The Incorporation of Math and Science Practices in Assessment & Instructional Planning

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Council for Exceptional Children 2017 Annual Meeting

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DYNAMIC LEARNING MAPS

Introductions

- Lindsay Ruhter
- Lori Andersen
- Allison Lawrence

Session Goals

- Participate in discussions about instructional activities that incorporate math and science Essential Elements.
- Learn how to plan instruction that integrates ideas from math and science practices.
- Understand how to develop integrated activities in your own classrooms using the methods shared in our presentation.
- Understand how to include differentiation into instruction to maximize accessibility.

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DYNAMIC LEARNING MAPS

Session Overview

1. Overview of Dynamic Learning Maps Alternate Assessment Consortium
2. Teacher Survey Data for Science
3. Intersection of math and science practices
4. Incorporating math and science content into lesson planning
5. Discussion of 3 instructional activities incorporating math and science practices

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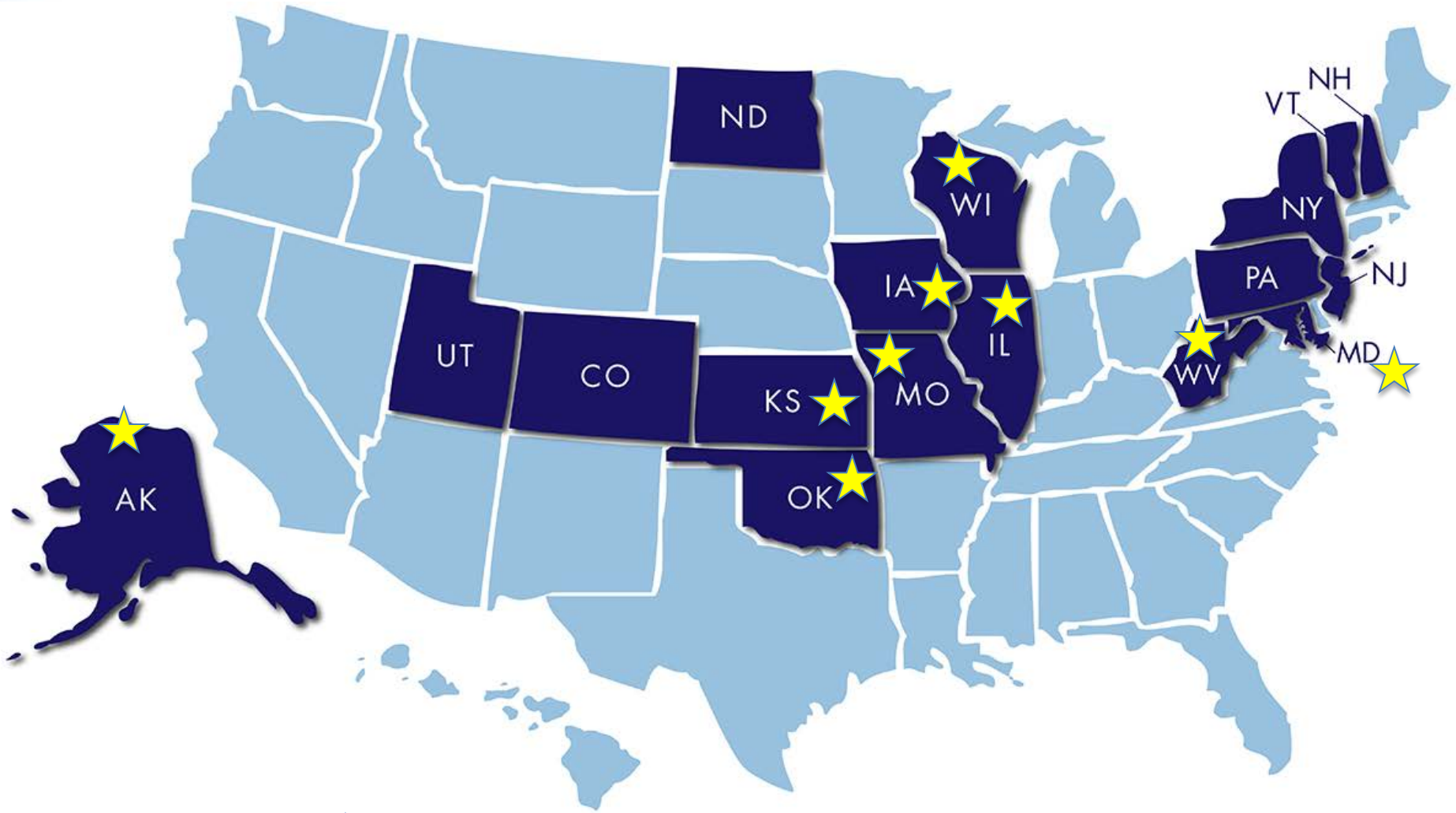
DYNAMIC LEARNING MAPS

OVERVIEW OF DLM

DLM Consortium



States participating in DLM science and math assessments

Students taking DLM assessments

- Common disability labels include autism, ID, multiple disabilities
- Over 90% can use a computer (independently or with human assistance or AT)
- 76% use speech for expressive communication
  - Speech: 71% use 3 or more words together
  - AAC users: 70% use only 1 symbol at a time

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TEACHER SURVEY DATA

Science Survey Data

- The survey was administered to 2,770 teachers of Students with Significant Cognitive Disabilities who administered the DLM science field test.
- 872 teachers responded.
- Survey questions measured students' opportunity to apply the science and engineering practices during science instruction.
- Choices included: none, 1-10 hours, 11-20 hours, 21-30 hours, or more than 30 hours.

