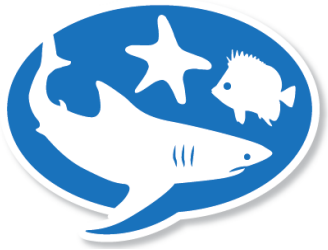
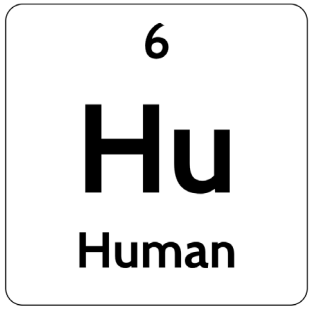
Practices of Scientists
Part A-C
(Part D & Extension later today)





Practices of Scientists

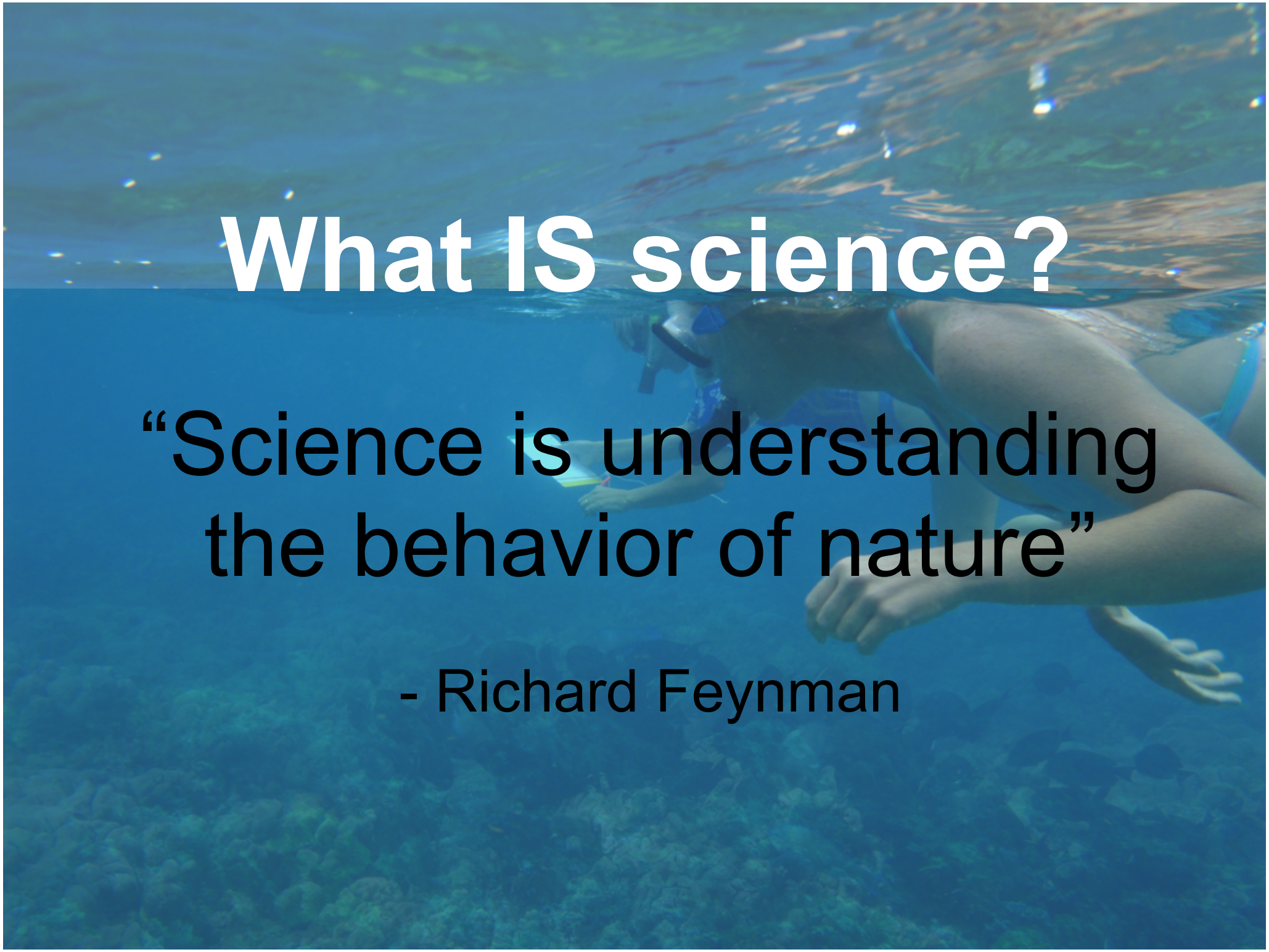
Activity Goals

- Identify the attributes of the discipline of science
- Connect with the practitioners of science (scientists) so that students begin to identify with scientists and view them as real people
- Identify and apply the practices of scientists, compare and contrast them with practices in other disciplines

This activity:

- Is teacher directed
- Requires evidence of student thinking and values student perspectives

What IS science?



What IS science?

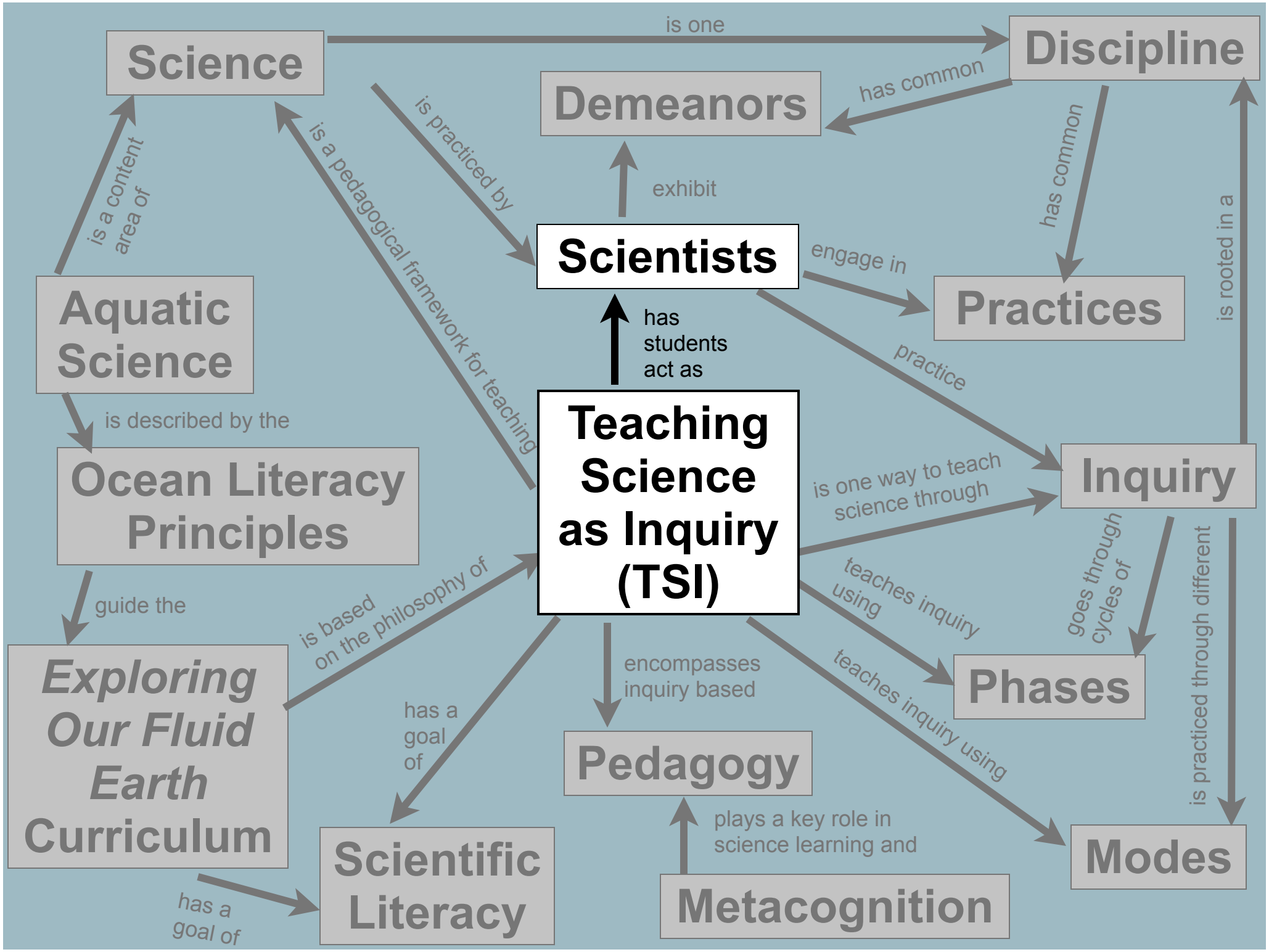
"Science is understanding the behavior of nature"

- Richard Feynman

What IS science?

"Science involves more than the gaining of knowledge. It is the systematic and organized inquiry into the natural world and its phenomena. Science is about gaining a deeper and often useful understanding of the world."

- from the Multicultural History of Science page at Vanderbilt University.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has a goal of
Scientific Literacy
Metacognition

What IS a scientist?

82% of Americans surveyed in 2004 by NSF said they do not know any scientists

Draw A Scientist

Draw what you think a scientist looks like

Describe Scientist Drawings

- Trade your drawing with a partner.
- Write down at least 3 words to describe *your partner's* scientist drawing
- We will then make a class list

Class Descriptions

- Which word categories are the most common?

- What do the word categories tell you about the drawings?

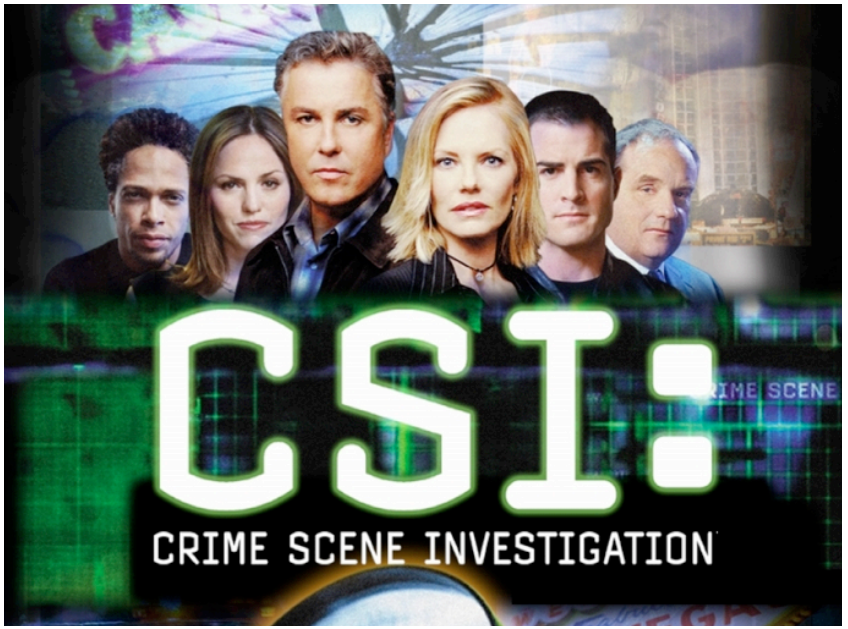
Draw a Scientist

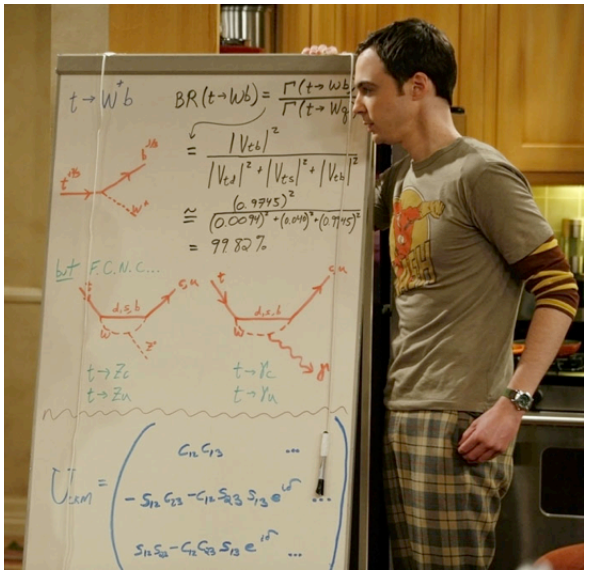
- Mead and Metraux (1958)
  - lab-coat-wearing,
  - old men of either tall-and-thin or small stature
  - work in a laboratory
  - surrounded by glassware
  - facial hair (indicating mature male)
- Chambers' (1983) - 4,807 students
- Thomas and Hairston's (2003) 757 students
  - lab coat
  - eyeglasses
  - facial hair (indicating mature male)

What IS a scientist?

