



NAEP Science
Assessment Framework





Webinar hosted by the National Assessment Governing Board
April 11, 2023, at 12:00 pm ET

Sharyn Rosenberg, National Assessment Governing Board
Aneesha Badrinarayan, Panelist
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Welcome

Lesley Muldoon
Executive Director
National Assessment Governing Board



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What is NAEP?

- Congressionally-mandated independent measure of student achievement
- Each student takes only a small portion of the full assessment
- Reports group-level performance (no results for individual students or schools)
- Reports scale scores and achievement levels
- Provides state-level and district-level results in several subjects
- Administered by National Center for Education Statistics (NCES)
- Also known as The Nation's Report Card



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National Assessment Governing Board

An independent nonpartisan board established by Congress in 1988 to oversee and set policy for all aspects of NAEP:

- Determine the assessment schedule
- **Develop assessment frameworks**
- Review and approve assessment and survey items
- Design methodology to ensure valid and reliable assessment
- Set achievement levels
- Release the Nation's Report Card

Membership (26) includes governors, legislators, teachers, principals, state superintendents, state and local school board members, testing and measurement experts, and the general public.



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NAEP Assessment Frameworks

- Developed through a comprehensive, inclusive, and deliberative process
- Describe the content and format of a NAEP assessment
 - What to measure at each grade
 - How to measure it
 - How achievement levels is reported
- Do not indicate what or how states and districts should teach students
- Bound by constraints of large-scale assessment and NAEP legislation



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Sample Item Based on the 2019 Framework

Question refers to dandelion plants, which make lots of seeds.



Where does the energy that dandelions use to make seeds come from?

A Sunlight

B Soil

C Rain

D Wind



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Sample Contextual Variable from Current Science Assessment

Does your school have laboratory facilities for 12th grade science?

School has Laboratory Facilities for 12th Grade Science	2019 Scaled Score
Yes	151
No	137

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2019 Science Assessment



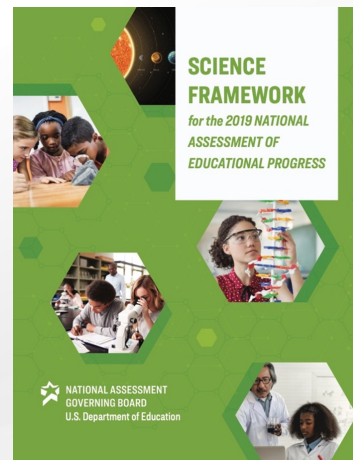
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Why Update the NAEP Science Framework?

The NAEP Science Assessment has not yet been informed by:

- Recent standards, curricula, and instruction
- Recent research on science achievement and assessment
- Latest perspectives on nation's future needs and desirable levels of achievement



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Timeline of Initial Framework Activities

Activity	Date
Public Comment on Current NAEP Science Framework	August – October 2021
Expert Panel and Discussions of Board Policy Considerations	March 2022
Board Charge to Framework Panels	May 2022
Open Call for Panelist Nominations	June – July 2022
Board Recommendation and Approval of Panelist Slate	August 2022
Panel Meetings Began	October 2022



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Current and Upcoming Framework Activities

Activity	Date
Development Panel produces Working Draft of Framework	November 2022 – March 2023
Public Comment on Working Draft	March 13 – April 17, 2023
Board Discussion of Public Comment	May 2023
Panel Discussion of Public Comment and Incorporation of Revisions to Framework	May – July 2023
Board Discussion of Revised Framework	August 2023
Board Action on Final Framework	November 2023





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Participants in Science Framework Process

- Governing Board members and staff
- Steering Panel members
- Development Panel members
- Panel Leadership Team
- NCES staff and contractors
- WestEd staff and subcontractors
- Technical Advisory Committee (TAC)
- Educator Advisory Committee (EAC)
- Widmeyer/FINN Partners
- Stakeholder Advisory Group (SAG)





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Panelist Selection

- Role
- Expertise and experience
- Organizational representation
- Demographic characteristics
- Inclusion of different perspectives, especially with regard to state standards





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Framework Panels

- **Framework Steering Panel** (30 members): provides high level guidance
- **Framework Development Panel** (20 members): develops specific recommendations
- **Panel Leadership Team** (4 members): plans and facilitates panel meetings to build consensus



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Panel Leadership Team

- **Aneesha Badrinarayan**, Learning Policy Institute
- **Jenny Christian**, Dallas Independent School District
- **Nancy Hopkins-Evans**, BSCS Science Learning
- **Joseph Krajcik**, Michigan State University



