Implications of New Science Frameworks for Alternate Standards, Instruction, and Assessment

http://tinyurl.com/dlmsciencecec2016

Lori Andersen, Sue Bechard, and Lindsay Ruhter

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DYNAMIC LEARNING MAPS

Session Topics

1. Brief overview of DLM science project
2. Introduction to Framework for K-12 Science Education
3. Opportunity to learn
4. Implications for instruction
5. Implications for assessment

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OVERVIEW OF DLM SCIENCE

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Brief Overview of DLM Science

- Consortium formed in 2014 to create new alternate science assessments
- *A Framework for K-12 Science Education*

  (National Research Council, 2012)

  - New structure for science content
  - Defines the breadth and depth of science content (for general education) in each grade band: K-2, 3-5, 6-8, 9-12
  - Basis of the *Next Generation Science Standards*

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DLM Science Consortium

- 2014/2015: 4 states
  - Spring 2015 Pilot Test: 1,605 students
- 2015/2016:
  - Fall 2015 Field Test: 5 states/5,663 students
  - Spring 2016 Operational Year-End Test: Anticipate 8 states + 2 BIE schools

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DLM Science

- Builds on well-established elements from the ELA and math alternate assessments
  - Accessibility research
  - Established technology platform that includes many accessibility features (Kansas Interactive Testing Engine, called KITE)

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INTRODUCTION TO *A FRAMEWORK FOR K-12 SCIENCE EDUCATION*

A Framework for K-12 Science Education

- 3 Dimensions
  - **Disciplinary Core Ideas**
    - » Grouped by discipline (PS, ESS, LS)
    - » Each core idea has 3 to 5 topics
  - **Science and Engineering Practices**
    - » 8 practices that scientists and engineers use
    - » Described as sets of smaller skills for each grade span
  - **Crosscutting Concepts**
    - » 7 overarching concepts that span multiple science disciplines (e.g., patterns)

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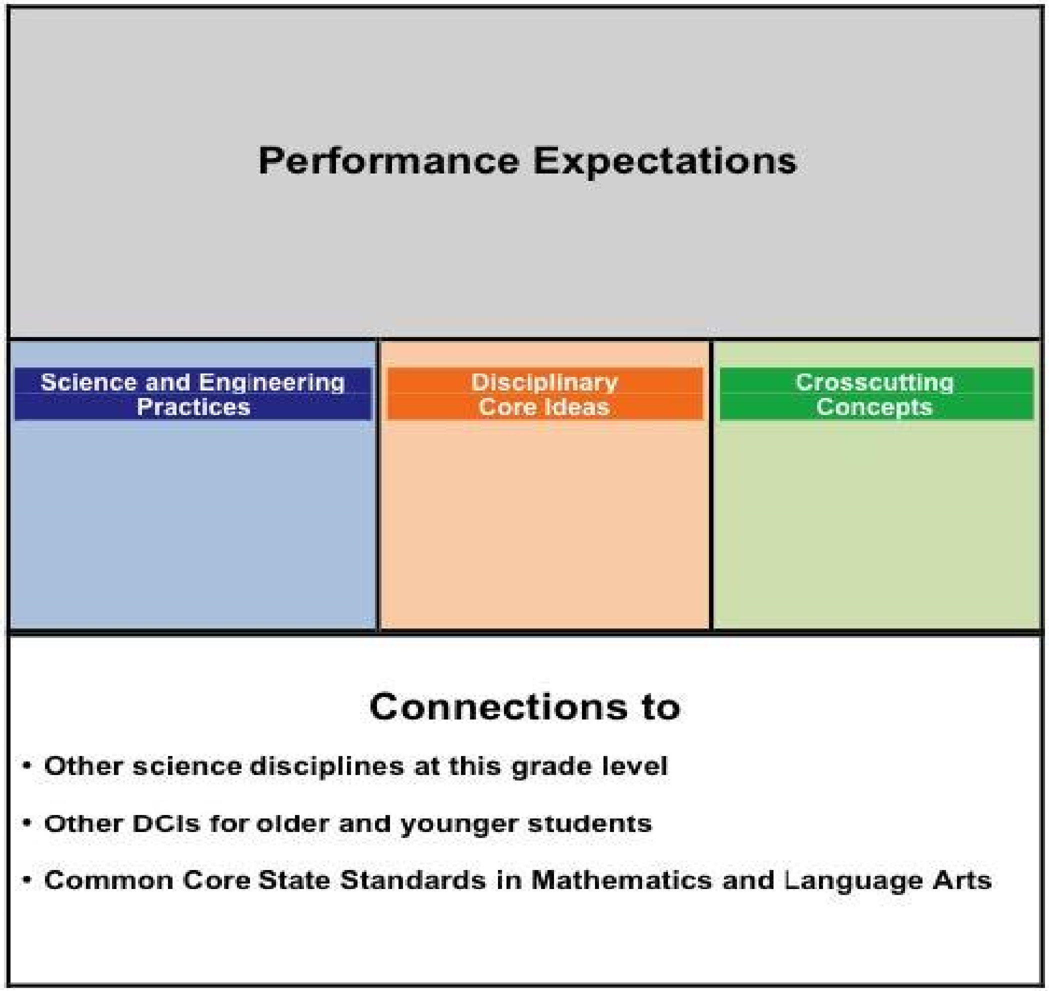
Performance Expectations are the "standards"

3.Interdependent Relationships in Ecosystems: Environmental Impacts on Organisms



Differences from prior national standards

- More emphasis on development of conceptual understanding over time
- Describes gradual (and systematic) growth to reach adult science literacy and college readiness
- Integrative approach that blends the three dimensions and includes engineering design

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Three-Dimensional Science Learning

- Every performance expectation integrates the three dimensions
- Content knowledge is gained and expressed through the practices
- Connections are made across topics using crosscutting concepts

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Challenge of the New Framework

- Presents a challenge to the entire field of science education because the structure is so different and new content is included.
  - The entire field of science education is in transition.
  - The challenge is greater for teachers of SWSCD because they typically have not been trained in how to teach science and may not have strong content knowledge.

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OPPORTUNITY TO LEARN

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Opportunity to Learn

- DLM science used a survey to find out how well what SWSCD are taught reflects the new framework.
- In the next few slides, we will ask you about the science topics that you teach and compare the results to our survey results.
- You can participate in the poll using text messages. Poll results will be updated in real time on the screen.

Disciplinary Core Idea PS1: Matter and its Interactions

Includes:

- Conservation of matter during different changes
- Properties of matter
- Chemical reactions
- Chemical properties
- Common chemical reactions in everyday life

How many hours in a school year do you plan to teach students about *Matter and its Interactions*?

