Innovations in Science Map, Assessment & Report Technologies

I-SMART

I-SMART Test Design Overview and Exemplars from a Precursor Linkage Level Testlet

Earth and Space Science

Disciplinary Core Idea: Earth and Human Activity

Science and Engineering Practice: Using Mathematics and Computational Thinking

Topic: Human Impacts on Earth Systems

Grade Band: High School

Linkage Level: Precursor

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I-SMART Purpose

Innovations in Science Map, Assessment & Report Technologies (I-SMART) is a federally funded research and development project. One purpose of I-SMART is to develop new ideas in assessment design that might improve measurement of complex Next Generation Science Standards (NGSS)-aligned performance expectations for students with the most significant cognitive disabilities and for students with and without disabilities who are consistently not successful with grade-level content.

I-SMART's assessment prototypes are designed to measure student learning of rigorous science standards as represented by the continua of knowledge, skills, and understandings in learning map models. While the examples of I-SMART innovations in this document are based on alternate assessments, the concepts and design ideas are relevant for assessments for all students.

Universal Design for Learning

A key aim of the I-SMART project was to consider test design innovations that would increase interest and engagement without introducing new accessibility barriers for students. Principles of Universal Design for Learning (UDL) is an approach to design where creators intentionally plan for ways to reduce barriers within a learning experience. Students with a variety of strengths and needs can easily engage with the content and be successful.

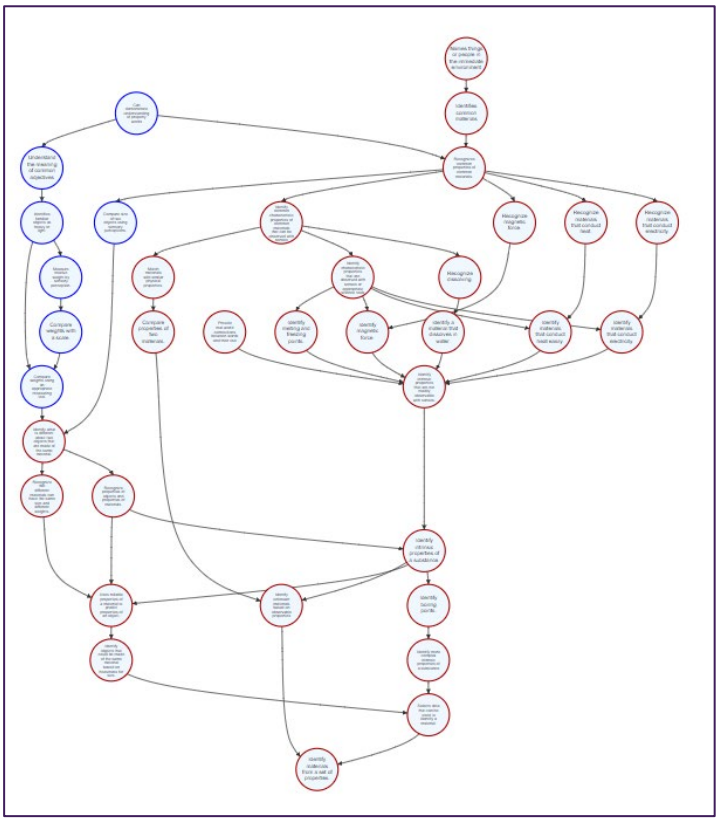
Our plan was to assess more complex science standards without introducing new barriers for students, especially for students with disabilities and struggling learners. Applying principles of UDL helped us imagine new ways to increase access to the science content as well as increase interest and engagement.

UDL's three main principles include providing multiple means of engagement, representation, and action and expression.

Learning Map Model Neighborhoods

A map neighborhood is a visual representation of a group of skills that are linked conceptually. The circles on the map are "nodes," which show discrete knowledge, skills, or understandings along pathways toward learning. The lines are "connections," which represent relationships between the nodes.

Figure 1. *Science Learning Map Model Neighborhood*



The nodes and connections show different pathways that students may follow to acquire knowledge. Multiple pathways provide flexibility for students with cognitive or sensory impairments, limited mobility, or limited communication so that they can move ahead in the map neighborhood in a variety of ways.

The skills increase in complexity from the top of the image, which focuses on foundational skills, to the bottom, which represents grade level. For I-SMART, one map neighborhood focuses on one extended content standard.

Each neighborhood addresses one science and engineering practice, one disciplinary core idea, and one cross-cutting concept.

