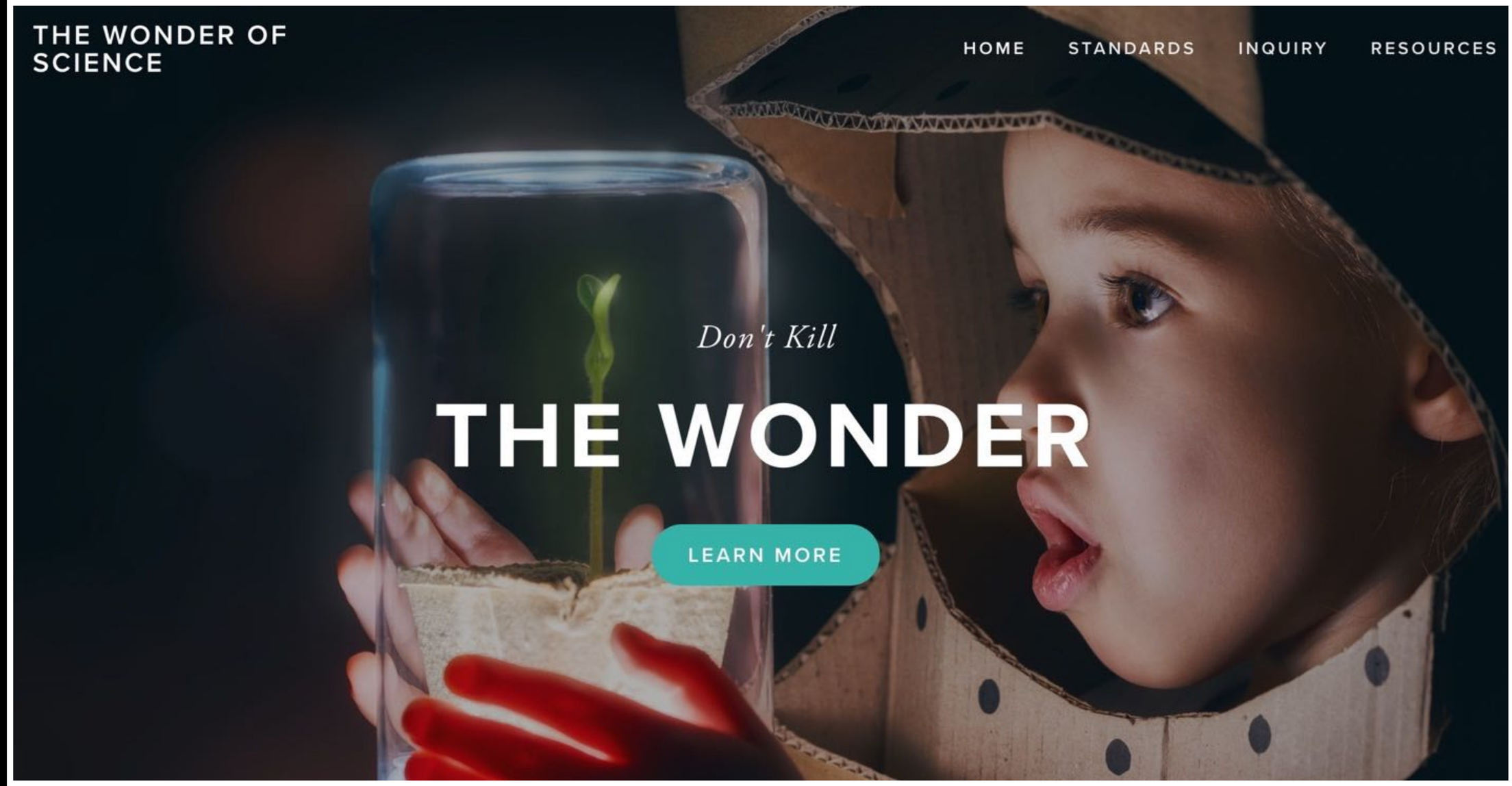
# Welcome

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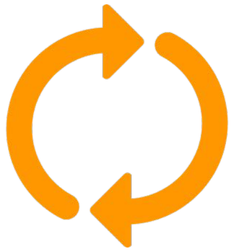
Disciplinary
Core Ideas
SCIENCE
STANDARDS