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Framework Panel Representation

Categories of Content Experts

- Teachers
- State and District Directors
- Policymakers from Educational Organizations
- Curriculum Specialists
- Assessment and Technical Experts
- Researchers
- Business Representatives





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Goals of Public Comment

- Very important milestone in Board process
- Engagement with many different stakeholders who use NAEP data
- Opportunity to incorporate substantive feedback in framework revision



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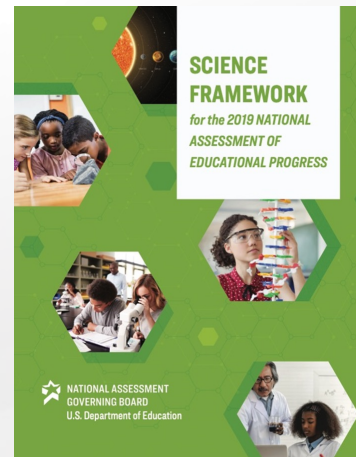
2019 NAEP Science Framework

Chapter One: Overview

Chapter Two: Science Content

Chapter Three: Science Practices

Chapter Four: Overview of the Assessment Design



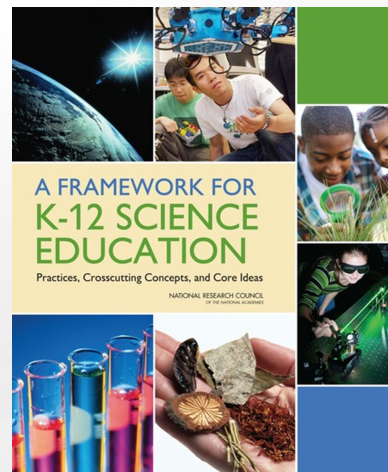
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NRC Framework for K-12 Science Education

- An evidence-based foundation for assessment standards
- Current scientific research
- The science all K–12 students should know and be able to do
- Three interrelated and equally important dimensions:
 - Science and Engineering Practices
 - Disciplinary Core Ideas
 - Crosscutting Concepts



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Changes in Science Standards Since 2005

Most current state science standards established sophisticated expectations of understanding scientific ideas and practices:

- Application of the three dimensions to make sense of phenomena and solve complex problems
- Inclusion of technology and engineering
- Centrality of phenomena and problems based in real-world contexts
- Emphasis on sense-making that integrates the three dimensions of science
- Focus on learning challenging ideas across time



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Initial Recommendations from the Steering Panel

- Update the construct of science to be assessed
- Update NAEP Science disciplinary concepts and practices, and add crosscutting concepts
- Expand the science construct to include aspects of technology and engineering
- Describe how the NAEP Science Assessment should assess the three dimensions of science
- Describe how student performance should be reported in light of science-specific contextual variables and students' opportunity to learn science





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Update the Construct to Be Assessed

Science achievement is the ability to use *relevant disciplinary concepts* (Physical Science, Life Science, Earth and Space Sciences), *crosscutting concepts*, and *science and engineering practices* to identify and address problems, make sense of phenomena, and evaluate information to make informed decisions.

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Update NAEP Science Disciplinary Concept Statements and Practices, and Add in Crosscutting Concepts

Disciplinary Concepts: well tested theories and explanations developed by scientists organized into three major disciplinary groupings: *Physical Science*; *Life Science*; and *Earth and Space Sciences*.

Crosscutting Concepts: concepts used across all science disciplines that provide scientists and engineers and thus also students tools for applying their knowledge of science to new phenomena or problems.

Science and Engineering Practices: ways of working to develop scientific explanations of phenomena or design engineering solutions to problems.

NOTE: There is no plan to report separately on practices and crosscutting concepts.

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Recommended NAEP Disciplinary Concepts

Disciplinary Concepts:

Physical Science; Life Science; and Earth and Space Sciences.

(Formerly NAEP Science Content Statements)

NAEP Physical Science Disciplinary Concepts		
Grade 4	Grade 8	Grade 12
Matter and Its Properties <i>How can the great variety of material substances and processes of change in matter be explained?</i>		
P.4.1 A small set of pieces combined in different ways can build a great variety of objects.	P.8.1. All substances are made from atoms. There are over 100 different types of atoms, which combine with one another in various ways. Atoms form molecules or extended structures.	P.12.1 Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.