Linkage Levels

I-SMART testlets measure extended content standards at four levels of complexity, known as linkage levels. Linkage level descriptions are created by synthesizing the meaning of the assessment targets within the linkage level. The four linkage levels are the Initial linkage level, Distal linkage level (high school grade band only), Precursor linkage level, and Target linkage level.

The set of linkage levels for each extended content standard span the learning map model neighborhood from beginning to end, providing access points for students with a wide range of levels of understanding (See the Learning Map Neighborhoods section of the I-SMART website to view example map neighborhoods).

Each linkage level is a group of four assessment targets or nodes that increase in complexity as the testlet progresses. We selected nodes for assessment so that each linkage level aligned with the disciplinary core idea (DCI) and science and engineering practice (SEP) for the extended content standard.[1] Integrated nodes

[1] While the cross-cutting concept is included in the science learning map neighborhood as a whole, it is not included at the level of an individual assessment target.

include both the DCI and SEP for the extended content standard. Thus, the progression of linkage levels reflects increasingly complex DCI and SEP content.

I-SMART Approach to Testlets and Items

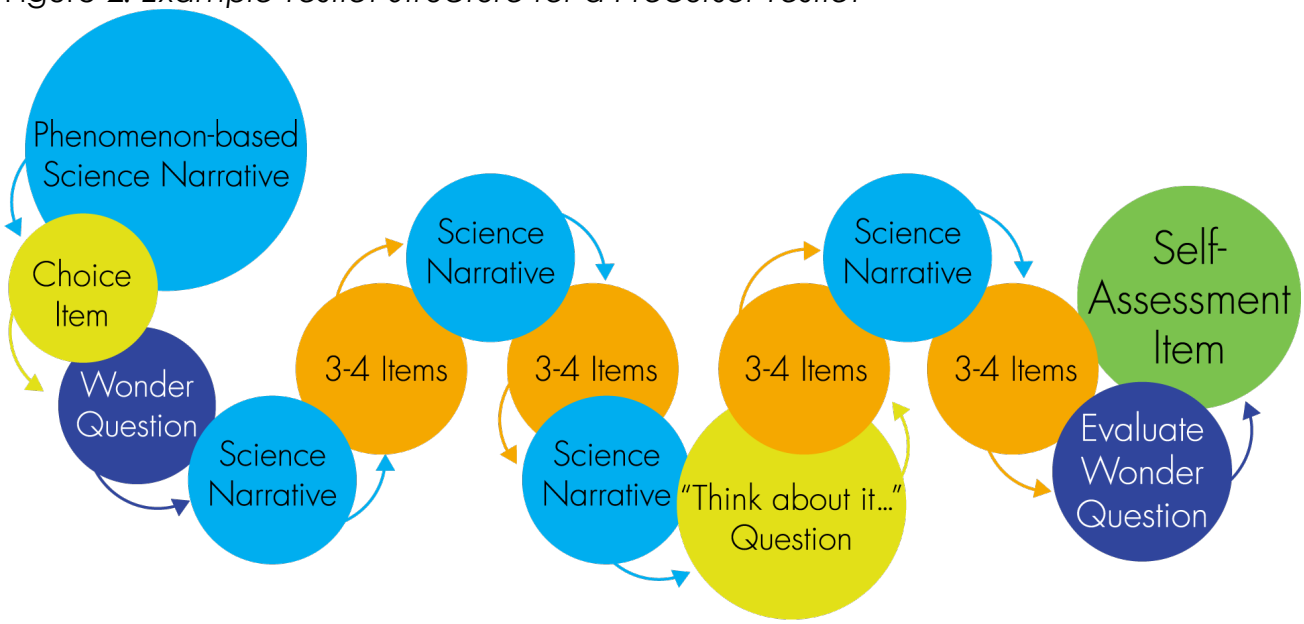
I-SMART grouped assessment items together into testlets. Each testlet assesses one linkage level for the extended content standard. Each testlet integrates items that measure elements of both the DCI and the SEP for the assessed extended content standard. Testlets include several features that are based on principles of UDL.

I-SMART testlets center around a science narrative that is based on a phenomenon. The science narrative presents the phenomenon for students to explore. We chose phenomenon that would be familiar to students and similar to something they might experience in the classroom. The SEP also appears in the science narrative. This helps ground the story in real-world science concepts. Overall, the science narrative is intended to support UDL by encouraging student interest and engagement while at the same time activating prior knowledge.