Does media portrayal help?

- Popularity of Crime Scene Investigation (CSI) type TV shows may glamorize and alienate science practices more than making science accessible





- CSI juror effect

(Willing 2005, Deutsch 2006)

Defining Science

In your group, come up with at least three words words or phrases to describe:

- The **discipline** of science (the attributes that make up the field, or practice, of science)
- The **demeanors**, or characteristics, of scientists (that scientists value)

For the purposes of this activity
***Idealized* scientists**

Defining Science

In your group, come up with at least three words words or phrases to describe:

- The **discipline** of science (the attributes that make up the field, or practice, of science)
- The **demeanors**, or characteristics, of scientists (that scientists value)

Defining Science

What does it mean to practice science?

Discipline

- A community of persons
- An expression of human imagination and ingenuity
- A mode of inquiring about the word
- A tradition
- A conceptual structure
- A specialized language or other system of symbols
- A heritage of literature and artifacts and networks of communication
- A system of values and demeanors
- An instructive community

Defining Science

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- An instructive community

Defining Science

What are the characteristics of scientists?

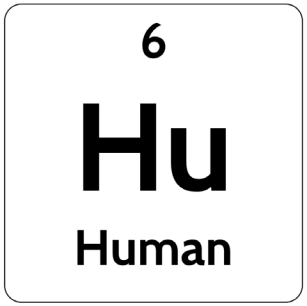
Demeanors

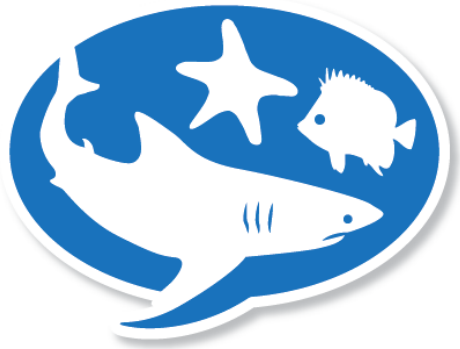
- Responsibility
- Courtesy
- Skepticism
- Respect for ideas of others
- Accuracy
- Honesty
- Open mindedness
- Evidence-based evaluation

Disciplinary Inquiry

Teaching via inquiry through the **authentic practice of science**

- Science is a community process
- Replicate scientific community in the classroom





Teacher as Research Director

Students as scientists in classroom

Application of disciplinary inquiry

- Facilitate learning
- Help students select and evaluate data, reason through analysis, interpret findings, and propose alternative explanations
- Direct students to assess the quality of procedures, results, and conclusions
- Allow students to recognize discrepancies in data, discuss variations, and identify sources of error

Disciplines

Math

Public Policy

Marketing

Journalism

Finance

Sociology

Visual Arts

Music

Economics

One discipline is not better than another, they are just different ways of looking at the world

Political Science

Science

Philosophy

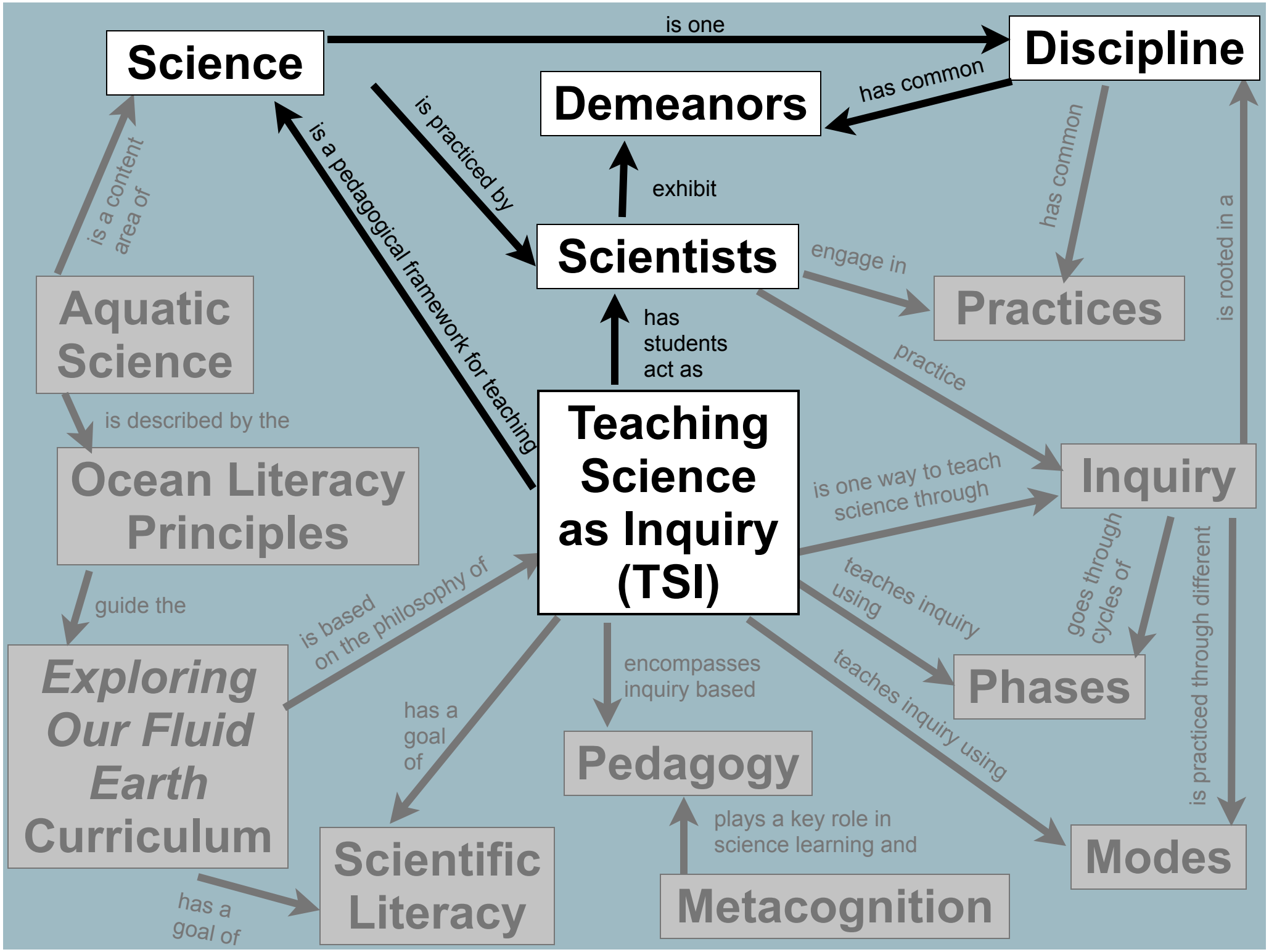
Social Work

Interior Design

Architecture

Computer Science

Religion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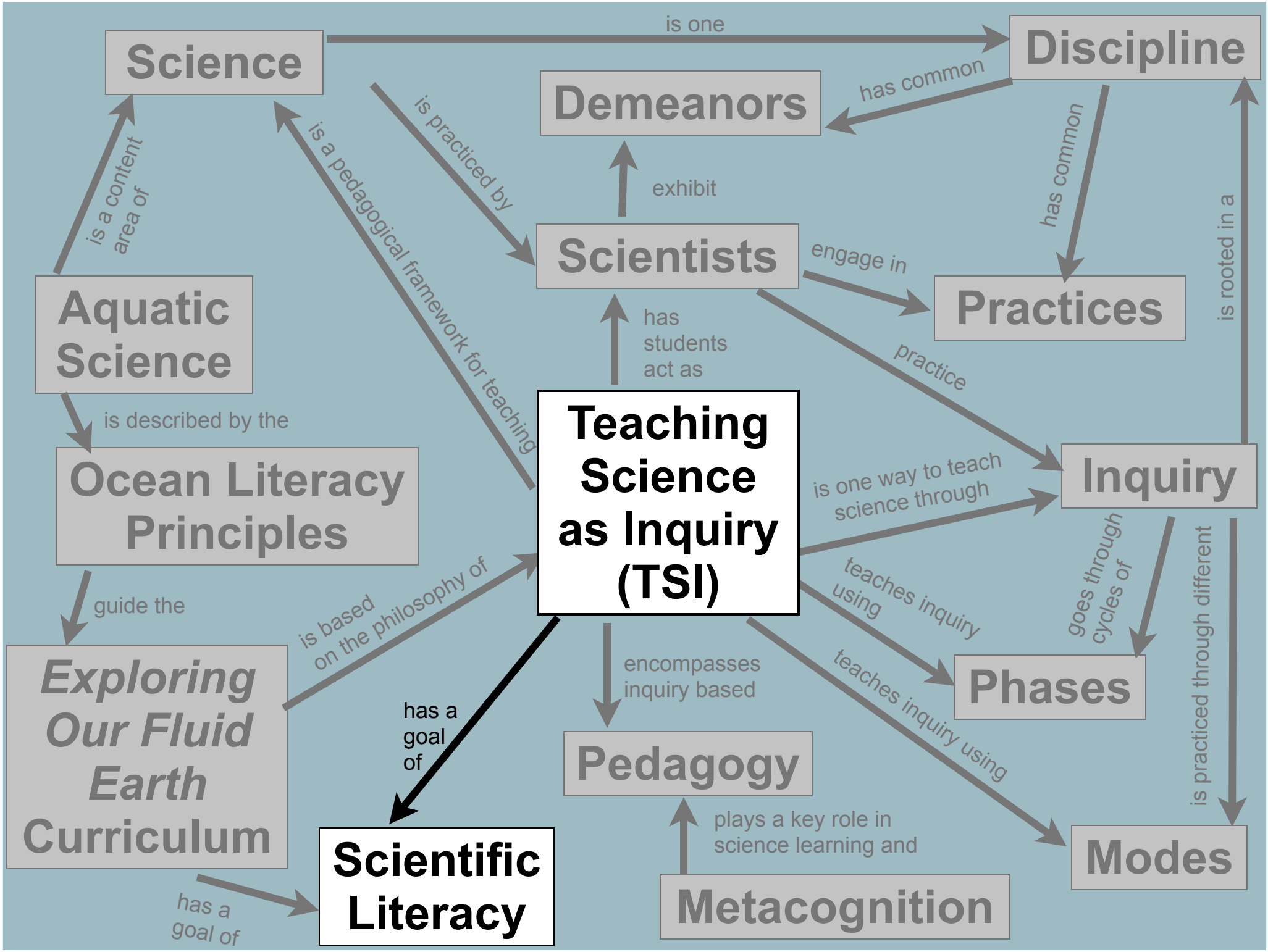
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Practices of Scientists