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Recommended NAEP Crosscutting Concepts

- Patterns
- Mechanisms and explanation: Cause and effect
- Scale, proportion, and quantity
- Systems and system models / systems thinking
- Conservation, flows, and cycles: Tracking energy and matter
- Relationships between structure and function
- Conditions for stability and change in systems

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Recommended NAEP Science and Engineering Practices

1. Asking Questions and Defining Problems
2. Developing and Using Models
3. Planning and Carrying Out Investigations
4. Analyzing and Interpreting Data
5. Using Mathematics and Computational Thinking
6. Constructing Explanations and Designing Solutions
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information



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Expand the Science Construct to Include Aspects of Technology and Engineering

Integration of technology and engineering concepts that are relevant to science achievement into science practices

1. Asking Questions and Defining Problems
2. Developing and Using Models
3. Planning and Carrying Out Investigations
4. Analyzing and Interpreting Data
5. Using Mathematics and Computational Thinking
6. Constructing Explanations and Designing Solutions
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information



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Describe How NAEP Science Should Assess the Three Dimensions of Science

The framework working draft calls for students to utilize the three dimensions of science as much as possible

- Items elicit evidence that require students to bring the three dimensions of science together to address the question posed to students.
- Items should be three-dimensional whenever possible.
- Each item and each multi-part item should be at least two dimensional and three dimensional if appropriate.
- Item sets and scenario-based tasks should be three dimensional.
- No item will be one dimensional.



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Sample Items

The following items are for Grade 8. They have been adapted to highlight specific important features and are intended to be a helpful guide to help operationalize this framework.

Source: [Disruptions in Ecosystems](#) Chapter 5 Assessment Task (pp. 59–63)



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Example 1: Stand-alone Multiple Choice Item (2D)

Disciplinary Concepts: L8.11; L8.16

Science and Engineering Practice: Developing and Using Models

Many animals and plants live in the sea near Seaside City. Recently, people who live in Seaside City have noticed that the beaches used to have a lot of seaweed, but they rarely see seaweed anymore. Seaweed is very important to the local ecosystem because it is a major food source and safe environment for many animals living in the region.

Data confirm that seaweed has been declining in the area over the last 30 years. This is shown in the graph below.

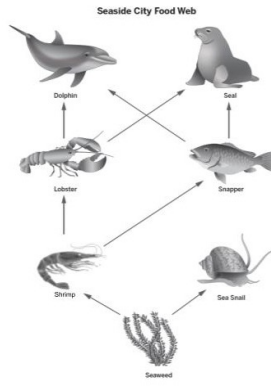
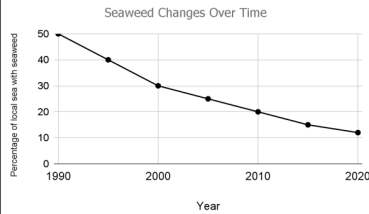


Figure 1: A diagram showing feeding relationships in the sea near Seaside City. Not all living things in this ecosystem are represented.

Item 1:

Based on the information provided, which observation would you expect to be true in this ecosystem?

- a) the total number of dolphins was higher in 2020 than in 1990
- b) individual seals were larger in 2020 than in 1990
- c) there was more competition among sea snails and shrimp in 2020 than in 1990
- d) Lobsters ate more seals in 2020 than in 1990

Example 2: Stand-alone Selected Response Item (2D)

Disciplinary Concepts: L8.11; L8.16

Science and Engineering Practice: Engaging in Argument from Evidence

Many animals and plants live in the sea near Seaside City. Recently, people who live in Seaside City have noticed that the beaches used to have a lot of seaweed, but they rarely see seaweed anymore. Seaweed is very important to the local ecosystem because it is a major food source and safe environment for many animals living in the region.

Data confirm that seaweed has been declining in the area over the last 30 years. This is shown in the graph below.

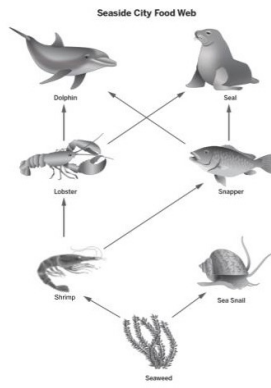
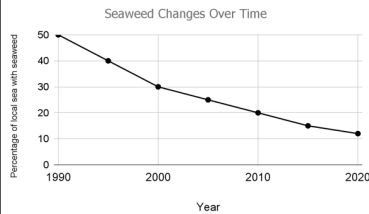


Figure 1: A diagram showing feeding relationships in the sea near Seaside City. Not all living things in this ecosystem are represented.