Your poll will show here

1

Install the app from pollev.com/app

2

Make sure you are in Slide Show mode

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or

Open poll in your web browser

Opportunity to Learn PS1: Matter and Its Interactions

- Survey results

Hours	% of Teachers
None	20%
1-10	58%
More than 10	22%

Disciplinary Core Idea ESS1: Earth’s Place in the Universe

Includes:

- Motion of the Sun and the Earth
- Seasonal patterns
  - Day length
  - Temperature
  - Height of Sun

How many hours in a school year do you plan to teach students about *Earth’s Place in the Universe*?

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Opportunity to Learn Disciplinary Core Idea ESS1

- Survey data

Hours	% of Teachers
None	20%
1-10	54%
More than 10	24%

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Disciplinary Core Idea LS1: Structure and Function

Includes:

- How plants and animals grow
  - Sources of food
  - Effect of environmental resources on growth of organisms
  - How structures support survival of animals
  - Functions of major organs
  - Organization and interaction of organs

How many hours in a school year do you plan to teach students about *Structure and Function*?

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Opportunity to Learn Disciplinary Core Idea LS1

- Survey data

Hours	% of Teachers
None	29%
1-10	51%
More than 10	18%

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Science and engineering practices

Practice	%
Asking Questions	81%
Planning and Conducting Investigations	58%
Analyzing Data	57%
Obtaining, Evaluating and Communicating Information	57%
Developing and Using Models	56%
Using Math and Computational Thinking	42%
Constructing Explanations and Designing Solutions	29%
Argumentation from Evidence	19%

Conclusions: Content

- Many students are not taught all the topics that are on the science test blueprints.
- The students with the lowest expressive communication abilities have the least opportunities to learn science topics.
- High school students have less opportunity to learn science than other students.

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Conclusions: Practices

- Many students have not had opportunities to use some of the practices
- Most students have had opportunities to use some practices.
- Many teachers/districts have not yet fully integrated the new *Framework* into science instruction.
- Resources are needed to help teachers to teach science.

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Sue Bechard

IMPLICATIONS FOR INSTRUCTION OF SWSCD

What do we know about the students?

- 2015 Fall Field Test Teacher Survey
  - Opportunity to learn science content
  - Opportunity to engage in science practices
- First Contact (FC) Survey
  - Must be completed for each student prior to testing
  - Determines appropriate level of difficulty of first testlet (student's performance then drives adaptivity)

First Contact Survey Information

- Special Education Services
  - Disability
  - Placement
- Student Functioning
  - Hearing
  - Vision
  - Mobility and health
- Computer Use
- Communication
  - Expressive
  - Alternate
  - Receptive
- Academic Skills
  - Reading
  - Mathematics
  - Writing
  - Science

Students taking DLM alternate assessments*

- 81% of students are characterized as having an intellectual disability, autism, or multiple disabilities.
- 67.6% of students are taught primarily in separate classrooms from their grade-level peers.
- 76% of students use expressive speech to communicate.
- 96% of the students access a computer using conventional means or an assistive device.
- Almost 60% of all students across grade levels read at the first grade level or below.

**DLM Census Survey 2012-13 (44,000 students, 14 states)*

Participant Demographics
Fall 2015 Field Test

- 64.8% male, 35.2% female

- 74.4% Caucasian
- 18.7% African American
- 2.2% Two or more races
- 2.0% Asian
- 1.7% American Indian

- Less than 1% participated in ESOL

Grade	Percent
3	4.8
4	6.1
5	19.8
6	6.4
7	6.3
8	20.5
9	6.0
10	8.8
11	16.3
12	5.1

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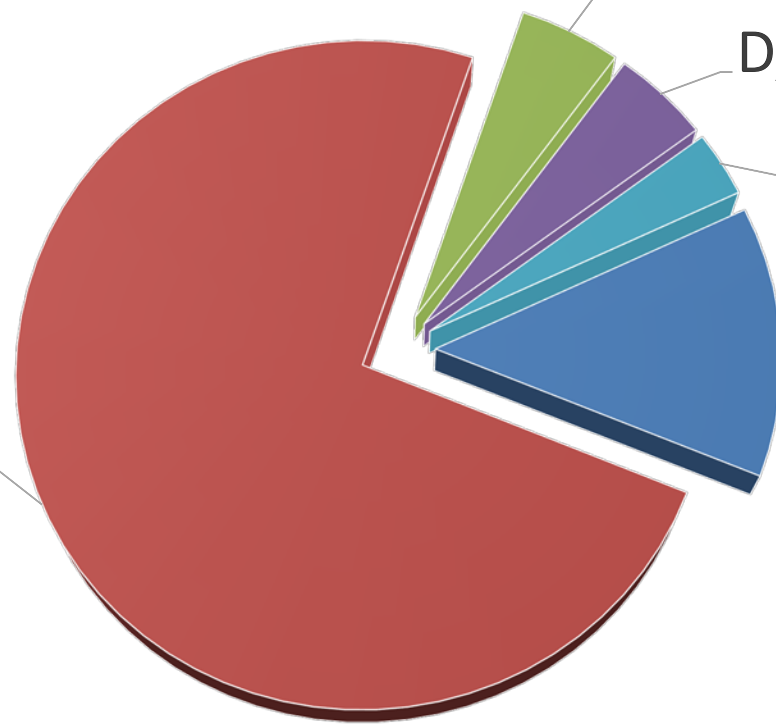
Participants by State

Fall 2015 Field Test (n = 5,669)