Items are embedded within the science narrative and ask students to make connections between the SEP and the DCI. Testlets contain 12–16 items with three to four items written to each of the four nodes in a linkage level. Assessments have either multidimensional items or are a blend of unidimensional and multidimensional items tested together in the context of the science narrative.

At the Distal, Precursor, and Target linkage levels, testlets are computer-delivered, and students navigate the testlets independently. Testlets at the Initial linkage level are teacher-administered.

Figure 2. *Example Testlet Structure for a Precursor Testlet*



I-SMART Sample Testlet—Precursor Linkage Level

We selected a sample testlet to demonstrate some of I-SMART's design innovations. We begin by describing the content that the testlet assesses as well as its item types and UDL features. Next, we walk through selected features of an I-SMART testlet at the Precursor linkage level for the high school grade band.

Content Components and Descriptions

The sample testlet covers the following science content.

Table 1. *Content Components and Descriptions of Sample Testlet*

Content Component	Description
Precursor Linkage Level Description	**Recognize and describe conservation strategies and identify the impact of choices on the environment and Earth systems.**
Science Phenomenon Explored	People do things to protect the environment. They make choices that can change their impact on the Earth. Local communities implement a variety of conservation strategies.
Extended Content Standard	Analyze data to determine the effects of a conservation strategy on the level of a natural resource.
Science and Engineering Practice	Using Mathematics and Computational Thinking

Assessed Nodes

Items in the sample testlet were written to measure the nodes in the figure and table below.

Figure 3. *Assessed Nodes in Sample Testlet*

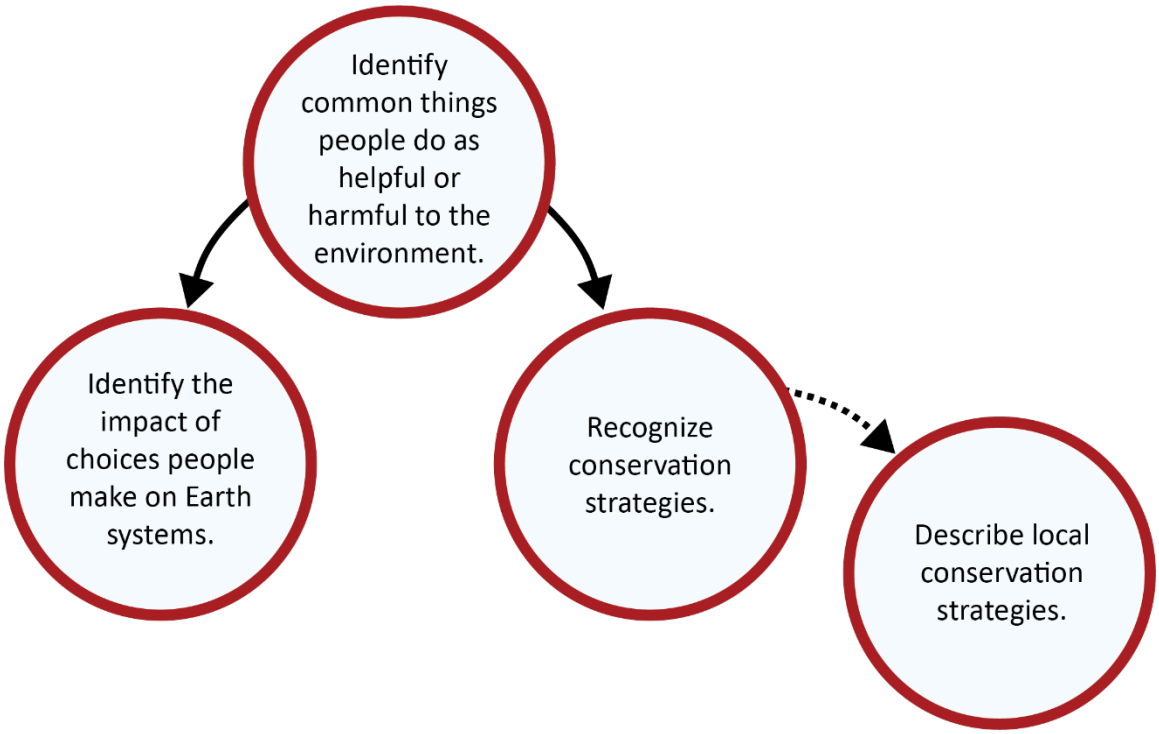


Table 2. *Assessed Nodes and Type of Node for Sample Testlet*

Assessed Nodes	Type of Node
1. Identify common things people do as helpful or harmful to the environment.	Integrated Node—DCI and SEP
2. Identify the impact of choices people make on Earth systems (e.g., people use reusable cups to reduce pollution of water and land.)	Integrated Node—DCI and SEP
3. Recognize conservation strategies (e.g., reduce, recycle, reuse)	DCI Node
4. Describe local conservation strategies (e.g., recycling)	Integrated Node—DCI and SEP