Some people claim that **the amount of seaweed near Seaside City is declining because people are eating more lobsters and snappers.**

The people investigating the decline in seaweed have made the following observations. Use your understanding of how organisms interact in ecosystems and the information provided to select three (3) statements to support the claim and three (3) statements that do not support the claim.

Evidence	SUPPORTS	DOES NOT SUPPORT
Both snapper and lobster populations have decreased from 1990-2020.	X	
Lobster and snapper both eat many organisms (including shrimp) that feed on seaweed.	X	
At a similar area nearby, the shrimp population is staying constant while seaweed is declining at a similar rate.		X
The number of shrimp is higher in 2020 than in 1990	X	
The shrimp population increases initially but then declines.		X
As the number of human-made buildings on the coast increases, the amount of seaweed decreases.		X

Example 3: Multi-part Item (3D)

Disciplinary Concepts: L8.11; L8.16

Crosscutting Concept: Mechanisms and explanation: Cause and effect

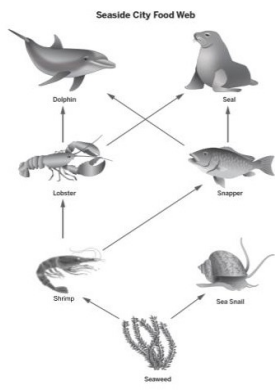
Science and Engineering Practice: Engaging in Argument from Evidence

Seaside City is a popular vacation spot. Each year, more tourists visit, and more people come to live there.

Observations of human impacts

- Increased fishing to provide food for people
- Disruptions to the local environment (land and sea) while building homes and businesses for people
- Decline of some species as human activities impact the resources they need to survive and reproduce

A wide range of animals and plants live in the sea near the city. Recently, people who live in Seaside City have noticed that the beaches used to have a lot of seaweed, but they rarely see seaweed anymore. Seaweed is very important to the local ecosystem because it is a major food source and safe environment for many animals living in the region.



The data below show how living and nonliving factors in this area have changed over the last 30 years.

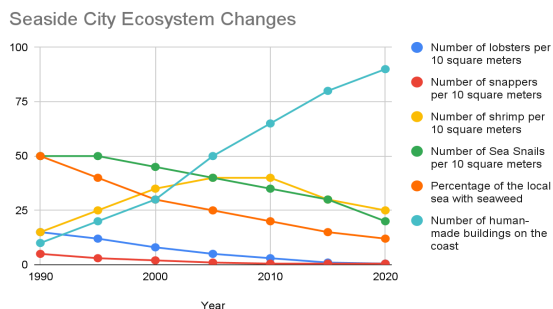


Figure 1: A diagram showing feeding relationships in the sea near Seaside City. Not all living things in this ecosystem are represented.

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Example 3: Multi-part Item (3D) continued

Disciplinary Concepts: L8.11; L8.16

Crosscutting Concept: Mechanisms and explanation: Cause and effect

Science and Engineering Practice: Engaging in Argument from Evidence

Some people claim that the amount of seaweed near Seaside City is declining because people are eating more lobsters and snappers.

Part A. The people investigating the decline in seaweed have made the following observations. Use your understanding of how organisms interact in ecosystems and the information provided to select three (3) statements to support the claim and three (3) statements that do not support the claim.

Evidence	SUPPORTS	DOES NOT SUPPORT
Both snapper and lobster populations have decreased from 1990-2020.	X	
At a similar area nearby, the shrimp population is staying constant while seaweed is declining at a similar rate.		X
Lobster and snapper both eat many organisms (including shrimp) that feed on seaweed.	X	
The number of shrimp is higher in 2020 than in 1990	X	
Shrimp population increases initially but then declines.		X
As the number of human-made buildings on the coast increases, the amount of seaweed decreases.		X

Part B (option 1): What is one different claim that could explain the seaweed decline? Base your answer on the evidence provided, the ecosystem model, and your understanding of interactions in ecosystems.

Part B (option 2): What is one different idea that could explain the seaweed decline? Select a possible alternative claim, based on the evidence provided, the ecosystem model, and your understanding of interactions in ecosystems.

- Changes in the sea snail population are leading to declines in the amount of seaweed.
- Increased human construction along the coast is destroying seaweed in the area.
- There is a disease killing seaweed.