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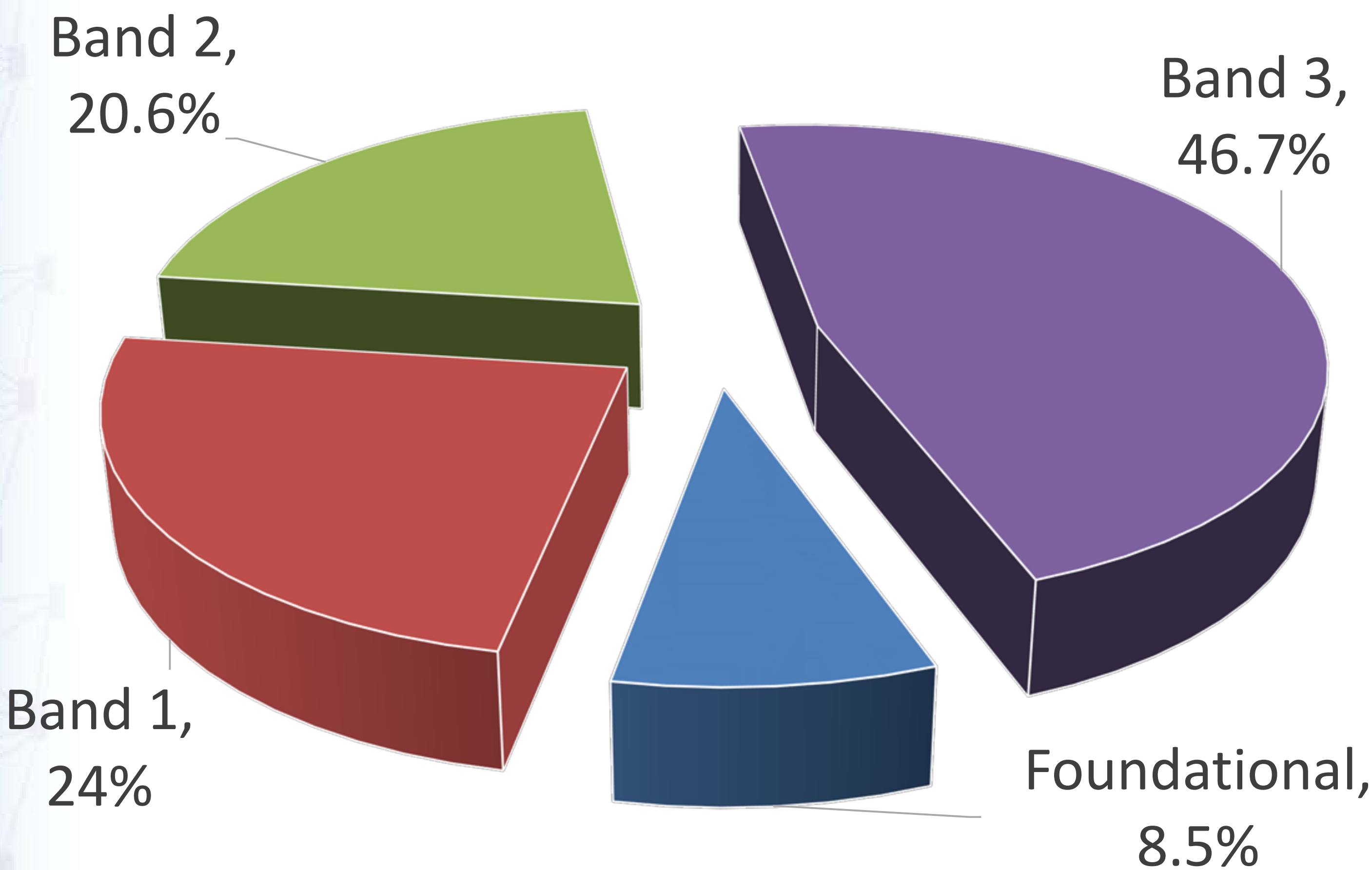
Participants by Communication Band

Fall 2015 Field Test (n = 5,669)



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Implications for Instruction of SWSCD in Science

- Complexity of new science standards
- Combining science content with practices and cross-cutting concepts
- Familiarity with new science standards for all teachers (especially teachers in special education)
- Lack of opportunity to learn and demonstrate new science performance expectations for SWSCD

How can science content and practices be made accessible for SWSCD?

- Develop alternate science standards that describe performance expectations at varying levels of cognitive complexity.
- Provide connections to alternate ELA and math standards (and skills students are already learning and using).
- Support educators with examples of activities that differentiate science instruction for students.

Connections to ELA and Math

Science and Engineering Practices

- Use development of skills in the science and engineering practices to adapt for SWSCD
- Build on and correlate with existing ELA/Math skills at the same grade levels

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Example: EE.MS-PS1-2

- **Target Level:** Interpret and analyze data on the properties (e.g., color, texture, odor, and state of matter) of substances before and after chemical changes have occurred (e.g., burning sugar or burning steel wool, rust, effervescent tablets).

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Example: EE.MS PS1-2

- **Connections to Science Practices**
  – Analyzing and Interpreting Data
- **Connections to ELA Essential Elements**
  – N/A
- **Connections to Mathematics Essential Elements**
  – **EE.6.SP.5:** Summarize data distributions shown in graphs or tables.
  – **EE.1.MD.4:** Organize data into categories by sorting.

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Science and Engineering Practices Adapted for SWSCD*

Science/Engineering Practice	Middle School
Analyzing and interpreting data	In addition to EL, data include: tables; graphical displays (bar or line graphs, pictographs, pie charts).
	Analysis can be used to: reveal patterns that indicate relationships; make sense of phenomena; discuss similarities and differences in findings; refine a problem statement.
	Students can be asked to: conduct multiple trials of qualitative observations; represent, analyze, and interpret data; use data to evaluate and refine design solutions.

*Adapted from NGSS, Appendix F

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Science Activity Examples

- Example of activities:
  - Elementary - analyzing data/Earth and the solar system
  - Middle - structure and properties of matter/analyzing data
  - High - Organ systems/structure & function/models
- Activities can be downloaded from http://www.dynamiclearningmaps.org/content/erp_sci

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Science Activity Example: EE.MS-PS1-2 (handout)

Target Level:	Precursor Level:	Initial Level:	Accessibility Considerations for Practice
EE.MS-PS1-2 Interpret and analyze data on the properties of substances before and after a chemical change	Gather data on the properties of substances before and after a chemical change	Observe and identify examples of change (color, temperature, odor)	• Data may be presented in graphical and/or tactile representations or by using objects for key visuals that represent concepts • Provide brief verbal description of visual phenomena, results, or patterns in the data • Consider the sensory capabilities of the student when selecting the best chemical change to use for the activity

Activity Title:	Estimated Classroom Time Needed:	Essential Questions for Concept
Chemical changes	Varies depending on which chemical reaction activity is selected.	• Does the student recognize that a chemical process results in a new substance? • Can the student recognize which properties of a substance change due to the chemical process?

Suggested Materials
Option 1: Steel wool, water, dish
Option 2: 3-5 pennies, vinegar, paper towel, saucer
Option 3: Effervescent tablet, 100 mL water, zip-top plastic bag
Option 4: 1L plastic bottle, a large balloon (18 in), a teaspoon of baking soda, 3 Tablespoons of vinegar, cellophane tape

Engage Students in the Activity
Tell students they are performing an experiment. Ask them to predict if anything will happen when the two substances (e.g., Option 4 - baking soda and vinegar) are combined. Tell the students they will be identifying changes in properties.

Activity Description
Teachers may choose an appropriate activity from the options below or may use another example of chemical change according to the needs of the student. *See Activity Option 3 for use with students with visually impairments.*

Activity Option 1: Students will observe changes in a piece of steel wool once it gets wet. A piece of steel wool should be handled and observed by each student. Direct students to describe specific traits of the steel wool. Make a list of the traits in order to use in a compare/contrast activity later. The teacher or a student will place a new piece of steel wool in water. Without squeezing the water out, the teacher/student will place the steel wool in a dry dish. Over the next several days or weeks, make observations about the changes that occur. Draw students' attention to specific words and observations to help them compare and contrast the changes. Take pictures of the changes from day to day. Once there is noticeable rust, help students to observe the changes. Finish by comparing and contrasting the original piece to the rusty piece. Discuss that the rust is a different substance than the steel wool. We know that rust is a different substance than steel wool because it has different properties.