Extension

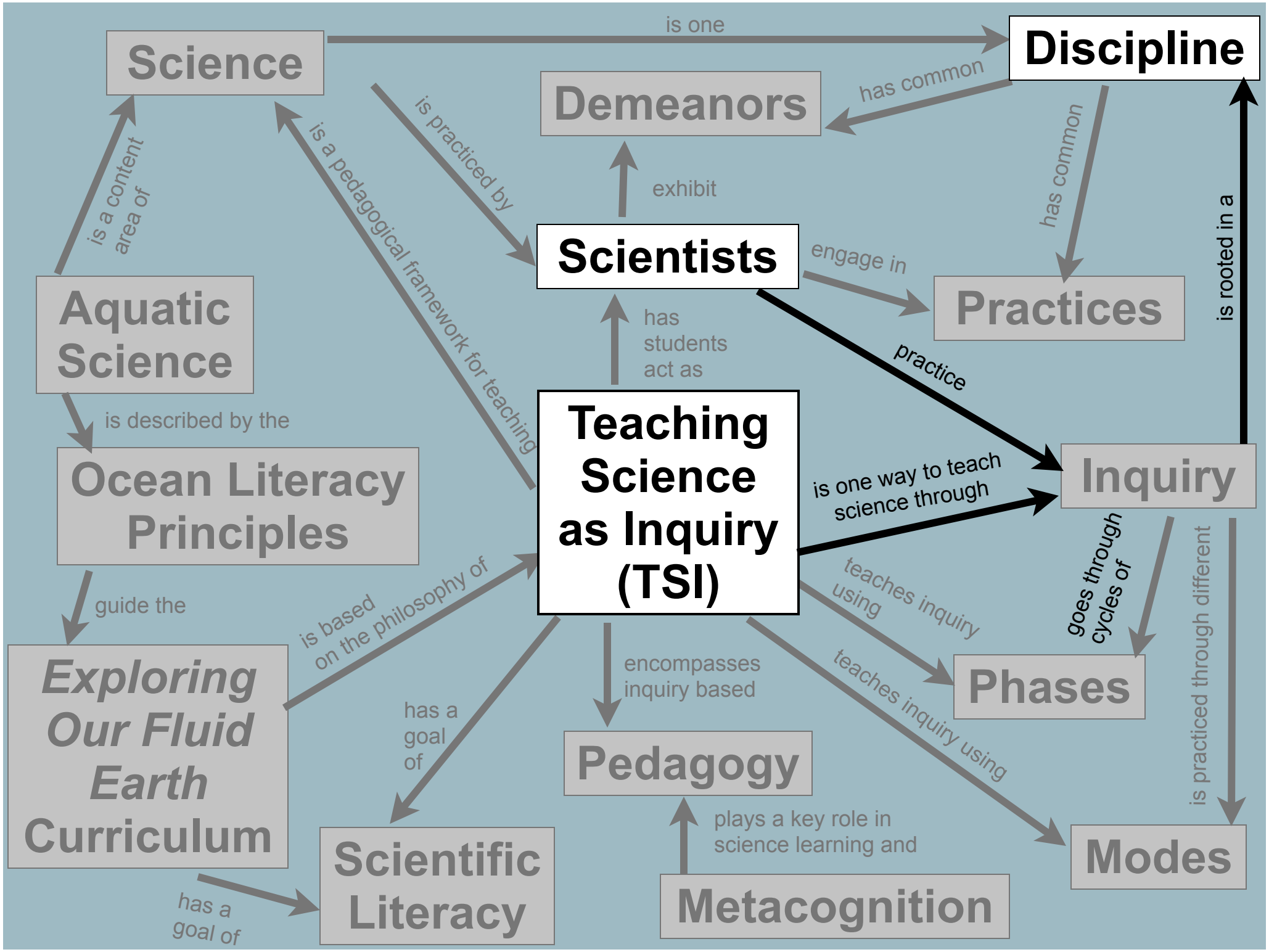
Scientific Literacy

Those who are scientifically literate “have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering, and technology”.

National Research Council 2011

Literacy Categories

- Visual
- Numerical
- Multimedia
- Information
- Computer
- Technological
- Ocean
- Climate
- Geographical
- Sexual
- Health
- Critical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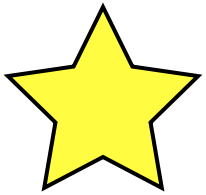
Soda and Scientific Reasoning



Soda & Scientific Reasoning

In regular tap water, what will happen to each of the following cans?

Yes

No

Metacognition

- Thinking about your thinking
- Awareness of your thinking processes
- Different levels of content and inquiry knowledge in PD - focus on becoming more metacognitive

Soda & Scientific Reasoning

Activity Goals

- Use your metacognitive skills while engaging in the practices of science.

This activity:

- Is open-ended
- Initiates a new concept
- Has multiple pathways to knowledge generation
- Avoids front-loading too much content

Soda & Scientific Reasoning

What will happen, and why, to the soda cans?

Soda	Prediction (Sink or Float?)	Explanation (Why?) e.g. variables	Observation

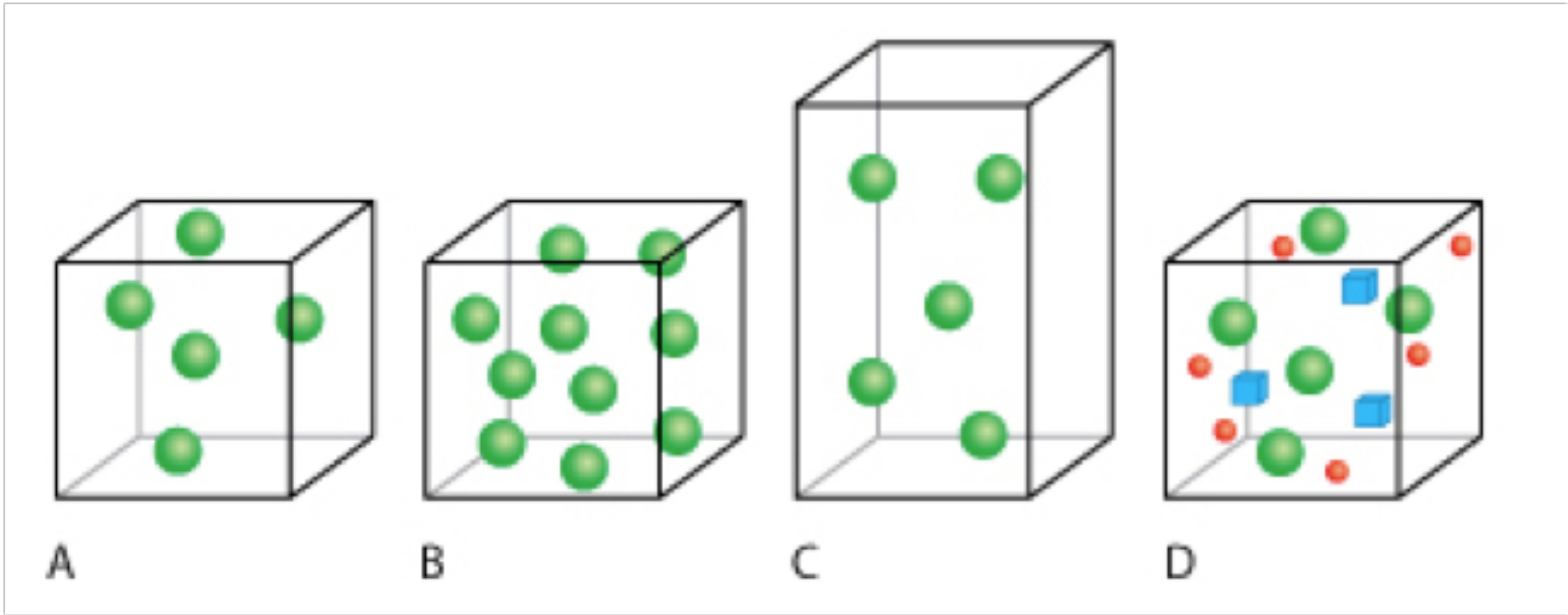
Soda & Scientific Reasoning

Use your powers of observation, investigation, and scientific thinking to figure out why some soda cans float and others sink.

Soda & Scientific Reasoning

Soda	Prediction (Sink or Float?)	Explanation (Why?) e.g. variables	Observation

Soda & Scientific Reasoning



Density = Mass/Volume

Soda & Scientific Reasoning

Relative Density

Soda & Scientific Reasoning

Tips and Tricks

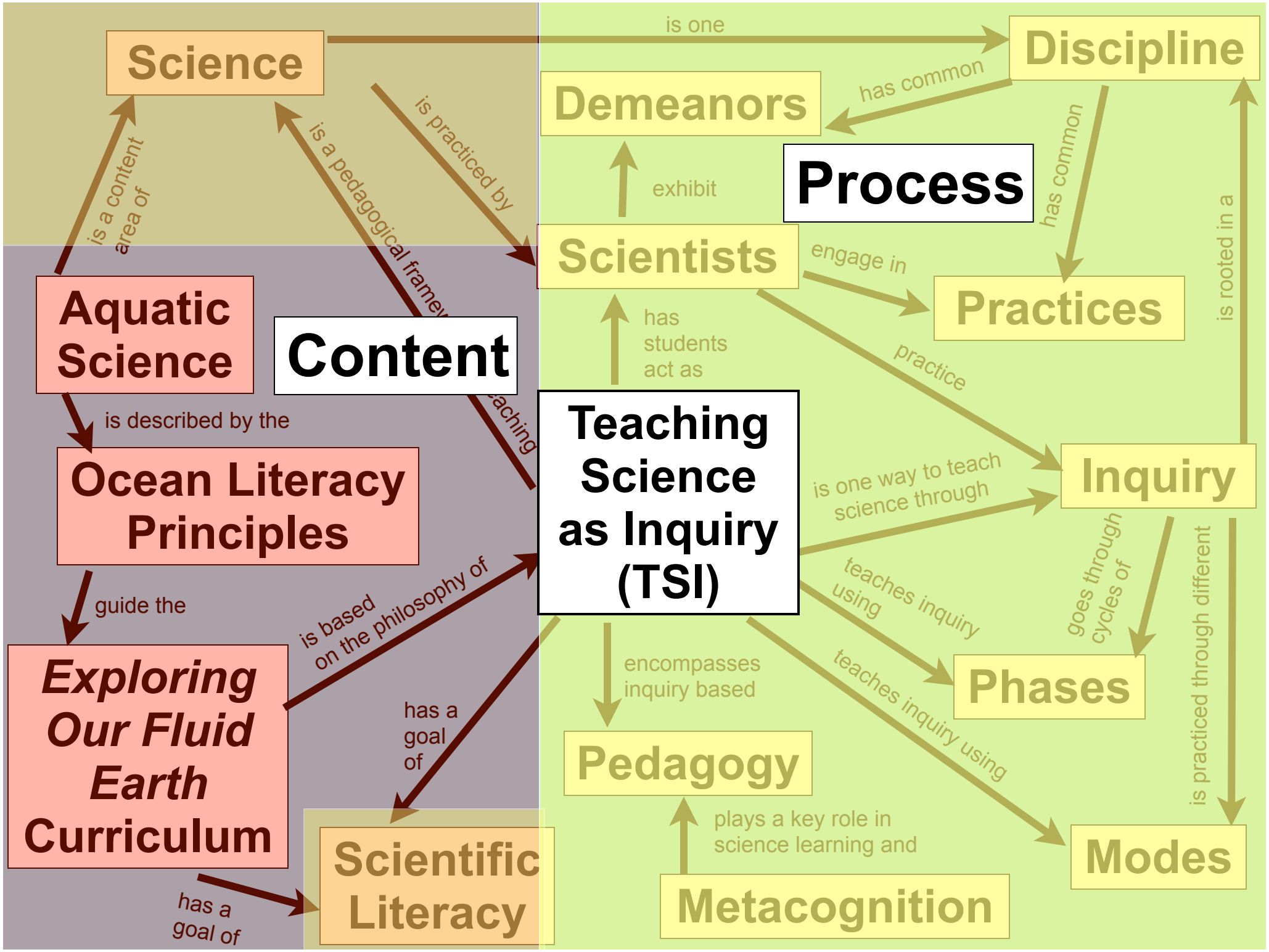
- Starters:
  - regular cola (sugar, caffeine)
  - diet cola (sweetener, caffeine)
  - caffeine-free regular root beer (sugar, non-caffeine)
  - caffeine-free diet root beer (sweetener, non-caffeine)
  - fruity soda (sugar, non-caffeine)
- Test cans
- Use “trick” cans (can create by shaking)
- Saving soda (don’t)