Part C: What additional information would you need to know to determine whether your new claim provides the best explanation for what is causing seaweed decline near Seaside City? Provide at least 2 additional pieces of information and describe why they would be needed.

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Example 4: Item Set (3D)

Disciplinary Concepts: L8.11; L8.16

Crosscutting Concept: Mechanisms and explanation: Cause and effect
Science and Engineering Practice: Engaging in Argument from Evidence

Many animals and plants live in the sea near Seaside City. Recently, people who live in Seaside City have noticed that the beaches used to have a lot of seaweed, but they rarely see seaweed anymore. Seaweed is very important to the local ecosystem because it is a major food source and safe environment for many animals living in the region.

Data confirm that seaweed has been declining in the area over the last 30 years.

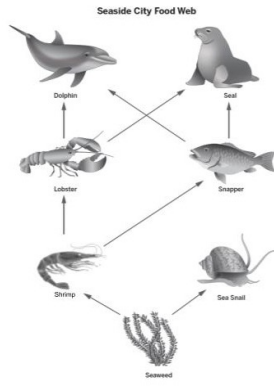
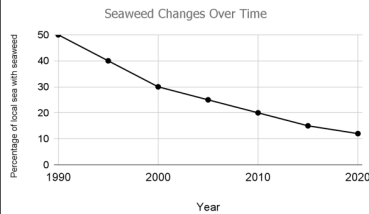


Figure 1: A diagram showing feeding relationships in the sea near Seaside City. Not all living things in this ecosystem are represented.

Item 1:

Based on the information provided, which observation would you expect to be true in this ecosystem?

- a. the total number of dolphins was higher in 2020 than in 1990
- b. individual seals were larger in 2020 than in 1990
- c. there was more competition among sea snails and shrimp in 2020 than in 1990
- d. lobsters ate more seals in 2020 than in 1990

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Example 4: Item Set (3D) continued

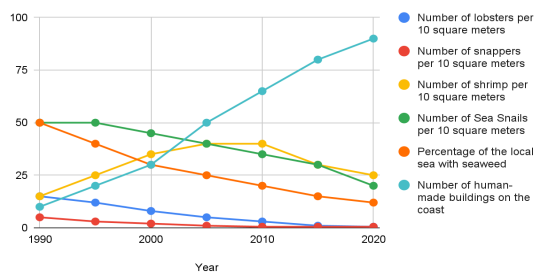
Disciplinary Concepts: L8.11; L8.16

Crosscutting Concept: Mechanisms and explanation: Cause and effect
Science and Engineering Practice: Engaging in Argument from Evidence

Item 2:

Some people claim that the amount of seaweed near Seaside City is declining because people are eating more lobsters and snappers. Scientists and community members examined how living and nonliving factors in this area have changed over the last 30 years.

Seaside City Ecosystem Changes



- Observations of human impacts**
- Increased fishing to provide food for people
 - Disruptions to the local environment (land and sea) while building homes and businesses for people
 - Decline of some species as human activities impact the resources they need to survive and reproduce

Part A: The people investigating the decline in seaweed have made the following observations. Use your understanding of how organisms interact in ecosystems and the information provided to select three (3) statements to support the idea and three (3) statements that do not support the claim.

Evidence	SUPPORTS	DOES NOT SUPPORT
Both snapper and lobster populations have decreased from 1990-2020.	X	
Lobster and snapper both eat many organisms (including shrimp) that feed on seaweed.	X	
The number of shrimp is higher in 2020 than in 1990	X	
At a similar area nearby, the shrimp population is staying constant while seaweed is declining at a similar rate.		X
The shrimp population increases initially but then declines.		X
As the number of human-made buildings on the coast increases, the amount of seaweed decreases.		X

Part B, CR Option: What is one different claim that could explain the seaweed decline? Base your answer on the evidence provided, the ecosystem model, and your understanding of interactions in ecosystems.

Part B, SR Option: What is one different idea that could explain the seaweed decline? Select a possible alternative claim, based on the evidence provided, the ecosystem model, and your understanding of interactions in ecosystems. [SR option]

- a) Changes in the sea snail population are leading to declines in the amount of seaweed.
- b) Increased human construction along the coast is destroying seaweed in the area.
- c) There is a disease killing seaweed.

Part C: What additional information would you need to know to determine whether your new claim provides the best explanation for what is causing seaweed decline near Seaside City? Provide at least 2 additional pieces of information, and describe why they would be needed.