Students' use of skills in science instruction

Skill consistently demonstrated during science instruction	% of students
Sort objects or materials by common properties	15
Identify similarities and difference	7
Compare conditions to determine if something changed	2
Use data to answer questions	2
Identify cause and effect relationships	2
Use diagrams to explain phenomena	1
Identify evidence that supports a claim	1

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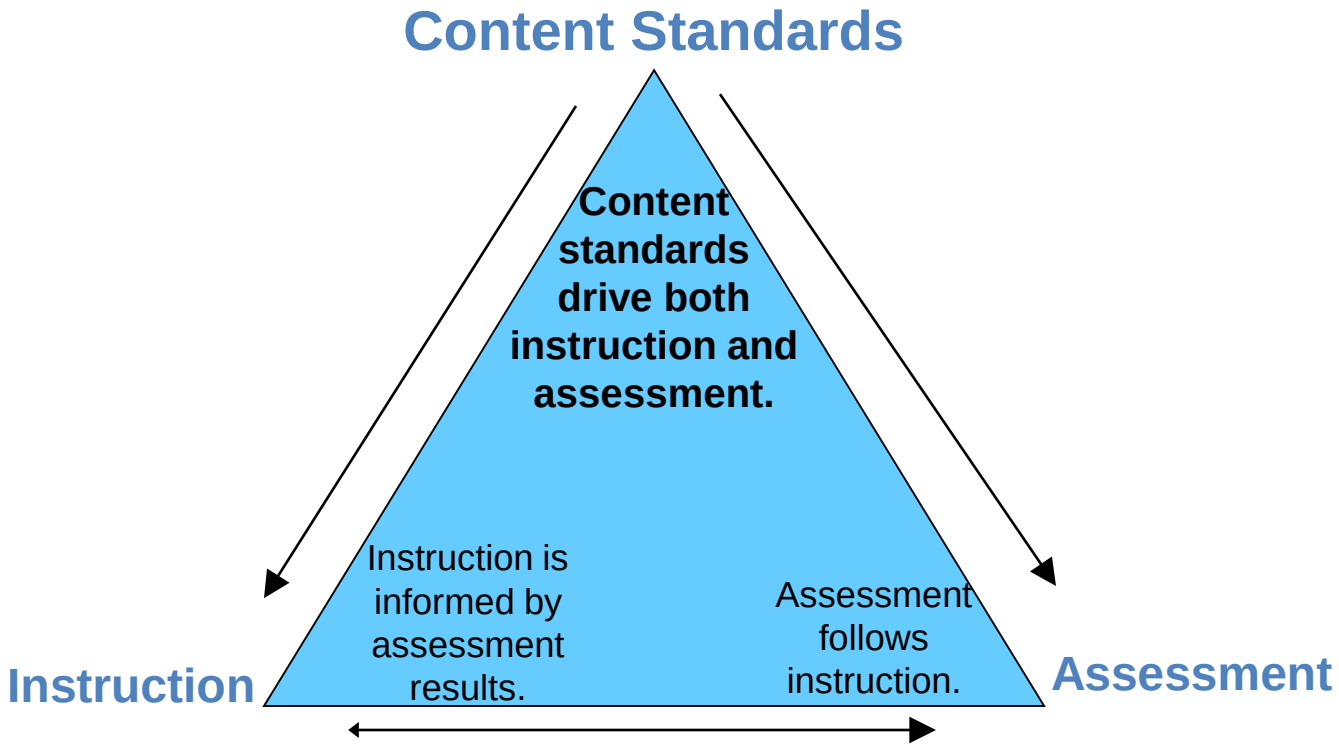
Significance of Findings

- Most students with significant cognitive disabilities have not had opportunities to use the science practices during instruction.
- It is important to provide instruction that supports students' development of these skills.

ALIGNMENT OF STANDARDS, INSTRUCTION, & ASSESSMENT

Alignment in General



DLM ESSENTIAL ELEMENTS
(CONTENT STANDARDS)

DLM Essential Elements

- Essential Elements (EEs) are statements of knowledge and skills linked to general education grade level, or grade band, expectations for students with the most significant cognitive disabilities.
- EEs build a bridge making content accessible for students.
- There are foundational EEs shared by all content areas.
- Each content area uses separate EEs, however there is considerable overlap between the types of skills measured.

DLM Essential Elements

- New standards have shifted thinking about what students should learn and be able to do in math and science
- Standards emphasize the use of practices (sets of skills) in the development of content knowledge, rather than just knowing and stating facts
- Practices are included in assessments and need to be a part of instruction

DLM ASSESSMENTS

Testlets

- Items are grouped together in testlets
  - Generally math and science testlets contain 3-9 items aligned to one or more EEs
  - Begins with an engagement activity or a story to activate prior knowledge
    - Provides a context for the testlet
    - Avoids asking questions in isolation
- In science and math, students use a blend of content knowledge and practices to answer items