Activity Option 2: Students will observe changes in pennies when exposed to acetic acid (i.e., vinegar). Fold the paper towel into a square. Place the folded towel in the saucer. Pour vinegar into the saucer to wet the towel. Place the pennies on top of the wet paper towel. Wait 24 hours. The tops of the pennies will turn green. This reaction occurs because the acetate part of the acid from the vinegar combines with the copper on the pennies. The green coating is composed of copper acetate. A copper-colored penny should be handled and observed by each student. Direct students to describe specific traits of the penny. Make a list of the traits in order to use in a compare/contrast activity later. Complete activity as described above. Over the next several days or weeks, make observations about the changes that occur. Draw students' attention to specific words and observations to help them compare and contrast the changes. Take pictures of the changes from day to day. Once there is a noticeable reaction, help students to observe the changes. Finish by comparing and contrasting a copper-colored penny to a green-colored penny. Discuss that the green on the penny is a different substance than the copper penny, and that we know this because it has different properties.

Activity Option 3: Students will observe phase and chemical changes when an Effervescent tablet is placed into water. Place 100 mL of water into a zip-top plastic bag. While the student is holding the bag, the teacher or the student will place a single effervescent tablet into the water. Carbon dioxide gas will form during the reaction between citric acid, sodium bicarbonate, and the water. The effervescent tablet and bag of water should be handled and observed by each student. Direct students to describe specific traits of each. Make a list of the traits in order to use in a compare/contrast activity later. Complete activity as described above. Make observations about the changes that occur. Draw students' attention to specific words and observations to help them compare and contrast the changes, including what they hear and feel as the reaction takes place. Help students to observe the changes the reaction occurs. Finish by comparing and contrasting the original reactants (i.e., the tablet and water) to the product. Discuss that the product is a different substance than the reactants, and that we know this because it has different properties (e.g., has bubbles). Note how the reaction consists of all three phase of matter, and how matter can be transformed.

Activity Option 4: Students will observe a chemical change when vinegar and baking soda mix together. Pour the baking soda into the bottle, and the vinegar into the balloon. Attach the open end of the balloon to the mouth of the bottle. Use the tape to secure the balloon to the bottle. Raise the balloon to allow the vinegar to pour into the bottle. As the chemical reaction takes place, the balloon will inflate because it becomes filled with the carbon dioxide gas produced. The baking soda and vinegar should be handled and observed by each student. Direct students to describe specific traits of each. Make a list of the traits in order to use in a compare/contrast activity later. Complete activity as described above. Make observations about the changes that occur. Draw students' attention to specific words and observations to help them compare and contrast the changes, including what happens to the balloon as the reaction takes place. Help students to observe the changes the reaction occurs. Finish by comparing and contrasting the original reactants (i.e. the baking soda and vinegar) to the product. Discuss that the product is a different substance than the reactants, and that we know this because it has different properties (e.g., phase change to gas). Note how the reaction consists of all three phase of matter, and how matter can be transformed.

Ideas for differentiating the activity

At the target level:	*At the precursor level:*	*At the initial level:*
Determine the property changes that occur during chemical reactions by analyzing a table of the properties of substances before and after a chemical reaction. Interpret the meaning of property changes that occur during a chemical reactions. (e.g., Option 1 - steel wool and water): Day 1: steel wool is dry and silver Day 2: steel wool is wet and silver Day 3: steel wool is wet and has brown spots.	Make a table to display data on the properties of substances (e.g., Option 2 - copper penny) before and after a chemical reaction. -Combine a picture format with text to assist with understanding	Make simple observations (phase of matter, texture, smell, color, hardness, etc.) of properties of substances, focusing attention on changes that occur with chemical reactions. (e.g., Option 3 - Effervescent tablet and water) -Allow the students to touch, smell, etc.

Checks for Understanding

At the target level, students will:	*At the precursor level, students will:*	*At the initial level, students will:*
Complete the table with text information or a timeline of pictures from the experiment. Compare the final properties to the initial properties. Understand that during a chemical change a different substance is formed. The new substance has different properties than the original substances.	Students put descriptions of properties in an organized data table. Properties include: state of matter, color, texture, and odor. Students sort pictures of the items into a before and after chart.	Indicate which picture shows the substances after the reaction (e.g., Option 2 - Which picture shows the penny after it reacts with vinegar?). Provide symbol support for the student to show understanding

Review questions

- Is the content aligned with the linkage levels?
- Is the science content accurate?
- Is the activity accessible?
  - Multiple means of engagement
  - Multiple means of representation
  - Multiple means of expression

Discussion

- How would you incorporate math skills in this activity in your classroom?
- What are the most useful aspects of the information provided?
- What additional information would you need to implement this activity?

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Lindsay Ruhter

IMPLICATIONS FOR ASSESSMENT OF SWSCD

DLM ESSENTIAL ELEMENTS & LINKAGE LEVELS

Challenges of science expectations

- Make the performance expectations of K-12 Frameworks accessible to SWSCD

Essential Elements for Science

- Specific statements of knowledge and skills linked to the grade-span performance expectations (EL, MS, HS) identified in the *Framework for K-12 Science Education* (National Research Council, 2012)
- Represent the most frequently assessed topics identified in alternate standards from seven DLM Science states.
- Focus on both content and practices

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What are Essential Elements?

Purpose of DLM EEs:

- To align to grade level science standards without compromising learning and development over time.
- EEs reflect both horizontal alignment with the grade level standards and vertical alignment across the grades.
- To specify appropriate learning targets for SWSCD without prescribing how students can engage in instruction or demonstrate understanding through an assessment (e.g., built with principles of Universal Design for Learning).

What are Essential Elements?

- Reduced depth, breadth, complexity
- Are *not* functional or pre-K skills or instructional descriptions
- Provide appropriate level of rigor and challenge
- A starting point for defining achievement standards
- Focus on the skills (with multiple means of demonstration)

DLM Essential Elements are NOT:

- Replacements for the general education grade level standards
- Downward extensions to pre-K
- Statements of functional skills
- Curriculum or learning progressions
- IEP goals or benchmarks

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DLM Science States' Selected Topics by Domain for all Grade Spans

Physical Science	Life Science	Earth/Space Science
Structure & Properties of Matter	Structure & Function	Earth & the Solar System
Forces and Motion	Growth & Development	Earth Materials & Systems
Conservation & Transfer of Energy	Interdependent Relationships in Ecosystems	Weather & Climate
	Inheritance & Variation of Traits	Natural Resources
	Adaptation	Human Impacts on Earth Systems

DLM Essential Elements Framework

Number of State Standards Addressed in EE Development: N=48

Grade Span	Physical Science	Life Science	Earth & Space Science	Total
Elementary	4	2	3	9
Middle School	4	4	6	14
High School	4	5	6	15
High School Biology	N/A	10	N/A	10

What are Essential Elements?

