Waves and Ocean Structures:
Why do some things wash up on the beach and others don't?
EQuIP Rubric for Science Evaluation

Developer/Curriculum: NextGen Science Storylines
Unit Name: Waves and Ocean Structures: Why do some things wash up on the beach and others don't?
Grade: 4
Date of Review: October 2019
Overall Rating (N, R, E/I, E): E
Category I: NGSS 3D Design Score (0, 1, 2, 3): 3
Category II: NGSS Instructional Supports Score (0, 1, 2, 3): 2
Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3): 3

Total Score (0–9): 8

Click here to see scoring guidelines

This review was conducted by the Achieve Science Peer Review Panel using the EQuIP Rubric for Science.

Category I Criteria Ratings		Category II Criteria Ratings		Category III Criteria Ratings	
A. Explaining Phenomena/Designing Solutions	Extensive	**A. Relevance and Authenticity**	Adequate	**A. Monitoring 3D Student Performances**	Extensive
B. Three Dimensions	Extensive	**B. Student Ideas**	Extensive	**B. Formative**	Extensive
C. Integrating the Three Dimensions	Extensive	**C. Building Progressions**	Adequate	**C. Scoring Guidance**	Adequate
D. Unit Coherence	Extensive	**D. Scientific Accuracy**	Extensive	**D. Unbiased Tasks/Items**	Adequate
E. Multiple Science Domains	Adequate	**E. Differentiated Instruction**	Inadequate	**E. Coherence Assessment System**	Adequate
F. Math and ELA	Adequate	**F. Teacher Support for Unit Coherence**	Extensive	**F. Opportunity to Learn**	Extensive
		G. Scaffolded Differentiation Over Time	Adequate		

Summary Comments

Thank you for your commitment to students and their science education. Achieve is glad to partner with you in this continuous improvement process. It is obvious that this unit was thoughtfully crafted. The unit is strong in several areas, including engaging students with a central phenomenon that is clearly integrated throughout the entire unit. Student learning is aimed at making sense of the chips washing up on the beach, and students regularly return to this anchoring phenomenon to develop and revise models and explanations.

Students also routinely engage in elements of the Science and Engineering Practices (SEPs) with emphasis on Developing and Using Models, Planning and Carrying Out Investigations and Constructing Explanations. The unit has multiple examples of three-dimensional learning activities with a wide variety of interconnected lessons in order for students to explain the phenomenon. The lesson sequence creates a coherent learning experience for students and all of the learning is in service to the Disciplinary Core Ideas (DCIs) targeted in the unit.

In addition, there is an effective use of scientifically-accurate articles, data tables, and graphs, which students utilize to make sense of the chips on the beach phenomenon. Many opportunities are provided for students to share their thinking and to give and receive feedback, and to reflect on their learning and progress. The unit materials also include a comprehensive teacher guide, which lays out the rationale for the strategies that are embedded within the unit, as well as the full set of student materials and a detailed unit plan with some supports for teachers to assist struggling students to make connections to ELA-Literacy, Mathematics, and Social Studies.

The unit will be a very promising example of a high quality, NGSS-designed unit with a few key revisions. During revisions, the reviewers recommend paying close attention to providing better support for the differentiation of learning for high-achieving students, to incorporating more detailed procedures for providing teacher feedback, and to supporting the students to utilize the feedback to make revisions to their models and explanations. All of these changes would strengthen the unit.

Also consider providing more opportunities for students to directly experience and explain the targeted Earth Science DCI by expanding the focus of Lesson Set 2. While this is a partially-addressed DCI, students could have a much better understanding of the connections between the Physical Science and Earth Science domains if they are given more time to explore maps displaying different water and land features of the Earth.

Note that in the feedback below, black text is used for either neutral comments or evidence the criterion was met and purple text is used as evidence that the criterion was not met.

Category I. NGSS 3D Design

Score: 3

***3:** At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C*

***2:** At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C*

***1:** Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C*

***0:** Inadequate (or no) evidence to meet any criteria in Category I (A–F)*

Waves and Ocean Structures:

Why do some things wash up on the beach and others don't?

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Rating for Criterion I.A Explaining Phenomena/Designing Solutions: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that learning is driven by students making sense of phenomena or designing solutions to a problem because students engage in a series of lessons in order to make sense of the anchoring phenomenon: thousands of bags of chips washed up on a beach.

In doing so, they also explore a number of lesson-level driving questions related to phenomena such as:

- What caused all those chips to get on the shore?
- Where did the chips come from?
- What was happening in the ocean when the container was lost?
- How can we make and describe different sizes of waves?
- How do different-looking waves move a floating object?
- How does the ship's location during the storm compare to other areas of the ocean?
- Does a slanted ocean floor change how waves move an object?

The anchoring phenomenon is rich enough to drive the learning throughout the unit and elicit a range of investigable questions related to phenomena over the course of the unit. Students regularly return to the phenomenon to add layers of explanation based on learning, or regularly build on what they have learned from smaller phenomena or problems to explain a broader science topic.

Student learning is focused on supporting students to better make sense of the phenomenon. For example:

- Lesson 2 - Analysis and Interpretation of Maps 1: Students analyze and interpret data from maps to decide if ocean currents or wind might have pushed the container.
- Lesson 3 - Wave Bin Investigation 1: Students use clear wave bins and a controlled paddle motion to make waves in water. They make observations about how their paddle speed and distance change the size of the waves, and they draw models of how those waves look.
- Lesson 4 - Wave Bin Investigation 2: Students use the wave bins and the same variety of paddle movements as in the previous lesson to make waves with different amplitudes and wavelengths, but they add a floating object to represent the container or chip bag. They observe and record how the waves move that object (or not).
- Lesson 6 - Wave Bin Investigation 3: Students modify their wave tubs to be more like the structure of the ocean floor near the beach (slanted up toward the beach). They conduct an investigation similar to what they did two lessons ago to see how this change to the floor affects structure of water waves passing over it, and how those waves affect the motion of objects floating on the surface of the water.

Students regularly return to the anchor phenomenon to add layers of explanation based on learning, or regularly build on what they have learned from smaller phenomena to explain a broader science topic. For example:

- Lesson 1: Students develop own initial model by drawing a first draft representation of what they think caused the container of chips to fall in the water off the boat and how the chips ended up on the beach. They then compare their models with others and develop a Class Consensus Model, which combines an overall class interpretation of what happened in this phenomenon. Students return to this class model throughout the unit to update their understanding of the phenomenon (Lesson 2, Lesson 5, Lesson 6, and Lesson 7).
- Lesson 2 - Students create own chart (Model Tracker) in their science notebooks to record what they figured out from this lesson (and add to it as the unit continues). Students return to this chart at the end of every lesson to help them recognize what they learned and what investigations/phenomena they will need to make sense of in the next lesson to better understand the anchor phenomenon (Lessons 3–7).
- Lesson 2 - Students create a class Scientific Principles Poster where as a class they will record what they know to be true based on the findings/investigations they have done in class. They return to this chart in Lessons 6 and 7 to reinforce the scientific principles they have discovered during investigations in Lessons 3–5.
- Lesson 1 - Students create a class Questions and Investigations T-Chart to display their questions and ideas that they would like to investigate in class in order to explain the phenomenon. This chart is continuously returned to throughout the unit as the students build their understanding of the phenomenon (Lessons 2–7).

All of the student learning across the three dimensions targeted by the unit is in service of students making sense of phenomena or designing solutions to a problem. In several lessons, students investigate the underlying scientific concept (DCI: 4.PS4.A) through reasoning about the evidence they observe during investigations (SEP). As students analyze and interpret data (SEP), they are continuously revisiting elements of the crosscutting concepts (CCC) of patterns as well as cause and effect. For example:

- Lessons 2 and 5 - Students analyze and interpret data gathered from maps to better understand how the chips could have gotten washed up on the beach.
- Lessons 3, 4, and 6 - Students plan and conduct investigations to better understand the mechanics behind wave motion and how waves move objects.
- Lessons 2–6 - Students observe the causes and effects of wave motions and record patterns observed in data analysis of investigations and research related to the anchor phenomenon.

