



**CLCC Spring Conference**  
**May 3, 2016**



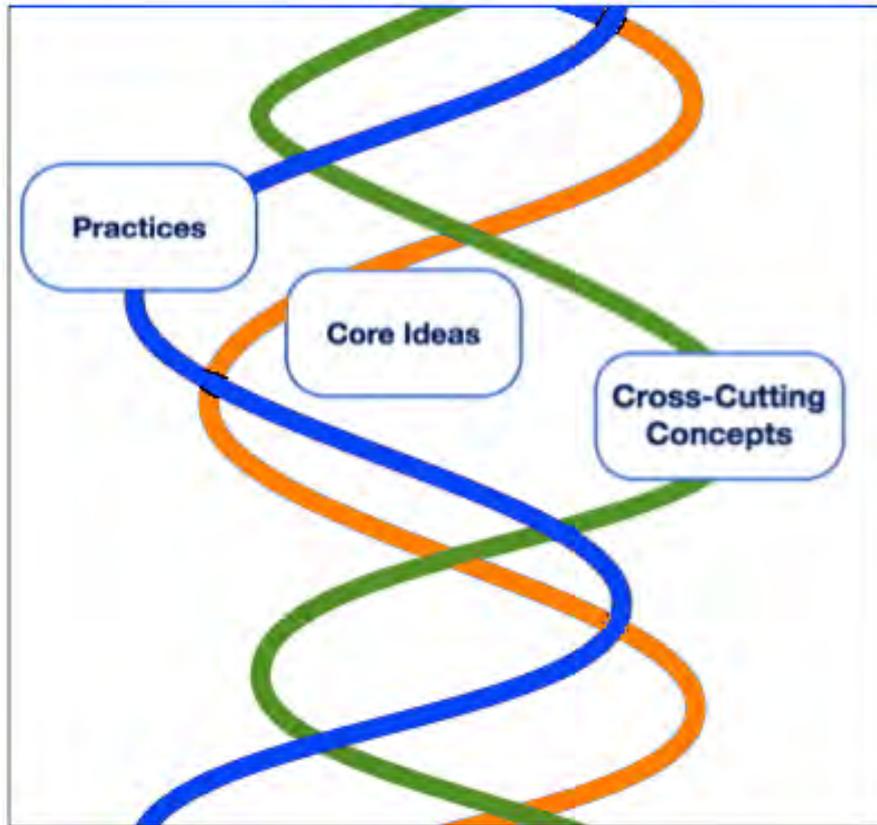
# Today's Session: Overview of Framework and the NGSS

- ▶ What does “THREE-DIMENSIONAL LEARNING” look like?
- ▶ Phenomena based instruction: Students constructing explanations
- ▶ Eight Science and Engineering PRACTICES; students making sense of phenomena and/or to design solutions to problems
- ▶ Seven CROSSCUTTING CONCEPTS provide ways of making connections of phenomena across different science disciplines
- ▶ Ideas for after school programming to support STEM learning (focus: Engineering Standards and Practices)

# Three Dimensions of the NGSS



# THREE DIMENSIONS INTERTWINED



- The NGSS are written as Performance Expectations
- NGSS will require contextual application of the three dimensions by students.
- Focus is on how and why as well as what

# Conceptional Shifts of the NGSS

1. Three-Dimensional Learning
2. Students Engaging in Phenomena and Designed Solutions
3. Engineering and Nature of Science is integrated into science
4. All three dimensions build coherent learning progressions
5. Science is connected to math and literacy



# Conceptional Shifts of the NGSS

Moving from kids...

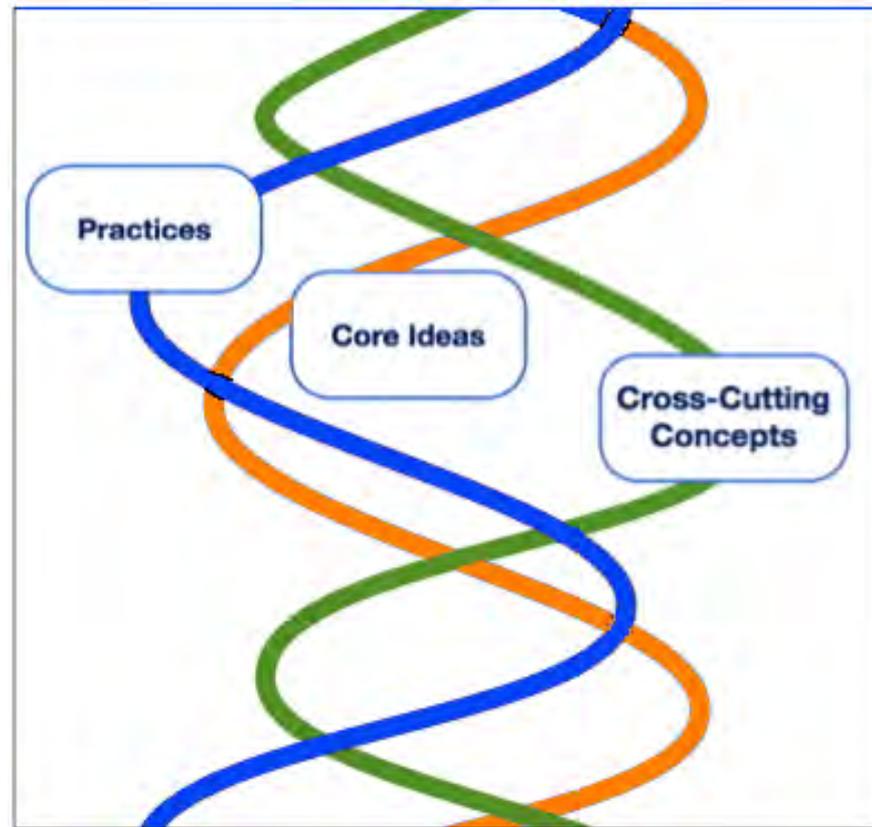
**learning about science to  
students figuring out an  
explanation or solving a problem**

Which students does  
NGSS target?