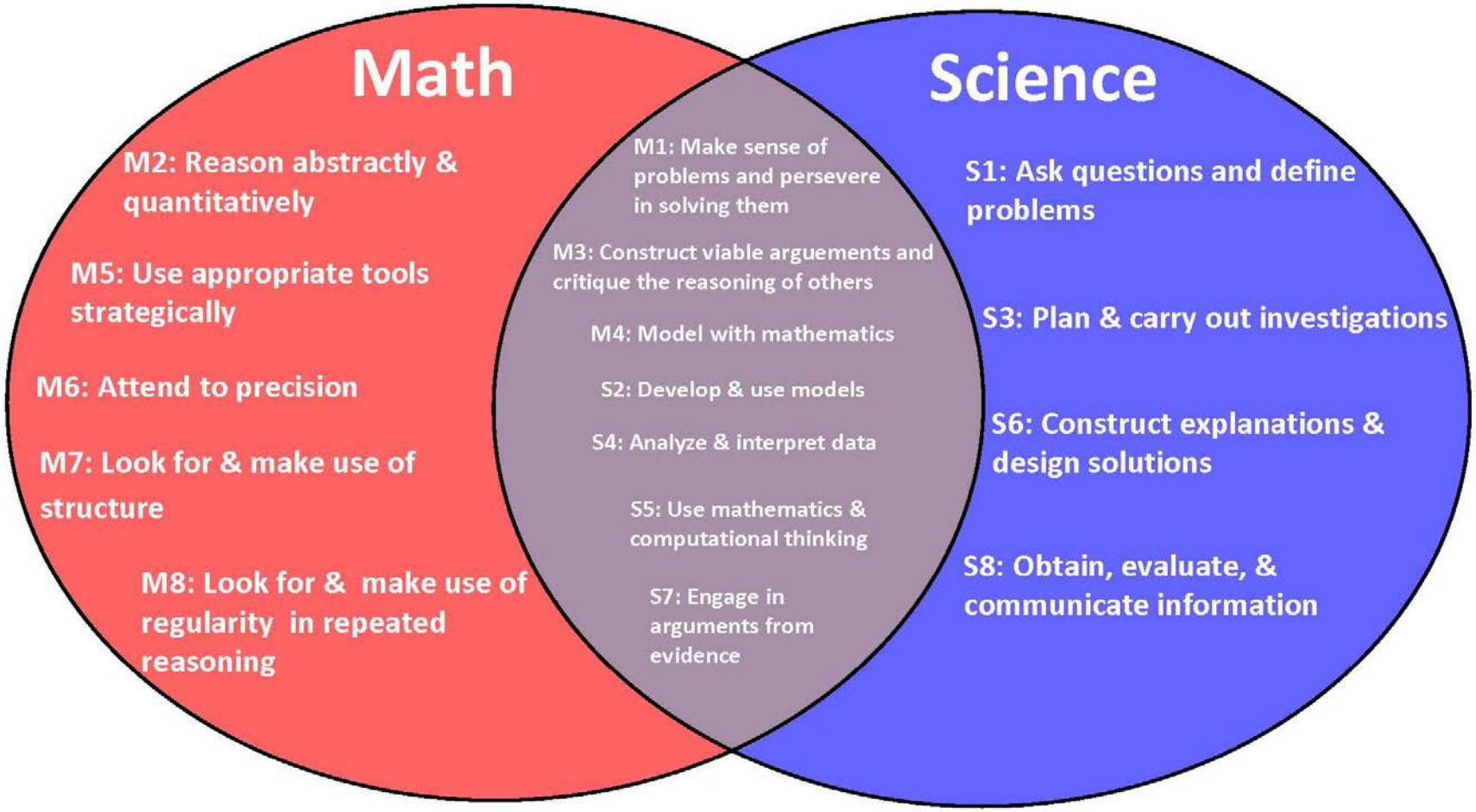
Putting It All Together

- Essential Elements (EEs) drive instruction and assessment
- Assessments (testlets) should inform and follow instruction
- Instruction must include math and science skills
- Skills are explicitly stated in the Standards of Mathematical Practice and the Science and Engineering Practices

INTERSECTION OF MATH AND SCIENCE PRACTICES

What Is A Practice?

- Sets of skills within a domain
- In the domains of math and science, there are sets of practices
  - Referred to as the Science and Engineering Practices in Science
  - Referred to as the Standards of Mathematical Practice in Math



Commonalities Among the Practices in Science and Mathematics

Based on work by Tina Chuek ell.stanford.edu

Science and Math Practices

- Standards of Mathematical Practice: 8
- Science and Engineering Practices: 8
  - Science only assesses 7 of the practices
- EEs incorporate these practices by design
  - Science explicitly identifies a practice for each EE
  - Math implicitly identifies a practice, or practices for each EE
- There is considerable overlap across the practices
- Promotes collaborative instruction

INCORPORATING MATH AND SCIENCE PRACTICES & ESSENTIAL ELEMENTS IN INSTRUCTIONAL PLANNING

Using the Overlap In Practices to Plan

- Use the overlap between math and science in the Venn diagram to guide instructional planning
  - Where do the two content areas overlap?
  - How can two sets of skills be incorporated into one lesson or unit?
- Incorporate multiple content areas in unit planning
  - Template on next slide
- Incorporate multiple content areas in classroom activities

“Big Picture” Planning

- Integrated Unit Planning Template
- Start with one content area and consider how to integrate different content areas
  - Refer to EE documents in both content areas to get started
- Integrated Unit Planning Template Tutorial
  - Walks you through how to complete the Integrated Unit Planning Template