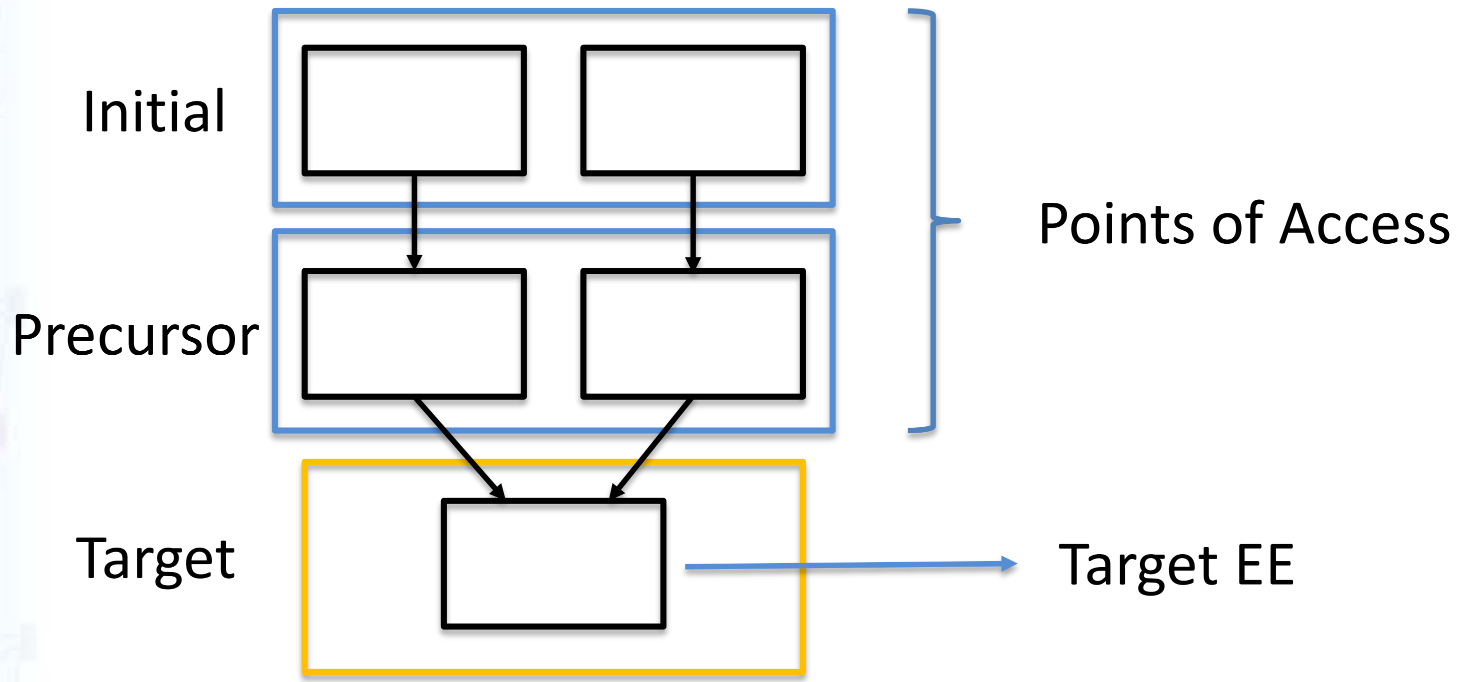
- Example: Elementary Physical Science

Frame-work Code	Grade Level Performance Expectation	EE Target Code	EE Target Level Description
5.PS.1.2	Measure & graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.	EE.5.PS.1.2	Use standard units to compare weights of substances before and after a change occurs when heating, cooling, or mixing substances.

Linkage Levels – A Definition

- Linkage levels (LLs) contain one or more learning targets that precede an identified EE. Links both identify important milestones en route to an EE and specify where a student is in relationship to the grade-span target.
- Science currently has two linkage levels that precede the Target EE:
  - Precursor
  - Initial

Relationship of EEs & LLs



EE Linkage Level Example: Middle School Physical Science*

Essential Element: EE.MS-PS1-2 **Target Level:** Interpret and analyze data on the properties (e.g., color, texture, odor, and state of matter) of substances before and after chemical changes have occurred (e.g., burning sugar or burning steel wool, rust, effervescent tablets).
Precursor Level: Gather data on the properties (e.g., color, texture, odor, and state of matter) of substances before and after chemical changes have occurred (e.g., burning sugar or burning steel wool, rust, effervescent tablets).
Initial Level: Observe and identify examples of change (e.g. state of matter, color, temperature, and odor).

*http://dynamiclearningmaps.org/content/essential-elements

Overview of DLM testlets

- Assessment items are grouped together in a testlet
  - Different from traditional multiple-choice assessments and portfolio alternate assessments
- Engagement Activity to activate prior knowledge and provide context
  - Science story
- 3-5 items
- Images

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Implications for Assessment

- Assessments must address DCIs and SEPs
    - Testlets engage students in the practices
    - Testlets assess knowledge of core ideas through practices
    - Very different from traditional science test items that rely on memory/recall

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Implications for Assessment

- Assessments should model pedagogically relevant contexts
  - Clear link between content, instruction and assessment
  - Engagement activities modeled after good instructional activities
  - Example testlet with science story and experiment on the following screens.

Example Testlet

- EE.HS.PS2-3.P
- Precursor level
- Use data to compare the effectiveness of safety devices to determine which best minimizes the force of a collision
- Science Practice: Constructing Explanations and Designing Solutions
- Testlet rooted in context of a good instructional activity and experiment.