***All Students!!***

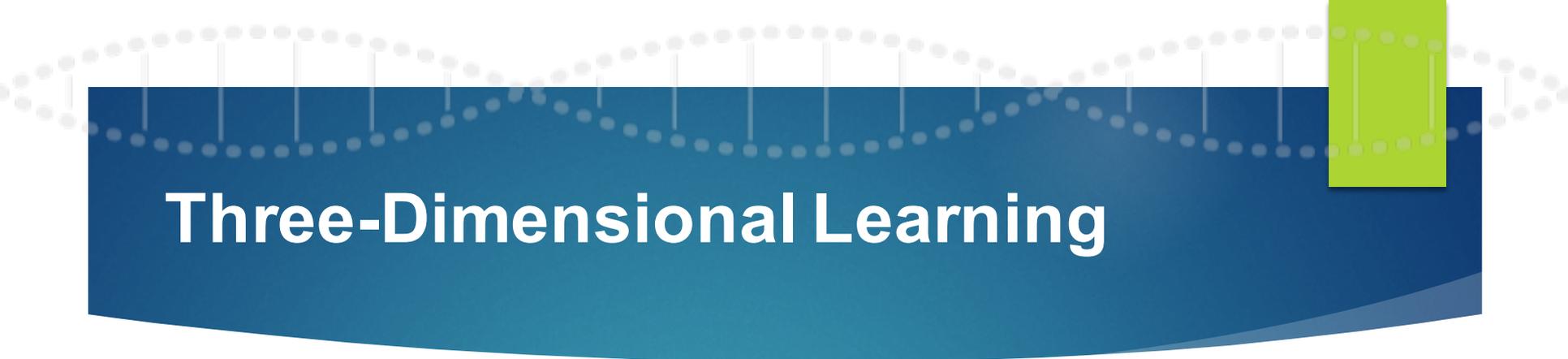


# What is Three-Dimensional Learning?



# Three-Dimensional Learning

- A. Grade-appropriate elements of the science and engineering practice(s), disciplinary core idea(s), and crosscutting concept(s), work together to support students in three-dimensional learning to make sense of phenomena and/or to design solutions to problems.
- i. Provides opportunities to develop and use specific elements of the practice(s) to make sense of phenomena and/or to design solutions to problems.
  - ii. Provides opportunities to develop and use specific elements of the disciplinary core idea(s) to make sense of phenomena and/or to design solutions to problems.
  - iii. Provides opportunities to develop and use specific elements of the crosscutting concept(s) to make sense of phenomena and/or to design solutions to problems.
  - iv. The three dimensions work together to support students to make sense of phenomena and/or to design solutions to problems.



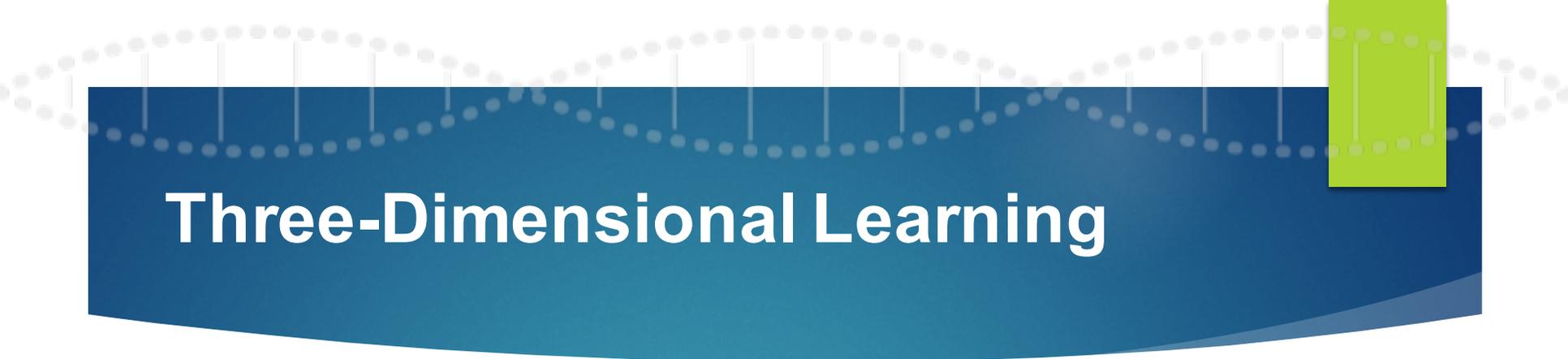
# Three-Dimensional Learning

Grade-appropriate elements of the science and engineering practice(s), disciplinary core idea(s), and crosscutting concept(s), work together to support students in three-dimensional learning to make sense of phenomena and/or to design solutions to problems.



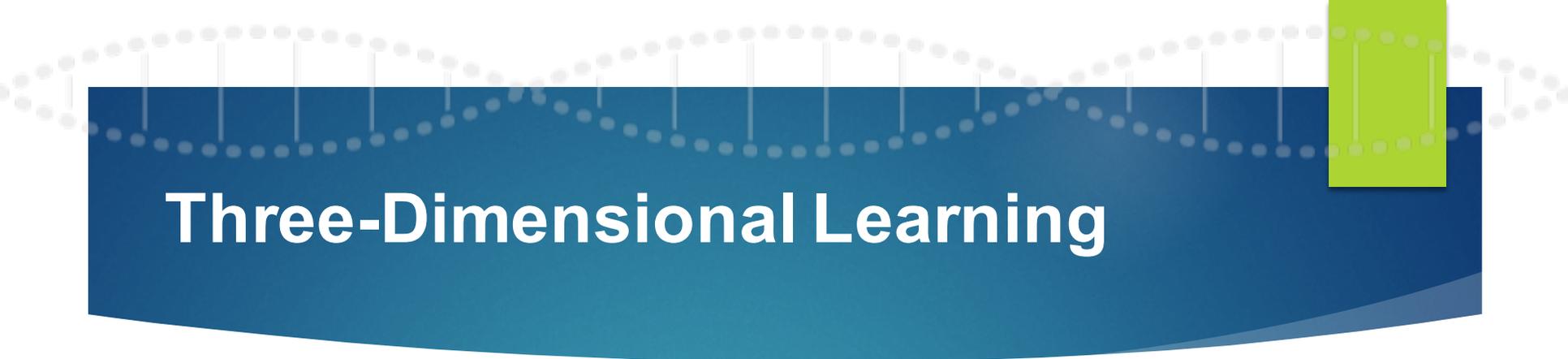
# Three-Dimensional Learning

Grade-appropriate elements of the **science and engineering practice(s)**, **disciplinary core idea(s)**, and **crosscutting concept(s)**, work together to support students in three-dimensional learning to make sense of phenomena and/or to design solutions to problems.