Student questions or prior experiences with the phenomena create a need for the students to engage throughout the materials. Materials provide structured support for teachers to draw out these connections from students and use these connections to motivate student learning. For example:

- Lesson 1 - Students create a Notice and Wonder chart to record their initial ideas about the phenomenon. These ideas help students work through their thinking about what happened to cause the phenomenon to occur and they help students contribute to an anchor chart containing the possible causes of the phenomenon and what they are wondering about the phenomenon.
- Lesson 1 - Students create a Related Phenomena chart where they record examples of when they've seen other items in the water move (or end up on the beach/shore) for any of the reasons they've discussed in class. They return to this chart in Lesson 4 in which students further investigate waves, specifically when waves move objects.
- Lesson 1 - Students develop a Driving Question Board based on their Notice and Wonder chart and their Related Phenomena chart. They frequently revisit the questions to connect what students now know and the ideas that still need to be figured out. This helps students drive the learning and remain motivated throughout the unit.
- The anchoring phenomenon is revisited throughout the unit and the learning in each lesson is in service to the phenomenon. Starting at Lesson 2, the conclusion of each lesson features students using the Progress Tracker to record what they investigated and how it contributed to their understanding of the phenomenon.

Suggestions for Improvement

None

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.

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

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

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

Rating for Criterion I.B. Three Dimensions: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions because there are multiple examples in which students are engaging in elements of the SEPs and the CCCs in order to understand the Disciplinary Core Ideas and apply the DCIs to the anchoring phenomenon. The following is a list of evidence to support the reviewers' rationale:

Science and Engineering Practices (SEPs): Extensive

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The reviewers found extensive evidence that the materials provide opportunities to develop and use specific elements of the SEPs. Students progressively engage in elements of the practices of **Asking Questions and Defining Problems**, **Developing and Using Models**, as well as **Analyzing and Interpreting Data** at a deeper level as the lessons progress. An element of the practice of **Planning and Carrying Out Investigations** is also present with evidence of student choice. In addition, elements of the practices of **Constructing Explanations** as well as **Obtaining, Evaluating, and Communicating Information** are present in some lessons. All of the activities are at a grade-appropriate level for a fourth-grade student and aid in student sense-making of the anchoring phenomenon. Below are several examples:

Asking Questions and Defining Problems

- *Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.*
    - Lesson 1 - Students record their questions about the observed phenomenon and other related phenomena. Students analyze their questions to determine which can be investigated in the classroom. Students group similar questions and determine a question that connects all the questions to create the Driving Question Board for the unit.
    - Lesson 3 - Students ask questions about motions needed in order to make different types of waves; this is further explored by additional student-created questions in Lesson 4, in which students investigate the types of waves needed to move an object.

Developing and Using Models

- *Develop and/or use models to describe and/or predict phenomena.*
    - Lesson 1 - Students create initial models of the phenomenon and then create a Class Consensus Model of the phenomenon that is changed throughout the unit with their learning.
- *Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.*
    - Lessons 2–6: Students continually revise the Class Consensus Model (additional labels, arrows, explanations) throughout the unit as they gather more information about the phenomenon.
    - Lessons 2–6: Students use Progress Tracker to record their understandings of the phenomenon throughout the unit.
    - Lessons 3–4 - Students develop a model of wavelength and amplitude that includes verbal descriptions of the patterns students found in wave motion.

Planning and Carrying Out Investigations

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

- In Lessons 2–3, students are encouraged to choose a question they would like to explore from the Driving Questions Board. Students are given time to brainstorm ways they could investigate waves in the classroom. They discuss what materials are needed, jobs, trial numbers and ways to record their data. Student Handouts 2.2, 2.3 and 2.4 help students organize their thoughts to develop a plan in order to conduct their investigation on making waves. While the experiment variables are discussed (the height of the water, the amount of force needed to use the paddle) there isn't a direct classification of what parts of the experiment are controlled.
- Lesson 4 - Students review the previous lesson on how to make different waves and then focus on planning an investigation in which they must move an object making different waves. Students are reminded of ways to conduct fair tests, any tips from the previous lessons, and proper group expectations. Student Handouts 4.1 and 4.2 help students organize their thoughts and develop a plan in order to conduct their investigation on making different types of waves in order to move an object.

- *Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.*
    - Lesson 6 - Students make observations based on their slanted "ocean" floor investigation to produce data in order to explain their understanding of how the slanted floor changes the shape of the wave, which then causes the object to be pushed in the direction in which the wave is moving. They record their drawings and descriptions on Student Handout 6.1.

Analyzing and Interpreting Data

- *Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.*
    - Lesson 2 - Students analyze and interpret map data to make connections to the pattern of events already established about how, where, and when the cargo ship lost its container(s). Students can record their understandings on Student Handout 2.2.
    - Lesson 5 - Students' Notice and Wonder responses help them identify the pattern of colors that show ocean depths and explain that most ships travel closer to the coast than farther out in the ocean. Students apply the patterns of "darker color shows deeper water" and "the ocean becomes shallower along the shoreline." However, while the Supporting Students in Making Connections to Math (L) has some suggestions about assisting students in understanding the graph on slide 24, adequate support is not currently given to ensure that students would accurately interpret the data being present in the graph and how it relates back to the phenomenon."

Constructing Explanations and Designing Solutions

- *Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.*
  - Lesson 7 - Students use the observational data they collected during investigations in addition to the patterns they found in the characteristics of waves in order to explain their understanding of how the structure of the ocean floor can cause waves to move a floating object differently.

Obtaining, Evaluating, and Communicating Information

- *Read and comprehend grade appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.*
  - Lesson 1 - Students read a grade-appropriate news article explaining what happened to the chips. Students are also guided through the Close Read process and can annotate the text on Student Handout 1.1. The students use the information from the text in order to make sense of where the chips came from.
  - Lesson 2 - Students read an additional grade-appropriate news article that gives more information about what happened to the ship carrying the container of chips (where it was leaving from, where it was going, the company who owns the ship, the weather conditions at the time). Students use the Close Read process again independently to annotate the text on Student Handout 2.1. A discussion is started by the teacher asking what information was learned through reading this article that is important. Students are asked by the teacher to supply evidence to support their answers.

Disciplinary Core Ideas (DCIs): Adequate

The reviewers found adequate evidence that the materials provide opportunities to develop and use specific elements of the DCIs because of the many opportunities for students to develop and use elements of the DCIs in both physical science and Earth and space science that are embedded throughout this unit. The activities are at a grade-appropriate level for a Grade 4 student and aid in sense-making of the anchoring phenomenon. Student understanding of the DCIs is deepened as the lessons progress, connecting prior ideas to new ideas through each activity.

Examples of evidence related to student use and building of the DCI elements include:

PS4.A: Wave Properties

- *Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach.*
  - Lesson 2 - Students design and carry out a test using bowls of water to explore how waves are formed (as a possible cause of the container washing ashore). They use their results

to plan a revised investigation to better visualize the structure and motion of water waves.

- Lesson 3 - Students use clear "wave bins" and a controlled paddle motion to make waves in water. They make observations about how their paddle speed and distance change the size of the waves, and they draw models of how those waves look.
- Lesson 6 - Students modify their wave tubs to be more like the structure of the ocean floor near the beach (slanted up toward the beach). They conduct an investigation similar to what they did in Lesson 4 to see how this change to the floor affects structure of water waves passing over it, and how those waves affect the motion of objects floating on the surface of the water.

- *Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).*
    - Lesson 3 - After students use clear "wave bins" and a controlled paddle motion to make waves in water, they describe the characteristics of those waves (wavelength and amplitude) and use these characteristics to compare different wave patterns.
    - Lesson 4 - Students use the wave bins and the same variety of paddle movements as in the previous lesson to make waves with different amplitudes and wavelengths, but they add a floating object to represent the container or chip bag. They observe and record how the waves move that object (or not).