Part D: If your claim is correct, how would you account for the relationship between snappers, lobsters, and seaweed?

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Example 4: Item Set (3D) continued

Disciplinary Concepts: L.8.11; L.8.16

Crosscutting Concept: Mechanisms and explanation: Cause and effect
Science and Engineering Practice: Engaging in Argument from Evidence

Item 3:

In 2021 Seaside City banned new building construction to prevent further damage to the marine ecosystem off its coast. Students at the local middle school have developed a model to predict what the organism populations might look like over time. Based on the model, students make two predictions about the shrimp population in 2030:

Option A: the shrimp population will remain about the same in 2030 compared to 2020.

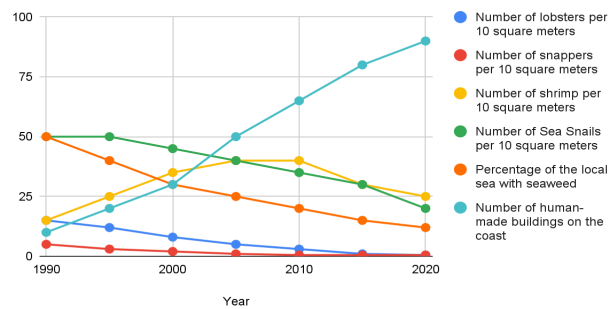
Option B: the shrimp population will increase by 2030, compared to 2020.

Choose one option and complete the statement below. (Note: Both options could be correct under the right conditions.)

The model predicts that shrimp population will remain about the same if the seaweed present will [remain the same, increase]. This is because how much the shrimp population grows will [be limited, increase, decrease] if competition for resources [stays the same, increases, decreases] compared to 2020.

- | Observations of human impacts |
|---|
| <ul style="list-style-type: none"> Increased fishing to provide food for people Disruptions to the local environment (land and sea) while building homes and businesses for people Decline of some species as human activities impact the resources they need to survive and reproduce |

Seaside City Ecosystem Changes



Describe How NAEP Science Should Assess the Three Dimensions of Science

The working draft provides recommendations and guidance on:

- Ensuring a broad range of difficulty in the assessment
- Using diverse tasks/phenomena/contexts for items
- Considering language complexity
- Eliminating concept maps and replacing hands-on tasks (HOTs) with scenario-based tasks (SBTs)



Distribution of Items by Disciplinary Concept Domain and Grade (Percentage of Student Time)

	Grade 4	Grade 8	Grade 12
Physical Science	33.3%	33.3%	33.3%
Life Science	33.3%	33.3%	33.3%
Earth and Space Sciences	33.3%	33.3%	33.3%



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Distribution of Items by Response Type and Grade (Percentage of Student Time)

	Grade 4	Grade 8	Grade 12
Selected response (multiple choice and multiple select) which includes technology enhanced (matching, zones, grid, inline choice)	50%	50%	50%
Constructed response (short and extended)	50%	50%	50%



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How Student Performance Should Be Reported

- Current subscales: Life Science, Physical Science, Earth and Space Sciences
- Proposed subscales: Sensemaking in Life Science, etc.
- Recommendations to update science-specific questionnaires to address (among other things):
 - student exposure to technology and engineering
 - amount that science is taught by grade 4
 - exposure to practices and CCCs in instruction



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2028 NAEP Science Framework

Chapter One: Overview

Chapter Two: The Three Dimensions of Science

Chapter Three: Overview of Assessment Design

**Chapter Four: Reporting Results of the NAEP
Science Assessment**



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Next Steps on Framework Revision

- Addressing input received during public comment
- Including more detail on how to measure each dimension
- Adding more sample items
- Developing achievement level descriptions
- Recommending new contextual variables
- Producing *Assessment and Item Specifications*



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Seeking Feedback

Contact us with any questions! Home About Working Draft Outreach Events Contact Us

2028 NAEP Framework Update

NATIONAL ASSESSMENT GOVERNING BOARD NAEP NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS The Nation's Report Card

About → Working Draft → Outreach Events → Contact Us →

Feedback must be submitted by 11:59 pm ET on Monday, April 17

Questions?

Email: NAEPScience@WestEd.org





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Seeking Feedback



- Overall representation of concepts and skills
- Sample items
- Glossary terms
- Disciplinary concept statements
- Science and engineering practices
- Crosscutting concepts
- Assessment design
- Contextual variables
- Impact on trend
- Anything else



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Questions?



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