# Three-Dimensional Learning

Grade-appropriate elements of the science and engineering practice(s), disciplinary core idea(s), and crosscutting concept(s), **work together to support students in three-dimensional learning** to make sense of phenomena and/or to design solutions to problems.

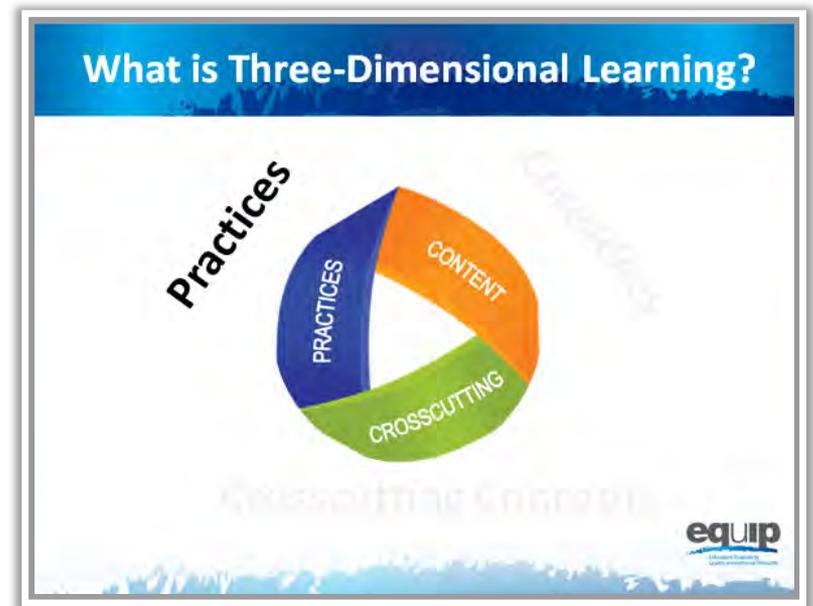


# Three-Dimensional Learning

Grade-appropriate elements of the science and engineering practice(s), disciplinary core idea(s), and crosscutting concept(s), work together to support students in three-dimensional learning to **make sense of phenomena** and/or to **design solutions to problems.**

# What Are Science and Engineering Practices?

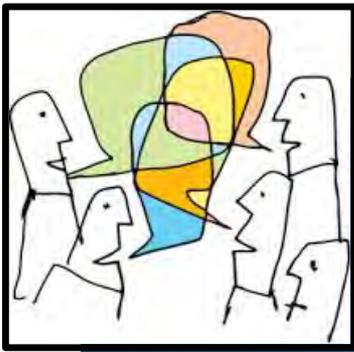
Practices are the behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems.





# Eight Science and Engineering Practices

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



# Analyzing Science & Engineering Practices

Three Dimensions of the *Framework for K-12 Science Education* being used to Develop the *Next Generation Science Standards* (NGSS)

## Scientific and Engineering Practices

### Asking Questions and Defining Problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.

Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world.

Both scientists and engineers also ask questions to clarify the ideas of others.

### Planning and Carrying Out Investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions.

### Analyzing and Interpreting Data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria—that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.

### Developing and Using Models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.

Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.

### Constructing Explanations and Designing Solutions

*The products of science are explanations and the products of engineering are solutions.*

The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.

The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

### Engaging in Argument from Evidence

*Argumentation is the process by which explanations and solutions are reached.*

In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits.

Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to identify strengths and weaknesses of claims.

### Using Mathematics and Computational Thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Statistical methods are frequently used to identify significant patterns and establish correlational relationships.

### Obtaining, Evaluating, and Communicating Information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to acquire information that is used to evaluate the merit and validity of claims, methods, and designs.

# Analyzing Practices: Investigations

## Practice 3 Planning and Carrying Out Investigations

Scientists and engineers investigate and observe the world with essentially two goals: (1) to systematically describe the world and (2) to develop and test theories and explanations of how the world works. In the first, careful observation and description often lead to identification of features that need to be explained or questions that need to be explored.

The second goal requires investigations to test explanatory models of the world and their predictions and whether the inferences suggested by these models are supported by data. Planning and designing such investigations require the ability to design experimental or observational inquiries that are appropriate to answering the question being asked or testing a hypothesis that has been formed. This process begins by identifying the relevant variables and considering how they might be observed, measured, and controlled (constrained by the experimental design to take particular values).

Planning for controls is an important part of the design of an investigation. In laboratory experiments, it is critical to decide which variables are to be treated as results or outputs and thus left to vary at will and which are to be treated as input conditions and hence controlled. In many cases, particularly in the case of field observations, such planning involves deciding what can be controlled and how to collect different samples of data under different conditions, even though not all conditions are under the direct control of the investigator.

Decisions must also be made about what measurements should be taken, the level of accuracy required, and the kinds of instrumentation best suited to making such measurements. As in other forms of inquiry, the key issue is one of precision—the goal is to measure the variable as accurately as possible and reduce sources of error. The investigator must therefore decide what constitutes

- ▶ Students create a consensus model explaining the behaviors they understand about light.
- ▶ This model is challenged in the first part of the lesson when students are asked to make predictions from their model.
- ▶ Students are then prompted to plan an investigation to collect data that can be used to enhance their model.

# Analyzing Practices: Investigations

## Practice 3

### Planning and Carrying Out Investigations

Scientists and engineers investigate and observe the world with essentially two goals: (1) to systematically describe the world and (2) to develop and test theories and explanations of how the world works. In the first, careful observation and description often lead to identification of features that need to be explained or questions that need to be explored.