ESS2.B: Plate Tectonics and Large-Scale System Interactions

- *The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth.*
    - Lesson 2 - Students are given maps of the geography of the U.S. east coast, ocean currents, and a nor'easter wind pattern. Then they analyze and interpret data from maps to decide if ocean currents or wind might have pushed the container. With teacher assistance, students use these maps to explain relationships between the locations of places.
    - Although the Supporting Students in Making Connections to Social Studies (F) suggests the teacher use the positioning of the map to identify directions, and use the map scale to estimate distances to assist the students in better making sense of this portion of the lesson, it is not clear that this concept is explored in enough detail for students to use the maps to explain the relationships between the locations of places.
    - Lesson 5 - Students analyze real-time maps of cargo ship routes and maps showing elevation of the ocean floor (bathymetry charts) in different locations off the Atlantic

coast to figure out how the structure of the ocean floor there compares to that of their wave bins.

- While the unit overview states that this DCI is only partially addressed, it is not clear that this concept is explored with enough detail for students to explain how the structure of the ocean floor there compares to that of the wave bins. Students are asked to answer these questions, but the lesson materials do not provide enough detail on how students learned about these concepts.

Crosscutting Concepts (CCCs): Extensive

The reviewers found extensive evidence that students have the opportunity to use or develop the CCCs in this unit because there is a sufficient number of Crosscutting Concept elements that are addressed and a match between most of the CCCs claimed and the evidence of students using or developing those CCCs at the appropriate element level. All the activities are at the grade-appropriate level for a Grade 4 student and aid in student sense-making of the anchoring phenomenon.

Patterns

- *Similarities and differences in patterns can be used to sort, classify, and analyze simple rates of change for natural phenomena.*
  - Lesson 2 - Students analyze and interpret data using logical reasoning to identify different patterns in different phenomena (a map of ocean currents and a wind/precipitation map).
  - Lesson 3 - The students are planning and conducting an investigation collaboratively to produce more reliable and easier to measure patterns in the waves produced when the spacing, timing, and depth of paddle pushes in a bin of water is varied.
  - Lesson 3 - Students develop a model based on evidence to show that waves are regular patterns of motion, and that waves of the same type can differ in amplitude and wavelength.
- *Patterns can be used as evidence to support an explanation.*
  - Lesson 2 - The Students compare and combine information across texts (news article about this event) to identify patterns that can be used as evidence to support an explanation for how the weather conditions and location of a ship along the coast caused it to lose a shipping container.
  - Lesson 5 - Students are analyzing and interpreting data from bathymetry charts/maps and a real-time ship tracking portal to find patterns in the structure and elevation of the ocean floor across different locations along the Atlantic coast and into the middle of the Atlantic Ocean.

Cause and Effect

- *Cause and effect relationships are routinely identified, tested and used to explain change.*

- Lesson 1 - Students read a news article about the chip event to identify natural and human causes for how the bags of chips came out of the shipping container, where it came from and what could have caused the ship to get to that place in the ocean.
- Lesson 4 - During an investigation, students determine if changing the wavelength or amplitude wavelength affects the motion of the object in the water.
- Lesson 6 - Students make observations during an investigation of how changing the structure of the ocean floor affects the structure floating on the water.

Suggestions for Improvement

SEPs

- Consider introducing the idea of conducting experiments using fair tests (**Planning and Carrying Out Investigations**) in Lesson 3 rather than Lesson 4. Students need to be aware of this element prior to planning and conducting experiments. Also, consider having the students discuss and possibly label the different types of variables for the experiments in order to have the students fully meet this element of **Planning and Carrying Out investigations**.

DCIs

- In Lesson 2, consider redirecting teachers back to the beginning of the lesson for Formative Assessment Guidance for support with students who are struggling with understanding the map data.

To support students in more fully building the ESS2.B DCI element, consider adding at least two more lessons for this 2nd lesson set in order to strengthen the ideas in this lesson so the students can better understand why the location of the ship in relation to the continental shelf is key to understanding this DCI tie in to the wave motion. Even with the Teacher Background Knowledge section and the Formative Assessment Guidance information, the reviewers felt more information would be needed for the students to make these connections.

CCCs

None

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.

Rating for Criterion I.C. Integrating the Three Dimensions: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that student performances integrate elements of the three dimensions in service of figuring out phenomena and designing solutions to problems. Throughout the unit, students use all three dimensions to develop their understanding of science ideas. The dimensions are intentionally integrated, and the teacher notes remind the teacher about what specific elements of a DCI, SEP, and CCC are being used. The student tasks build the understanding needed to eventually explain the phenomenon. As students use SEPs and CCCs to investigate the anchoring phenomenon more, the DCIs related to the anchor phenomenon emerge.

Each lesson describes three-dimensional Learning Performances on the first page of the Teacher Guide and these three-dimensional pieces are noted throughout the lesson in the right-hand column of the lesson. The SEP, CCC, and DCI elements are clearly indicated for each lesson. Teacher background notes and explanations within the teacher instructions for facilitating student tasks clarify and further develop specific elements of the three dimensions to ensure that the student learning experiences are conducted in a three-dimensional manner.

The following is a list of evidence to support the reviewers' rationale:

- Lesson 2 - The students compare and combine information across texts using the news articles (SEP) to identify patterns (CCC) that are used as evidence to support an explanation for how the weather conditions and location (DCI) of ship along the coast caused it to lose a shipping container.
- Lesson 2 - Students analyze and interpret data (SEP) to identify different patterns (CCC) in a map of ocean currents and a wind/precipitation map (DCI).
- Lesson 3 - The students develop a model based on evidence (SEP) to show that waves are regular patterns of motion (CCC), and that waves of the same type can differ in amplitude and wavelength (DCI).
- Lesson 4 - Students plan and carry out an investigation collaboratively using fair tests in which variables are controlled and the number of trials are considered (SEP) to determine how changing the amplitude or wavelength (DCI) of water waves produced affects (CCC) the motion of an object floating on the surface as the waves pass underneath it (DCI).
- Lesson 6 - Students modify their wave tubs to be more like the structure of the ocean floor near the beach (DCI). They conduct an investigation (SEP) to see how this change to the floor affects (CCC) structure of water waves passing over it, and how those waves affect the motion of objects floating on the surface of the water (DCI).
- Lesson 7 – Students use evidence from previous lessons to construct an explanation (SEP) of the causes of waves, and the effects (CCC) of waves on the motion (DCI) of the shipping container, and their role in causing the shipping container to get to the beach.

Suggestions for Improvement

- Stating which elements of the SEPs, DCIs, and CCCs that are addressed in each lesson could help teachers focus their instruction around those elements, especially in the area of CCCs and SEPs. While the Unit Front Matter page contains information about the learning sets and the length of time that is needed for each one, consider redirecting teachers or mentioning this information in each lesson.

- The Unit Front Matter page also contains a summary of the dimensions addressed; however, it might be helpful for teachers to view the specific elements targeted in each of the lessons.

I.D. Unit Coherence: Lessons fit together to target a set of performance expectations.

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.

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

Rating for Criterion I.D. Unit Coherence: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that lessons fit together coherently to target a set of performance expectations because in most cases, student questions drive the current lesson and questions unanswered by the sense-making opportunities in that lesson drive the next lesson. Student questions are answered by connecting evidence from investigations to science ideas and concepts. Students revisit the driving question/unit phenomenon multiple times, taking stock of how well they can explain the phenomenon, creating key links across the unit. Students revisit their original questions while also having the opportunity to develop new questions.

Unit coherence is clearly evident throughout the lessons. Lessons build on each other as questions raised in previous lessons are addressed in subsequent lessons. Students regularly revisit the anchor phenomenon to connect with what they figure out during the lessons. For example:

- Students begin the unit by generating a Driving Question Board about the chips on the beach phenomenon. In the Looking Back and Moving Forward section or the Determine Next Steps section of each lesson, students revisit the Driving Question Board. For example, in Lesson 2 after students conduct an investigation bowls or buckets of water in order to determine how waves are produced, they complete a model tracker and then they are asked to revisit the Driving Questions Board or Questions and Investigations T-Chart to discuss which questions they created that still need to be explored.
- In Lesson 5, students begin the lesson with Looking Back and Moving Forward to revisit the Questions and Investigations T-Chart, which provides them with guidance on which of their questions they should address next.

- Each learning set progresses in a meaningful way by using students' questions and what they have figured out so far. Students gain a piece of the chips on the beach explanation but need to complete both learning sets to make a final claim about why the chips ended up on the beach.