# Life Sciences

LS1

From Molecules to Organisms

LS2



Ecosystems

LS3

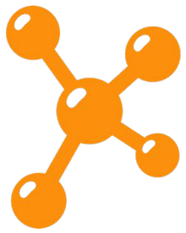
Heredity

LS4

Biological Evolution

# Engineering Technology

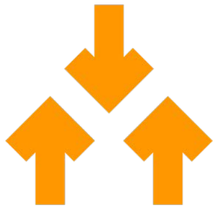
# Physical Sciences



PS1

Matter and Its Interactions

PS2



Motion and Stability: Forces and Interactions

PS3

Energy

PS4

Waves and Their Applications in Technology

# Earth Space Sciences

ESS1

Earth's Place in the Universe

ESS2

Earth's Systems

ESS3

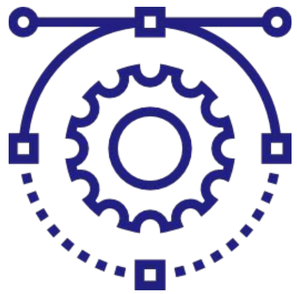
Earth and Human Activity

# Disciplinary Core Ideas

# Science and Engineering Practices

Defining Problems

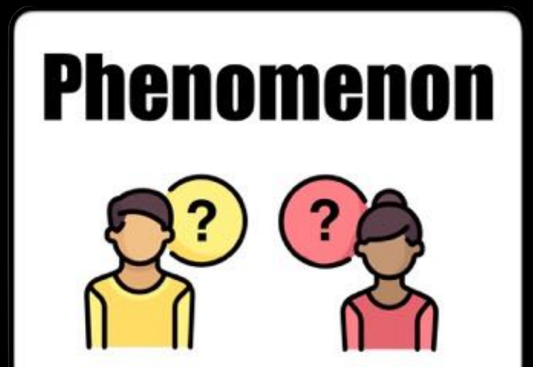
Asking Questions



Developing and Using Models

Planning and Carrying Out Investigations

Analyzing and Interpreting Data




Mathematics

Computational Thinking

Designing Solutions

Constructing Explanations

Engaging in Argument from Evidence

Obtaining, Evaluating, and Communicating Information

# Crosscutting Concepts

Scale
Proportion
Quantity

Systems
System Models

Energy
Matter

Structure
Function

Phenomenon

Stability
Change

Cause
Effect

Patterns

# Inquiry

# Scientific Inquiry

Engineering Technology

1 Asking Questions

2 Developing and Using Models

3 Planning and Carrying Out Investigations

4 Analyzing and Interpreting Data

5 Mathematics Computational Thinking

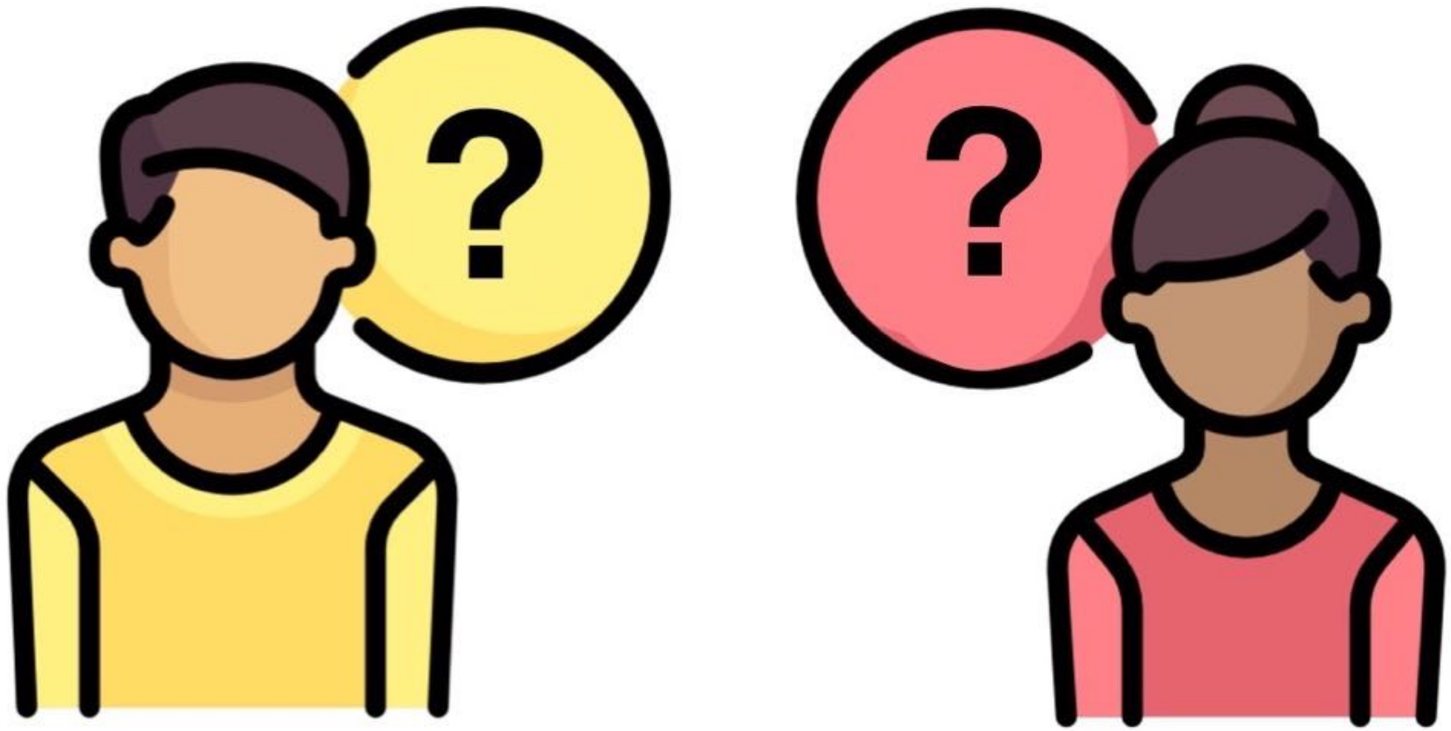
6 Constructing Explanations