The second goal requires investigations to test explanatory models of the world and their predictions and whether the inferences suggested by these models are supported by data. Planning and designing such investigations require the ability to design experimental or observational inquiries that are appropriate to answering the question being asked or testing a hypothesis that has been formed.

This process begins by identifying the relevant variables and considering how they might be observed, measured, and controlled (constrained by the experimental design to take particular values).

Planning for controls is an important part of the design of an investigation. In laboratory experiments, it is critical to decide which variables are to be treated as results or outputs and thus left to vary at will and which are to be treated as input conditions and hence controlled. In many cases, particularly in the case of field observations, such planning involves deciding what can be controlled and how to collect different samples of data under different conditions, even though not all conditions are under the direct control of the investigator.

Decisions must also be made about what measurements should be taken, the level of accuracy required, and the kinds of instrumentation best suited to making such measurements. As in other forms of inquiry, the key issue is one of precision—the goal is to measure the variable as accurately as possible and reduce sources of error. The investigator must therefore decide what constitutes

- ▶ The students design an investigation.
- ▶ Students formulate questions
  - ▶ Students consider variables and reactions
  - ▶ Record and [post all questions
  - ▶ Group questions into related ideas for possible experimentation

# Analyzing Practices: Investigations

## Practice 3

### Planning and Carrying Out Investigations

Scientists and engineers investigate and observe the world with essentially two goals: (1) to systematically describe the world and (2) to develop and test theories and explanations of how the world works. In the first, careful observation and description often lead to identification of features that need to be explained or questions that need to be explored.

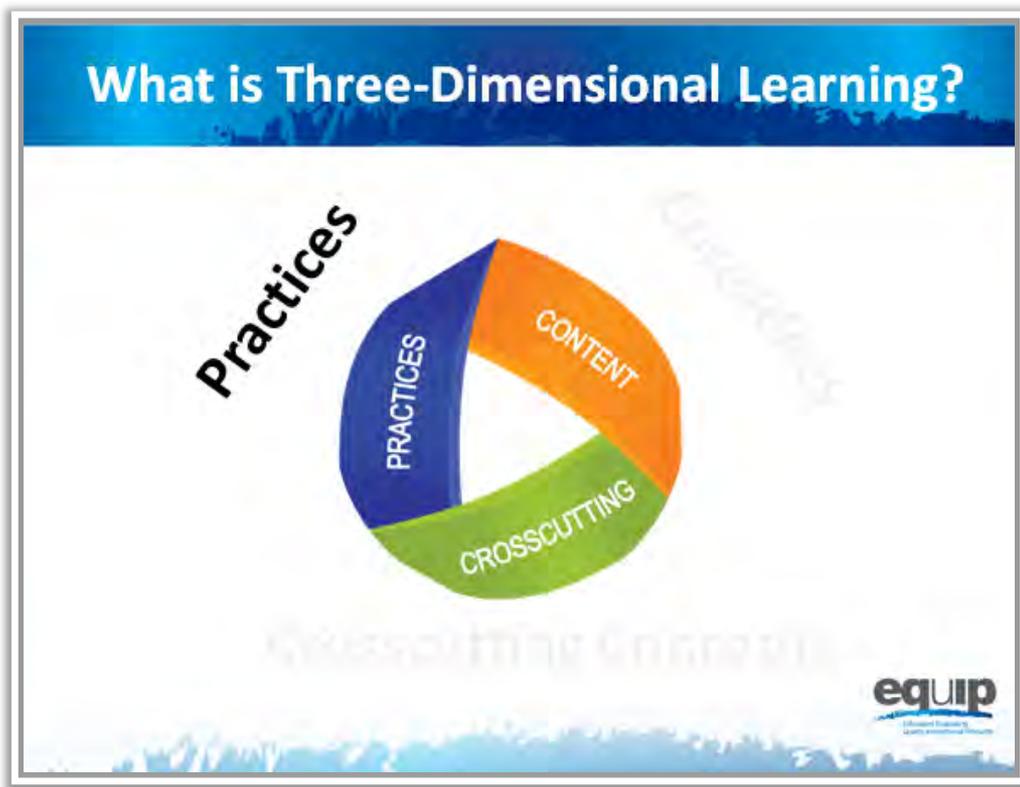
The second goal requires investigations to test explanatory models of the world and their predictions and whether the inferences suggested by these models are supported by data. Planning and designing such investigations require the ability to design experimental or observational inquiries that are appropriate to answering the question being asked or testing a hypothesis that has been formed. This process begins by identifying the relevant variables and considering how they might be observed, measured, and controlled (constrained by the experimental design to take particular values).

Planning for controls is an important part of the design of an investigation. In laboratory experiments, it is critical to decide which variables are to be treated as results or outputs and thus left to vary at will and which are to be treated as input conditions and hence controlled. In many cases, particularly in the case of field observations, such planning involves deciding what can be controlled and how to collect different samples of data under different conditions, even though not all conditions are under the direct control of the investigator.

Decisions must also be made about what measurements should be taken, the level of accuracy required, and the kinds of instrumentation best suited to making such measurements. As in other forms of inquiry, the key issue is one of precision—the goal is to measure the variable as accurately as possible and reduce sources of error. The investigator must therefore decide what constitutes

- ▶ Students determine what to test.
  - ▶ Students are asked to collect materials that would be beneficial to test.
  - ▶ Students bring in objects and select from objects available in the classroom.
- ▶ Students determine how to test the objects.
  - ▶ Students call upon their past experience in the unit to decide the tools needed and required measurements.