Item Types and UDL Features

The sample testlet includes single-select multiple-choice and multiple-choice-multi-select items. Single-select multiple-choice items are used when the learning target has one clear, correct response. Multiple-choice-multi-select items prompt students to choose more than one response from a larger set of response options. These items are used when the learning target is more complex and has multiple correct responses. All items are embedded within the science narrative to support students making connections between the SEP and the DCI.

We also embedded new UDL features into the science narrative. We intended the UDL features to increase student interest and engagement throughout the testlet and to reduce barriers to accessing the science content in the testlet.

As you envision how the testlet flows, note that we do not display the entire science narrative nor all the items. Instead, we present one sample narrative screen and one item per node.

The sample testlet demonstrates features in the following list.

- Science narrative
- Choice item
- Wonder question
- "Think about it…" question
- Single-select multiple-choice and multiple-choice-multi-select
- Self-assessment item

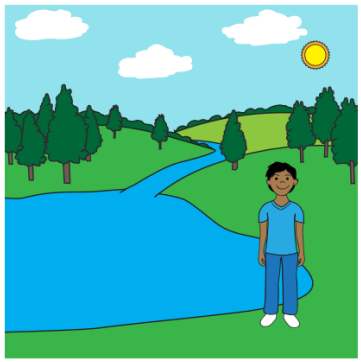
Science Narrative Screen

The science narrative begins on the testlet's first screen. The narrative provides context for the testlet's science concepts and introduces the phenomenon (i.e., a common, high-interest situation that a student may experience). The SEP also appears in the science narrative. This helps to ground the story in real-world science concepts.

This example screen provides context for the upcoming construct-relevant choice item.

Figure 4. *Science Narrative Example Screen*

Jake likes to spend time outside with friends and family. Jake knows it is important to be environmentally friendly. Jake wants to make choices that are helpful to the environment.



Choice Item

The first item is unscored and offers students a choice between two content narratives based entirely on their preference (e.g., camping or picnic).

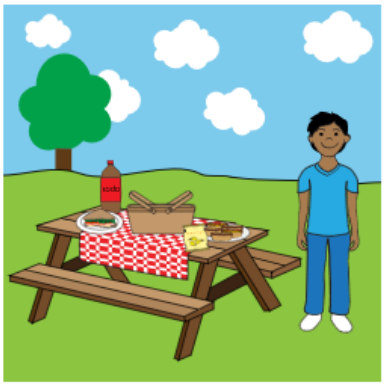
Once chosen, the remainder of the science narrative and items correspond with the choice. In the sample testlet, the student chose camping as the preferred narrative. We designed construct-relevant choice items to help maintain engagement throughout the assessment.

Figure 5. *Choice Item Example*

Jake and his friends like to go on picnics by the lake. Jake and his friends like to go camping in the woods. What should Jake and his friends do?

They should go camping in the woods.

They should go on a picnic by the lake.