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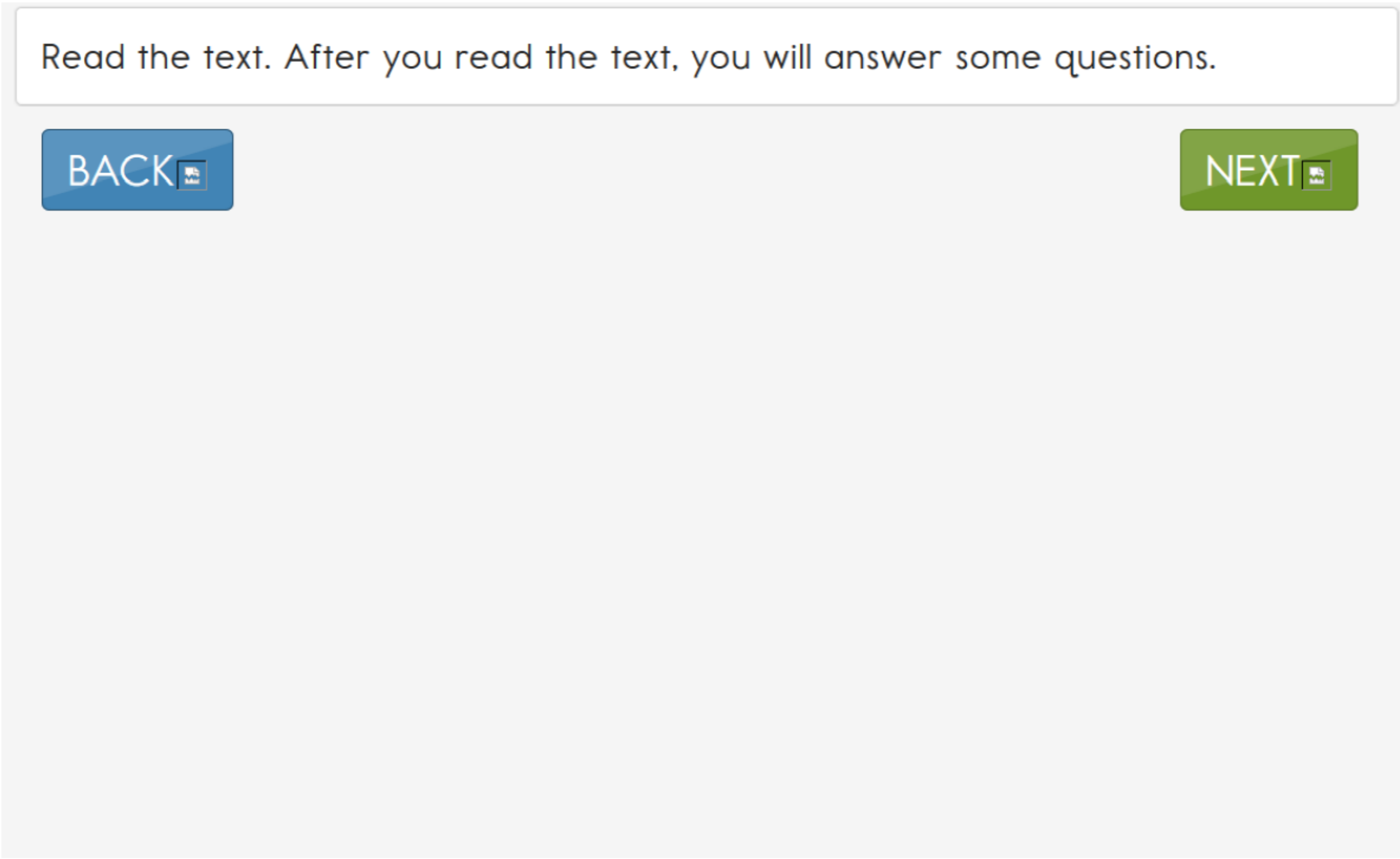
Example Testlet

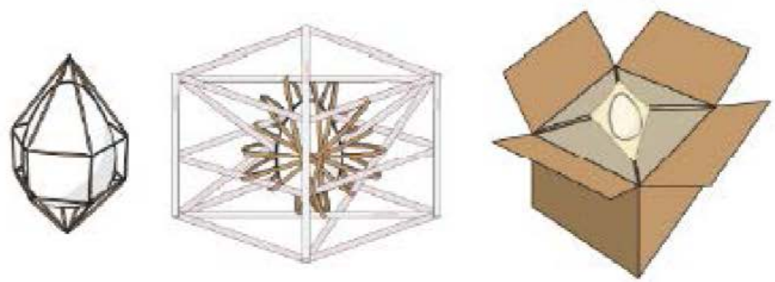


Example Testlet

Example Testlet

Example Testlet

Tomas makes 3 egg safety devices.



Device 1 Device 2 Device 3

BACK

EXIT DOES NOT SAVE

NEXT

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Example Testlet

Tomas drops the egg safety devices from different heights. Tomas compares the 3 safety devices. Tomas makes a table.

Safety Devices

Device	Safe Drop Height
1	10 feet
2	15 feet
3	18 feet

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Example Testlet

Tomas compares the 3 safety devices. Tomas makes a table.

Safety Devices

Device	Safe Drop Height
1	10 feet
2	15 feet
3	18 feet

Which device has the biggest safe drop height?

Device 1

Device 2

Device 3

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Example Testlet

Tomas compares the 3 safety devices. Tomas makes a table.

Safety Devices

Device	Safe Drop Height
1	10 feet
2	15 feet
3	18 feet

Which device lowers the force on the egg the most?