Practices of Scientists

Part D

Practices of Science

Science are engaged in the process, or **practices of science**. These are the things scientists actually do.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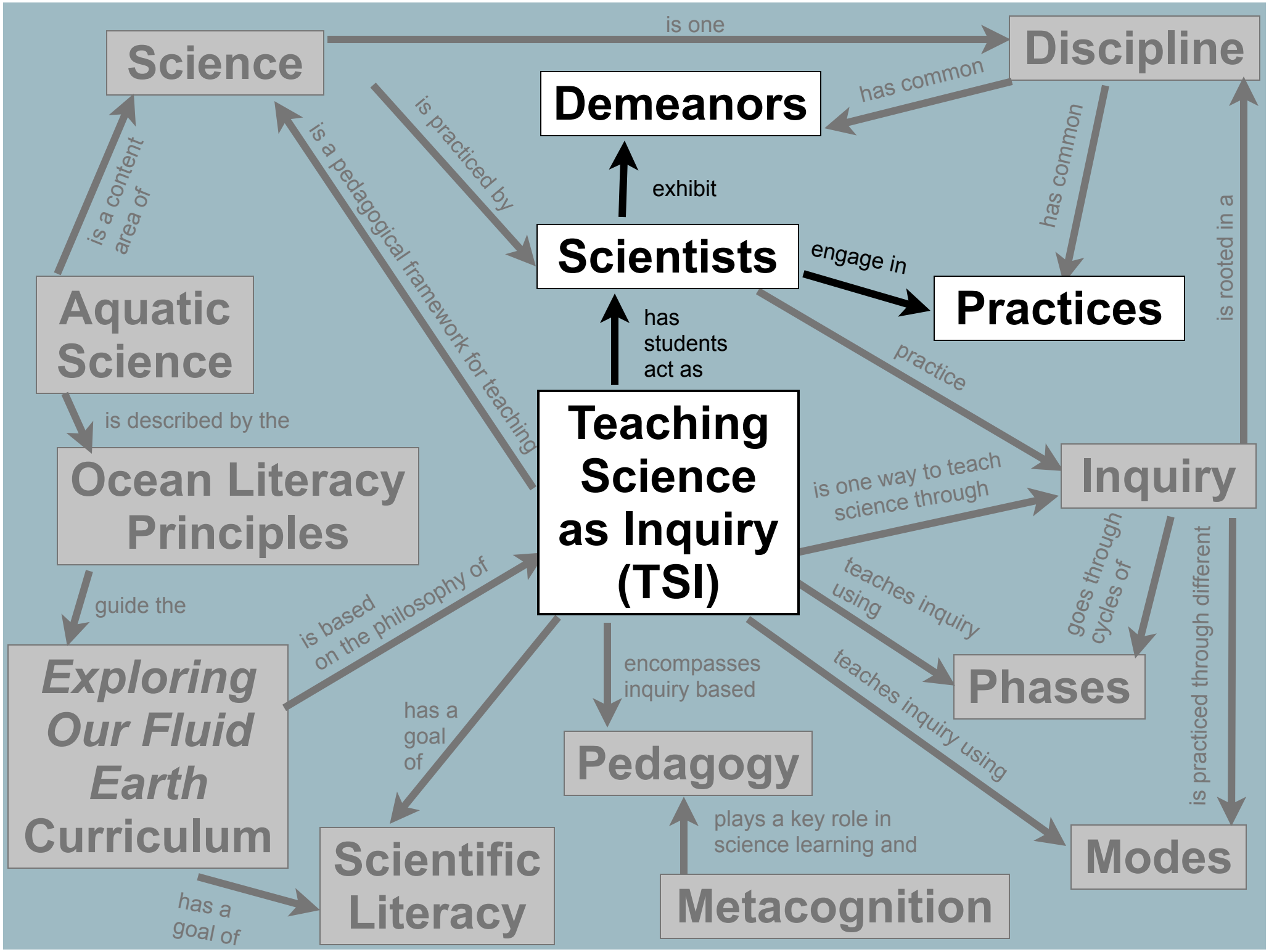
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Practices of Science

Practices of Science:
Things you *actually do* when doing science = verbs

- *Asking* questions
- *Making* observations
- *Devising* a testable hypothesis
- *Collecting, analyzing,* and *interpreting* data
- *Constructing and critiquing* arguments
- *Communicating*

Practices of Science

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Demeanors:
Adverbs to the practice verbs

- Responsibly
- Courteously
- Skeptically
- Respectfully
- Accurately
- Honestly
- Open-mindedly
- Evidentually

- I am honestly communicating the results of my analysis
- We are accurately collecting data by measuring sharks with our ruler

Density Bags

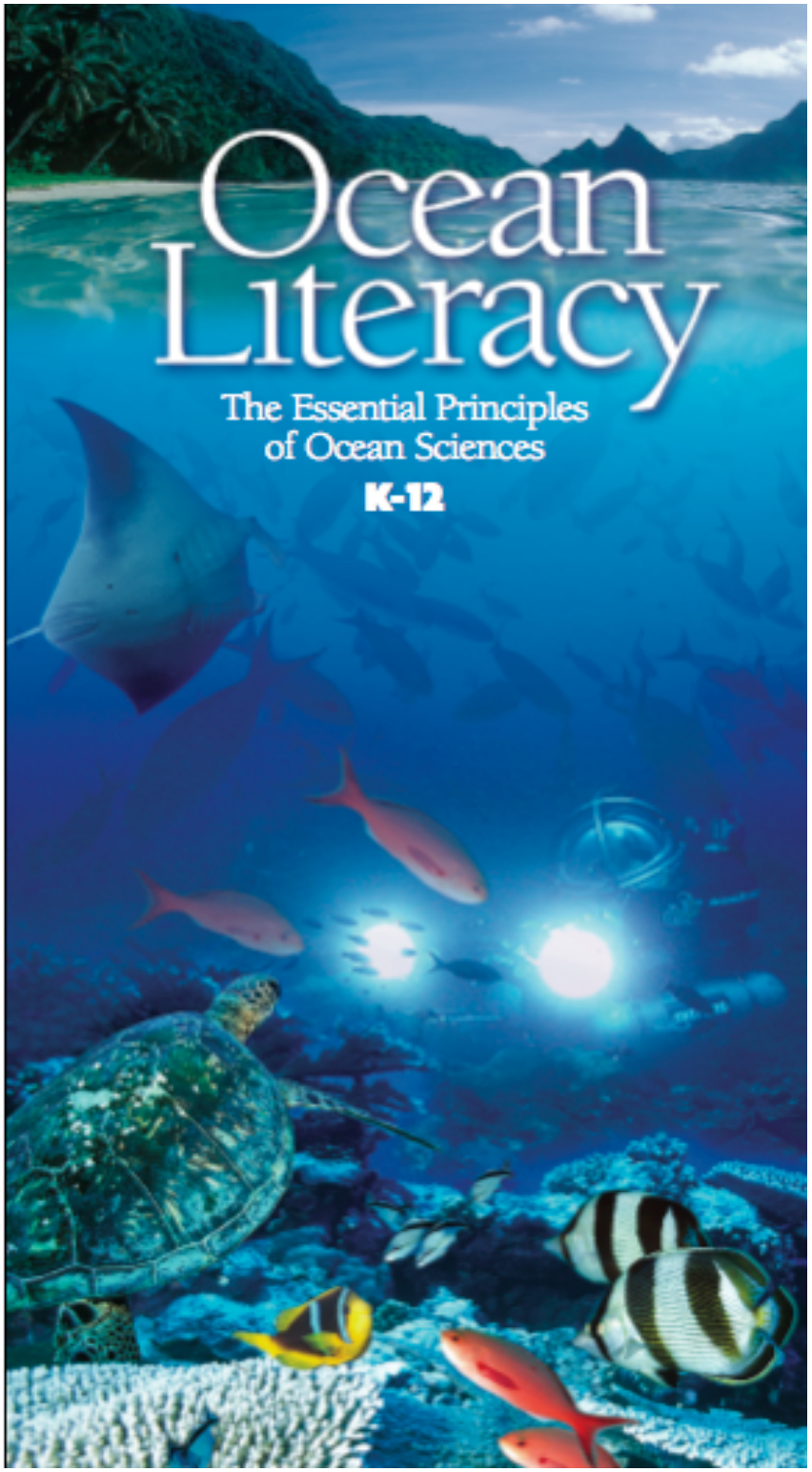
Density Bags

Activity Goals

- Determine the effect of temperature and salinity on relative density
- Explain the relationship between floating, sinking and relative density

This activity:

- Scaffolds scientific content and practices
- Reviews and revisits concepts (density)
- Emphasizes the importance of predictions and careful observations
- Demonstrates the role of teacher as research director



1. Earth has one big ocean with many features.

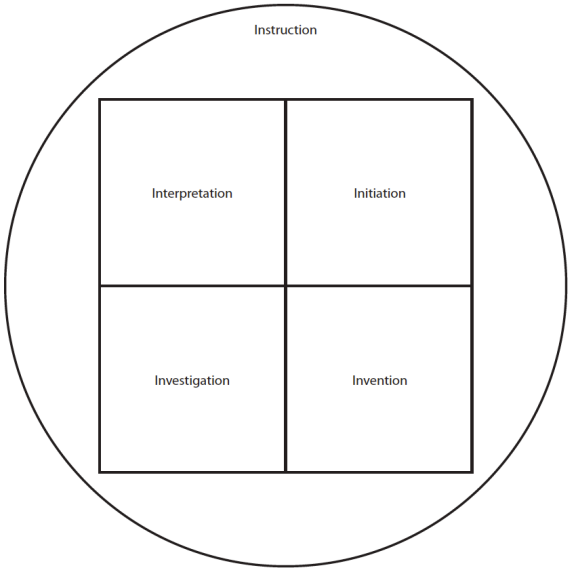
Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the earth's rotation (Coriolis effect), the sun, and water density differences. The shape of the ocean basins and adjacent landmasses influence the path of circulation. (OLP 1c)

Most of Earth's water (97 percent) is in the ocean. Seawater has unique properties: it is saline, its freezing point is slightly lower than fresh water, its density is slightly higher, its electrical conductivity is much higher, and it is slightly basic. The salt in seawater comes from eroding land, volcanic emissions, reactions at the seafloor, and atmospheric deposition. (OLP 1f)