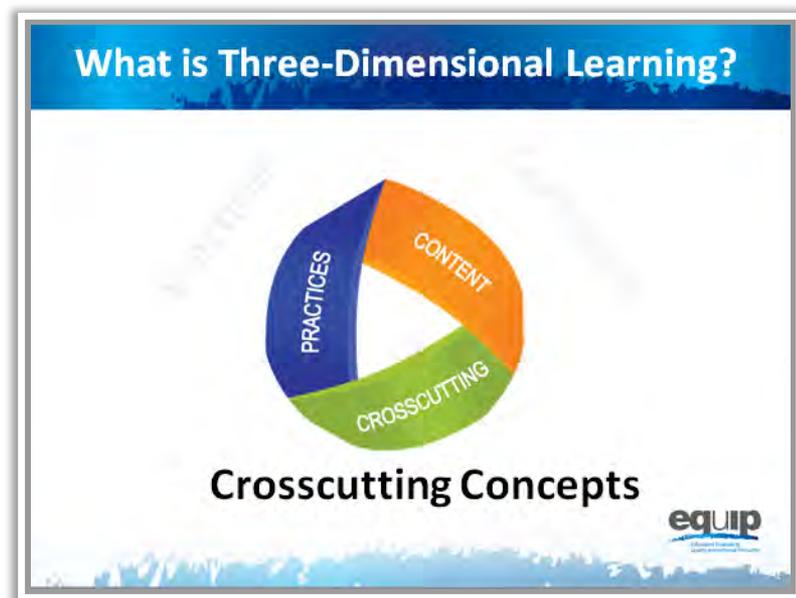
# Conclusions: Science and Engineering Practices



At this point, what can we take away from our work regarding the **Science and Engineering Practices** in Three-Dimensional Learning?

# What Are Crosscutting Concepts?

Crosscutting concepts are concepts that have application across all disciplines of science. As such, they provide a way of linking the different disciplines of science.



# Seven Crosscutting Concepts

1. Patterns
2. Cause and Effect
3. Scale, Proportion, and Quantity
4. Systems and System Models
5. Energy and Matter
6. Structure and Function
7. Stability and Change



# Analyzing Crosscutting Concepts

## Crosscutting Concepts

### Patterns

Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

### Cause and Effect: Mechanism and Explanation

Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

### Scale, Proportion, and Quantity

In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

### Systems and System Models

Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

### Energy and Matter: Flows, Cycles, and Conservation

Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

### Structure and Function

The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

### Stability and Change

For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

# Analyzing Crosscutting Concepts: Patterns

## Patterns

Patterns exist everywhere—in regularly occurring shapes or structures and in repeating events and relationships. For example, patterns are discernible in the symmetry of flowers and snowflakes, the cycling of the seasons, and the repeated base pairs of DNA. Noticing patterns is often a first step to organizing and asking scientific questions about why and how the patterns occur.



One major use of pattern recognition is in classification, which depends on careful observation of similarities and differences; objects can be classified into groups on the basis of similarities of visible or microscopic features or on the basis of similarities of function. Such classification is useful in codifying relationships and organizing a multitude of objects or processes into a limited number of groups. Patterns of similarity and difference and the resulting classifications may change, depending on the scale at which a phenomenon is being observed. For example, isotopes of a given element are different—they contain different numbers of neutrons—but from the perspective of chemistry they

can be classified as equivalent because they have identical patterns of chemical interaction. Once patterns and variations have been noted, they lead to questions;

- ▶ Students look at patterns in the objects.
- ▶ When looking for patterns, students observe and naturally classify the objects.

# Analyzing Crosscutting Concepts: Patterns

## Patterns

Patterns exist everywhere—in regularly occurring shapes or structures and in repeating events and relationships. For example, patterns are discernible in the symmetry of flowers and snowflakes, the cycling of the seasons, and the repeated base pairs of DNA. Noticing patterns is often a first step to organizing and asking scientific questions about why and how the patterns occur.

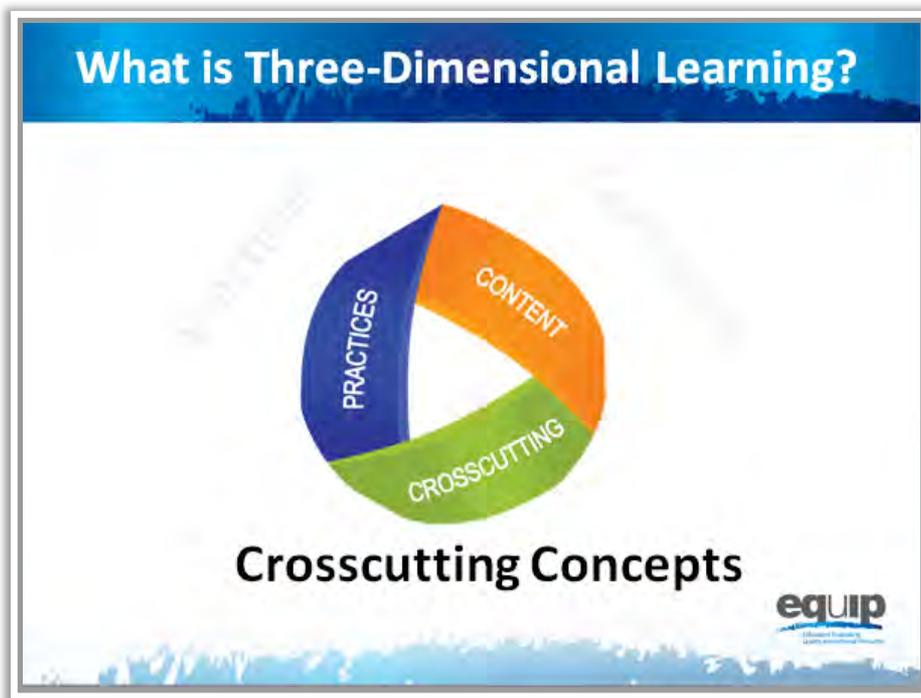


One major use of pattern recognition is in classification, which depends on careful observation of similarities and differences; objects can be classified into groups on the basis of similarities of visible or microscopic features or on the basis of similarities of function. Such classification is useful in codifying relationships and organizing a multitude of objects or processes into a limited number of groups. Patterns of similarity and difference and the resulting classifications may change, depending on the scale at which a phenomenon is being observed. For example, isotopes of a given element are different—they contain different numbers of neutrons—but from the perspective of chemistry they

can be classified as equivalent because they have identical patterns of chemical interaction. Once patterns and variations have been noted, they lead to questions;