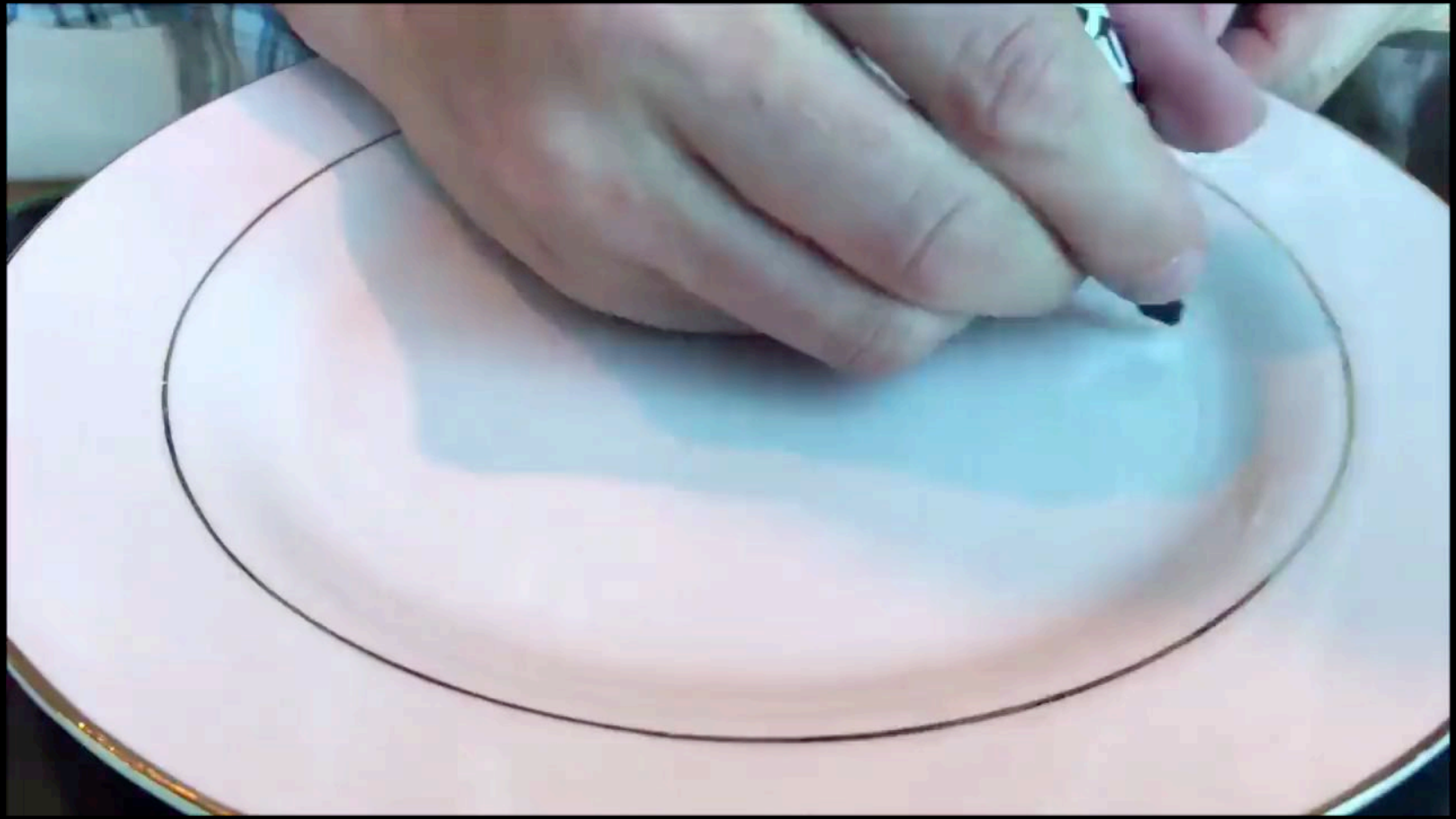
7 Engaging in Argument from Evidence

8 Obtaining, Evaluating, and Communicating Information

# Phenomenon

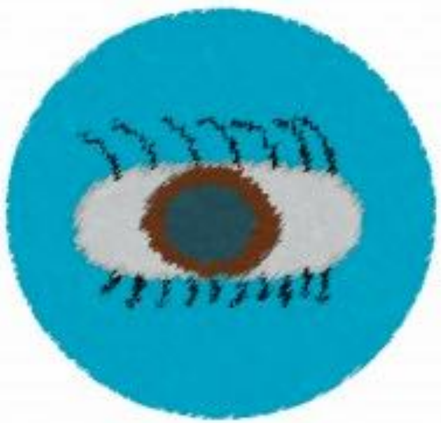
# Phenomenon





# My Model

# See Think Wonder



**MAKING THINKING VISIBLE**

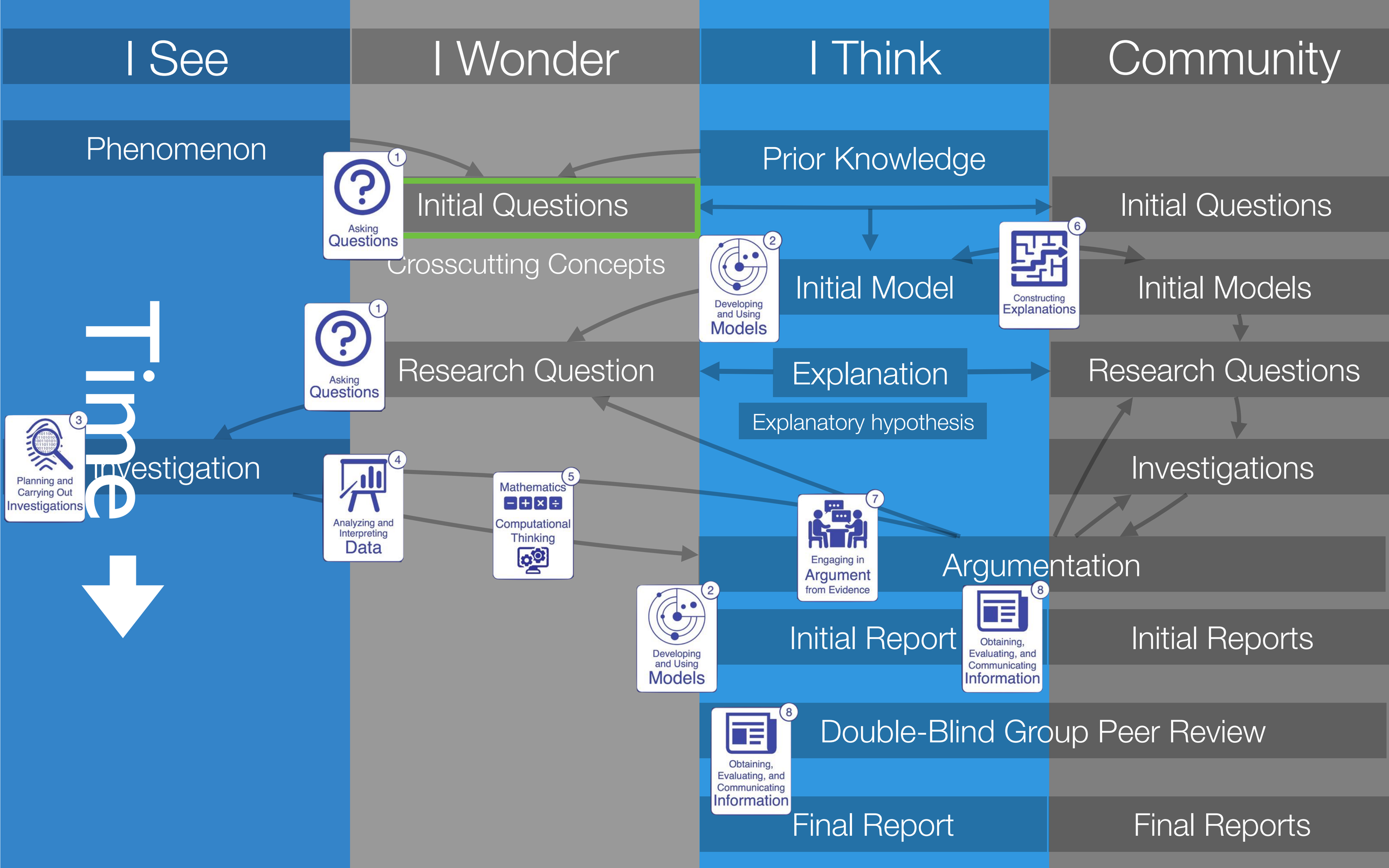
*Ritchhart, Church, and Morrison 2011*

See

Wonder

Think

SHARE



I See
I Wonder
I Think
Community
Phenomenon
Prior Knowledge
Initial Questions
Initial Questions
Crosscutting Concepts
Initial Model
Initial Models
Time
Research Question
Explanation
Research Questions
Explanatory hypothesis
Investigation
Investigations
Argumentation
Initial Report
Initial Reports
Double-Blind Group Peer Review
Final Report
Final Reports
1 Asking Questions
1 Asking Questions
2 Developing and Using Models
6 Constructing Explanations
3 Planning and Carrying Out Investigations
4 Analyzing and Interpreting Data
5 Mathematics Computational Thinking
7 Engaging in Argument from Evidence
2 Developing and Using Models
8 Obtaining, Evaluating, and Communicating Information
8 Obtaining, Evaluating, and Communicating Information

| I See | I Wonder | I Think | Community |
| --- | --- | --- | --- |
| Phenomenon | | Prior Knowledge | |
| | Initial Questions | | Initial Questions |
| | Crosscutting Concepts | Initial Model | Initial Models |
| | Research Question | Explanation | Research Questions |
