I-SMART Test Design Overview and Exemplars from an Initial Linkage Level Testlet

Life Science

Disciplinary Core Idea: Ecosystems: Interactions, Energy, and Dynamics

Science and Engineering Practice: Constructing Explanations and Designing Solutions

Topic: Interdependent Relationships in Ecosystems

Grade Band: Middle School

Linkage Level: Initial

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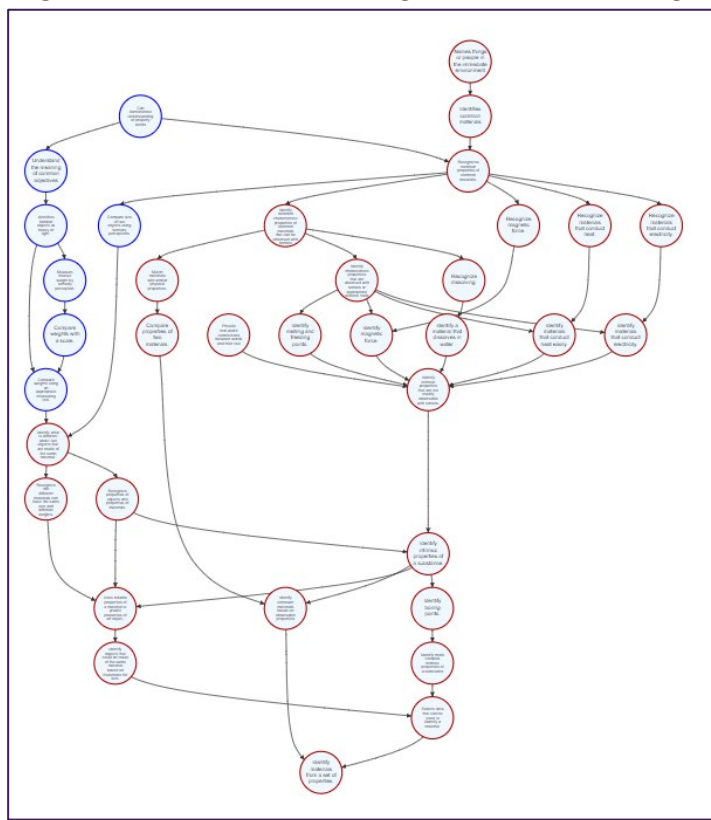
UDL's three main principles include providing multiple means of engagement, representation, and action and expression.

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. Nodes progress from preacademic to grade-level knowledge of the Disciplinary Core Idea (DCI) and Science and Engineering Practice (SEP) components of the Essential Element. 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 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 DCI and SEP for the extended content standard. Integrated nodes include both the DCI and SEP for the extended content standard.[1]

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[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.

Thus, the progression of linkage levels reflects increasingly complex DCI and SEP content.
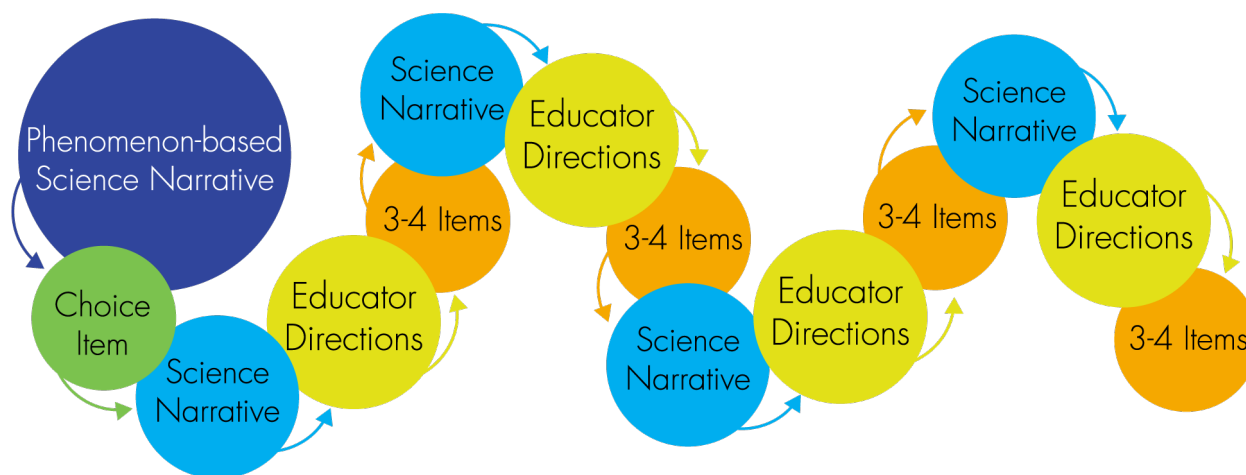
I-SMART Approach to Testlets and Items