Performance Expectations are clearly stated for each lesson, and corresponding Evidence Statements link the Performance Expectations to student artifacts and activities. For example:

- Each lesson includes a cover page that provides a snapshot of what the students will do and what they will figure out, a brief synopsis of the previous lesson, current lesson and next lesson as well as the standards being addressed.
- Throughout lessons 3–4, students are reminded of the previous lesson investigation and how it ties into the anchoring phenomenon. Students use their Progress Tracker to return to investigations from previous lessons in order to build on their current understanding of the phenomenon.

Suggestions for Improvement

None

I.E. Multiple Science Domains: When appropriate, links are made across the science domains of life science, physical science and Earth and space science.

- Disciplinary core ideas from different disciplines are used together to explain phenomena.
- The usefulness of crosscutting concepts to make sense of phenomena or design solutions to problems across science domains is highlighted.

Rating for Criterion I.E. Multiple Science Domains: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that links are made across the science domains when appropriate because the unit focuses on core ideas from two disciplines. While the unit conveys how ideas from different domains are connected and how ideas from different domains can be used together to explain phenomena, in order to fully address the phenomenon, more support would be needed for DCI ESS2.B. In addition, the reviewers did not see evidence that the crosscutting concepts are intentionally or explicitly used to make connections.

- PS4.A: Wave Properties is sufficiently covered within the series of lessons.
- Lesson 5 asks students to analyze real-time maps of cargo ship routes and maps showing elevation of the ocean floor (bathymetry charts) in different locations off the Atlantic coast to figure out how the structure of the ocean floor there compares to that of their wave bins. However, it is not clear that this concept is explored with enough detail for students to explain how the structure of

the ocean floor compares to that of the wave bins. Students are asked to answer these questions, but the lesson materials do not provide enough detail on how students learned about these concepts.

Suggestions for Improvement

- Enhancements to this unit to include more investigation and understanding lessons featuring Plate Tectonics and Large-Scale System Interactions would strengthen the connection to the Earth Science domain ESS2, specifically several elements from ESS2.B, and the unit would be more meaningful for students.

I.F. Math and ELA: Provides grade-appropriate connection(s) to the Common Core State Standards in Mathematics and/or English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects.

Rating for Criterion I.F. Math and ELA: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials provide grade-appropriate connections to mathematics, English language arts (ELA), history, social studies, or technical standards. Students use grade level writing and reading skills to explain and communicate their understanding of scientific concepts. Although there are connections to mathematics standards, opportunities were missed to fully connect to grade-appropriate expectations. Students are also using mathematics skills to explain the results of investigations and better understand the phenomenon. Teacher support is provided for reading strategies for students struggling to read at grade level or reading complex texts.

In this unit, students are using grade level writing skills to explain and communicate their understanding of the scientific concepts/phenomena/results. While there are many opportunities for the students to record their observations from investigations and explain their findings, most of the standards below are stated in the unit as teacher support and it is not clear if they are optional or for all students:

L.4.5.c Demonstrate understanding of words by relating them to their opposites (antonyms) and to words with similar but not identical meanings (synonyms).

- Lesson 1, page 9 - When students are creating their class consensus model, teachers are directed to "Name almost-synonyms for "beach," such as shoreline or coast. Discussing words like sand, water, or ocean may be helpful to EL students as you are modeling." The teacher is provided this support to use as needed with the students.

L.4.5.C Demonstrate understanding of words by relating them to their opposites (antonyms) and to words with similar but not identical meanings (synonyms).

- Lesson 3, page 10 - When students are working as a class to add to their Scientific Principles Poster, the teacher is instructed to, "Introduce additional words such as crest and trough or peak and valley, if you think it makes referring to these different kinds of points clearer. If you introduce these words, you may want to use a photo of a long bin where pigs eat and show students that this is also called a trough (because of a similar structure) and that the top of a cardinal's (or other decorative feathers on a bird's head) is a crest. Or point out the connection to peaks and valleys in a mountain range."

L.4.6 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal precise actions, emotions, or states of being (e.g., quizzed, whined, stammered) and that are basic to a particular topic (e.g., wildlife, conservation, and endangered when discussing animal preservation).

- Lesson 3, page 12 - Students are introduced to terms like wavelength and amplitude.

SL.4.1.C Pose and respond to specific questions to clarify or follow up on information and make comments that contribute to the discussion and link to the remarks of others.

- Lesson 4, page 9 - Students participate in a Building Understanding Discussion and the teacher supports state, "Help students see that you have the same expectations for high-level classroom discourse about science topics as you have during ELA discussions. Before or throughout this discussion. Refer to classroom charts, sentence starters, or other supports and routines you have in your classroom for helping students pose and respond to specific questions, clarify or follow up on information, and make comments that link to the remarks of others".

L.4.5.A Explain the meaning of simple similes and metaphors (e.g., as pretty as a picture) in context.

- Lesson 5, page 11 - Students use similes or metaphors to describe the ocean floor.

SL.4.1.C Pose and respond to specific questions to clarify or follow up on information and make comments that contribute to the discussion and link to the remarks of others.

- Lesson 6, page 9 - Students are participating in the Building Understandings Discussion and are encouraged to practice proper group protocol when expressing scientific findings and ideas.

L.4.3.A Choose words and phrases to convey ideas precisely.

- Lesson 6, page 8 - Students are encouraged to include specific vocabulary (wavelength and amplitude) during their investigations.

W.4.2.D Use precise language and domain-specific vocabulary to inform about or explain the topic.

- Lesson 7, page 6 - Students are given the opportunity for students to explain their learning in writing using precise language and domain-specific vocabulary, but the directions do not include a word bank. Teachers are instructed to "if needed, provide a list of suggested words to use to help students precisely explain the causes, effects, and evidence."

W.4.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

- Lesson 7, page 6 - Students complete an assessment that asks them to write to explain their science thinking, giving them a chance to apply the learning they've done about conventions and organized writing to another discipline.

Students use grade level reading skills to develop understanding and explanations of scientific concepts/phenomena/results. Both reading selections are grade-level appropriate and help to understand scientific concepts. The two passages are very similar in format, style, and tone, and one or both of the reading assignments make use of the following standards:

RI.4.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

- Lesson 1, page 7 - Students are guided through the close read process and work with partners to annotate news articles.

RI.4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

- Lesson 2, page 7 - Students do an additional close read of a different text in order to piece together a timeline of what happened to the cargo ship in order for the container to fall off.

RI.4.9 Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably.

- Lesson 2, page 9 - Students are encouraged to use both articles (Lessons 1–2) in order to update the questions and investigations chart.

RI.4.7 Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.

- Lesson 5, page 6 - Students are given charts and graphics that connect to Lessons 1–2 articles to further enforce information pertaining to the container making its way to the beach.

Students have opportunities for high-level verbal discourse, in a variety of formats and scenarios (partners, small groups, formal presentations). For example:

- Lesson 2, page 8 - Students participate in a whole group Building Understandings Discussion in order to better understand information read in two articles. Letter E, Attending to Equity states, "During a Building Understandings discussion, students can practice talking with each other in a community of learners. Engaging in this practice can support all learners in developing academic discourse. They listen to each other's ideas and findings, ask questions about evidence, and come to an agreement about what the class figured out in an investigation."
- Lesson 5, page 7 - After students analyze the shipping routes independently, they are asked to share their ideas with a partner and then share out as a group. Students are reminded of classroom/Build Understandings Discussion norms while speaking in a group.

- Lesson 7, page 4 - Students choose a question they can answer from the DQB as a result of working through the unit. They then summarize the answer on a blank sheet of paper and participate in a gallery walk. During the gallery walk, students read each question and then decide if they agree or not with the answer. If so, they write a check mark on the paper showing the answers they agree with. If a student has an addition/annotation they want to nominate, they can draw a star on the answer paper and add the comment to be discussed with the class after the gallery walk. After the gallery walk students come together to explain what evidence they have for their answers.

Students use grade level mathematics skills to explain and understand the scientific concepts, phenomena, and results. While there are many opportunities for the students to quantify their data from investigations, most of the standards below are stated only as teacher support:

4.MD.A.2 ~~Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit~~. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.