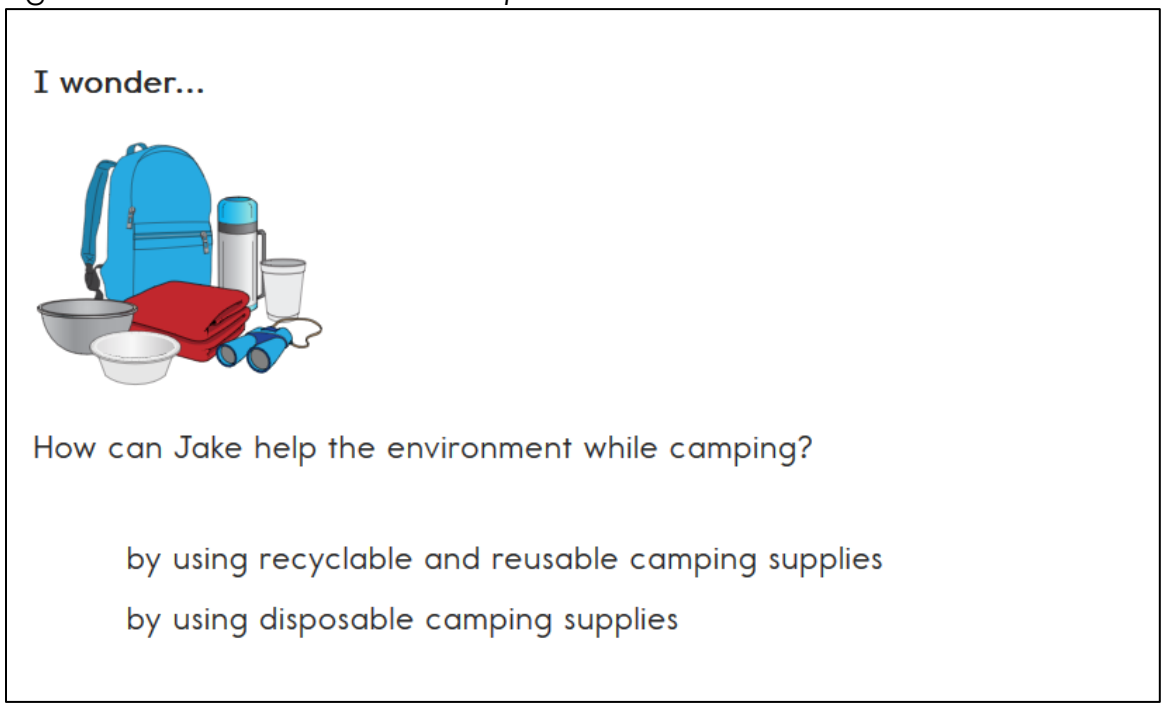


Wonder Question

Wonder questions are intended to promote inquiry and to help students connect the science concepts in the testlet to real-world scenarios. They also prompt students to reflect on the phenomenon that will be explored in the science narrative.

We designed the wonder question to increase students' interest and capacity for progress monitoring as they reflect on their understandings. Students reevaluate the wonder question and their original answer at the end of the testlet.

Figure 6. *Wonder Question Example*



"Think about it…" Question

"Think about it..." questions are unscored and ask students, "What should you do next?" or "How would you find this answer?" The questions encourage students to reflect on science concepts.

The computer displays a response screen directly following the question screen. The response provides options for executive function in terms of planning and strategy development in science problem-solving. Answer screens also assist students with capacity for monitoring progress.