| Investigation | | | Investigations |
| | | Argumentation | |
| | | Initial Report | Initial Reports |
| | | Double-Blind Group Peer Review | |
| | | Final Report | Final Reports |

# Questions we ask

Scale
Proportion
Quantity

Systems
System Models

Energy
Matter

Structure
Function

Phenomenon

Stability
Change

Cause
Effect

Patterns

PEARSON

# Supporting Grade 5-8 Students in Constructing Explanations in Science

*The Claim, Evidence, and Reasoning Framework for Talk and Writing*

...atherine L. McNeill  Joseph Kr...

PEARSON PROFESSIONAL DEVELOPMENT

# What's Your Evidence?

*Engaging K-5 Students in Constructing Explanations in Science*

Carla Zembal-Saul  Katherine L. McNeill
Kimber Hershberger

# Argument-Driven Inquiry in BIOLOGY

LAB INVESTIGATIONS for GRADES 9–12

...on, Patrick Enderle, Leeanne Gleim,
...ooms, Melanie Hester,
...erland, and Kristin Wilson

NSTA press
National Science Teachers Association

# Argument-Driven Inquiry in PHYSICAL SCIENCE

LAB INVESTIGATIONS for GRADES 6–8

Jonathon Grooms, Patrick J. Enderle,
Todd Hutner, Ashley Murphy, and Victor Sampson

NSTA press
National Science Teachers Association

# Argument-Driv
in
# BIOLOG

LAB INVESTIGATIO
for GRADES 9–

Victor Sampson, Patrick Enderle, Leeanne Gleim,
Jonathon Grooms, Melanie Hester,
Sherry Southerland, and Kristin Wilson

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## SECTION 1
## Using Argument-Driven Inquiry

