. Critical Juncture assessments are often end-of-chapter explanations or arguments. These three-dimensional performance tasks support students' consolidation of the ideas encountered in the chapter and provide insight into students' developing understanding.

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		• **End-of-Unit assessment (summative):** These assessments employ discussion, modeling, and written explanations or arguments to enable students to demonstrate understanding and growth at the conclusion of a unit. • **Investigation assessment (summative):** In each grade, there is one opportunity to summatively assess an embedded performance in which students plan and conduct investigations. This three-dimensional assessment provides an opportunity for teachers to assess students' facility with the practices of Planning and Conducting Investigations and Analyzing and Interpreting Data as well as students' understanding of disciplinary core ideas and crosscutting concepts. • **Portfolio assessment (summative):** Through the portfolio assessment students have an opportunity to reflect on their goals and growth throughout the school year as they compile and reflect on work products from each unit. Guidance is provided for teachers and students on selecting work and reflecting on and evaluating growth across the year. • **Benchmark Assessments**: Delivered three to four times per year in Grades 3–8, benchmark assessments report on students' facility with each of the grade-level appropriate DCIs, SEPs, CCCs, and performance expectations of the NGSS.[1] Evidence: Select examples from the **Patterns of Earth and Sky** unit (grade 5): • Lesson 1.1: Students are given information about an ancient artifact depicting the sky and are tasked with explaining why the sky looks different in different sections of the artifact. This pre-unit writing assessment is an opportunity for students to articulate their initial ideas about how Earth's movement causes changes in what we see in the sky and about the crosscutting concept of Patterns. In Lesson 3.6, students write their final explanations about why the sky looks different in different sections of the artifact. These written explanations and follow-up questions provide a good basis to assess each student's level of understanding of the core concepts from the unit. These explanations also reveal students' developing facility with the science and engineering practice of Constructing Explanations. In addition, students' written explanations provide evidence of growth over time when compared with their pre-unit assessments. • Lesson 4.3: Students follow plans they made in the previous lesson as they conduct investigations of the visibility of stars and constellations and look for patterns in the data. After 15 minutes, they reflect with their partners about the challenges they faced while investigating and then share and receive support in a whole-class setting. Student pairs revise their investigation plans and conduct their investigations again. Students reflect on the role of revision

[1] *The Amplify NGSS Benchmark Assessments were authored by Amplify and were not developed as part of the Amplify Science program or created by the Lawrence Hall of Science.*

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<tr><td></td><td></td><td>in investigation and think about how professional scientists often have to change their investigation plans along the way. This investigation serves as an assessment that is designed to reveal students’ facility with the performances of Planning and Conducting Investigations and Analyzing and Interpreting Data, and with their understanding of unit-specific science concepts, and the crosscutting concept of Patterns.
● Lesson 2.5: Students use the Patterns of Earth and Sky Modeling Tool to show which way is up and which way is down for people on opposite sides of Earth. The teacher uses this as an On-the-Fly Assessment opportunity to assess students’ understanding of the effect of gravity on perceptions of up and down, as expressed through their models. Guidance on what to look for when reviewing students’ models, and how to tailor instruction based on what is noticed, is included in the Instructional Guide.</td></tr>
<tr><td></td><td>e. Materials include rubrics, exemplars, or other resources to help teachers set clear and high expectations for students.</td><td>Guidance on interpreting student performance along the three dimensions is included in all Amplify Science units. Categories of evaluation guidance found throughout the program include:
● Assessment guides/rubrics: Guidance is provided to gauge the level of student performance on the assessment task, with suggestions for student feedback and questioning strategies to advance learning, revise performance, or elicit and clarify student thinking. Assessment guides/rubrics are available as a digital resource in the Lesson Brief for the lesson in which the task occurs.
● Possible student responses: Possible student responses are provided to model how evidence of understanding, or partial understanding, may be demonstrated by the student for the specific task. Possible student responses are provided as a PDF at the unit level. Possible student responses also appear in the Assessment Guide for the End-of-Unit Assessment (in Digital Resources).
● Look for/Now what? notes: Each On-the-Fly Assessment includes a two-part description of what evidence of understanding would look like for the task (Look for) and how instruction may be adjusted in response (Now what?). These are accessible by pressing the orange hummingbird icon in the activity in which they appear.
● Assess understanding/Tailor instruction notes: Each Critical Juncture Assessment includes a two-part description of how the expected level of student understanding may be demonstrated in the task (Assess understanding) and how instruction may be adjusted in response (Tailor instruction) at the class, group, and student level. These are accessible by pressing the orange hummingbird icon for the activity in which they appear.</td></tr>
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		Crosscutting Concept Tracker: The Crosscutting Concept Tracker provides a set of prompts for eliciting student understanding of the focal crosscutting concept, a list of specific activities where these prompts should be used, and a space for recording notes to track student or class progress over the course of the unit. The Crosscutting Concept Tracker is provided with the first lesson in which it is relevant (in Digital Resources) and is also linked from the relevant On-the-Fly Assessments, Critical Juncture Assessments, and Assessment Opportunity Teacher Support notes. Evidence: **Ecosystem Restoration** unit (grade 5): For the End-of-Unit Assessment in Lesson 3.7, students write final scientific arguments in response to the same prompt as they did in the Pre-Unit Assessment. Students' arguments provide an opportunity to assess their level of understanding of the core concepts from the unit, as specified in the Progress Build, and provide evidence of growth over time when compared with their pre-unit writing. Students' arguments also reveal students' developing facility with the practice of engaging in argument from evidence. In the "Guide to Assessing Students' End-of-Unit Arguments" (located in Digital Resources for Lesson 3.7), two rubrics are provided for assessing students' writing along several dimensions. These dimensions include attention to students' understanding about how energy and matter flows in an ecosystem, students' knowledge of how parts of an ecosystem interact, and students' abilities to construct scientific arguments from evidence. **Energy Conversions** unit (grade 4): In Lesson 1.6, students gather additional evidence to support a claim and write their first argument of the unit. The Possible Responses tab of the Instructional Guide provides teachers with example responses. In addition, the "On-the-Fly Assessment" reference information guides teachers with the following information: "As students are recording evidence, notice if they are including evidence that is relevant to the claim and that also comes from one of the sources designated on the notebook page. Since this is students' first experience in this unit with providing evidence to support a claim, it is acceptable at this stage if not all students have mastered this. If you find that many of your students are including irrelevant evidence or writing down their own opinions rather than evidence from a specific unit source, you may decide to add in further discussion after students complete pages 18–19, 'Writing an Argument About the Blackout,' in the notebook. You may also choose to present a student work example that includes evidence supporting the claim and talk through why the evidence is relevant and where it came from."