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 SEP[2] 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 phenomena that would be familiar to students and like 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 an Initial Testlet*

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[2] The cross-cutting concept was excluded from the assessment target to reduce complexity.

I-SMART Sample Testlet—Initial Linkage Level

Teacher-administered testlets are designed for educators to administer outside the system, with the test administrator recording responses in the system rather than the student recording their own responses. Before administration, educators access the Test Specification Page to learn about the testlet and access a set of picture response cards.

All teacher-administered testlets have some common features:
- On-screen directions and scripted statements guide the test administrator through the administration process.
- The test administrator presents the item to the student by interacting with them directly, usually with picture response cards, objects, or manipulatives.
- The test administrator enters responses based on observation of the student's behavior in response to the item, regardless of the student's response mode.

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 Initial linkage level for the middle 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
Initial Linkage Level Description	**Place objects in categories, identify common animals and plants, and determine the relationship between organisms in a food chain.**
Science Phenomenon Explored	Producers (i.e., plants) make their own food, while consumers eat plants and/or other animals.
Extended Content Standard	Use models of food chains/webs to identify producers and consumers in aquatic and terrestrial ecosystems.
Science and Engineering Practice	Constructing Explanations and Designing Solutions: Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena.

Assessed Nodes

Items in the sample testlet were written to measure the nodes in the following figure and table.
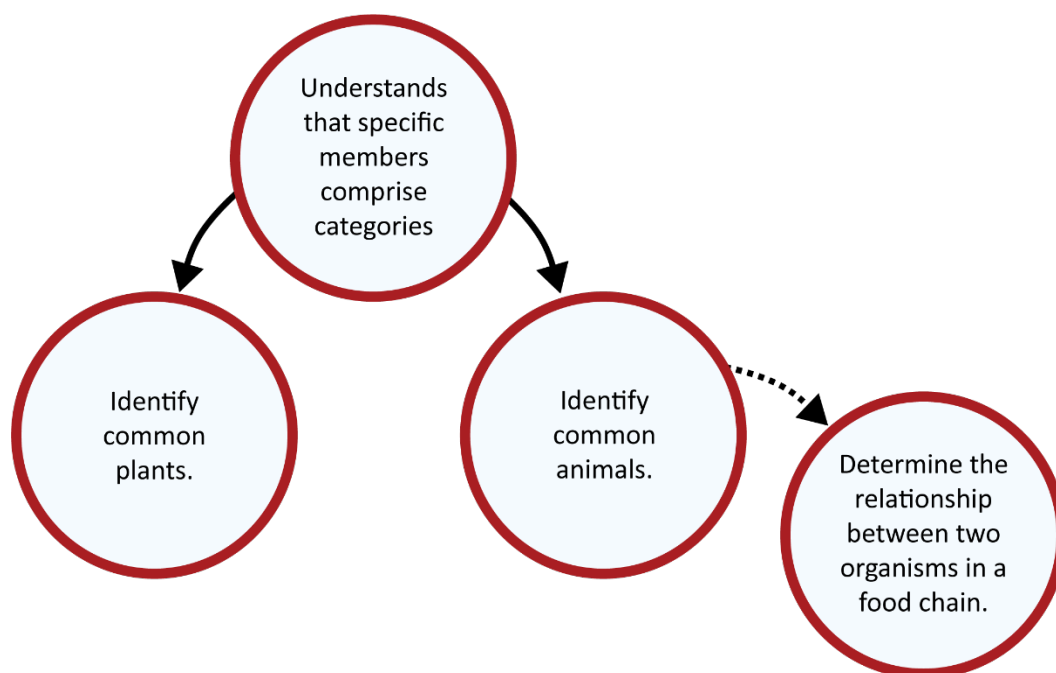
Figure 3. *Assessed Nodes in Sample Testlet*

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

Assessed Nodes	Type of Node
1. Understands that specific members comprise categories.	Integrated Node—DCI and SEP
2. Identify common plants.	Integrated Node—DCI and SEP
3. Identify common animals.	Integrated Node—DCI and SEP
4. Determine the relationship between two organisms in a food chain.	Integrated Node—DCI and SEP

Item Types and UDL Features

Teacher-administered items have five options that describe anticipated student behaviors. Test administrators select the description that most closely matches their observations of student response when the item is administered.