- Lesson 3, page 11 - Students use a ruler to measure the length of the wave they drew and report its wavelength. They are then asked to use a ruler to measure the length of the wave's amplitude. Supporting Students in Making Connections to Math, Letter G, states, "Students should be comfortable with measuring, estimating, and comparing measurements in centimeters and inches from second grade, but applying those skills to this new shape may be tricky. Fourth graders are called upon to use these measurements in problem-solving situations using any of the four operations. Slow down and practice this measuring as needed so students are confident with this skill in preparation for more measurement in upcoming investigations."

Mathematical Practices #6: Attend to precision: Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning

- Lesson 4, page 8 - During students' wave investigations they are reminded to record their observations in the data chart. While doing this, they are also reminded to be sure they are recording their data accurately. Supporting Students in Making Connections to Math, Letter E, states, "Remind students that precision is critical to scientific data collection like it is in their mathematics work. Keeping careful track of measurements and observations and recording them accurately is key to being able to use that data to support your thinking about this phenomenon."

4.MD.A.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. ~~Record measurement equivalents in a two-column table.~~

- Lesson 5, pages 8–9 - Students are analyzing an ocean depth map. Supporting Students in Making Connections to Math, Letter H, states, "Students should know relative sizes of measurement units within a single system of units. So, you could take a minute to convert 200 meters into centimeters and/or find out how many yards 656 feet is. Also, it might be helpful to understanding the scale of this water depth by comparing it to something better known by the students. For example, the Washington Monument is 169 m tall, Seattle's Space Needle is 184 m tall, and Lake Point Tower in Chicago is 197 m tall."

- *Mathematical Practice #2: Reason abstractly and quantitatively: Mathematically proficient students make sense of quantities and their relationships in problem situations.* ~~*Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.*~~
- Lesson 5, page 11 - Students discuss the shape of the ocean floor near the coast by examining the satellite images. The teacher notes state, "The students may wonder how far that shelf goes out, so display for evidence that the shelf extends about 100 km (62 mi) from shore at Cape Hatteras. That is plenty of room for cargo ships like the *Courtney L* to be travelling "near" the coast and still on the shallow sloping shelf." Supporting Students in Making Connections to Math, Letter L, states, "Students should be familiar with number lines (horizontal and vertical) and the scale along the axis of graphs, but to help them reason through this particular graphic, it may be helpful to point out that the vertical axis of the graph on slide 24 counts by thousands of meters. Therefore, the slope of the 100-meter deep shelf near the shoreline is hard to see and understand at this scale. Consider working as a class to "zoom in" and redraw just the part of the graph from 0 to 100 km"
- *Mathematical Practices #3: Construct viable arguments and critique the reasoning of others*
- Lesson 7 - During the gallery walk, students are reminded that in science, like in mathematics, we look for reasoning to support someone's argument, and it is okay to respectfully disagree or ask for more evidence or explanation about someone's ideas.

Suggestions for Improvement

- Consider including writing assignments that are varied in structure and purpose and are rigorous.
- Consider interweaving the CCSS ELA-Literacy and Mathematics standards into the lessons, not only as teacher supports. For example, Lesson 5 would be an excellent place to expand on the mathematical practices in order for the students to better understand the phenomenon.
- When analyzing ocean depth in Lesson 5, consider including ways to support students' connections between this lesson and standard 4.MD.A.1..

Overall Category I Score (0, 1, 2, 3): 3

Unit Scoring Guide – Category I

Waves and Ocean Structures:
Why do some things wash up on the beach and others don’t?
EQuIP Rubric for Science Evaluation

Criteria A–F **3:** At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C **2:** At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C **1:** Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C **0:** Inadequate (or no) evidence to meet any criteria in Category I (A–F)

Category II. NGSS Instructional Supports

Score: 2

Criteria A-G:

***3:** At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria*

***2:** Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A*

***1:** Adequate evidence for at least three criteria in the category*

***0:** Adequate evidence for no more than two criteria in the category*

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.

- Students experience phenomena or design problems as directly as possible (firsthand or through media representations).
- Includes suggestions for how to connect instruction to the students' home, neighborhood, community and/or culture as appropriate.
- Provides opportunities for students to connect their explanation of a phenomenon and/or their design solution to a problem to questions from their own experience.

Rating for Criterion II.A. Relevance and Authority: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world because the unit materials provide methods to make connections between the phenomena and students' lives. The anchor phenomenon is accessible to most students and they can connect their questions about why the chips and container ended up on the beach with experiences they have had with waves and storms in their own lives. Creating tub wave models allows students who have limited prior knowledge with waves the opportunity to answer questions generated after the readings and after looking at ocean current maps in an engaging way. The following is a list of evidence to support the reviewers' rationale:

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

- Lesson 1 - Students interact with several photos and news stories about the shipping container accident.
- Lessons 2–4 - Students conduct investigations to learn more about wave patterns and what motions are needed to move objects.
- Lesson 6 - Students continue their investigation by modifying wave tubs after learning that the ocean floor affects their waves.

The materials include suggestions for how to connect instruction to the students' home, neighborhood, community, or culture as appropriate.

- Lesson 1 - Students create a Related Phenomenon chart where they record examples of when they've seen other items in the water move (or end up on the beach/shore) for any of the reasons they've discussed in class. They return to this chart in Lesson 4, when students are further investigating waves, specifically when waves move objects.
- Lesson 1 - Students are reminded about shipping containers on trains that are frequently seen when living in the Midwest. However, reviewers were concerned about connections for students who do not live in the Midwest. This is a missed opportunity for a connection to be made with the students' specific community or culture.
- Lesson 4 - Students discuss interactions with a wave pool and how the floor is slanted. Students discuss the idea of waves "moving things forward" through previous experiences with a wave pool. However, this is another missed opportunity for students to be connected with the phenomenon to a specific waterway, event, etc. in their community.

The materials provide opportunities for students to connect their explanation of a phenomena to their own experiences. For example:

- Lessons 2–4 - Students conduct investigations and complete progress tracker to document their understanding of the phenomenon. Students discuss these documents and use them to reference DQB throughout the unit.
- Lesson 7 - Students return to the Driving Questions Board and select questions they can answer now that they've completed this unit.

Suggestions for Improvement

- Consider whether there are other possible phenomena related to this topic that students would have more direct connections with. Finding ways to make the anchoring phenomenon more connected to their community or culture in ways that the teacher can explicitly call on may help students make better connections.
- In Lesson 1, adding teacher guidance for students who live in all areas (i.e., outside the Midwest) would be helpful.

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

Rating for Criterion II.B. Student Ideas: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials provide students with opportunities to both share their ideas and thinking and respond to feedback on their ideas because student ideas and questions drive the learning throughout the unit. Students frequently collaborate to share ideas and use the ideas to revise models and written explanations. Students reflect on their learning and provide peer-to-peer feedback as well. There are opportunities to apply their learning to other scenarios beyond the chips on the beach phenomenon.

The following is a list of evidence to support the reviewers' rationale:

- Classroom discourse focuses on explicitly expressing and clarifying student reasoning. Students have multiple opportunities to share their reasoning during engage lessons when beginning to understand the data or phenomenon they are investigating. Questions and ideas elicited here are then used to drive the learning in the next series of lessons.
- Students participate in building understanding discussions during every collaborative investigation in each learning set. Students participate in an interactive discussion where consensus is achieved through structured conversations focused on justifying their understandings and explanations.
- Students are required to elaborate and revise their initial thoughts throughout the unit on the progress tracker. Multiple modes of feedback are provided. Questions are provided for the teacher to help elicit student ideas.
- Students participate in multiple group learning routines (Class Consensus Discussions, etc.), which focus on sharing student ideas with one another. Students are provided with multiple modalities for assessment from written feedback from the teacher, from other students, models, and written explanations.
- The unit provides supports to teachers to help elicit student ideas. The unit materials frequently provide ways to help English Learners, make math and social studies connections, provide differentiation suggestions, as well as attend to equity.

Suggestions for Improvement

None

II.C. Building Progressions: Identifies and builds on students' prior learning in all three dimensions, including providing the following support to teachers:

Explicitly identifying prior student learning expected for all three dimensions

Clearly explaining how the prior learning will be built upon.