***Chapter 1: Argument-Driven Inquiry*** ..... 3

***Chapter 2: Lab Investigations*** ..... 19

## SECTION 2—Life Sciences Core Idea 1
## From Molecules to Organisms: Structures and Processes

### INTRODUCTION LAB

***Lab 1. Osmosis and Diffusion: Why Do Red Blood Cells Appear Bigger After Being Exposed to Distilled Water?***

## SECTION 6—Appendixes

***Appendix 1: Standards Alignment Matrixes*** ..... 386

***Appendix 2: Options for Implementing ADI Lab Investigations*** ..... 391

***Appendix 3: Investigation Proposal Options*** ..... 399

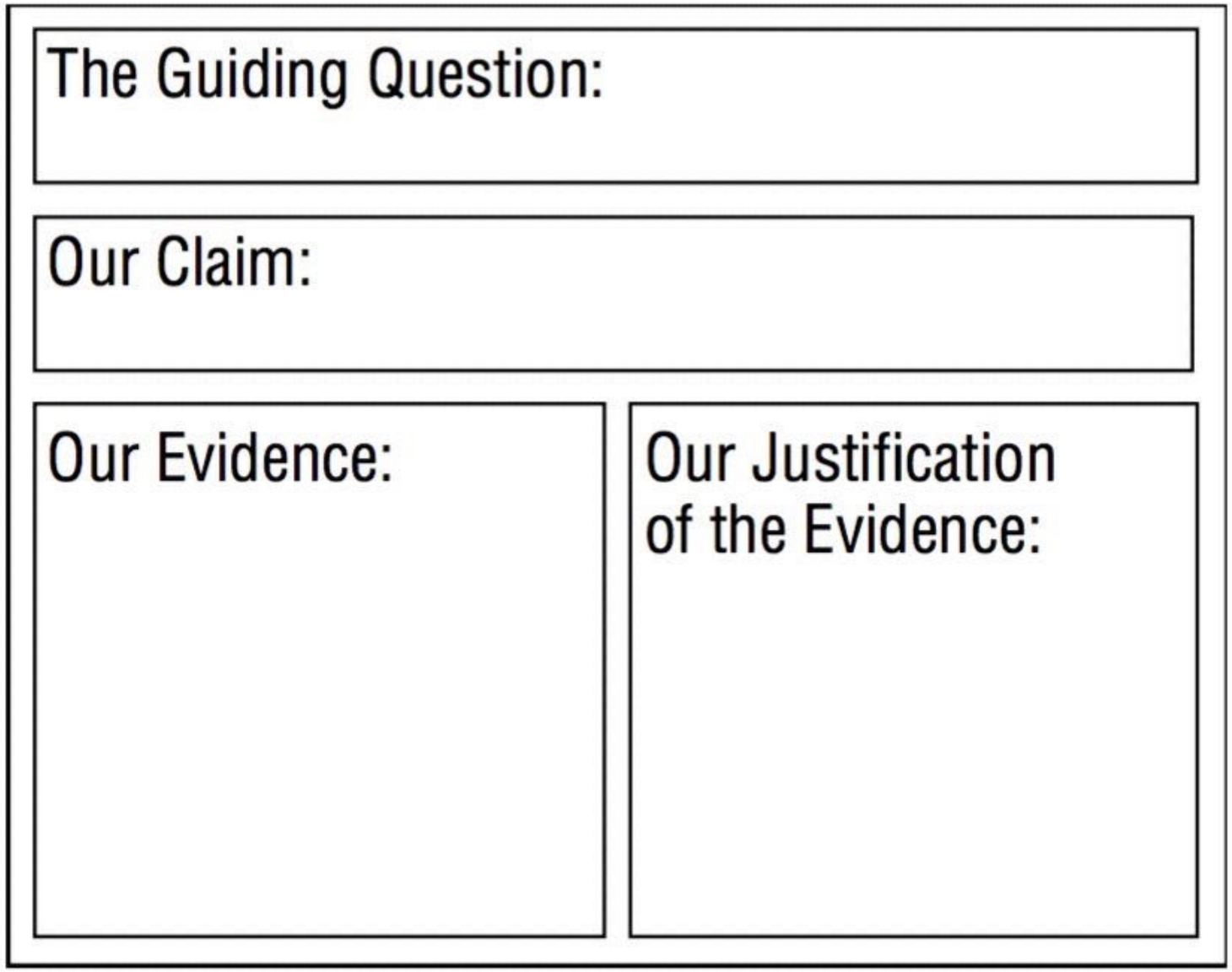
***Appendix 4: Peer-Review Guide and Instructor Scoring Rubric*** ..... 403