Density Bags

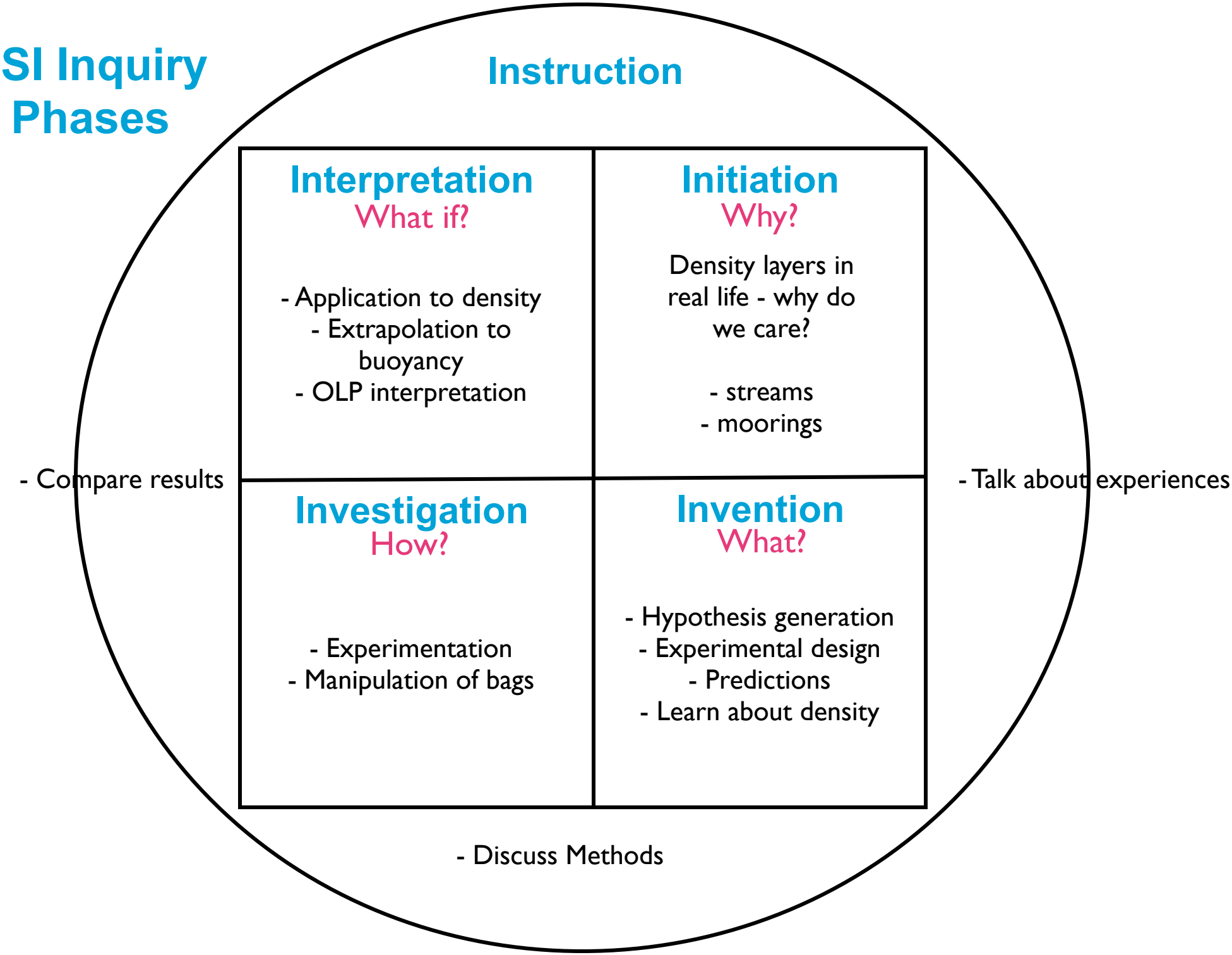
Student-Teacher Hat

Metacognition

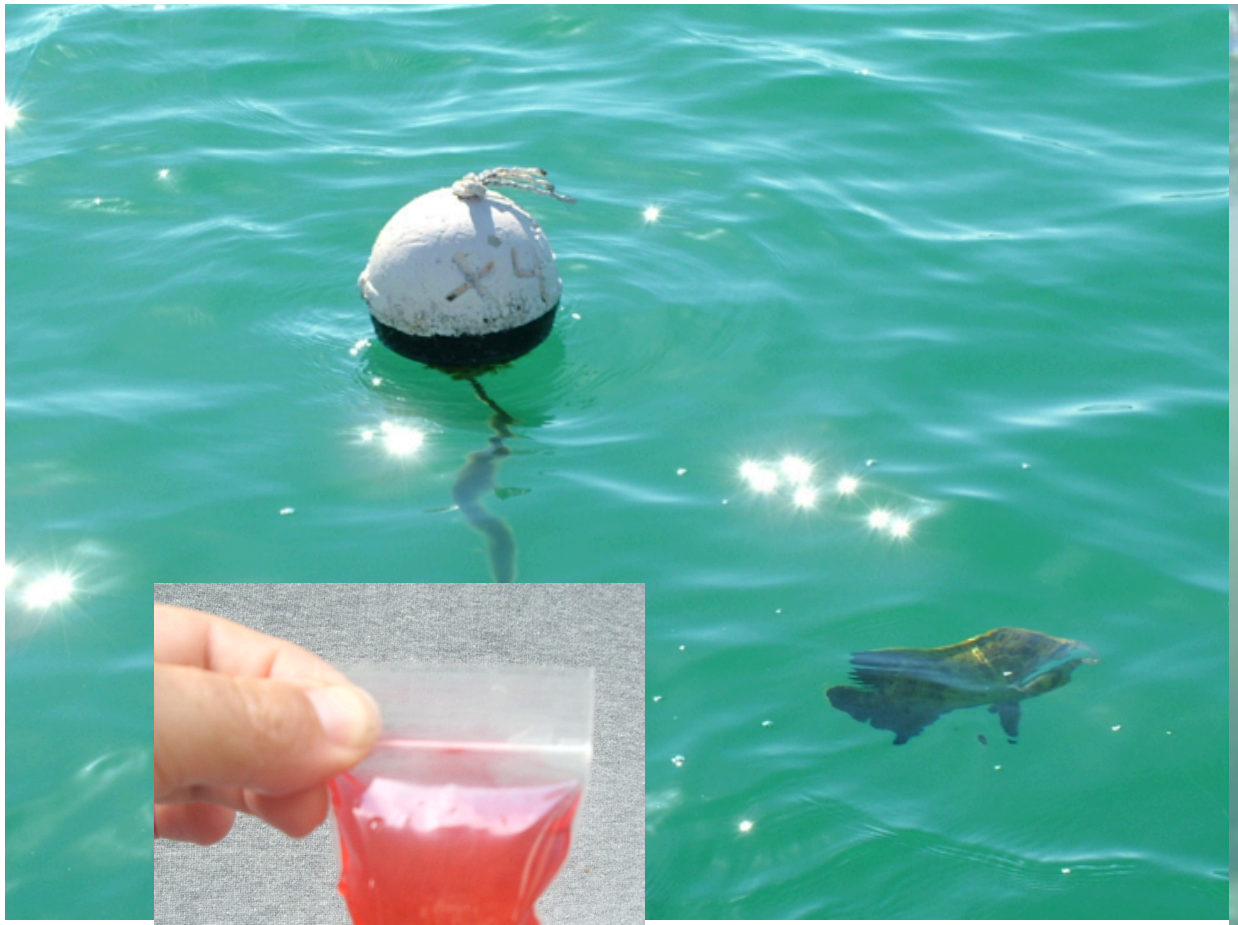


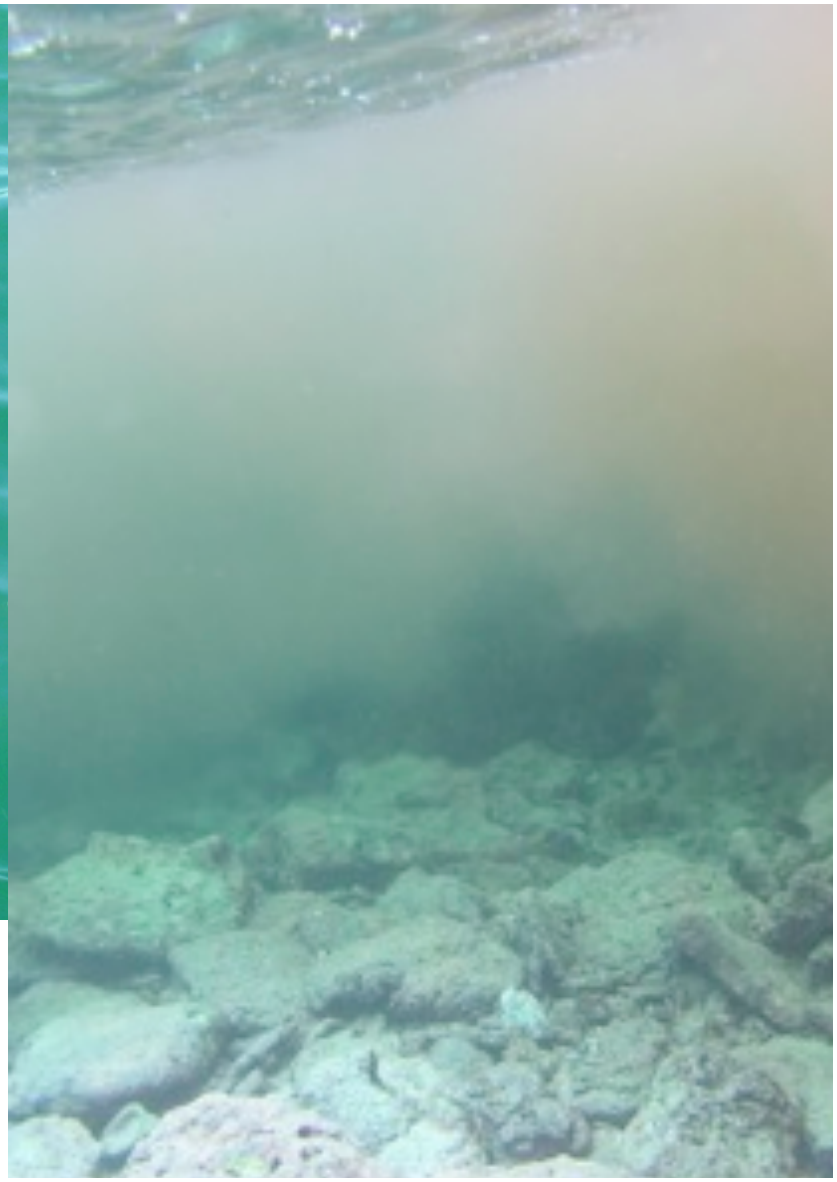
TSI Phases

TSI Inquiry Phases



Density Bags





Effect of Salinity (Part A)

- For each combination of fresh and salt water, predict whether the bag will:
    a. sink
    b. float
    c. subsurface float
- Record your predictions in Table 2.1

Salinity - Predications

Liquid in beaker	**Liquid in bag**	
	Fresh water	Salt water
Fresh water	Predicted	Predicted
	Actual	Actual
Salt water	Predicted	Predicted
	Actual	Actual

Predictions are VERY important

Filling Bags

- Use a permanent marker to label
- (Optional) Add a drop of food coloring
- Fill using small cup
- Overfill the bag with water using the small cup
- Seal the bag so it does not leak or have air bubbles
- Shake the bag to distribute the food coloring
- Pat the plastic bag dry
- Cut off excess plastic of the bag above the closure

Effect of Salinity

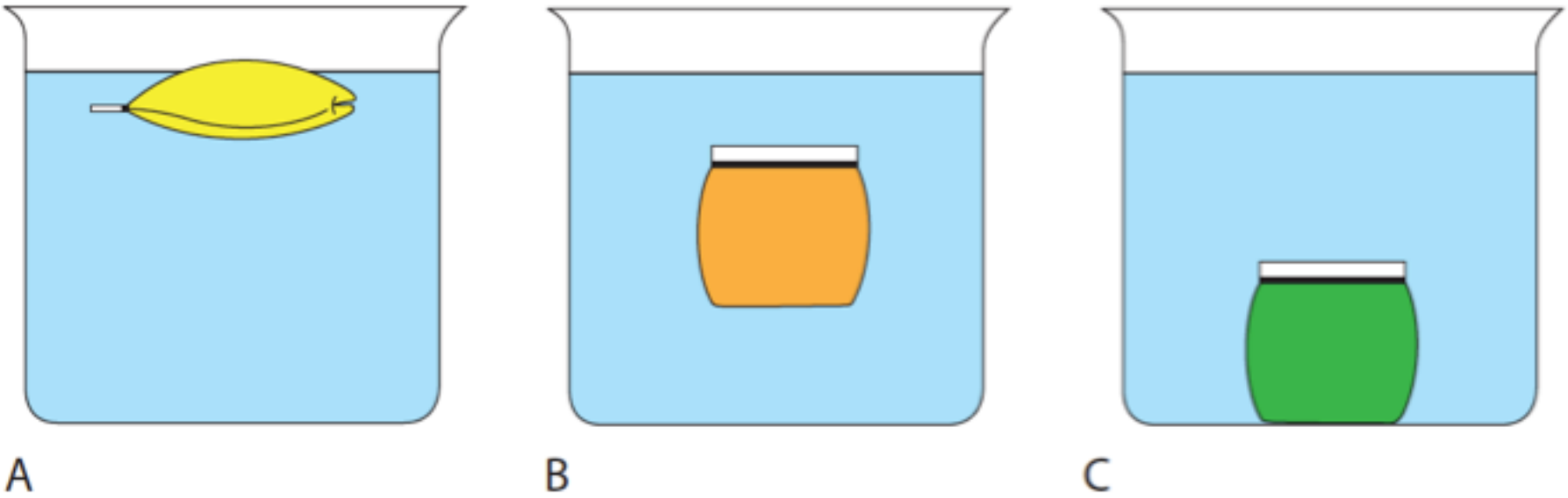
Liquid in beaker	Liquid in bag	
	Fresh water	Salt water
Fresh water	Predicted	Predicted
	Actual	Actual
Salt water	Predicted	Predicted
	Actual	Actual

Effect of Salinity

Liquid in beaker	Liquid in bag	
	Fresh water	Salt water
Fresh water	Predicted	Predicted
	Actual Float (*subsurface)*	Actual Sink
Salt water	Predicted	Predicted
	Actual Float	Actual Float (*subsurface)*

- Compare Results
- Did anyone have subsurface floating?

Density Bags



Relative Density

Effect of Temperature (Part B)

- For each combination of hot and cold fresh water, predict whether the bag will:
    a. sink
    b. float
    c. subsurface float
- Record your predictions in a data table

Temperature - Predications

Liquid in beaker	**Liquid in bag**	
	Cold water	Hot water
Cold water	Predicted	Predicted
	Actual	Actual
Hot water	Predicted	Predicted
	Actual	Actual

Effect of Temperature

Liquid in beaker	Liquid in bag	
	Cold water	Hot water
Cold water	Predicted	Predicted
	Actual	Actual
Hot water	Predicted	Predicted
	Actual	Actual

Effect of Temperature

Liquid in beaker	**Liquid in bag**	
	Cold water	Hot water
Cold water	Predicted	Predicted
	Actual Float (*subsurface*)	Actual Float
Hot water	Predicted	Predicted
	Actual Sink	Actual Float (*subsurface*)

- Compare Results
- Did anyone have subsurface floating?

Effects of Both Salinity & Temperature (Part C)

- Design an experiment to test the effects of both temperature—hot or cold—and salinity—fresh water or salt water—on the rising and sinking of bags of liquid. For example, you might want to determine the relative density of a hot salty water bag in a beaker of cold fresh water.

Temperature & Density
Predicted Results

Liquid in Container	Liquid in bag			
	Cold Salt	Cold Fresh	Hot Salt	Hot Fresh
Cold Salt				
Cold Fresh				
Hot Salt				
Hot Fresh				

Which combinations have we already tested?

Temperature & Density
Predicted Results

Liquid in Container	Liquid in bag			
	Cold Salt	Cold Fresh	Hot Salt	Hot Fresh
Cold Salt				
Cold Fresh		*Float (ss)*		*Float*
Hot Salt				
Hot Fresh		*Sink*		*Float (ss)*

Are there any combinations we can make inferences about given our previous trials?