Rating for Criterion II.C. Building Progressions: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials identify and build on student learning in all three dimensions. The unit explicitly displays where the three dimensions are built upon in each lesson. Each lesson notes typical levels of proficiency that students at this grade level have with each of the three dimensions. Also, each lesson makes clear the expected level of proficiency students should have with all three dimensions for the core learning in the unit and provides suggestions for adaptation if students are struggling at this level. However, the unit did not include adaptations for students who are above level.

Prior student learning is stated in the "Building Progressions" section at the end of each lesson as well as within some lessons. The inclusion of the grade band below and above elements for all three dimensions provides teachers with the information needed to figure out where the skills and understandings of students are placed in the overall progression of learning. For example:

- The Unit Front Matter document contains information about where this unit is going as well as the unit structure. The unit skeleton is also included here so teachers can see how each lesson builds upon the next and how students make the connections between each lesson and each dimension.
- Lessons 1–7 - The lessons explicitly state what the students are doing and how these actions are tied to each dimension by color code.
- Lessons 1–7 - Teachers are given background information (Where we are going and Where we are NOT going) in order to share with teachers how the information specific to the lesson ties in with the overall unit and how the information in the lesson ties into the middle school standards/expectations.
- Lessons 1–7 - Common student ideas are also included to assist teachers in better understanding grade appropriate ideas for the topics discussed in the lesson. However, this was a missed opportunity to include differentiation for high-level learners.
- Lessons 1–7 - Teachers are also given information through the Formative Assessment Guidance section. The three dimensions are color coded to show teachers how they are able to assess whether or not students are progressing in their understanding of the topics featured in the lessons. However, options for above-level formative assessment guidance is not included.
- Lessons 2–7 - Students use the progress tracker to model and explain their understandings as they move through the unit.

Suggestions for Improvement

- Adaptations for students who are above level would assist teachers in ensuring students of all levels are engaged in explaining the phenomenon.
- Materials could be more explicit as to the learning progression of using crosscutting concepts as a lens for sense-making. Including this progression information may help teachers in determining their students' level of proficiency.

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

Rating for Criterion II.D. Scientific Accuracy: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials use scientifically-accurate and grade-appropriate scientific information because the science ideas within the unit are accurate and there are teacher supports that provide insight on student ideas and possible misconceptions or gaps in their understanding. The following is a list of evidence to support the reviewers' rationale:

- The scientific concepts included in the materials are accurate.
- Lessons 1–2 - Students read news articles and view photos from news sources in order to better understand the phenomenon.
- Lesson 2 - Students analyze scientifically-accurate map data to better understand the storm system that was passing through the area at the same time of the shipping container incident.
- Lesson 5 - Students utilize a ship tracking website to better understand the concept of the ocean floor having varying depths in different places.
- The unit materials provide teacher supports for how to address student thinking that may not be fully developed or accurate. The unit includes suggestions for quick interventions when students are struggling with a concept. There are numerous "Differentiation Points" throughout the unit to provide teachers with additional strategies or scaffolded activities if students need more support. The Formative Assessment Guidance also includes information to assist teachers with struggling students as they move throughout the lesson.

Suggestions for Improvement

None

II.E. Differentiated Instruction: Provides guidance for teachers to support differentiated instruction by including:

- Appropriate reading, writing, listening, and/or speaking alternatives (e.g., translations, picture support, graphic organizers, etc.) for students who are English language learners, have special needs, or read well below the grade level.
- Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations.
- 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.

Rating for Criterion II.E. Differentiated Instruction: Inadequate

(None, Inadequate, Adequate, Extensive)

Waves and Ocean Structures: Why do some things wash up on the beach and others don't? EQuIP Rubric for Science Evaluation

The reviewers found adequate evidence that the materials provide guidance for teachers to support differentiated instruction because, although the unit provides extensive differentiation strategies for English Learners, the unit materials do not provide adequate differentiation opportunities for high-interest students and students who have already met the performance expectations. There is also a lack of clearly-defined support for students with special needs or those that read well below grade level.

The following is a list of evidence to support the reviewers' rationale:

- Lessons 1–7 - Formative Assessment Guidance is located in each lesson. This gives teachers varying ways to approach each objective for the lesson in order to assist struggling students.
- Lesson 2 - The Additional Guidance section on the sidebar gives teachers insight as to how they can shift the lesson to guide the students through the content. It says, "If there are questions or suggestions that you know are not priorities for this lesson or the near future, it's okay to "steer" the conversation by asking, "What do we need to know before that?" or "Is there something else we should investigate first?'"
- Lesson 2 - The Attending to Equity section assists teachers in ensuring all students are participating in the analysis of the news article in the lesson. It says, "Depending on your students' needs, you may choose to scaffold this work in one or more of the following ways: Work with a partner to read and / or annotate, Teacher reads text aloud and students annotate, Read together in a guided reading group."
- Lesson 3 - Teacher support for students who are struggling with wavelength and amplitude is a suggestion to use a piece of string or yarn and have students physically manipulate the string to enhance the discussion of the vocabulary. This type of extra support, though, is primarily provided by handouts and prepared tables and charts. There are not opportunities for multiple means of representation, action, expression, and engagement (examples might include: online simulations, videos and animations with video captioning, speech to text options, choice of related reading material, songs) for ALL students and ALL teachers.
- Lesson 4 - Teachers are given suggestions through the Alternative Activities section to help students differentiate during the wave bin lesson. It says, "Students may suggest wanting to include an object to represent the shipping container instead, such as a small plastic toy brick."
- Lesson 6 - The Formative Assessment Guidance section of the lesson offers suggestions for teachers on addressing struggling learners. It says, "If students are struggling to make and record accurate observations of their investigations, you could again take photos or videos of the wave bin action as suggested in earlier lessons - being able to pause the motion should allow students to draw and describe more clearly what they see. They could go so far as to trace the line of the water's surface on the photo or paused video if that helps them see the shape of the wave and location of the bag. If students' work seems incomplete or sloppy, you may choose to pull together anyone who's struggling to work carefully and debrief why scientists need to record their data accurately."

Suggestions for Improvement

- Including differentiation strategies and activities for learners above and below grade level throughout each learning cycle would strengthen this unit.
- Consider providing opportunities for multiple means of representation, action, and expression. Simulations, videos, and animations would assist students in better understanding the phenomenon.
- Consider including clearly-defined support for students with special needs (text to speech, teacher assisted modeling activities).

II.F. Teacher Support for Unit Coherence: Supports teachers in facilitating coherent student learning experiences over time by:

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.).

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

Rating for Criterion II.F. Teacher Support for Unit Coherence: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials support teachers in facilitating coherent student learning experiences over time. Students have an opportunity to engage in asking questions about phenomena that they feel they need to address in upcoming lessons, and there is a focus on future investigations answering these student-generated questions. All students are engaged with a phenomenon that is meaningful and relevant; has supports for all students; and that can be explained through the application of targeted grade-appropriate SEPs, CCCs, and DCIs as the central component of learning.

The following is a list of evidence to support the reviewers' rationale:

- Students make progress towards elements of each dimension within each learning set and supports are provided for teachers to help identify the learning expectations for each activity.
- Numerous strategies are provided to teachers to ensure sense-making is connected to all three dimensions throughout the unit.
- Teachers are given suggestions for students who have questions that do not fit into the flow of this unit. Suggestions for how to deal with these student questions are given as guidance for the teacher.

- Students figure out what the next question is to pursue by utilizing a driving question board and revisiting their questions frequently throughout the unit. Multiple supports are provided to assist teachers with the driving question board routine.

Suggestions for Improvement
None

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.