Integrated Unit Planning Template

Unit Title:	Time Frame:	Grade Level:
Unit Summary:		
Essential Elements:		
Linkage Levels:		
Key Vocab:		
Content Connections:		
Key Concepts:		

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Integrated Unit Planning Template

Instructional Materials/Resources
Lessons/Activities:
Instructional Strategies:

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Integrated Unit Planning Template

Checks for Understanding:
Reflection and Future Ideas

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3 INSTRUCTIONAL ACTIVITIES INCORPORATING MATH AND SCIENCE PRACTICES AND ESSENTIAL ELEMENTS

Instructional Activities

- Science Instructional Activities were written and reviewed by educators in 2015
  - Educators had expertise in science content and/or the DLM population
- DLM staff saw the connections between science and math standards and practices and developed some integrated instructional activities
  - We will provide examples of 3 instructional activities at the elementary, middle, and high school levels
- The activity template makes planning cross curricular activities easier

Related Cross-Content EEs

- Example Instructional Activities Provided
  - Elementary
    - Science: 5-ESS1-2 (5th Grade Earth Space Science)
    - Math: 5.MD.2 (5th Grade Measurement and Data)
  - Middle School
    - Science: MS.PS1-2 (Middle School Physical Science)
    - Math: 8.SP.4 (8th Grade Statistics & Probability)
  - High School
    - Science: HS-ESS3-3 (High School Earth Space Science)
    - Math: S-ID.3 (High School Statistics & Interpretation of Categorical & Quantitative Data)

Elementary Activity

EE.5-ESS1-2 & M.EE.5.MD.2
Chart Area
Science and Math Instructional Activity – *page 1 of 3*

Target Level: Represent and interpret data on a picture, line, or bar graph to show seasonal patterns in the length of daylight hours	**Precursor Level:** Recognize patterns about length of daylight hours over time (e.g., week to week, month to month)	**Initial Level:** Order events in daily routine including sunrise and sunset	**Accessibility Considerations for Science and Engineering Practice: Analyzing and Interpreting Data** • 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
Content Connection: Math			
Target Level: Represent data using a bar graph, picture graph, or line plot and use the graphs to read between the data	**Proximal Precursor Level:** Use bar graphs, picture graphs, or line plots to read the data	**Distal Precursor Level:** calssify and order objects **Initial Precursor Level:** arrange objects in pairs and recognize attribute values	**Connections to Mathematical Standard of Practice:** **Make sense of problems and perservere in solving them** • Use concrete objects or illustrations to think about and solve problems • Describe posible approaches to a solution **Model with Mathematics** • Apply mathematics to solve problems in everyday life • Identify important quantities and use tools to map relationships
Activity Title: The daylight hours	**Estimated Classroom Time Needed:** One hour	**Essential Questions:** • Does the student observe patterns of sunrise and sunset? • Does the student understand that daylight hours change across seasons? • Does the student accurately interpret data presented in different forms? • Does the student accurately represent data in different forms?	
Suggested Materials • Data for the length of daylight hours over a period of time (weeks/months for precursor, a year for target) • Chart paper, markers • Graphing calculator or other computer graphing application, such as http://nces.ed.gov/nceskids/createAgraph/		**Engage Students in the Activity** Ask students about when it gets dark at night. Does it always get dark at the same time? Are there times of the year when the days are longer or shorter? Do changes in the length of the day follow a pattern?	
Activity Description Give students a table of the length of daylight hours for their city and state. Round the number of daylight hours to the nearest hour before giving data to students, and/or calculate the average for each month. Have the students create a bar graph using the data. Divide students in pairs to graph each month's daylight hours and compare each month for a city. Data Source: http://aa.usno.navy.mil/data/docs/Dur_OneYear.php			

Elementary Activity

Science and Math Instructional Activity – *page 2 of 3*

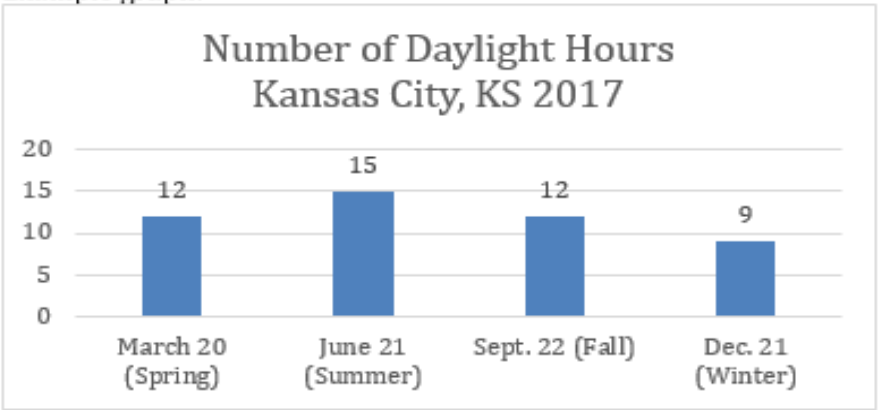
In this example the data shown is for Kansas City, Kansas in 2017:

Number of Daylight hours on the first day of each season:

March 20	Spring	12
June 21	Summer	15
September 22	Fall	12
December 21	Winter	9

After students have created a graph, have the students answer questions using the graph.

Example graph:



- Which season has the most daylight hours?
- Which season has the least daylight hours?
- What happened to the number of daylight hours from Spring to Winter?