Figure 7. *"Think about it…" Question Example*

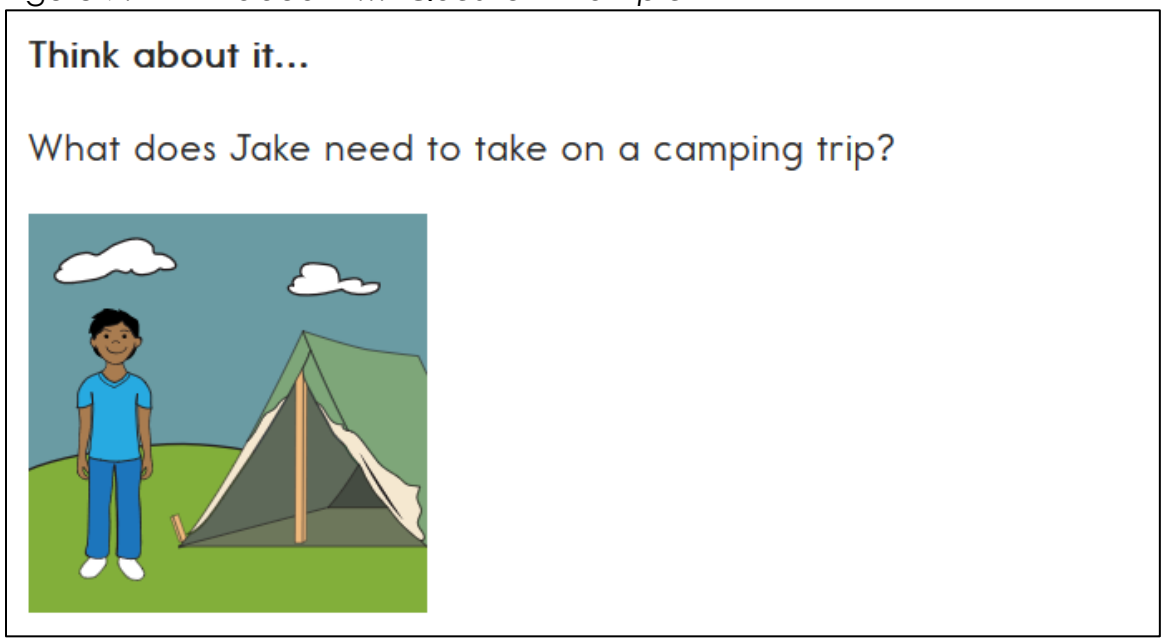
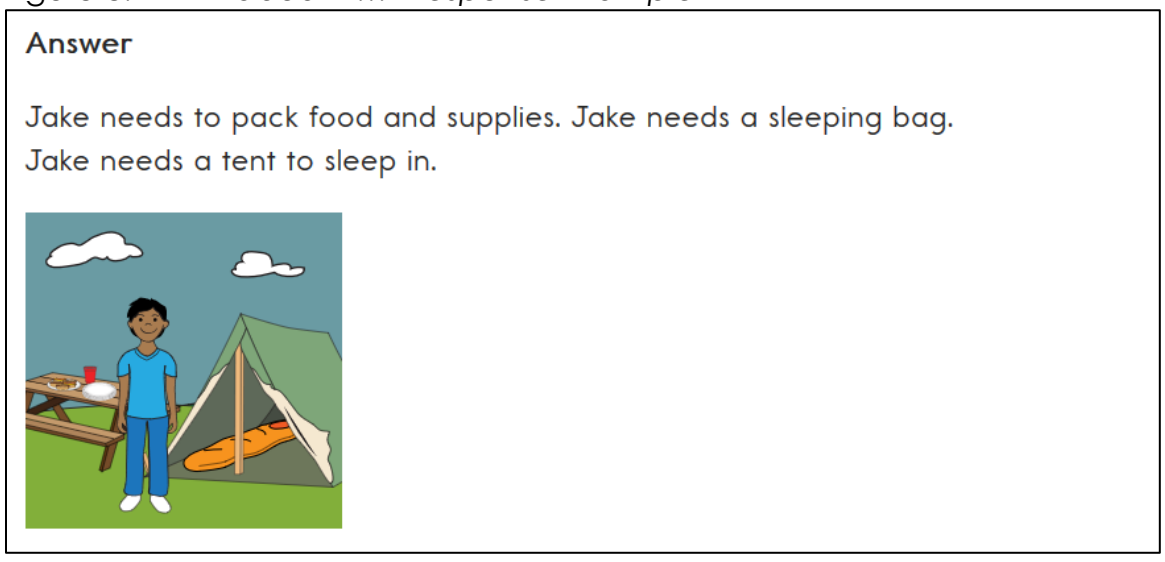


Figure 8. *"Think about it…" Response Example*



Science Narrative and Single-Select Multiple-Choice Item Example—Node 1

As the science narrative continues, it reinforces connections to real-world science practices.

Figure 9. *Science Narrative Example Screen*

Jake makes a list of things he needs for his camping trip.

Here is an example of a single-select multiple-choice item for Node 1, "Identify common things people do as helpful or harmful to the environment."

Figure 10. *Single-Select Multiple-Choice Item Example—Node 1*

Which activity is harmful to the environment?

recycling aluminum cans

reusing plastic containers

throwing paper on the ground

Science Narrative and Single-Select Multiple-Choice Item Example—Node 2

This science narrative screen demonstrates how the story develops and creates logical places to embed items.

Figure 11. *Science Narrative Example Screen*

Jake needs to buy some of the camping supplies. Jake goes to the store.

This example single-select multiple-choice item assesses Node 2, "Identify the impact of choices people make on Earth systems."

Figure 12. *Single-Select Multiple-Choice Item Example—Node 2*

Jake buys food in containers that can be recycled. How does buying recyclable containers help the environment?

It reduces water use.

It reduces the wildlife.

It reduces trash.

Science Narrative and Single-Select Multiple-Choice Item Example—Node 3

The science narrative continues to present the phenomenon for students to explore.

Figure 13. *Science Narrative Example Screen*

Jake thinks about how to help the environment at the campsite.

As shown here, this single-select multiple-choice item assesses Node 3, "Recognize conservation strategies."