Teacher-administered item response options are presented in a multiple-choice format often called a Teacher Checklist. The Teacher Checklist provides response options that reflect a full range of behaviors that students may demonstrate while responding to the item. If a student is not engaged with the item, the fourth or fifth response option provides test administrators options to record what was observed.

These checklists typically follow the following outline.
- The first response option is the key.
- The second and third response options reflect incorrect options.
- The fourth response option reflects the student choosing more than one.
- The second-to-last response option usually is "Attends to other stimuli."
- The last response option usually is "No response."

The 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
- Educator directions
- Concrete pictures and/or tactile representations or objects
- Teacher-administered items
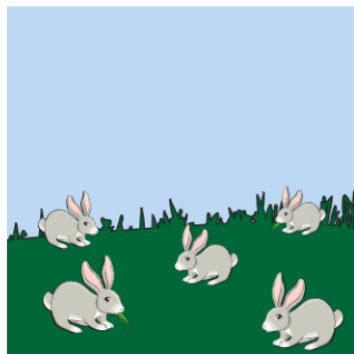
Science Narrative Screen

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*

Choice Item

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

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

Figure 5. *Choice Item Example*

Educator Directions

Figure 6 illustrates directions to the test administrator, including discussion of the Test Specification Page. This page includes a set of picture response cards that can be printed locally and used as a stimulus for students to indicate their response. These pictures match the graphics used in the testlet. Teachers may substitute objects or use alternate text for picture response cards as appropriate. Alternate text includes descriptions of graphics and images and is included with the Test Specification Page.

Figure 6. *Educator Directions Example*

Educator Directions:

In this testlet, the student will use picture response cards to identify plants and animals and their relationship in a food chain.

Before you begin working with the student, gather the following pictures provided with the Test Specification page:

- pigs
- chickens
- cows
- farm animals
- crops
- farm scene with plants and animals
- corn
- an egg
- an apple
- a tractor
- a truck
- a sheep
- a dog

Figure 7. *Educator Directions Example*

Educator Directions:

Gather the picture response cards provided with the Test Specification page. You will use the picture response cards to engage the student during the testlet. Read the narrative and items to the student. Record the student's response to the items.

Science Narrative Screen, Educator Directions, and Teacher-Administered Item – Node 1

The test administrator uses shared reading strategies (e.g., discussing words, connecting words or pictures to student background knowledge and experience, asking questions to further engage students) to recruit student interest and promote engagement throughout the testlet. As the science narrative continues, it reinforces connections to real world science concepts.

Figure 8. *Science Narrative Example Screen*

Educator Directions:
SAY: "You can find lots of things on a farm. There are different kinds of animals. Some animals live in pens. Other animals live in fields."

The educator directions screen provides instructions to the test administrator about which picture response cards and/or materials to show and what to say. The test administrator shows the picture response card and/or materials indicated by the SHOW statement and then says the SAY statement in the order presented.

The student indicates their response to the picture response cards using any response mode or form of communication that they would typically use (e.g., gesture, eye gaze). The educator must be very familiar with the student's typical modes of expressive communication. Using the options on the screen, the educator selects the response that best matches the student's behavior.

This example teacher-administered item assesses Node 1, "Understands that specific members comprise categories."

Figure 9. *Educator Directions Example*

Educator Directions:

SHOW: the picture of pigs.
SAY: **"These are pigs."**

SHOW: the picture of chickens.
SAY: **"These are chickens."**

SHOW: the picture of a cow.
SAY: **"These are cows."**

SHOW: the picture of pigs, the picture of chickens, and the picture of a cow.
SAY: **"Show me the birds."**

This screen contains response options that match the picture response cards and/or materials used on the previous screen. The test administrator records the student's response.
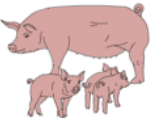
Figure 10. *Teacher-Administered Item Example – Node 1*

Choose the answer option that best describes the student's response.