Device 1

Device 2

Device 3

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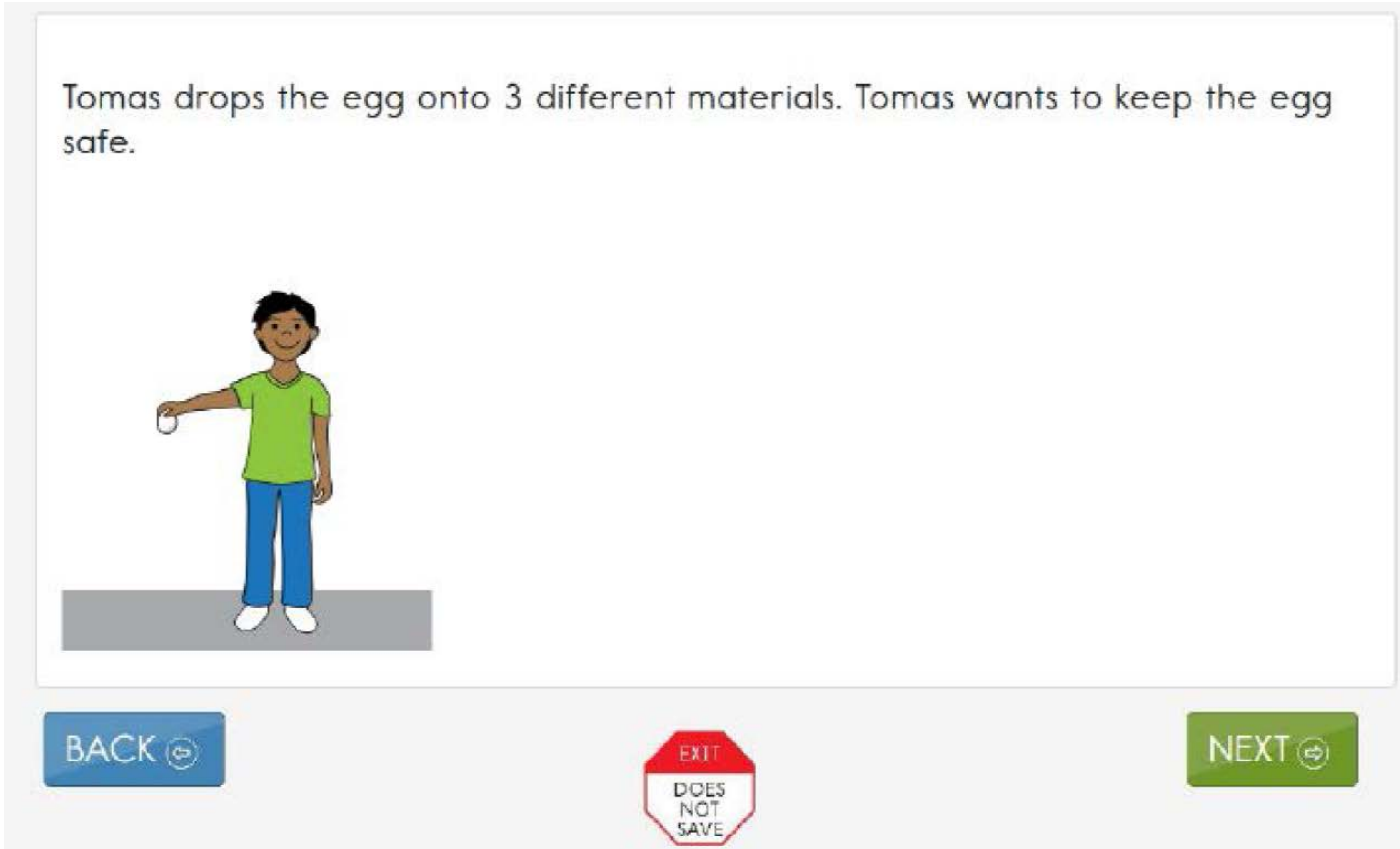
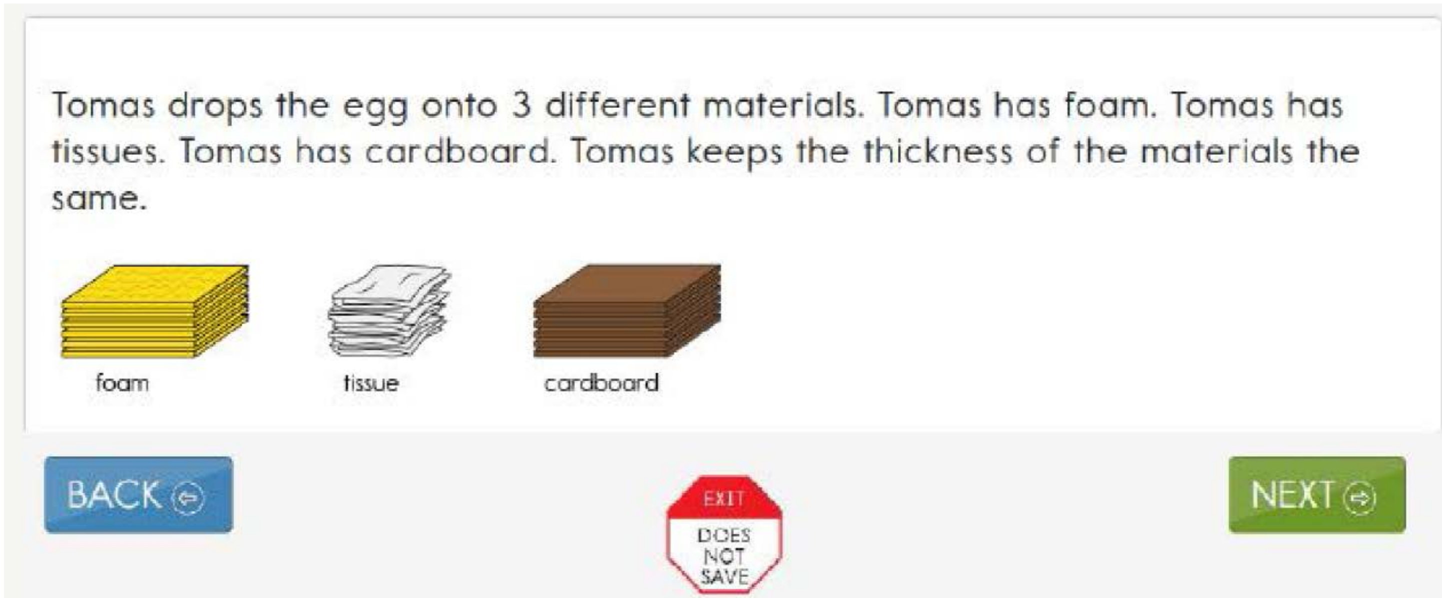
Example Testlet



Example Testlet



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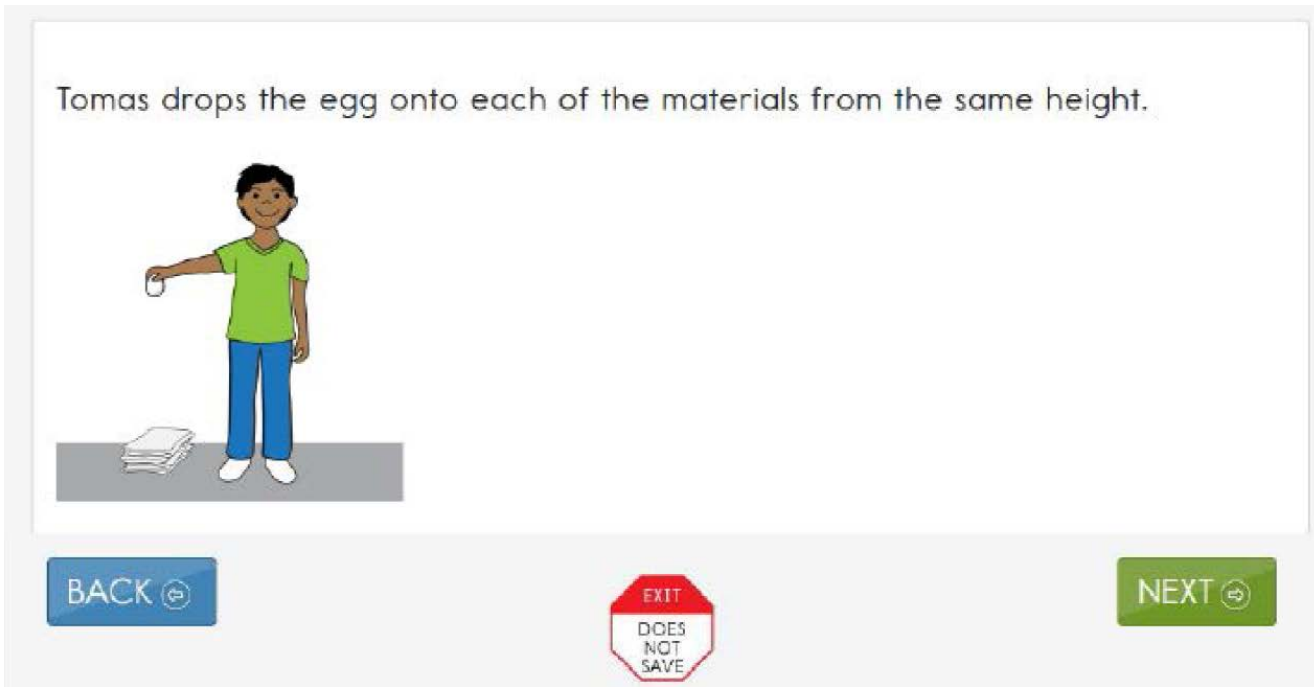
Example Testlet



Example Testlet

Tomas drops the egg onto each of the materials. Tomas checks to see if the egg is safe. Tomas makes a table.