Temperature & Density
Predicted Results

Liquid in Container	Liquid in bag			
	Cold Salt	Cold Fresh	Hot Salt	Hot Fresh
Cold Salt	Float (ss)	Float	Float	
Cold Fresh	Sink	*Float (ss)*		*Float*
Hot Salt	Sink		Float (ss)	Float
Hot Fresh		*Sink*	Sink	*Float (ss)*

Green underlined = salinity Blue = temperature

Liquid in Container	Liquid in bag			
	Cold Salt	Cold Fresh	Hot Salt	Hot Fresh
Cold Salt	Float (ss)	Float	Float	
Cold Fresh	Sink	*Float (ss)*		*Float*
Hot Salt	Sink		Float (ss)	Float
Hot Fresh		*Sink*	Sink	*Float (ss)*

Green underlined = salinity Blue = temperature

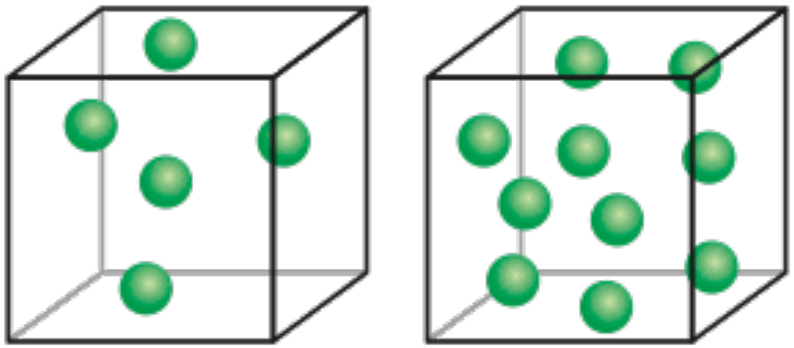
Temperature & Density
Idealized Results

Liquid in Container	Liquid in bag			
	Cold Salt	Cold Fresh	Hot Salt	Hot Fresh
Cold Salt	Float (ss)	Float	Float	Float
Cold Fresh	Sink	*Float (ss)*	Depends	*Float*
Hot Salt	Sink	Depends	Float (ss)	Float
Hot Fresh	Sink	*Sink*	Sink	*Float (ss)*

Green underlined = salinity Blue = temperature

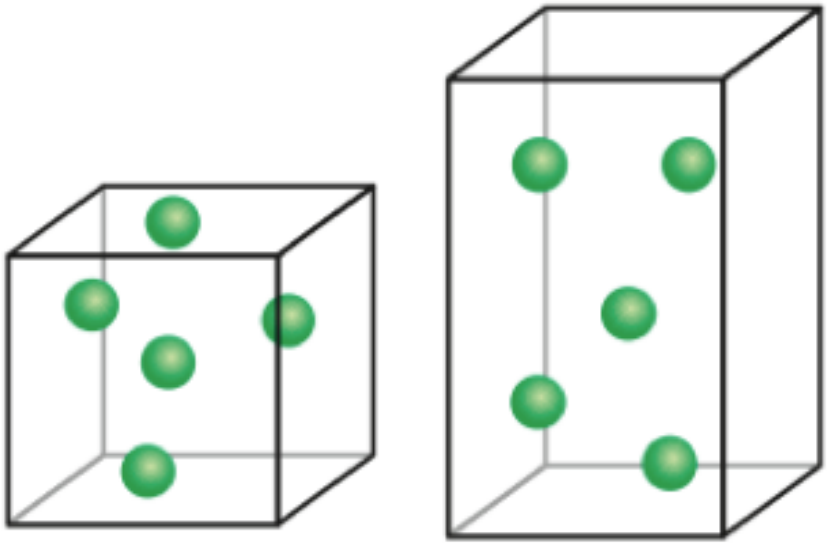
Density Bags

Increase in salinity



A B

Increase in temperature

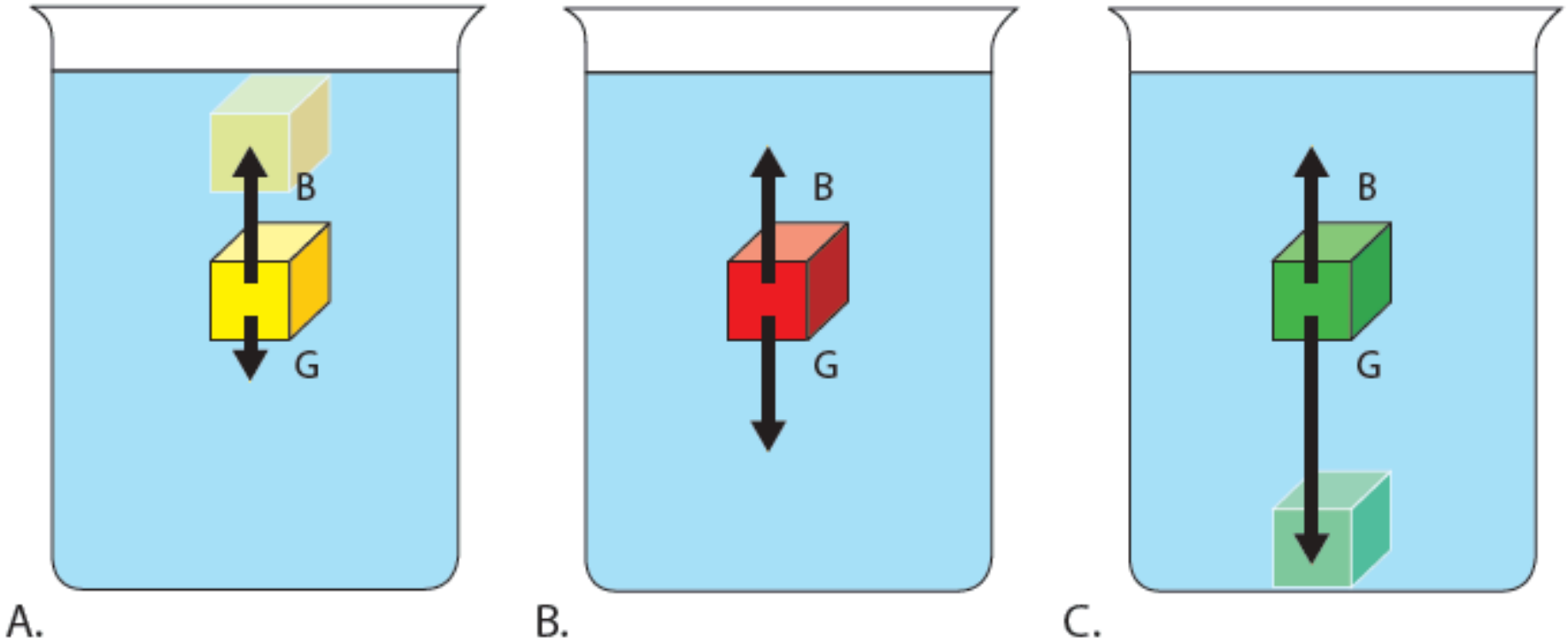


A C

Density, Temperature, and Salinity

Gravitational force (G) & Buoyant force (B)

Three cubes with different densities



A. G < B

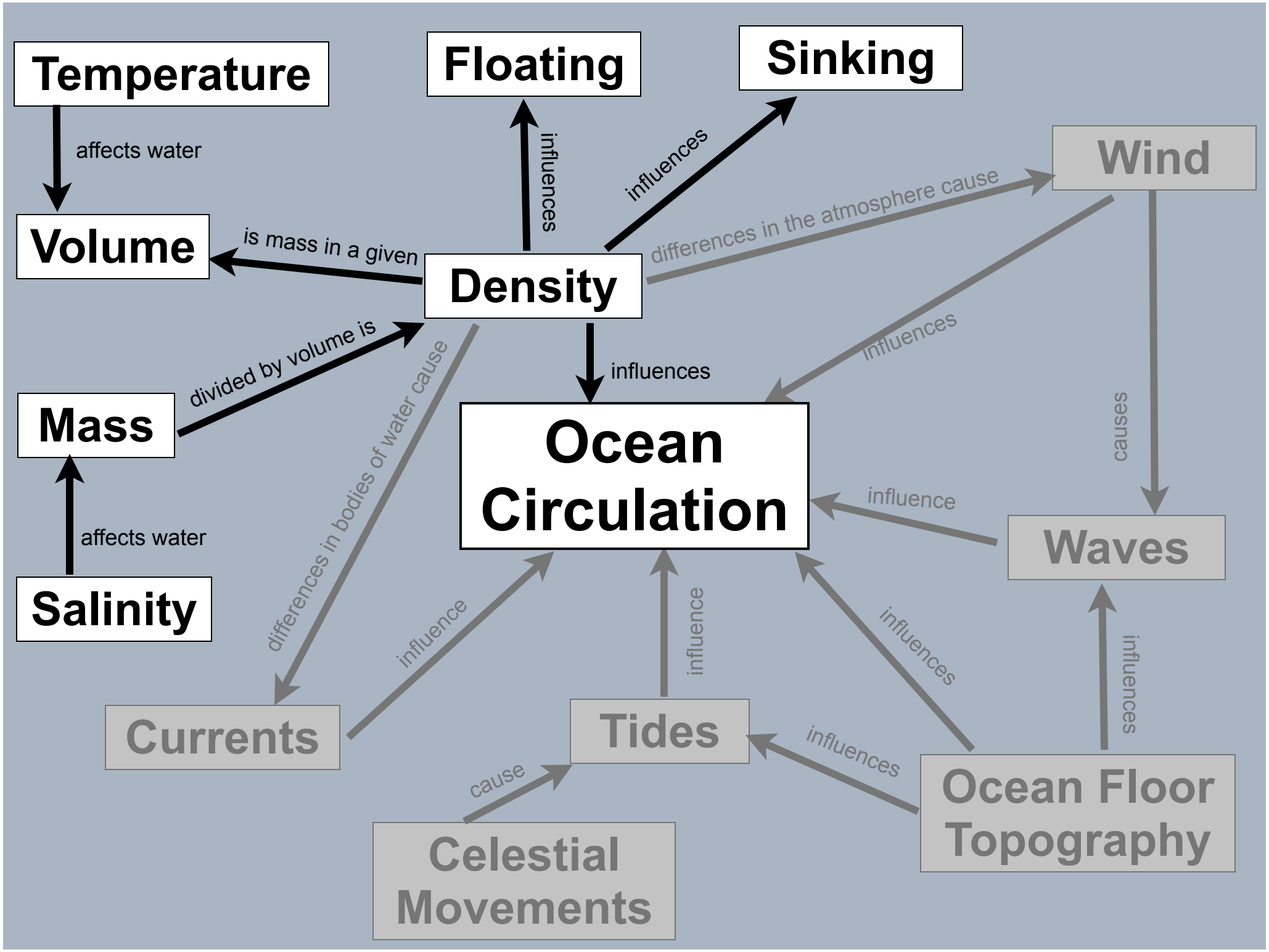
B. G = B

C. G > B

Density Bags

Tips and Tricks

- Break up procedure parts over multiple days
- Make salt water super-salty
- Options to heat up water (safety concern)
- Jewelry bags - tape up leaks
- Water baths for pre-filled bags