□ Indicates the picture of the chickens

□ Indicates the picture of the pigs

□ Indicates the picture of the cow

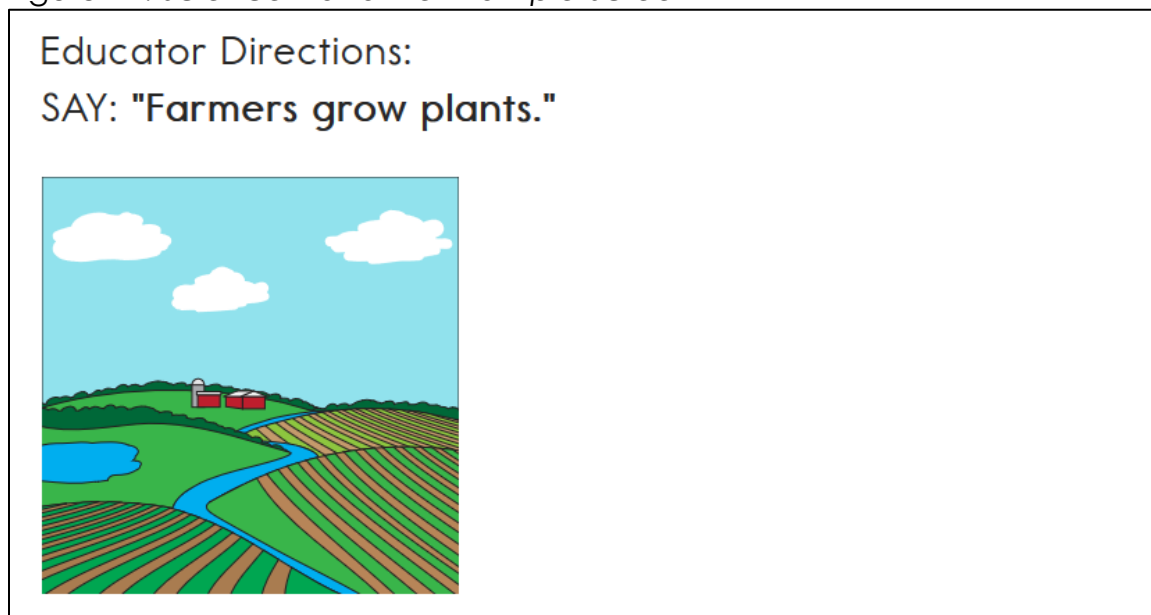□ Indicates multiple pictures

□ Attends to other stimuli

□ No response

Science Narrative Screen, Educator Directions, and Teacher-Administered Item— Node 2