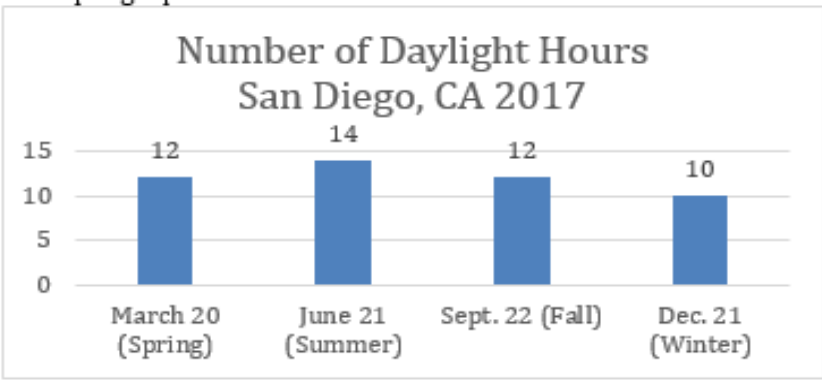
In this example the data shown is for San Diego, California in 2017:

Number of Daylight hours on the first day of each season:

March 20	Spring	12
June 21	Summer	14
September 22	Fall	12
December 21	Winter	10

After students have created a graph, have the students answer questions using the graph.

Example graph:



- Which season has the most daylight hours?
- Which season has the least daylight hours?
- What happened to the number of daylight hours from Spring to Winter?

Elementary Activity

Ideas for differentiating the activity			
At Successor level or above Target level:	***At the Target level:***	***At the Precursor/Proximal level:***	***At the Initial/Distal level:***
• Students will be provided data for two different cities and states from the source above. Students will need to calculate the mean number of daylight hours for each month in both data sets. • Students will create a graph of the mean number of hours and minutes of daylight for each month for each city/state, then compare the display of the two graphs. • Students will make conjectures based on the number of daylight hours and the position of the states chosen. For example, how do San Diego and Boston differ in the number of daylight hours in the month of June, why do you think that is?	• Students will create a bar graph of seasonal variations in the number of daylight hours. Students will then interpret the graph to answer questions about the maximum, minimum, or trend between points in time. • Students will create a bar graph of monthly variations in the number of daylight hours. Students will then interpret the graph to answer questions about the maximum, minimum, or trend between points in time.	• Students will interpret graphs or tables with data on weekly or monthly variations of the number of daylight hours to answer questions about the maximum, minimum, or trend between points in time. • Students will interpret picture graphs with data on weekly variations of the number of daylight hours and answer basic questions.	• Students will identify which is first or last when given two events which include sunset and/or sunrise. • Students will identify which day or month has more daylight hours when looking at a picture graph represented using manipulatives. • Students will identify which day or month has the same number of daylight hours.

Checks for Understanding		
At the Target/Successor level, students will:	***At the Precursor/Proximal level, students will:***	***At the Initial/Distal level, students will:***
The student correctly represents data for seasonal variations in the number of daylight hours on a graph. The student can answer questions about the graph (most/least/trend) correctly.	The student recognizes patterns for weekly or monthly variations in the number of daylight hours on a graph. The student can answer questions about the graph (most/least/trend) correctly.	The student can identify which events in a daily routine (waking up, going to bed, eating lunch, going to school, etc.) come before or after sunrise or sunset. The student can identify which months/days have the same number of daylight hours.

Middle School Activity

EE.MS.PS1-2 & EE.M.8.SP.4

Science and Math Instructional Activity – *page 1 of 3*

Target Level: EE.MS-PS1-2 Interpret and analyze data on the properties of substances before and after a chemical change	**Precursor Level:** Gather data on the properties of substances before and after a chemical change	**Initial Level:** Observe and identify examples of change (color, temperature, odor)	**Accessibility Considerations for Science and Engineering Practice: Analyzing and Interpreting Data** • 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
Content Connection: Math			
Target Level: Represent data using a bar graph, picture graph, line plot, or tally chart; use graphs and tally charts to read between the data	**Proximal Precursor Level:** Use bar graphs, picture graphs, line plots, and tally charts to read data and answer questions	**Distal Precursor Level:** Recognize structure of a bar graph, line plot, picture grpah, tally chart **Initial Level:** Classify and order objects	**Connections to Mathematical Standards of Practice:** **Make sense of problems and perservere in solving them** • Use concrete objects or illustrations to think about and solve problems • Describe posible approaches to a solution **Model with Mathematics** • Apply mathematics to solve problems in everyday life • Identify important quantities and use tools to map relationships
Activity Title: Chemical changes	**Estimated Classroom Time Needed:** 1 hour	**Essential Questions for Concept** • 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 Effervescent tablet, 100 mL water, zip-top plastic bag		**Engage Students in the Activity** Tell students they are performing an experiment. Ask them to predict if anything will happen when the two substances are combined. Tell the students they will be identifying changes in properties and collecting data on these changes and representing data in the form of a graph or line plot.	

Middle School Activity

Activity Description: Students will observe properties of materials before and after chemical changes when an Effervescent tablet is placed into water.