- ▶ From this investigation, students ask more questions

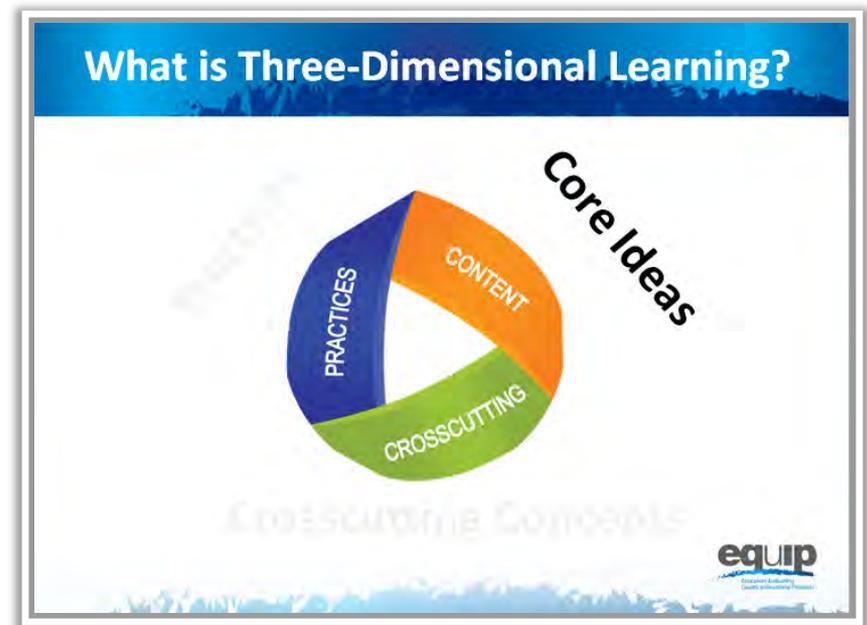
# Conclusions: Crosscutting Concepts



At this point, what can we take away from our work regarding the **Crosscutting Concepts** in Three-Dimensional Learning?

# What Are Disciplinary Core Ideas?

Disciplinary core ideas are the big ideas of science that provide scientists and engineers with the concepts and foundations to make sense of phenomena and/or design solutions to problems.



# What Are the Core Ideas in . . . ?

PHYSICAL SCIENCE

- Matter & Its Interactions
- Motion & Stability: Forces & Interactions
- Energy
- Waves & Their Applications in Technologies for Information Transfer

# What Are the Core Ideas in . . . ?

LIFE SCIENCES

- From Molecules to Organisms: Structures & Processes
- Ecosystems: Interactions, Energy, & Dynamics
- Heredity: Inheritance & Variation of Traits
- Biological Evolution: Unity & Diversity

# What Are the Core Ideas in . . . ?

EARTH & SPACE  
SCIENCES

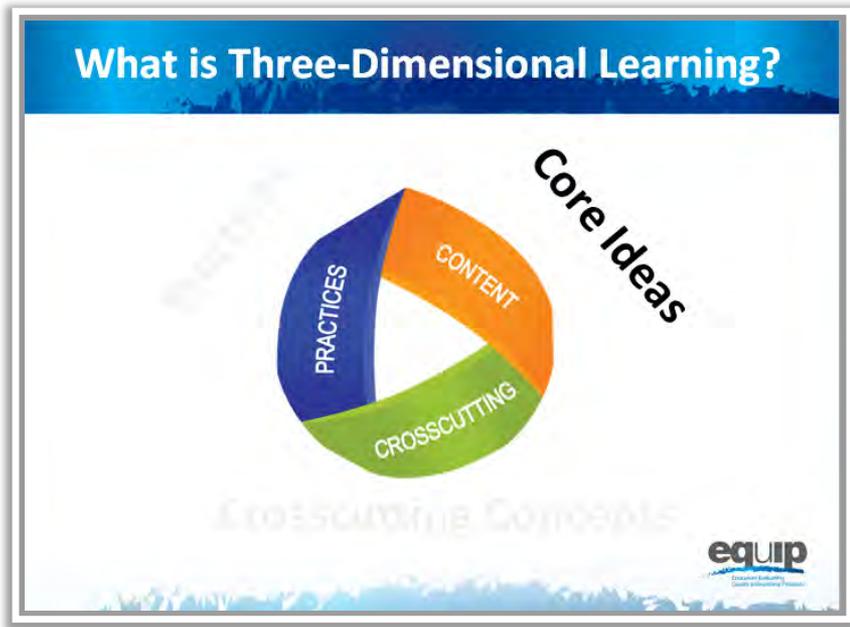
- Earth's Place in the Universe
- Earth's Systems
- Earth & Human Activity

# What Are the Core Ideas in . . . ?

ENGINEERING,  
TECHNOLOGY, &  
APPLICATIONS  
OF SCIENCE

- Engineering Design
- Links Among Engineering, Technology, Science, & Society

# Conclusions: Disciplinary Core Ideas



At this point, what can we take away from our work regarding the **Disciplinary Core Ideas** in Three-Dimensional Learning?

## MS-ETS1 Engineering Design

### MS-ETS1 Engineering Design

Students who demonstrate understanding can:

- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.**
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.**

*The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*.*

#### Science and Engineering Practices

##### Asking Questions and Defining Problems

Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

- Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1)

##### Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4)

##### Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)

##### Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.

- Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)

#### Disciplinary Core Ideas

##### ETS1.A: Defining and Delimiting Engineering Problems

- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1)

##### ETS1.B: Developing Possible Solutions

- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3)
- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)
- Models of all kinds are important for testing solutions. (MS-ETS1-4)

##### ETS1.C: Optimizing the Design Solution

- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3)
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)

#### Crosscutting Concepts

##### Influence of Science, Engineering, and Technology on Society and the Natural World

- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1)
- The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)



# Let's Look for Evidence of 3-Dimensional Teaching and Learning



# Observing a Chemical Reaction

**Purpose:** In this lab experiment you will observe that when a chemical reaction occurs the materials that are formed have new properties from those of the starting materials.

**Background knowledge:** When a chemical reaction occurs, the products that form have different properties than the initial materials.