Safety Materials

Material	Safety
Foam	Safe
Tissue	Not Safe
Cardboard	Not Safe

Which material protects the egg the best?

foam

tissue

cardboard

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Example Testlet

- Instructionally relevant
  - Real-life classroom activity
  - Not a significant leap from instruction to assessment
- Engages student in the science practice
- Does not rely on long-term memory to answer questions

Example Item – Initial level

Educator Directions:

SHOW: picture of a solid stick of butter
SAY: "This is a stick of butter."

SHOW: picture of a melting stick of butter
SAY: "This is another stick of butter."

SHOW: both pictures
SAY: "Show me the one where the butter changes from solid to liquid."

BACK

EXIT
DOES NOT SAVE

NEXT

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Example Item – Initial level

- Reduced complexity
- Instructionally relevant
  - Real-life classroom activity
  - Not a significant leap from instruction to assessment
- Think about instruction for both linkage levels

Lessons Learned from Pilot and Field Test

- Minimize dependence on memory
- Accessibility concerns w/graphics and tables for students with BVI
- Challenging to assess complex assessment targets while still adhering to accessibility guidelines
- Opportunity to learn negatively affects our ability to evaluate test items

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DYNAMIC LEARNING MAPS

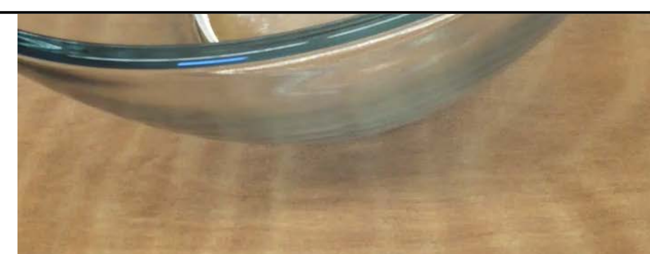
Bringing it All Together

- What can we do in our classroom to make sure a student can be successful on testlets?
  - Link between content, instruction, and assessment

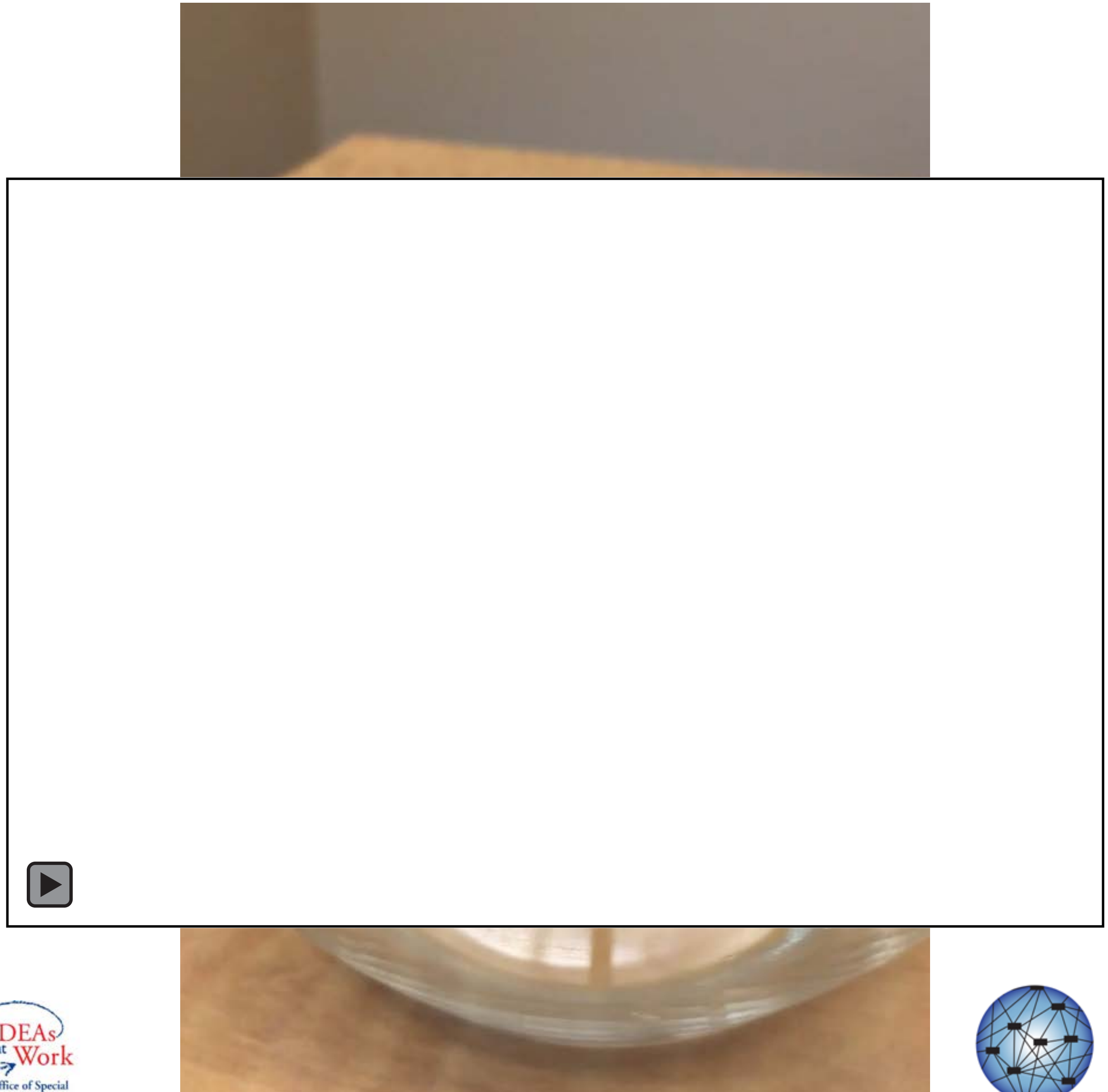
Using Essential Elements and Linkage Levels to Plan Instruction

- Review science instructional activity
  - Focus on the differentiation by linkage level
- Checks for Understanding
  - Learning through the *process* rather than direct instruction only
  - How can we check that all students understand the concept?

Baking Soda & Vinegar



The Reaction



Science Activity Example

- Baking soda and vinegar experiment
- How can we differentiate this activity by linkage level?

Discussion

- Usability
- Feasibility
- What else do educators need to implement these activities?

Thank You!

http://dynamiclearningmaps.org/

http://tinyurl.com/dlmsciencecec2016

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