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<tr><td></td><td></td><td>Changing Landforms unit (grade 2): In Lesson 1.1, students are presented with a rock arch in the ocean and are told that the hole in the arch has gotten bigger over time. Students are asked to explain why the hole got bigger. This pre-unit writing assessment is an opportunity for students to articulate their initial ideas about why and how landforms can change over time. This will allow the teacher to draw connections to students' experiences and to watch for alternate conceptions that might get in the way of students' understanding. In "Guide to Interpreting Students' Pre-Unit Explanations" (in Digital Resources for Lesson 1.1), guidance is provided to help the teacher draw insights into students' initial thinking about the content. The Guide includes examples of students' experiences that the teacher can connect to activities in the unit, ideas students may have about rock, and alternate conceptions to watch out for.</td></tr>
<tr><td></td><td>f. Materials include guidance and resources designed specifically to build teachers' knowledge.</td><td>Ample instructional support and background information is provided at all levels of Amplify Science. The Teacher's Guide includes a wealth of resources through which Amplify Science teachers can develop and extend their knowledge, including:
Unit-level resources:
Unit Overviews
Lesson Overview Compilations
Standards and Goals overviews
Science Background information
Getting Ready to Teach information
Assessment System resources
Embedded teacher supports in the lessons:
Differentiation strategies for each lesson
Teacher Support notes for activities within the lessons, including background knowledge on the scientific information being taught, pedagogical rationale, and suggestions on technology usage
Clear step-by-step instructions for each activity, including slides, model language to use in class, answer keys with sample student responses, recommendations for classroom set up, rubrics for scoring written assessments, and a listing of standards covered
The Science Background resource is particularly useful for building teachers' subject matter knowledge. It contains background information about the science concepts relevant to the unit, the rationale for the selection and organization of particular concepts within the unit, and a discussion of misconceptions students may hold about these concepts.</td></tr>
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5. Impact on Learning *Note:* For CURATE reviews, DESE's research office determines ratings for this indicator and criterion.	**a. Research demonstrates that the materials have a positive impact on student learning.**	Multiple gold-standard studies[2] have examined the efficacy of the underlying approach in Amplify Science, called *Do, Talk, Read, Write* (first used in the Lawrence Hall of Science's legacy program, *Seeds of Science, Roots of Reading*). More recently, as part of a National Science Foundation study, WestEd conducted a "gold standard" randomized controlled study that examined the efficacy of the Amplify Science Middle School curriculum for improving seventh-grade students' learning in relation to NGSS performance expectations in physical science. Analysis showed that implementing Amplify Science had a significant positive impact on student learning. Seventh-grade students who participated in the Amplify Science curricular units in physical science outperformed students in the control classrooms on the outcome measure that was aligned to the NGSS PEs. The difference was statistically significant ($p < 0.001$), with an estimated effect size of +0.40. While the study focused on middle school students, initial findings from a similar WestED study involving first grade students were recently released and also demonstrate efficacy. Specifically, the study results show that first grade students using Amplify Science significantly outperformed students in comparison classrooms on two NGSS-focused assessments. Full details of the initial results can be found here.

[2] https://amplify.com/wp-content/uploads/2021/03/CRESST-Efficacy-GR2_3-Wang_Herman-2005.pdf
https://amplify.com/wp-content/uploads/2021/03/CRESST-Efficacy-Gr3_4-Goldschmidt-2010.pdf
https://amplify.com/wp-content/uploads/2021/03/Efficacy-Final-Gr-5-Duesbury_Werblow_Twyman-2011.pdf
https://amplify.com/wp-content/uploads/2021/03/NRC-Paper-2014-Barber-and-Pearson.pdf