## Materials for each group:

- 1 baggie with zip seal
- 1 plastic spoon
- 1 25-ml graduated cylinder
- 1 film canister or small container
- 1 plastic spoonful of sodium bicarbonate (baking soda)
- 2 plastic spoonfuls of calcium chloride (road salt)

## Safety:

Wear goggles at all times

Wash your hands after you finish the investigation.

## Procedure

1. Recall the solubility data about baking soda and road salt from Lesson 2. Both baking soda and road salt are soluble.
2. Observed what the baking soda looks like and record the information in your table.
3. Place 1tsp of the baking soda in the plastic bag.
4. Observed what the rock salt looks like and record the information in your table.
5. Place 2tsp of road salt into a plastic bag.
6. Observe if anything happens.
7. Use a graduated cylinder to measure 10mL of water.
8. Pour the water into a small container that was provided.
9. Carefully set the container inside the bag without spilling any of the water.
10. Zip the bag closed. Do not spill the container as you zip the bag closed.
11. Tip over the container inside the sealed bag.
12. Make careful observations.
13. Record your observations in your data table.

## Data Collection:

Record you data in the following table.

Substance	Observations before mixing substances		
	Color	Solubility in water	State of Matter
Baking Soda		<i>Soluble</i>	
Road Salt		<i>Soluble</i>	
Observations after mixing substances but before adding water			
Observations after mixing substances and adding water			

## Data Analysis:

When you mixed the baking soda, calcium chloride and water together what changes did you see that would indicate a chemical reaction occurred? Remember, when a chemical reaction occurs new properties are formed in the materials.

## Conclusions:

Write a statement if a chemical reaction occurred or not.

## What happens to properties when I combine substances?

### Purpose:

In this investigation, you will make observations of baking soda, road salt, powdered sugar, and water. Then you will combine the four substances, observe what happens and write a scientific explanation.

### Safety:

- Wear safety goggles.
- Wash hands after completing this investigation.

### Procedure:

1. Put 1 teaspoon of baking soda, 1 teaspoon of powdered sugar, and 2 teaspoons of road salt in separate small containers. Label each container.
2. Measure 10 mL of water with a graduated cylinder. Pour it into a small container.
3. Write your observations of baking soda, powdered sugar, road salt, and water in the table below.
4. Pour the baking soda, powdered sugar, and road salt into a corner of a zip seal bag.
5. Stand the container of water upright in the bag. Be careful not to tip it over.
6. Remove as much air as possible.
7. Zip the bag closed. Be sure the bag is completely sealed. Tip over the container to combine the substances.
8. Write your observations of the four substances combined in the table below.
9. Save your bag with substances until your teacher asks you to throw it away.

### Data Collection:

Substances	Observations
Baking Soda	
Powdered Sugar	
Road Salt	
Water	

**Scientific Explanation:** Look for patterns in your data to write a **scientific explanation** that states whether new substances were formed after combining the baking soda, powdered sugar, road salt, and water.

**Claim:** (Write a statement that responds to the original question.)

**Evidence:** (Provide scientific data to support your claim. You should only use appropriate data and include enough data. Appropriate data is relevant for the problem and allows you to figure out your claim. Remember that not all data is appropriate. Enough data refers to providing the pieces of evidence necessary to convince someone of your claim.)

**Reasoning:** (In your reasoning statement, connect your claim and evidence to show how your data links to your claim. Also, tell why your data counts as evidence to support your claim by using scientific principles. Remember, reasoning is the process where you apply your science knowledge to answer the question.)

### **What New Questions do you have?**

## What combination caused the changes?

### Purpose:

In this activity, your group will design and carry out an experiment to determine what combination of 3 substances from the last investigation caused new substances to be formed.

What evidence will you look for to determine what caused the changes?

### Safety:

- Wear goggles during this investigation.
- Wash hands after completing this investigation.

### Procedure:

With your group, discuss what your procedure should be. Record your procedure below. Use numbers or bullet points.

### Data Collection:

Create a data table below where you will record your results.

### Explanation of what caused the changes?

Write a scientific explanation of what substances caused the changes.

## What happens to properties when I combine substances?

### Purpose:

In this **investigation**, you will make observations of baking soda, road salt, powdered sugar, and water. Then you will **combine the four substances**, **observe what happens** and **write a scientific explanation**.

### Safety:

- Wear safety goggles.
- Wash hands after completing this investigation.

### Procedure:

1. Put 1 teaspoon of baking soda, 1 teaspoon of powdered sugar, and 2 teaspoons of road salt in separate small containers. Label each container.
2. Measure 10 mL of water with a graduated cylinder. Pour it into a small container.
3. Write your observations of baking soda, powdered sugar, road salt, and water in the table below.
4. Pour the baking soda, powdered sugar, and road salt into a corner of a zip seal bag.
5. Stand the container of water upright in the bag. Be careful not to tip it over.
6. Remove as much air as possible.
7. Zip the bag closed. Be sure the bag is completely sealed. Tip over the container to combine the substances.
8. Write your observations of the four substances combined in the table below.
9. Save your bag with substances until your teacher asks you to throw it away.

### Data Collection:

Substances	Observations
Baking Soda	
Powdered Sugar	
Road Salt	
Water	

**Scientific Explanation:** Look for **patterns** in your data to write a **scientific explanation** that states whether **new substances were formed after combining** the baking soda, powdered sugar, road salt, and water.

**Claim:** (Write a statement that **responds to the original question**.)

**Evidence:** (Provide scientific data to support your claim. You should only use appropriate data and include enough data. Appropriate data is relevant for the problem and allows you to figure out your claim. Remember that not all data is appropriate. Enough data refers to providing the pieces of evidence necessary to convince someone of your claim.)

**Reasoning:** (In your reasoning statement, connect your claim and evidence to show how your data links to your claim. Also, tell why your data counts as evidence to support your claim by using scientific principles. Remember, reasoning is the process where you apply your science knowledge to answer the question.)

**What New Questions do you have?**

## What combination caused the changes?

### Purpose:

In this activity, your group will **design and carry out an experiment** to determine **what combination of 3 substances** from the last investigation **caused new substances to be formed**. What **evidence** will you look for to determine what **caused the changes**?

### Safety:

- Wear goggles during this investigation.
- Wash hands after completing this investigation.