Figure 14. *Single-Select Multiple-Choice Item Example—Node 3*

What can Jake do to help the environment on his next camping trip?

buy all new supplies

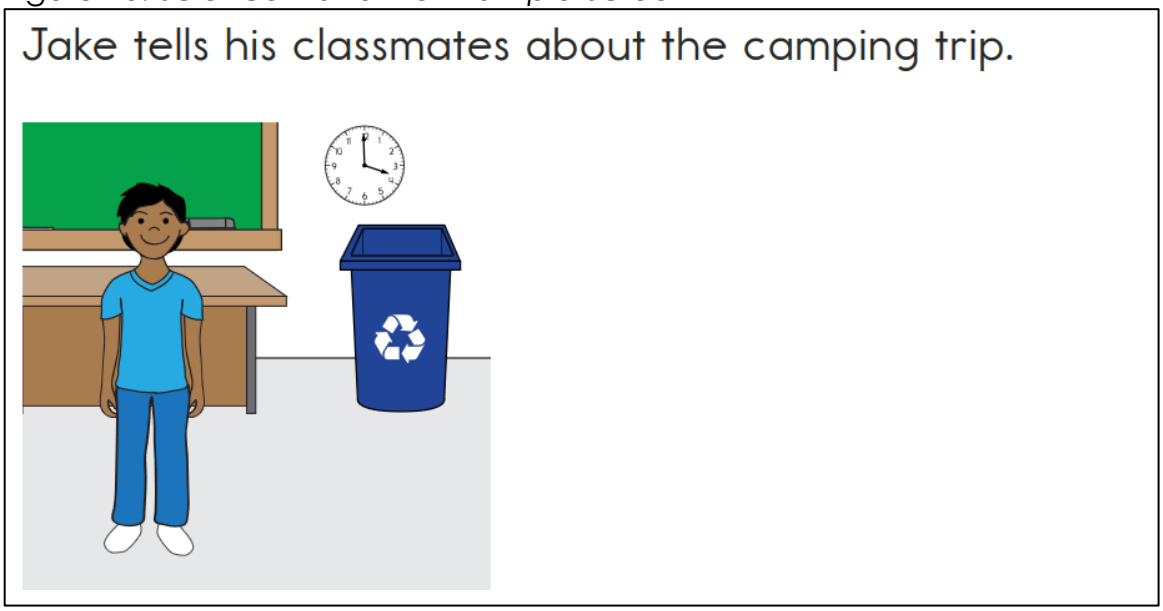
throw away disposable supplies after use

reuse the supplies from this camping trip

Science Narrative and Multiple-Choice-Multi-Select Item Example—Node 4

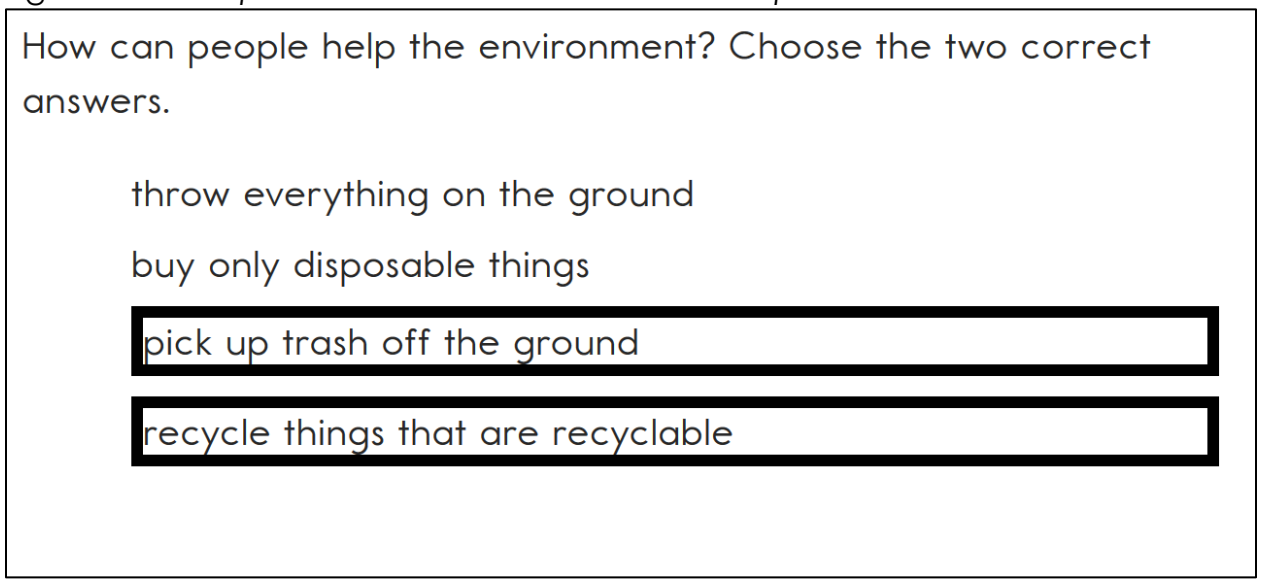
As illustrated in this science narrative screen, the story draws to a close towards the end of the testlet.