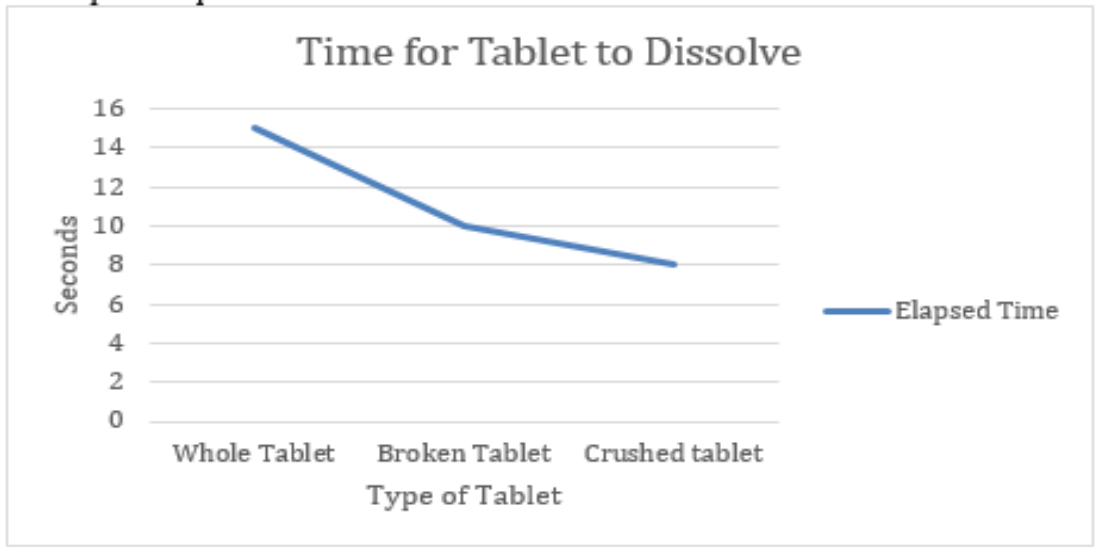
Steps:

1. Place 100 mL of water into a zip-top plastic bag.
2. While the student is holding the bag, the teacher or the student will place a single effervescent tablet into the water. (either whole, crushed, or powered)
3. Carbon dioxide gas will form during the reaction between citric acid, sodium bicarbonate, and the water. Have a student record the time it takes for the table to dissolve.
4. The effervescent tablet and bag of water should be handled and observed by each student. Direct students to describe specific traits of each. Help students to observe the changes the reaction occurs.
5. Make a list of the traits in order to compare/contrast the tablet and water from the end result. 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.
6. Graph the changes in time given the different types of tablet, and have the students make predictions about other possible scenarios. (i.e. more tablets, more water, hotter or colder water, etc.)
7. 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.
8. Possible Extension Activity: Repeat the activity using different temperatures of water and different numbers of tablets. Have a student record the time it takes for the tablet(s) to completely dissolve for each situation, and create charts and graphs.

Example Table:

Material	Properties Before Reaction	Properties During Reaction	Properties After Reaction	Time it took tablet to dissolve
1 Whole Tablet	round, white, solid	shrinking with bubbles around it	cloudy water	15 sec
1 Tablet Broken Apart	broken pieces, white, solid	shrinking with bubbles around it	water with bubbles	10 sec
1 Tablet Crushed	white, powdery	dissolves, some bubbles	powder at bottom of bag	8 sec

Example Graph:

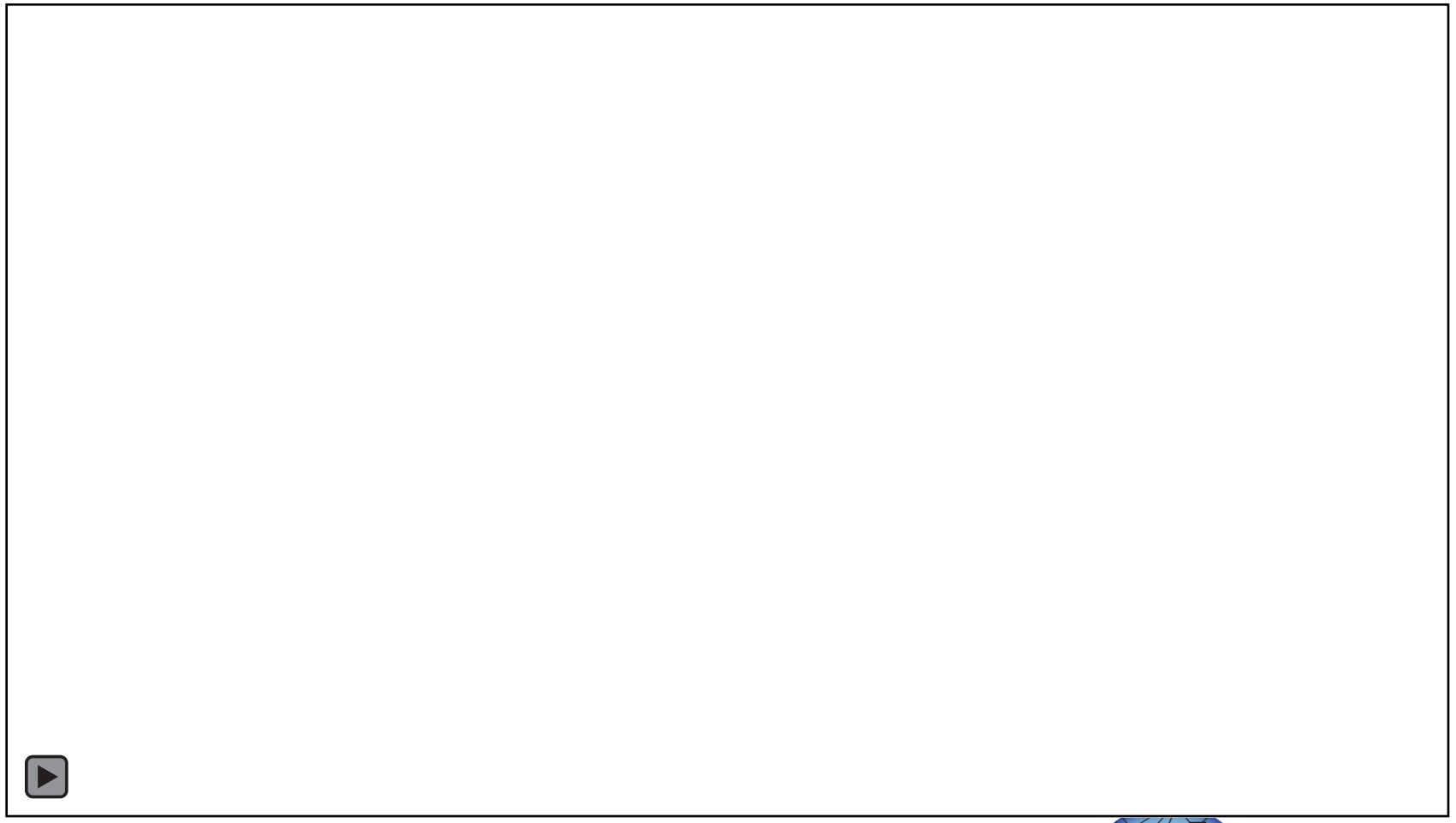


Middle School Activity

Ideas for differentiating the activity			
At the Successor level or above Target level:	***At the Target level:***	***At the Precursor/Proximal level:***	***At the Distal/ Initial level:***
• Using the data from the first set of observations, make predictions about what would happen with more than one tablet.	• Determine the property changes that occur during chemical reactions by analyzing a table of the properties of substances before and after a chemical reaction. • Discuss how the properties of the materials changed during and after the reaction.	• Make a table to display data on the properties of substances before and after a chemical reaction. • Explain chemical reactions through both pictures and text.	• Make simple observations (phase of matter, texture, smell, color, hardness, etc.) of changes that occur with chemical reactions. ○ Allow the students to touch, smell, etc. • Use pictures to sort the order in which the reaction took place.

Checks for Understanding		
At the target/successor level, students will:	***At the precursor/proximal level, students will:***	***At the initial/distal 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 Provide symbol support for the student to show understanding

Activity



High School Activity

EE.HS-ESS3-3 & M.EE.S-ID.3

Science and Math Instructional Activity – *page 1 of 3*

Primary Content Area: Science			
Target Level Analyze data to determine the effects of a conservation strategy on the level of a natural resource.	**Precursor Level** Organize data on the effects of conservation strategies (e.g., using less energy, using rechargeable batteries, recycling or repurposing materials).	**Initial Level** Gather data on the effects of a local (e.g., class or school-wide) conservation strategy.	**Accessibility Considerations for Science and Engineering Practice: Using Mathematics and Computational Thinking** • Access mathematical information through concrete pictures and/or tactile representations/objects. • Represent relationships between variables with diagrams showing only the most relevant information. • Use templates or organizers to organize data in meaningful ways.
Content Connection: Math			
Target Level: Analyze the overall shape of the data distribution and draw inferences by interpreting general trends on a graph or chart.	**Proximal Precursor Level:** Recognize characteristics of a data dirstribution, such as symmetry, outliers, peaks, and variability.	**Distal Precursor Level:** Recognize the structure of data displays such as pie charts, bar and picture graphs, and line plots. **Initial Precursor Level:** Classify and order groups of objects or data	**Connections to Mathematical Standard of Practice:** **Make sense of problems and perservere in solving them** • Use concrete objects or illustrations to think about and solve problems • Describe posible approaches to a solution **Model with Mathematics** • Apply mathematics to solve problems in everyday life • Identify important quantities and use tools to map relationships
Activity Title Conserving Natural Resources	**Estimated Classroom Time Needed** One session (recycling program can be ongoing)	**Essential Questions** • Can the student determine whether a conservation strategy was effective? • Can the student recognize the effect of conservation on our natural resources?	
Suggested Materials • Pictures or tactile representations of natural resources (e.g., wind, soil, water, wood, coal, oil, sunshine) • Recycled materials		**Engage Students in the Activity** Have a discussion about the importance of recycling. Build on prior knowledge about natural resources (e.g., water, wood, metal, coal)—materials in the environment that humans use for many things. Natural resources are used for electricity, transportation, and many objects. Some resources are limited, and we cannot get more of them (i.e., not renewable in 100 years), like oil. This is why it is important to not be wasteful of natural resources. Talk about how students recycle and how the	

High School Activity

• Data about local recycling rates that student can organize into a table or tactile graph	community recycles to conserve natural resources. It might be helpful to compare the terms *renewable* and *recyclable*. Recycling, while using recovered resources, does not make more of a resource. Use a sample video to build or link to prior knowledge on natural resources: "Natural Resources," https://www.brainpop.com/science/energy/naturalresources/ "Resources: Welcome to the Neighborhood," https://www.youtube.com/watch?v=8LfD_EKze2M "Science Video for Kids: Natural Resources of the Earth," https://www.youtube.com/watch?v=Qw6uXh9yM54

Activity Description
In this activity, students will collect data about materials recycled in local areas.