### Procedure:

With your group, **discuss what your procedure** should be. **Record your procedure** below. Use numbers or bullet points.

### Data Collection:

Create a data table below where you will record your results.

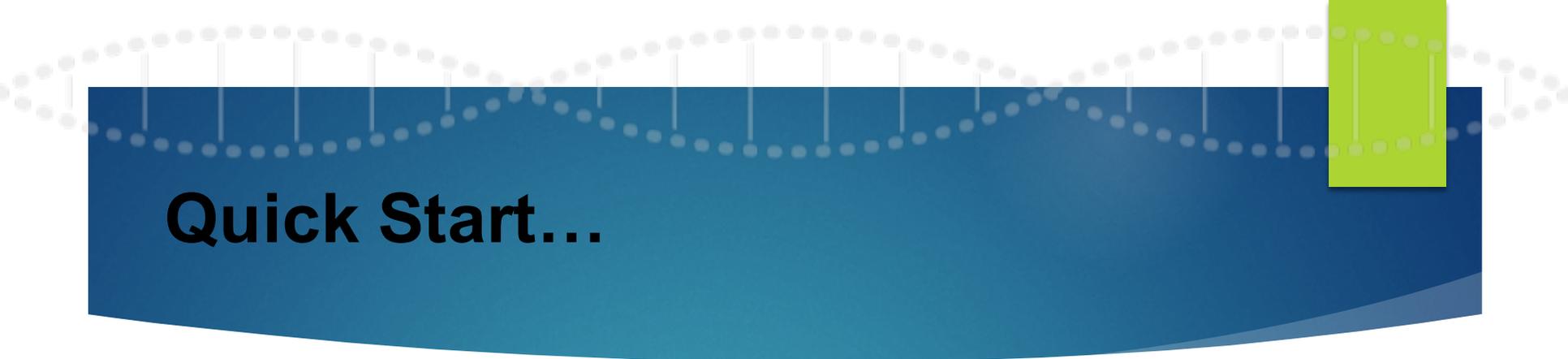
### Explanation of what caused the changes?

**Write a scientific explanation** of **what substances** **caused the changes**.



# Key Differences

- Sample 1 (Observing a Chemical Reaction)
  - “Cookbook” step by step instructions
  - No requirement to show understanding of content or practice, certainly no crosscutting concept
  - Conclusion is a restatement of findings, not applicable to new situations
- Sample 2 (What Happens to Properties When I Combine Substances?)
  - Involves two lessons in a progression toward students designing their own lab
  - Students are required to demonstrate understanding of all three dimensions
  - The lessons are structured such that student responses are focused on using the dimensions to explain the phenomena



# Quick Start...

- ▶ Grade Appropriate Elements
- ▶ Provides opportunities to develop and use specific Science and Engineering Practices, Crosscutting Concepts and Disciplinary Core Ideas
- ▶ The three dimensions work together to support students to make sense of phenomena and/or design solutions to problems



# Example Resources

- ▶ AAAS NetLinks
- ▶ NSTA Sample lessons
- ▶ Teach Engineering.org
- ▶ Teachers Try Science



## Search Results

SEARCH

Grades ALL K 1 2 3 4 5 6 **7** 8 9 10 11 12

Themes ALL EARTH SCIENCE PHYSICS ASTRONOMY CHEMISTRY BIOLOGY HEALTH / MEDICINE ENGINEERING  
SOCIAL SCIENCES TECHNOLOGY MATHEMATICS / STATISTICS NATURE OF SCIENCE CAREERS

Content ALL LESSONS TOOLS COLLECTIONS **AFTERSCHOOL RESOURCES** SCIENCE UPDATES

+ Filter Your Search

### Type

ALL AUDIO HANDS-ON  
INTERACTIVE TEACHING AID  
VIDEO WEBSITE

### RESOURCE

### BEST FOR GRADES

#### Make a Mission >

5,6,7,8

AFTERSCHOOL RESOURCE

This activity introduces kids to the MESSENGER Mission to the planet Mercury.



Looking for a great project-based lesson? Teachers TryScience features hands-on lessons focused on environmental science. Each lesson is integrated with effective teaching strategies, practical how-to's and other helpful supports.

**CREATE A LESSON PLAN**

Share your lesson with the Teachers TryScience community! Your lesson will help grow the instructional content on the site.

Click below to get started!

[Create A Lesson Plan!](#)

### EQuIP Reviewed Lessons



In the United States, the Next Generation Science Standards (NGSS) lay out disciplinary core ideas, science and engineering practices, and crosscutting concepts that students should master in preparation for college and careers. Through a project with Achieve, Inc. and the New York Hall of Science, Teachers TryScience is providing a growing set of lessons that reflect some of the shifts in the NGSS, along with resources that will support you in aligning your own lessons to NGSS.

### Units

#### THINK: The Process of Innovation



Using the THINK app (free for iPad and 10" Android tablets), students will explore how progress is shaped through a common and systematic approach that follows a five-step process of Seeing, Mapping, Understanding, Believing and Acting (SMUBA). Your students will explore the process of innovation and participate in as many as three units, featuring hands-on lessons that will help them become innovators in their own right and to take actions that can help them become forward-thinking citizens of the world.

# References

- ▶ Illinois Association of Regional Superintendents of Schools (IARSS) Foundational Services – Science <http://iarss.org/foundational-services/>
- ▶ Framework for K-12 Science Education, NAP [http://sites.nationalacademies.org/dbasse/bose/framework\\_k12\\_science/index.htm](http://sites.nationalacademies.org/dbasse/bose/framework_k12_science/index.htm)
- ▶ Next Generation Science Standards (NGSS) <http://nextgenscience.org/>
- ▶ Achieve <http://www.achieve.org/>
- ▶ American Association for the Advancement of Science (AAAS) <http://www.aaas.org/>
- ▶ Teachers Try Science <http://www.teacherstryscience.org/>
- ▶ STEM Teaching Tools <http://stemteachingtools.org/>

# Contact Information

Gil Downey, Science Education Consultant

Normal, IL

[gdowney20@gmail.com](mailto:gdowney20@gmail.com)

309-824-3242