Image Credits ..... 405

Index ..... 409

# FIGURE 4

**Suggested layout of the components of an argument on a whiteboard**



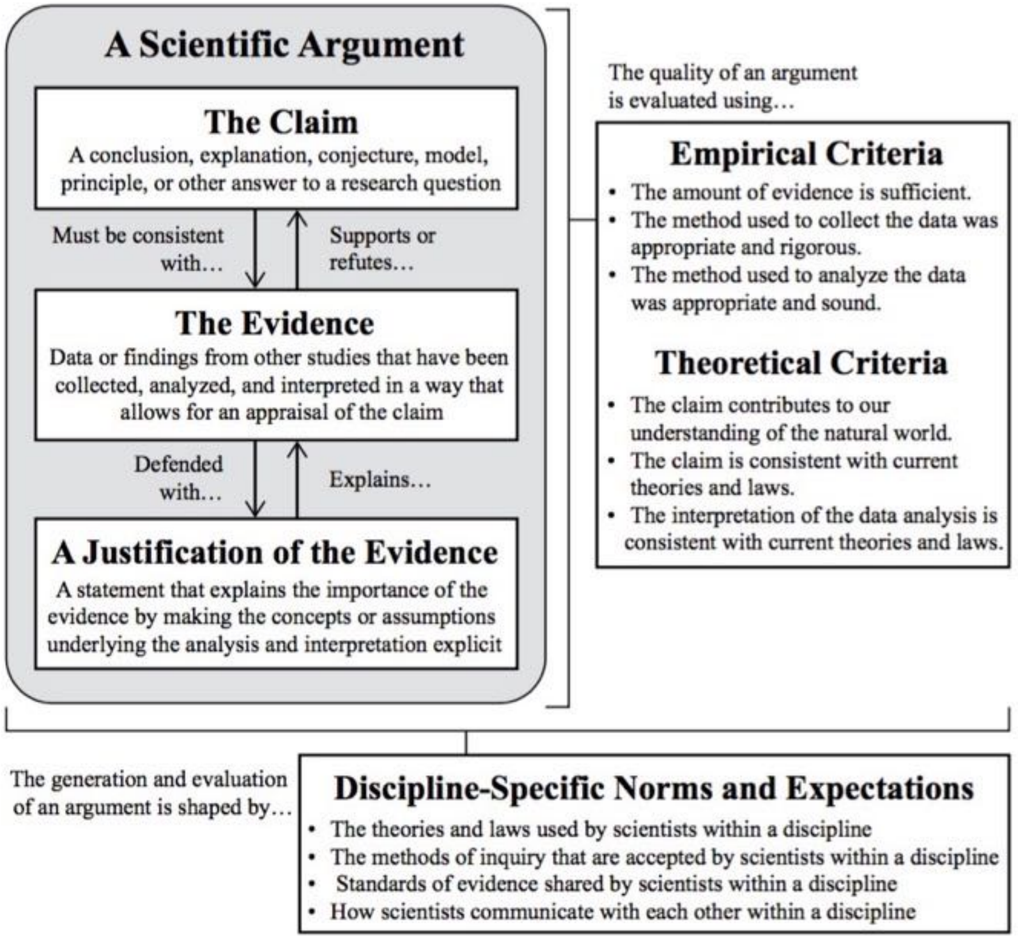
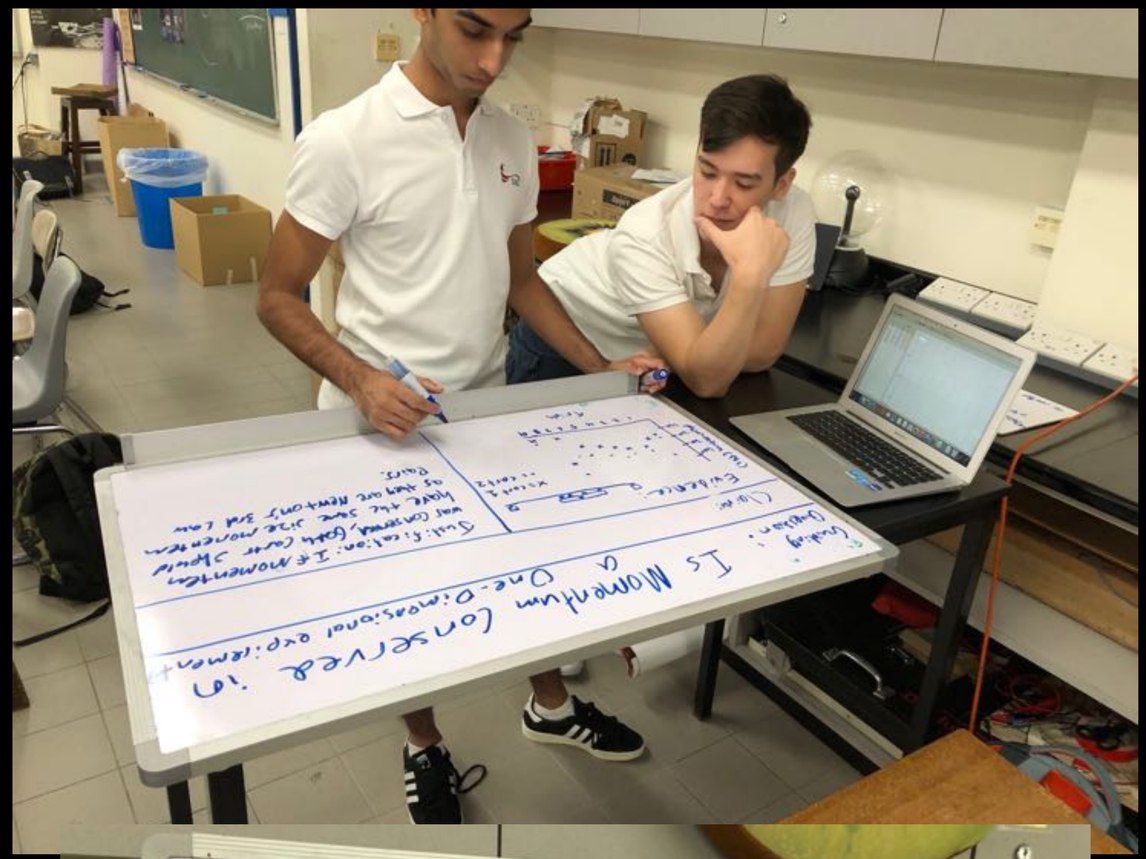
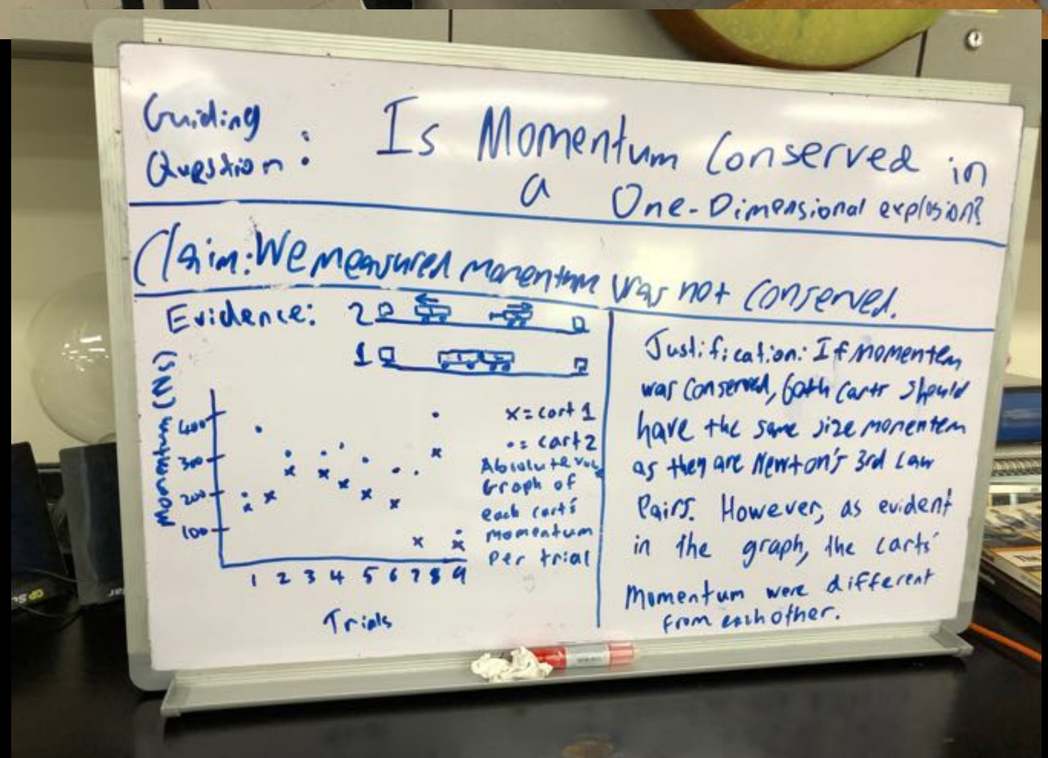