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

Figure 11. *Science Narrative Example Screen*

Here is an example of a teacher-administered item for Node 2, "Identify common plants."
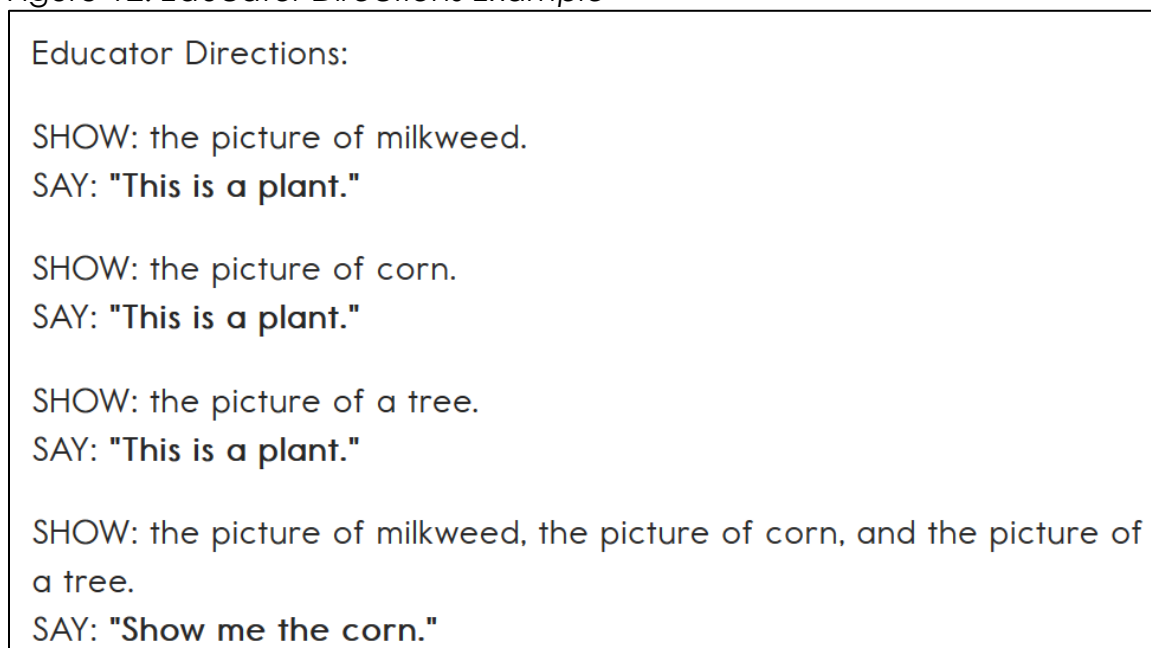
Figure 12. *Educator Directions Example*

Educator Directions:

SHOW: the picture of milkweed.
SAY: **"This is a plant."**

SHOW: the picture of corn.
SAY: **"This is a plant."**

SHOW: the picture of a tree.
SAY: **"This is a plant."**

SHOW: the picture of milkweed, the picture of corn, and the picture of a tree.
SAY: **"Show me the corn."**

Figure 13. *Teacher-Administered Item Example—Node 2*

Choose the answer option that best describes the student's response.

□ Indicates the picture of corn

□ Indicates the picture of a tree

□ Indicates the picture of milkweed

□ Indicates multiple pictures

□ Attends to other stimuli

□ No response

Science Narrative Screen, Educator Directions, and Teacher-Administered Item— Node 3

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

Figure 14. *Science Narrative Example Screen*

> ## Educator Directions:
> ## SAY: "There are many animals on a farm."

"Identify common animals" is the assessed node in this item.

Figure 15. *Educator Directions Example*

Educator Directions:

SHOW: the picture of a cat.
SAY: **"This is an animal."**

SHOW: the picture of a goat.
SAY: **"This is an animal."**

SHOW: the picture of a mouse.
SAY: **"This is an animal."**

SHOW: the picture of a cat, the picture of a goat, and the picture of a mouse.
SAY: **"Show me the cat."**

Figure 16. *Teacher-Administered Item Example—Node 3*

Choose the answer option that best describes the student's response.

□ Indicates the picture of a cat

□ Indicates the picture of a goat

□ Indicates the picture of a mouse

□ Indicates multiple pictures

□ Attends to other stimuli

□ No response

Science Narrative Screen, Educator Directions, and Teacher-Administered Item—Node 4

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

Figure 17. *Science Narrative Example Screen*

Figure 18. *Science Narrative Example Screen*

Figure 19. *Science Narrative Example Screen*

As shown here, this teacher-administered item assesses Node 4, "Determine the relationship between two organisms in a food chain."

Figure 20. *Educator Directions Example*

Educator Directions:

SHOW: the picture of the pig eating corn.
SAY: **"Pigs eat corn."**

SHOW: the picture of the chicken eating insects.
SAY: **"Chickens eat insects."**

SHOW: the picture of the horse eating hay.
SAY: **"Horses eat hay."**

SHOW: the picture of the pig eating corn, the picture of the chicken eating insects, and the picture of a horse eating hay.
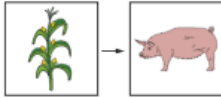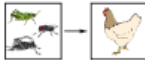SAY: **"Show me the pig eating corn."**

Figure 21. *Teacher-Administered Item Example—Node 4*

Choose the answer option that best describes the student's response.

    □ Indicates the picture of the pig eating corn

    □ Indicates the picture of the chicken eating insects

    □ Indicates the picture of the horse eating hay

    □ Indicates multiple pictures

    □ Attends to other stimuli

    □ No response

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.