Rating for Criterion II.G. Scaffolded Differentiation Over Time: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjusts supports over time because the unit materials provide specific guidance targeting diverse learners in order to use the SEPs and make sense of phenomena. Students build an understanding of and proficiency in the SEPs over time through a variety of student approaches over the course of the unit. The following is a list of evidence to support the reviewers' rationale:

Developing and Using Models

- Lesson 1, page 8 - Students create initial models to show what they think happened between the cargo ship and the beach. The teacher is directed to either introduce or review modeling depending on students' prior experience with this SEP. Students revise their models throughout the next 5 lessons. For students who have not had experience with Developing and Using Models in K-2, The Supporting Students in Developing and Using Models section gives teachers insight as to how they can support students in creating their own model of the phenomenon. It states, "Depending on your students' experiences from this year, take more or less time to introduce or review modeling. Explain or remind them that models can involve objects, but for today we will use drawing. Since our priority is getting our thoughts onto paper, we want to work carefully and neatly, using clear sketches or diagrams rather than beautiful artwork. The hope is that if students don't label their models at first, they will realize the need for labels as this lesson goes on. "
- Lesson 3, page 8 - The Supporting Students in Developing and Using Models section builds upon the models drawn in Lessons 1–2 by giving teachers more support for students who are struggling with representing their understanding of the phenomenon through the model. It says, "Students sometimes struggle to draw an abstract representation of waves that shows the differences in wavelength and amplitude they're able to create with the paddle. While you're circulating during

the investigation, if you notice that a student's wave drawings all look the same throughout the page, you may need to help that student move to see the side of the bin and more carefully observe how the waves change as a groupmate moves the paddle differently. If needed, use a digital device to take several photos or a video you can pause to see how the waves look different. Ask the student to describe how tall the waves are compared to the top of the bin, or if you can see only one wave on the screen at a time or several. Specific questions about how the waves look different should help the student better illustrate those differences in his or her drawings".

- Lesson 6, page 11 - Students are reminded about the class consensus model to revisit their understandings of the phenomenon. Supporting Students in Developing and Using Models section states, "The NGSS ask students at this age to collaboratively develop and revise a model based on evidence that shows the relationships among variables. We want the students to try on their own but also want to encourage them to use the ideas we developed in the consensus model over multiple lessons".

Planning and Carrying Out Investigations

- Lessons 2–3 - Students are encouraged to choose a question they would like to explore from the Driving Questions Board. Students are given time to brainstorm ways they could investigate waves in the classroom. They discuss what materials are needed, jobs, trial numbers and ways to record their data. While the experiment variables were discussed (the height of the water, the amount of force needed to use the paddle) there wasn't a direct classification of what parts of the experiment were controlled.
- Lesson 3, page 8 - Students conduct their first wave bin investigation in order to figure out what motions cause waves to happen. The Supporting Students in Planning and Carrying out Investigations states, "Asking students to consider what didn't work well last time and how they hope to change it this time will help them evaluate their tools and methods in order to design an investigation that gets them the data they need".
- Lesson 4 - Students review the previous lesson on how to make different waves and then focus on planning an investigation where they must move an object making different waves. Students are reminded of ways to conduct fair tests, any tips from the previous lessons and proper group expectations.

Suggestions for Improvement

- More direct and explicit support for students building and progressing with elements of the SEPs of **Developing and Using Models** and **Planning and Carrying Out Investigations** would strengthen the scaffolding. The Supporting Student sections of the teacher's guide could better help teachers gradual release of scaffolds to give students increased responsibility for these SEPS. Using a variety of approaches to assist students in developing their understanding of the SEP elements will strengthen the unit.

Waves and Ocean Structures:
Why do some things wash up on the beach and others don't?
EQuIP Rubric for Science Evaluation

Overall Category II Score (0, 1, 2, 3): 2

Unit Scoring Guide – Category II
Criteria A-G: **3:** At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria **2:** Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A **1:** Adequate evidence for at least three criteria in the category **0:** Adequate evidence for no more than two criteria in the category

Category III. Monitoring NGSS Student Progress

Score: 3

Criteria A–F:

3*: At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion*

2*: Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A*

1*: Adequate evidence for at least three criteria in the category*

0*: Adequate evidence for no more than two criteria in the category*

III.A. Monitoring 3D 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.

Rating for Criterion III.A. Monitoring 3D Student Performances: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials elicit direct, observable evidence of students using practices with core ideas and crosscutting concepts to make sense of phenomena because tasks are driven by engaging phenomena that are designed to elicit rich, three-dimensional student performances.

The following is a list of evidence to support the reviewers' rationale:

- The lessons involve phenomena and are engaging through varied activities.
- The scenarios require three-dimensional performances to address the learning expectations.
- Each of the three dimensions is routinely used in service of sense-making. Two examples of this are: Lesson 4 - Students are planning and carrying out an investigation collaboratively using fair tests in which variables are controlled and the number of trials are considered (SEP) to determine how changing the amplitude or wavelength (DCI) of water waves produced affects (CCC) the motion of an object floating on the surface as the waves pass underneath it (DCI). Lesson 6 - Students modify their wave tubs to be more like the structure of the ocean floor near the beach (DCI). They conduct an investigation (SEP) to see how this change to the floor affects (CCC) structure of water waves passing over it, and how those waves affect the motion of objects floating on the surface of the water (DCI).

- There are multiple opportunities for students to visibly demonstrate their understanding and ability to use grade-appropriate elements of the SEPs.
- Students use the CCCs to make sense of the phenomenon and there are multiple opportunities for students to visibly demonstrate their understanding and ability to use grade-appropriate elements of these concepts.
- Grade-appropriate DCI elements are required in student sense-making and there are multiple and varied opportunities for students to visibly demonstrate their understanding and ability to use grade-appropriate elements of these core ideas.
- Tasks routinely integrate the three dimensions in varied ways. The Final Performance Task has students showing their learning in all three dimensions as they develop and represent their model and a written explanation of the phenomenon.

Suggestions for Improvement

- Adding more, and varied, methods of monitoring students' performance in the Progress Tracker would strengthen the unit. Students currently utilize the same modeling activity after each learning cycle, and they therefore might benefit from more variety and student choice.
- Teacher support for including all students in class discussions and consensus building might include opportunities for non-verbal or language learners to better engage in this important part of the overall learning and sense-making around the phenomenon.

III.B. Formative: Embeds formative assessment processes throughout that evaluate student learning to inform instruction.

Rating for Criterion III.B. Formative: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials embed formative assessment processes throughout that evaluate student learning and inform instruction because the unit materials include frequent opportunities for formative assessment in each learning set. The materials spell out the concepts students should be able to explain before moving to the next lesson.

The following is a list of evidence to support the reviewers' rationale:

- Lessons 1–7 - Formative Assessment Guidance is located in each lesson. This gives teachers varying ways to approach each objective for the lesson in order to assist struggling students and ways to evaluate student learning to inform instruction.
- Students are asked to participate in class consensus discussions, which are identified in the unit as great opportunities to gain insight into student thinking.

- The Progress Tracker is completed by students after each lesson and is cited as an opportunity for the teacher to make decisions regarding next steps based on students' understanding.
- On the Resource Landing page, the link for Unit Assessments contains multiple documents that can be used for assessments. The Assessment Opportunities page lists each lesson and examples of embedded pretest opportunities (Pages 1 and 4) as well as summative assessment opportunities (Page 13).
- There are also opportunities for Pre- and Post-tests in the Assessment Opportunities (Page 4) for this unit. The formal pre-assessment before Lesson 1 is listed as optional, as it may undermine the sense of mystery and wonder students form with the Driving Question Board.
- Entrance and Exit Ticket examples are also given (Page 12).

Suggestions for Improvement

- Including formative assessments in multiple modalities might be useful in allowing all students access to showing their thinking and understanding.

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.

Rating for Criterion III.C. Scoring Guidance: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials include aligned rubrics and scoring guidelines that help the teacher interpret student performance for the three dimensions. The reviewers found that guidance is provided for teachers to interpret student progress, in relation to both the instructional materials as well as the targeted standards/dimensions/parts of dimensions and learning performances; however, explicit support for all three dimensions is not clearly stated for the summative assessment.

The following is a list of evidence to support the reviewers' rationale:

- An assessment outline for each of the three dimensions is provided in the front matter of each lesson in the form of color coding indicating which SEP, DCI, and CCC elements are addressed in the objectives that are the focus of that lesson.
- A Final Explanatory Model rubric and exemplary student work are provided for student models for multiple lessons.
- The summative assessment at the end of the unit includes a detailed set of rubrics to help teachers evaluate student learning. At each level of the rubric, specific examples of student thinking are included; however, the reviewers felt the summative assessment rubric could be improved by more explicit guidance for incorporating the CCCs and SEPs.