**FIGURE 6**

**A high school student presents her group's argument to another group during the argumentation session.**





# APPENDIX 4

# Peer-Review Guide and Instructor Scoring Rubric

Report By: _____ (ID Number) Author: Did the reviewers do a good job? 1 2 3 4 5 (Rate the overall quality of the peer review)

Reviewed By: _____ (ID Number) _____ (ID Number) _____ (ID Number) _____ (ID Number)

| Section 1: Introduction and Guiding Question | Reviewer Rating | | | Instructor Score |
|---|---|---|---|---|
| 1. Did the author provide enough *background information* about the concept, theory, law, or model underlying the investigation? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| 2. Did the author *describe the goal* of the study? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| 3. Did the author make the *guiding question* explicit and explain how the guiding question is related to the background information? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| **Reviewers:** If your group made any "No" or "Partially" marks in this section, please **explain how the author could improve** this part of his or her report. | **Author:** What revisions did you make in your report? Is there anything you decided to keep the same even though the reviewers suggested otherwise? Be sure to explain why. | | | |

| Section 2: Method | Reviewer Rating | | | Instructor Score |
|---|---|---|---|---|
| 1. Did the author describe the *procedure* he/she used to gather data and then explain why he/she used this procedure? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| 2. Did the author explain *what data* (quantitative or qualitative) was collected (or used) and why that data was collected (or used)? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| 3. Did the author describe *how* he or she *analyzed the data* and explain why the analysis helped him/her answer the guiding question? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| 4. Did the author use the *correct term* to describe his/her investigation (i.e., experiment, systematic observation, interpretation of a data set)? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| **Reviewers:** If your group made any "No" or "Partially" marks in this section, please **explain how the author could improve** this part of his or her report. | **Author:** What revisions did you make in your report? Is there anything you decided to keep the same even though the reviewers suggested otherwise? Be sure to explain why. | | | |

| Section 3: The Argument | Reviewer Rating | | | Instructor Score |
|---|---|---|---|---|
| 1. Did the author include a *claim* that answers the guiding question? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| 2. Did the author support his or her claim with *high-quality evidence*? | | | | |
| ▪ Was the analysis of the data appropriate and free from errors? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| ▪ Was the author's interpretation of the analysis valid? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| ▪ Is there enough evidence to support the claim? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| 3. Did the author *present the evidence* in an appropriate manner by: | | | | |
| ▪ Using a correctly formatted and labeled graph (or table); | | | | |
| ▪ Including correct metric units (e.g., m/s, g, ml, and so on); and, | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| ▪ Referencing the graph or table in the body of the text? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| 4. Did the author include a *justification of the evidence* that: | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| ▪ Explains why the evidence is important? | | | | |
| ▪ Defends the inclusion of the evidence with a specific science concept or by discussing an underlying assumption? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| 5. Did the author *discuss the arguments* made by other groups by: | | | | |
| ▪ Describing some of the claims made by other groups? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| ▪ Describing how well the other claims align with his or her claim? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| ▪ Critiquing the evidence provided for the other claims? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| 6. Did the author use *scientific terms* (hypothesis vs. prediction, data vs. evidence) and phrases (supports vs. proves) correctly? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| **Reviewers:** If your group made any "No" or "Partially" marks in this section, please **explain how the author could improve** this part of his or her report. | **Author:** What revisions did you make in your report? Is there anything you decided to keep the same even though the reviewers suggested otherwise? Be sure to explain why. | | | |

| Mechanics | Reviewer Rating | | | Instructor Score |
|---|---|---|---|---|
| 1. *Organization:* Is each section easy to follow? Do paragraphs include multiple sentences? Do paragraphs begin with a topic sentence? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| 2. *Grammar:* Are the sentences complete? Is there proper subject-verb agreement in each sentence? No run-on sentences. | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| 3. *Conventions:* Did the author use appropriate spelling, punctuation, paragraphing and capitalization? | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| 4. *Word Choice:* Did the author use the appropriate word (there vs. their, to vs. too, and so on) | ☐ No | ☐ Partially | ☐ Yes | 0 1 2 |
| **Instructor Comments:** | | | | |
| | | | | |
| Was the investigation rigorous and appropriate given the nature of the guiding question? | | | | 0 1 2 |

Total: _____/50

# Empirical Criteria

- The amount of evidence is sufficient.
- The method used to collect the data was appropriate and rigorous.
- The method used to analyze the data was appropriate and sound.

# Theoretical Criteria

- The claim contributes to our understanding of the natural world.
- The claim is consistent with current theories and laws.
- The interpretation of the data analysis is consistent with current theories and laws.