Define (throughout the activity): recycle, natural resources

Step 1: Collect recyclable materials for the classroom or the school (e.g., paper, plastic water bottles). The students will collect data (e.g., sort into categories and count items) about the amount and type of objects being recycled. Students can sort the information in multiple ways (type of item, resource being conserved). Once sorted, students can identify which categories have the most and least amounts. An extension of this step is to create a table or a tactile graph of the data.

Sedgwick Recycling	
Year	**Tons of Paper**
2012	25,000
2013	27,000
2014	32,000

Step 2: Present students with data about local recycling. Information can be taken from government resources or can be simulated by the teacher. For example, the table includes data regarding recycling in Sedgwick County, Kansas. Here, recycling paper has increased over a 3-year period. Provide students with data points and ask them to organize the information (2012, 25,000 tons; 2013, 27,000 tons; 2014, 32,000 tons) in a table or tactile graph.

Step 3: After students have organized the information in a table or tactile graph, ask questions about the pattern of the data. Some example questions could include: Which year had the greatest (or least) amount of paper recycled? What happened the second year of collection (more or less was recycled)? Talk with students about how the data relate to the conservation of natural resources. In this example, more recycling of paper helped save more trees, a natural resource. (To elaborate on the link between recycling paper and saving trees, you can investigate how much of a natural resource is used to make something. For example, 12 trees are used to produce one ton of paper. In 2012, 25,000 tons of paper was recycled. Therefore, more than 2,000 trees were saved in 2012). You can also talk to students about the impact of recycling less—more natural resources would have to be used for the things we make.

High School Activity

Ideas for Differentiating the Activity			
At the Successor level or above Target level:	***At the Target level:***	***At the Precursor/Proximal level:***	***At the Initial/Distal level:***
• Students will compare two sets of data on different conservation strategies to draw inferences about the strategies impact on natural resources, either positive or negative. • Students will estimate future amounts of recycling based on the given data sets.	• Students will use data to determine the effects of a conservation strategy on the level of a natural resource. • Students will determine if the natural resource is increasing or decreasing due to the recycling strategy.	• Students will organize data in a table or tactile graph. • Students will represent the data in multiple forms and choose which type of data display (bar graph, picture graph, and pie chart) represents the data best.	• Students will gather data (count) from real-word conservation strategies (e.g., recycling). • Students will group like numbers together to observe patterns in the data.

Checks for Understanding		
At the Target/Successor level, students will:	***At the Precursor/Proximal level, students will:***	***At the Initial/Distal level, students will:***
Accurately identify patterns in data regarding a conservation strategy and make connections between the data and levels of natural resource (e.g., recognize patterns in recycling increasing and understanding that more recycling saves trees from being cut down to make paper).	Accurately organize or identify data in a table or tactile graph when given a prompt.	Accurately count the number of objects and identify groups of objects with the greatest and fewest numbers.

Instructional Activity Template

Primary Content Area: Science			
Target Level: *(Insert Science Linkage Level descriptions here)*	**Precursor Level:** *(Insert Science Linkage Level descriptions here)*	**Initial Level:** *(Insert Science Linkage Level descriptions here)*	**Accessibility Considerations for Science and Engineering Practice:** *(Insert Science and Engineering practice here)* •
Content Connection: Math			
Target Level: *(Insert Math Linkage Level descriptions here)*	**Proximal Precursor Level:** *(Insert Math Linkage Level descriptions here)*	**Distal Precursor Level:** *(Insert Math Linkage Level descriptions here)* **Initial Precursor Level:** *(Insert Math Linkage Level descriptions here)*	**Connections to Mathematical Standard of Practice:** *(Insert Mathematical Standard of Practice here)* •
Target Level: *(Insert Math Linkage Level descriptions here)*	**Proximal Precursor Level:** *(Insert Math Linkage Level descriptions here)*	**Distal Precursor Level:** *(Insert Math Linkage Level descriptions here)* **Initial Precursor Level:** *(Insert Math Linkage Level descriptions here)*	**Connections to Mathematical Standard of Practice:** *(Insert Mathematical Standard of Practice here)* •

Instructional Activity Template

Activity Title *(Name of Activity)*	**Estimated Classroom Time Needed** *(Usually one hour)*	**Essential Questions:** *(What do you want your students to learn during this activity?)* •
Suggested Materials *(What materials are needed?)*		**Engage Students in the Activity** *(Getting students interested in the activity)*
Activity Description (Describe activity in detail)		

Instructional Activity Template

Ideas for Differentiating the Activity			
At the Successor level or above Target level:	***At the Target level:***	***At the Precursor/Proximal level:***	***At the Initial/Distal level:***
• (List ideas for how to increase the difficulty of this activity)	• (List ideas for how to change this activity)	• (List ideas for how to include students at a lower level in this activity)	• (List ideas for how to include students at a lower level in this activity)

Checks for Understanding		
At the Target/Successor level, students will:	***At the Precursor/Proximal level, students will:***	***At the Initial/Distal level, students will:***
(How will you know students understand the material?)	(How will you know students understand the material?)	(How will you know students understand the material?)

Questions?

THANK YOU!

For more information, please contact:

dlm@ku.edu

or

Go to: www.dynamiclearningmaps.org

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