Figure 15. *Science Narrative Example Screen*



As seen in this multiple-choice-multi-select item, nodes such as Node 4, "Describe local conservation strategies," can best be assessed by allowing the student to select multiple correct answers. To reduce the complexity of this item type, the system directs the student to select two correct answers. In this item, the student selected the third and fourth answer options.

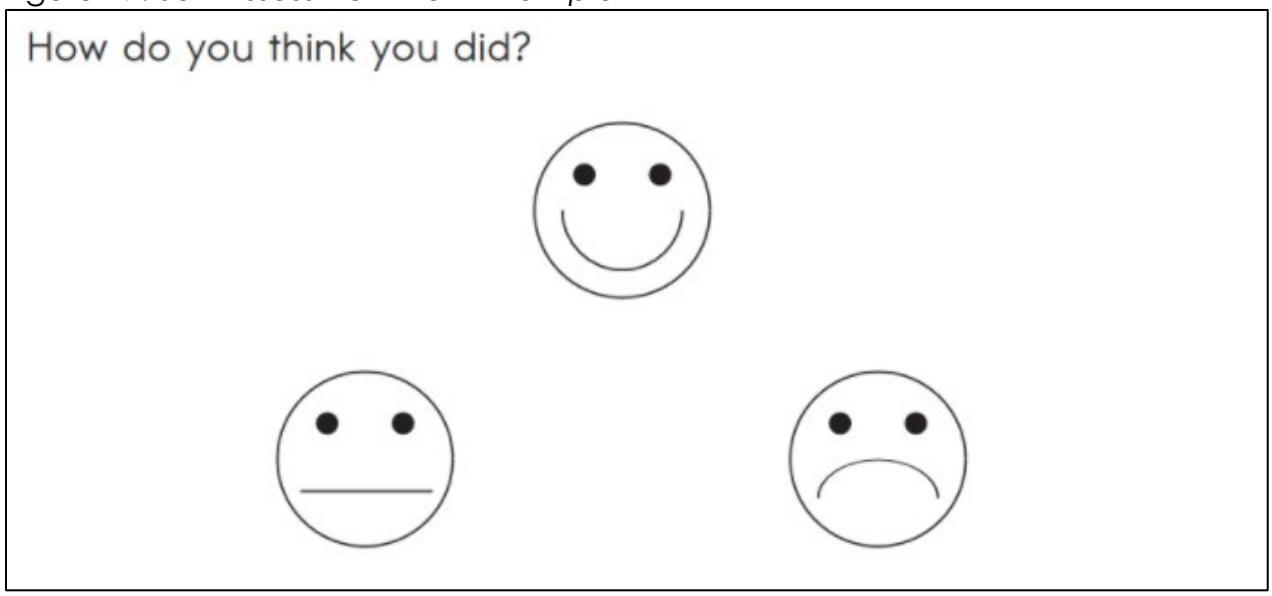
Figure 16. *Multiple-Choice-Multi-Select Item Example—Node 4*



Self-Assessment Item

The last item is unscored and offers students a chance to reflect on their performance. The answer options are images of emoticons displayed in a familiar layout. Self-regulation is essential to human development and helps students become better at coping and engaging with their environments.

Figure 17. *Self-Assessment Item Example*



Summary

I-SMART assessment prototypes focus on improving achievement in multidimensional science content standards for students with the most significant cognitive disabilities and students who are not meeting grade-level expectations through deep integration of UDL principles.

Further Information

More detailed information about I-SMART testlets can be found in the technical report, *Designing, Developing, and Evaluating Innovative Science Assessments: Evidence from the I-SMART Project* available at the I-SMART resources page.

For more information regarding the innovative approaches used in the I-SMART project, please visit the I-SMART website.