Research Question:

1 How does the (independent variable) affect the motion of of the bird ?

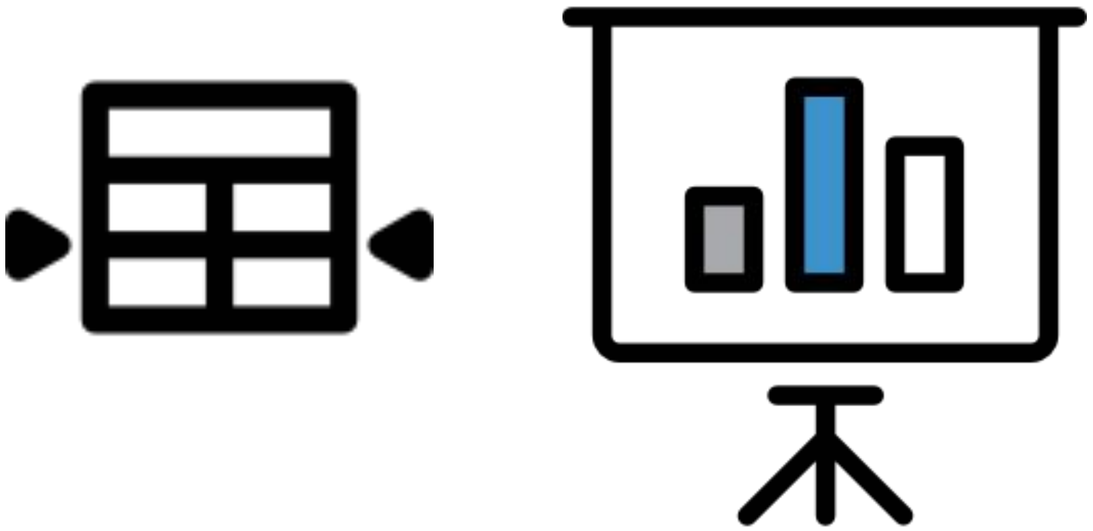
Our Claim:

4 Answer

2 Define all relevant terms

Our Evidence:

3 "Observations and Measurements"



Our Reasoning:

5 "Justification of the Evidence"

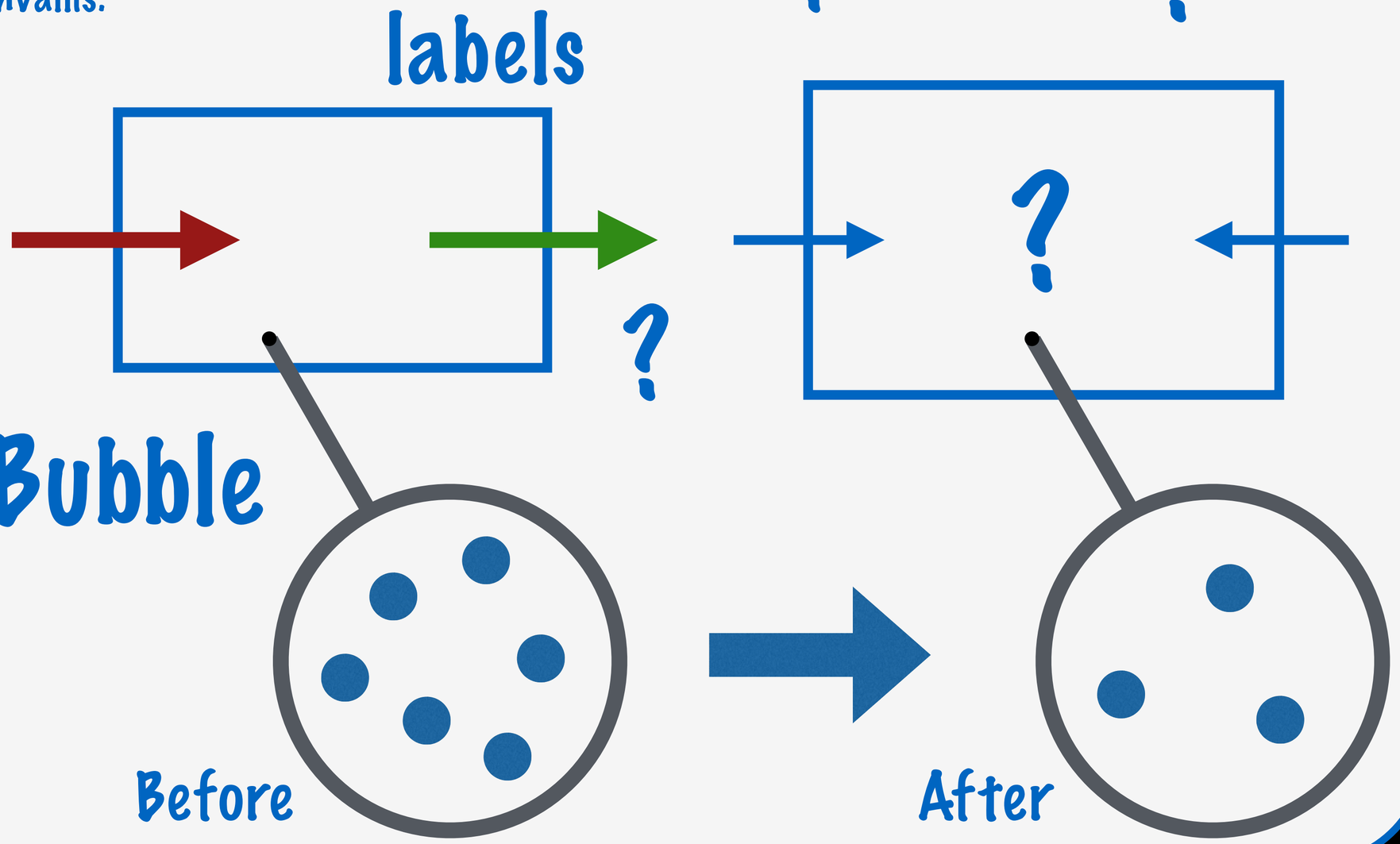
# Explanation

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Curabitur mattis eros a quam lacinia, sit amet auctor dolor volutpat. Etiam efficitur nulla ultricies erat elementum, vitae vehicula sapien convallis.

# Questions

# Pictures

# Colors

# Zoom-in Bubble

# Time