- There are multiple instances where students receive feedback from peers and revise models; and teacher feedback is given to build the class consensus model and as a result, students add to their Progress Tracker to elaborate on their understanding of the phenomenon.

Suggestions for Improvement

- Ensure that all three dimensions are equally included in the scoring rubrics.
- To increase the reliability of the scoring rubric for the summative assessment, the rubric could include more specific language about how the student should be using an element of the SEP of Modeling and an element of the CCC of Patterns to explain the phenomenon.
- It would be helpful to include a range of student responses and interpretation guidance needs for the summative assessment.

III.D. Unbiased tasks/items: Assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.

Rating for Criterion III.D. Unbiased Task/Items: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials assess student proficiency using accessible and unbiased methods, vocabulary, representations, and examples. Vocabulary (science and non-science) is grade level appropriate and the amount of text in tasks and items is grade appropriate. Representations or scenarios are culturally neutral or supports teachers to be aware of the limitations of the scenario for reaching all students and provide potential scaffolds to make sure that students have the background they need to be successful with the task**.** Tasks and items provide a variety of ways for students to convey their answers (e.g., talking about their learning; creating visual representations, writing both short and more complex answers, etc.).

The following is a list of evidence to support the reviewers' rationale:

- Lessons 1–7 - Formative Assessment Guidance provides teachers multiple ways to attend to equity and give students the opportunity to represent their understanding of the objectives. For example, in Lesson 1 it states, "If students' individual models do not attempt to describe the phenomena or possible causes, consider printing the slide images for them to refer to when thinking about how this could happen. If they're having trouble visualizing the ocean and beach situation, ask them to consider videos, TV shows, or movies they may have seen that feature a shoreline."
- Lesson 3 - Teachers are given tips on how to Attend for Equity (page 11) when discussing science concepts using vocabulary. It states, "Discuss science concepts using everyday language at first. Students are more likely to participate in the investigation and discussion when they encounter it

with everyday language. Then, after everyone has shared the experience of that concept, you can name it with science terminology, when they all have more schema to connect with this new word so they can truly understand it." Reviewers felt this was a missed opportunity for students to make connections to their lives beyond the classroom.

- Lesson 5 - Teachers are given assistance on how to help students better understand the shape of the ocean floor. The Formative Assessment Guidance states, "If some students are struggling to describe or picture the shape of the ocean floor as it changes in elevation toward the coastline, see if they can connect to other similar situations: the gentle rise of a hill or road over a bridge / expressway entrance ramp, or the zero-depth entry to a wave pool (an image is provided in the lesson materials). Help them imagine filling the pool or the road with water - it would be deeper where the slope is lower and shallower toward the "top." Have them identify where the "beach" would be in these alternate examples." However, this could be a missed opportunity to provide students with a choice of performance tasks across multiple modalities.

Suggestions for Improvement

- The reviewers recommend including at least one significant task that provides students with a choice of responses across multiple modalities.

III.E. Coherent Assessment system: Includes pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.

Rating for Criterion III.E. Coherent Assessment System: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning because multiple forms of assessment opportunities are used in a variety of ways to apply elements of the three dimensions. However, a three-dimensional assessment rationale for teachers is not included and not all the assessment tasks balance the three dimensions.

The following is a list of evidence to support the reviewers' rationale:

- Lessons 1–7 - The Formative Assessment Guidance is located in each lesson. This gives teachers varying ways to approach each objective for the lesson in order to assist struggling students and ways to evaluate student learning to inform instruction. However, clear evidence of how these objectives are quantified is missing.
- The Progress Tracker is completed by students after each lesson and is cited as an opportunity for the teacher to make decisions regarding next steps based on students' current understanding.

- On the Resource Landing page, the link for Unit Assessments contains multiple documents that can be used for assessments. The Assessment Opportunities page lists each lesson and examples of embedded pretest opportunities (Pages 1 and 4) as well as summative assessment opportunities (Page 13).
- There are also opportunities for Pre- and Post-tests on the Assessment Opportunities (Page 4) section. It states, "An optional Pre-Post Growth Based Assessment (Version A) is available for this unit. (For after the unit, Version B not exactly mirrored, but is very similar so your students can show the learning they've done.)" However, many of these assessments are focused only on students' understanding of the DCI.
- Assessments focused on student understanding of the CCCs and SEPs are loosely found in Lessons 6–7.

Suggestions for Improvement

- Rubrics to assist teachers in the Formative Assessment Guidance would be helpful for teachers to better understand how to quantify the students' understanding of the concepts.
- Assessments featuring all three dimensions would be helpful for teachers to better understand students' progression in synthesizing the performance expectations throughout the unit.

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

Rating for Criterion III.F. Opportunity to learn: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials provide multiple opportunities for students to demonstrate performance of practices connected with their understanding of core ideas and crosscutting concepts. Included in the unit are multiple, linked student performances that provide students with several opportunities to demonstrate understanding. Students utilize multi-modal feedback across a series of student performances to demonstrate new thinking based on peer and teacher feedback and personal reflection.

The following is a list of evidence to support the reviewers' rationale:

- Classroom discourse focuses on explicitly expressing and clarifying student reasoning. Students have multiple opportunities to share their reasoning during engage lessons when beginning to understand the data or phenomenon they are investigating.
- Students participate in building understanding discussions during every collaborative investigation in each learning set. Students participate in an interactive discussion where

consensus is achieved through structured conversations focused on justifying their understandings and explanations.

- Students are required to elaborate and revise their initial thoughts throughout the unit on the Progress Tracker. Multiple modes of feedback are provided. Questions are provided for the teacher to help elicit student ideas.
- Students participate in multiple group learning routines (Class Consensus Discussions, etc.), which focus on sharing student ideas with one another. Students are provided with feedback in multiple ways including written and oral feedback from the teacher, from other students, model revisions with partners, and peer comments during gallery walks.

Suggestions for Improvement

- Consider providing suggestions for how students can use technology as a way to showcase their understanding of the phenomenon.
- Although assessments are three dimensional, consider adjusting the measurement of the three dimensions proportionally to match up with the learning goals.

Overall Category III Score (0, 1, 2, 3): 3

Unit Scoring Guide – Category III
Criteria A–F: **3**: At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion **2**: Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A **1**: Adequate evidence for at least three criteria in the category **0**: Adequate evidence for no more than two criteria in the category

Overall Score

Category I: NGSS 3D Design Score (0, 1, 2, 3): 3
Category II: NGSS Instructional Supports Score (0, 1, 2, 3): 2
Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3): 3
Total Score: 8
Overall Score (E, E/I, R, N): E

Scoring Guides for Each Category
Unit Scoring Guide
Category I (Criteria A–F): **3:** At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C **2:** At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C **1:** Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C **0:** Inadequate (or no) evidence to meet any criteria in Category I (A–F)
Category II (Criteria A-G):

Waves and Ocean Structures:
Why do some things wash up on the beach and others don't?
EQuIP Rubric for Science Evaluation

3: At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria **2:** Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A **1:** Adequate evidence for at least three criteria in the category **0:** Adequate evidence for no more than two criteria in the category
Category III (Criteria A–F): **3**: At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion **2**: Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A **1**: Adequate evidence for at least three criteria in the category **0**: Adequate evidence for no more than two criteria in the category

Overall Scoring Guide
E: Example of high quality NGSS design—*High quality design for the NGSS across all three categories of the rubric; a lesson or unit with this rating will still need adjustments for a specific classroom, but the support is there to make this possible; exemplifies most criteria across Categories I, II, & III of the rubric. (total score ~8–9)* ***E/I: Example of high quality NGSS design if Improved—****Adequate design for the NGSS, but would benefit from some improvement in one or more categories; most criteria have at least adequate evidence (total score ~6–7)* ***R: Revision needed—****Partially designed for the NGSS, but needs significant revision in one or more categories (total ~3–5)* ***N: Not ready to review****—Not designed for the NGSS; does not meet criteria (total 0–2)*