Temperature
affects water
Volume
Floating
Sinking
influences
influences
is mass in a given
Density
differences in the atmosphere cause
Wind
divided by volume is
influences
influences
causes
Mass
Ocean Circulation
affects water
Salinity
differences in bodies of water cause
influence
influence
influence
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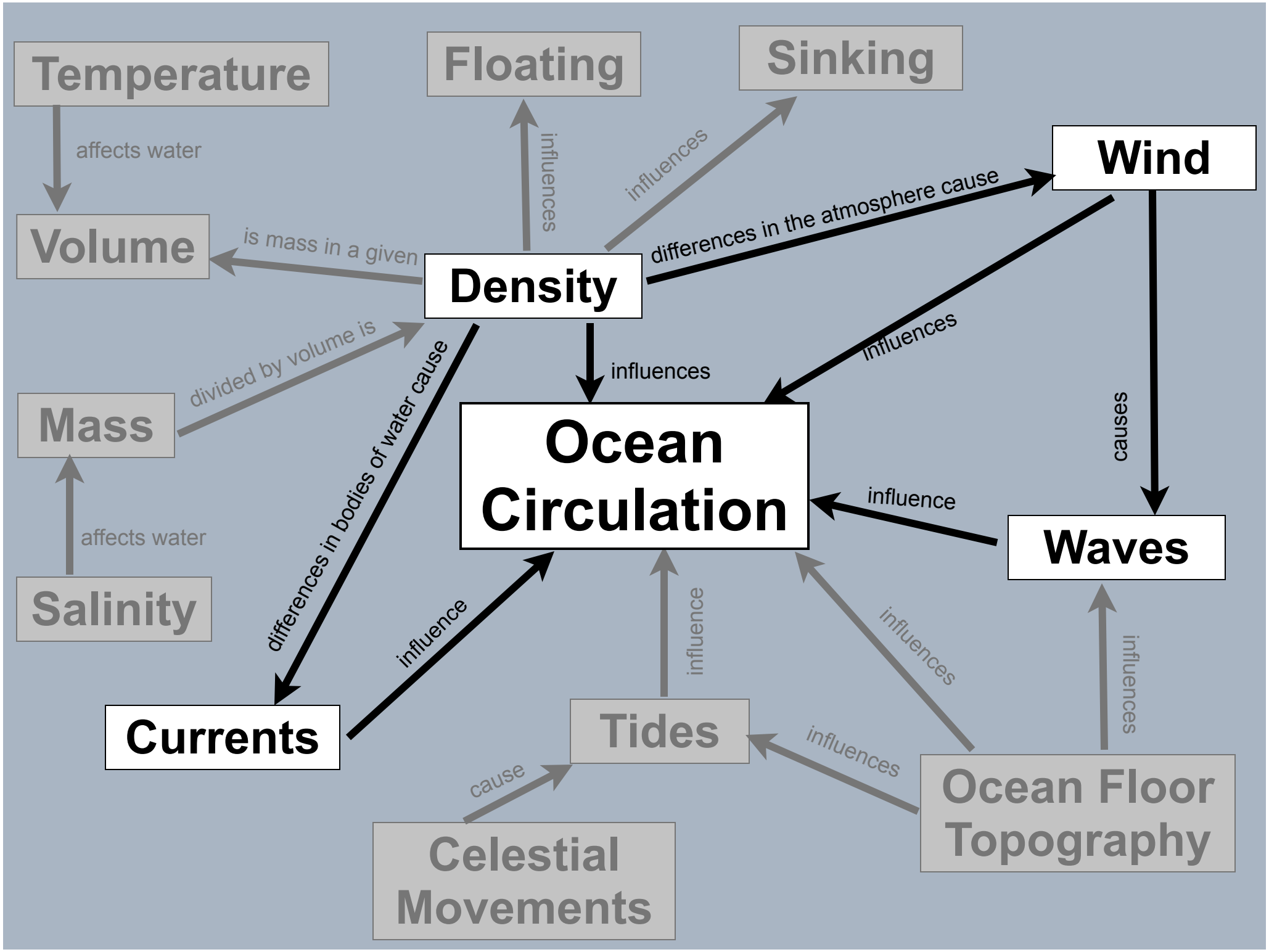
influences
influence
Waves
Currents
Tides
cause
influences
Ocean Floor Topography
Celestial Movements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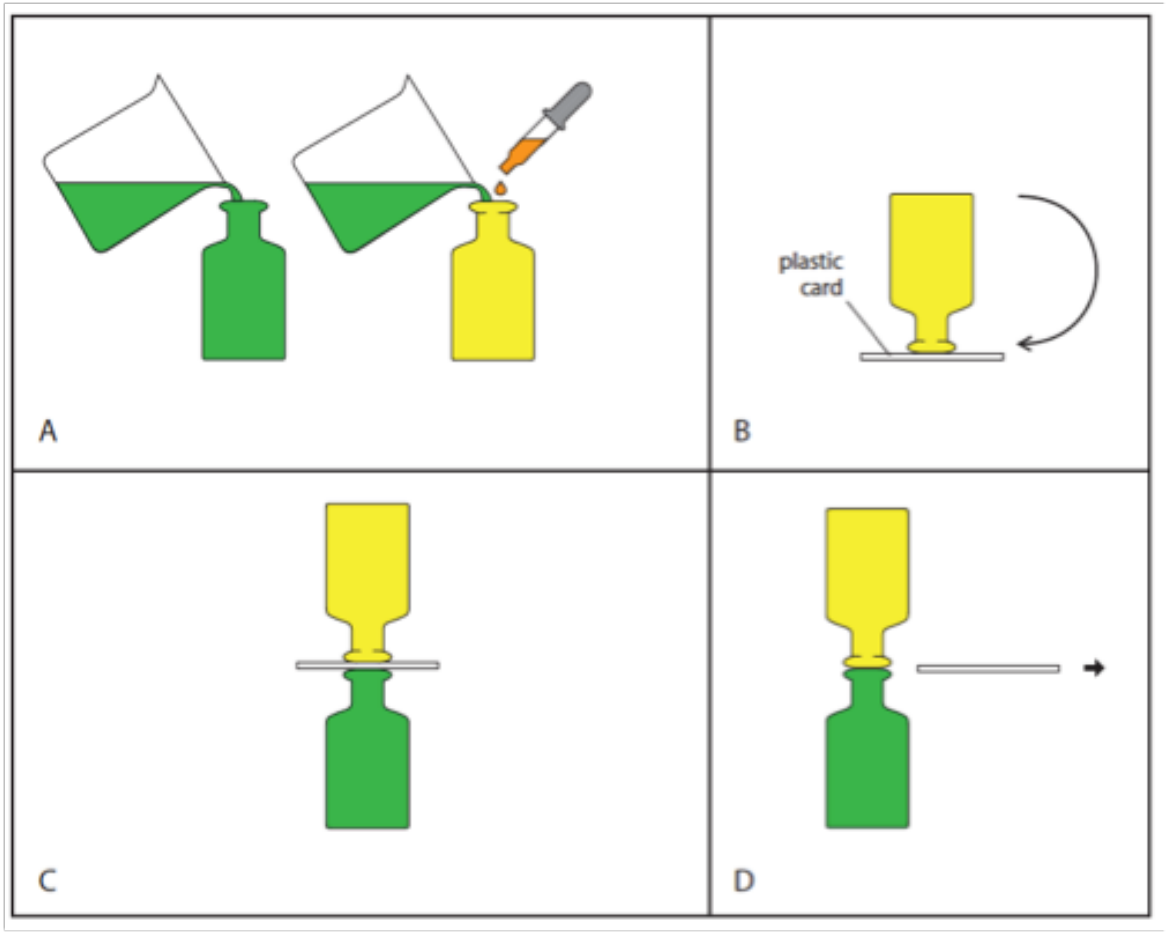
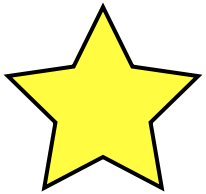
Gravitational Currents



Kinesthetic Moon Model



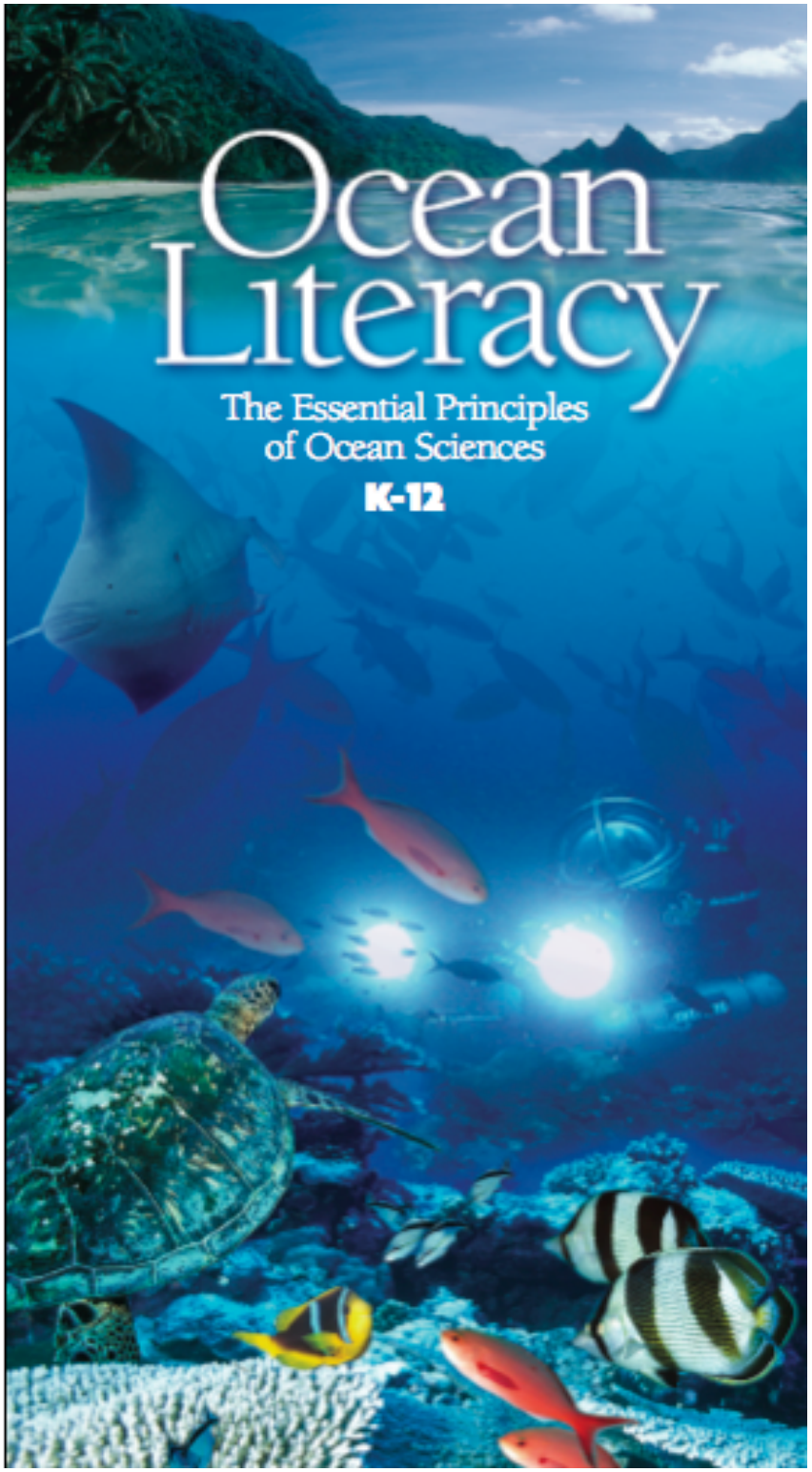
Kinesthetic Moon Model

Activity Goals

- Model the movements of the sun, earth and moon
- Relate the movement of celestial bodes to tides on earth

This activity:

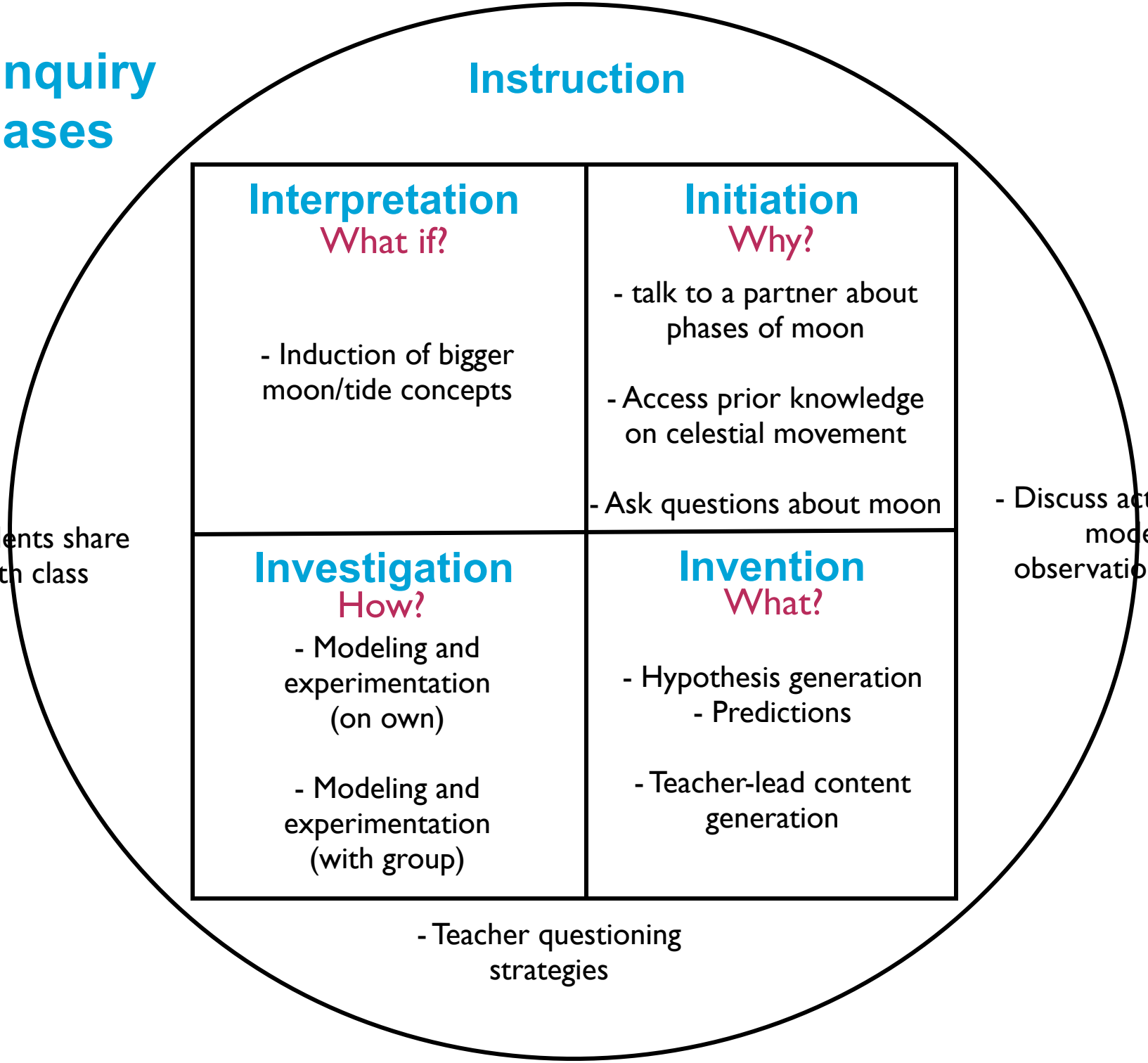
- Is scripted, within the script concepts are scaffolded
- Shows immediate evidence of student thinking
- Utilizes a model
- Avoids front-loading too much content
- Purposefully uses questioning strategies



1. **Earth has one big ocean with many features.**

Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the earth's rotation (Coriolis effect), the sun, and water density differences. The shape of the ocean basins and adjacent landmasses influence the path of circulation. (OLP 1c)

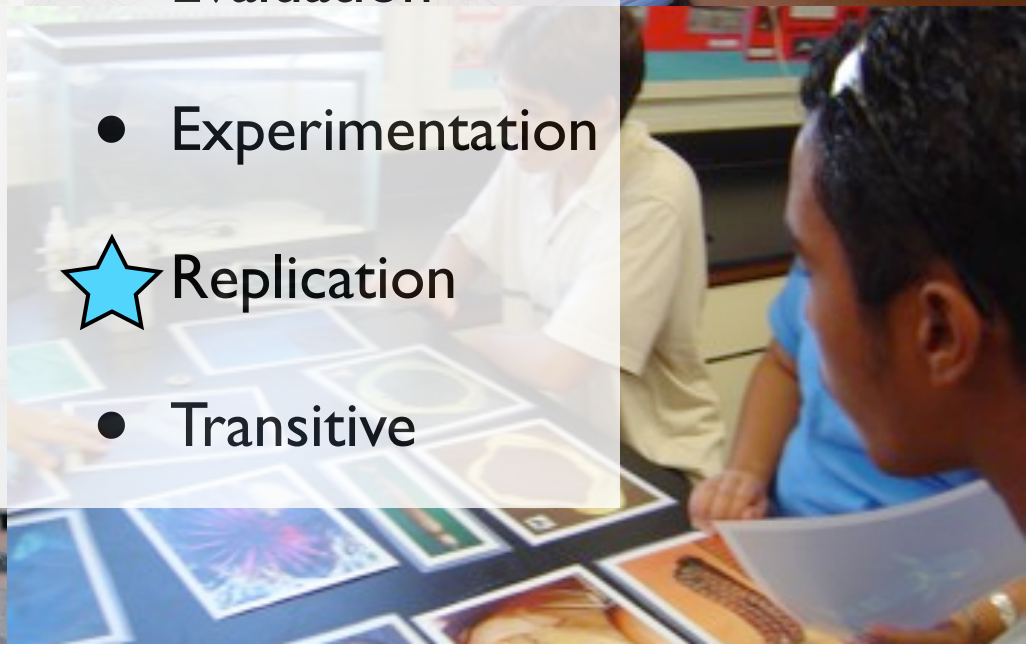
TSI Inquiry Phases



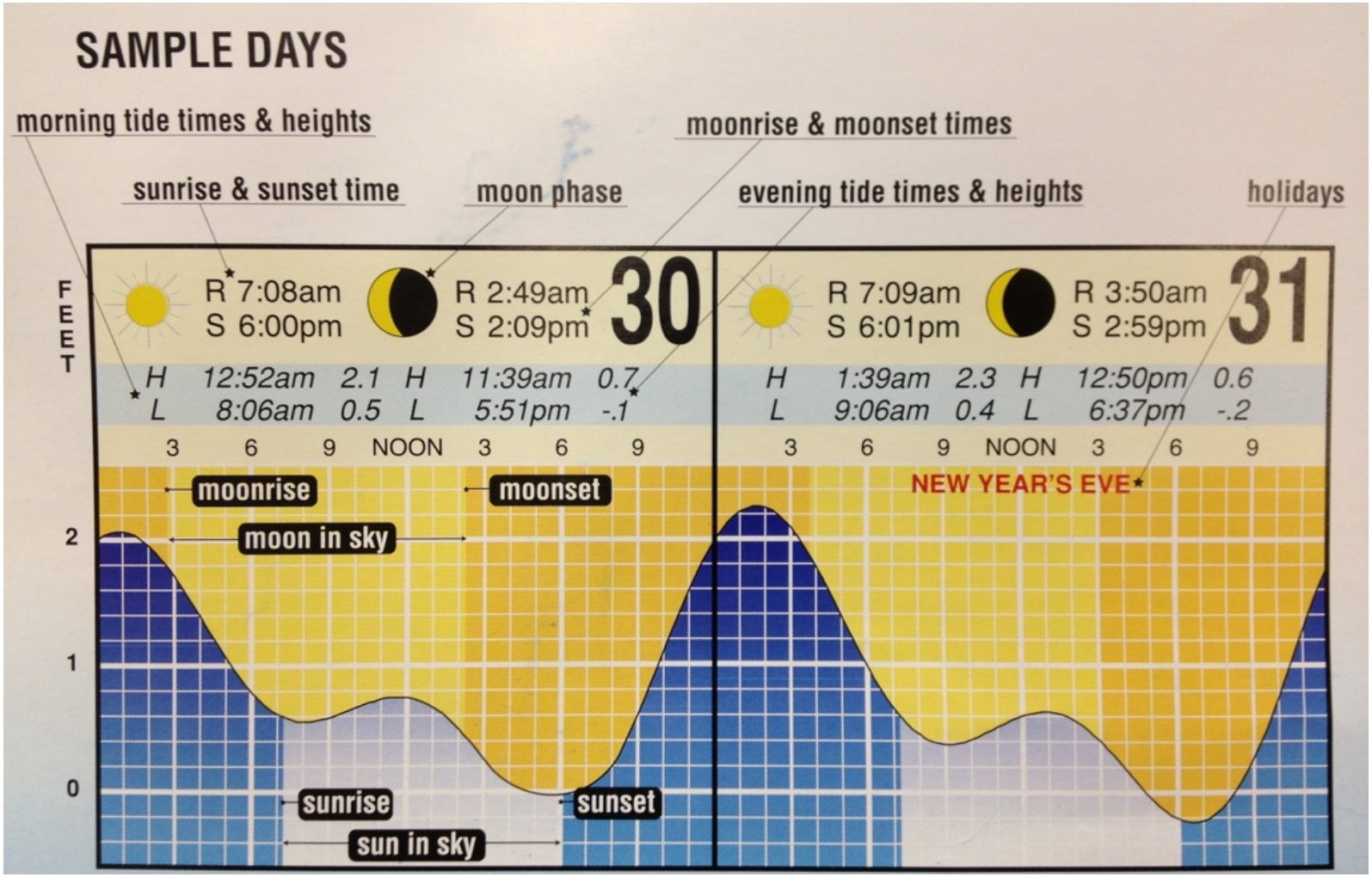
TSI Modes of Inquiry

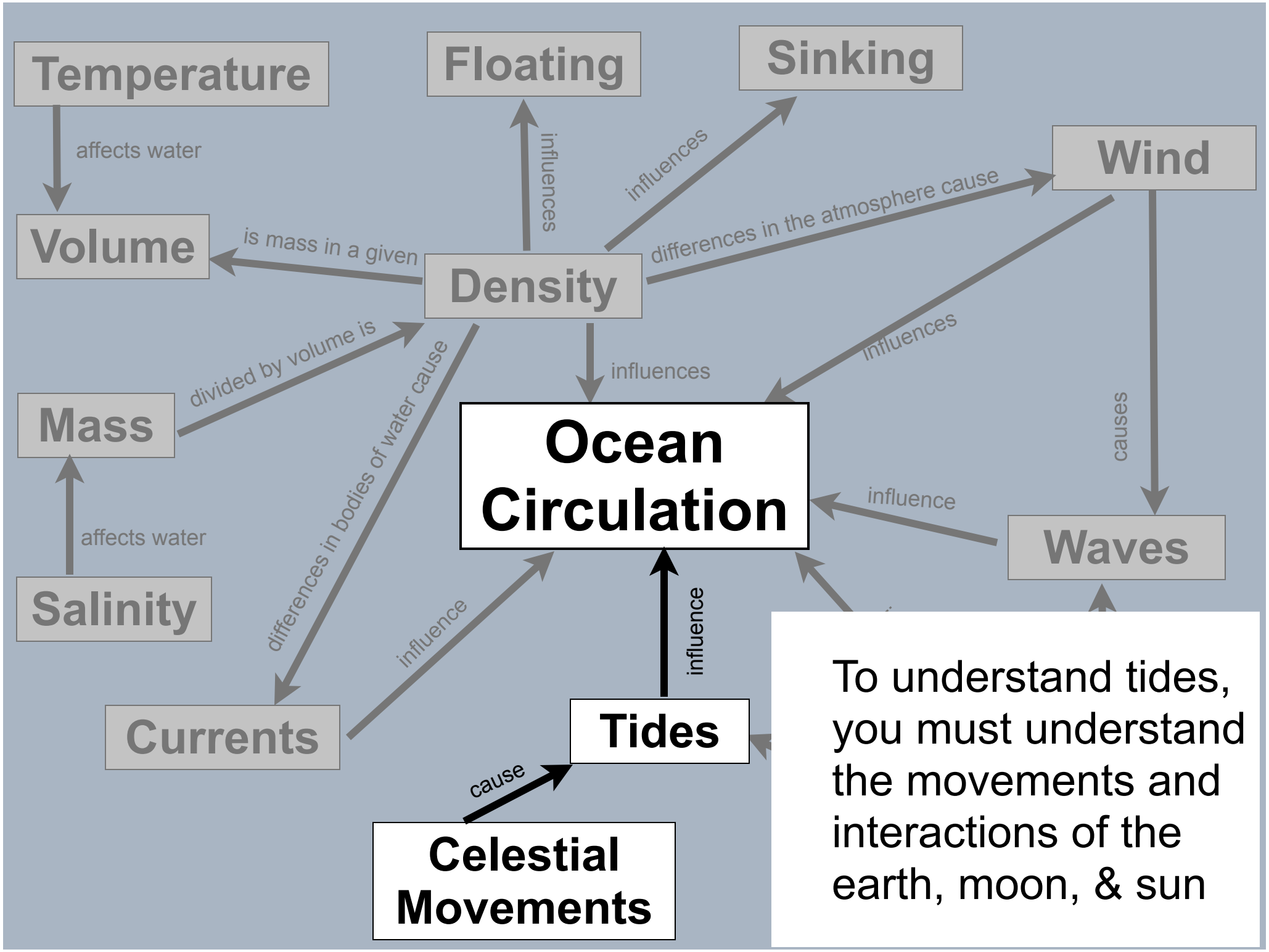
- Curiosity
- ★ Description
- ★ Authoritative Knowledge
- Deduction
- ★ Induction

- ★ Technology
- Product Evaluation
- Experimentation
- ★ Replication
- Transitive



Kinesthetic Moon Model

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influence
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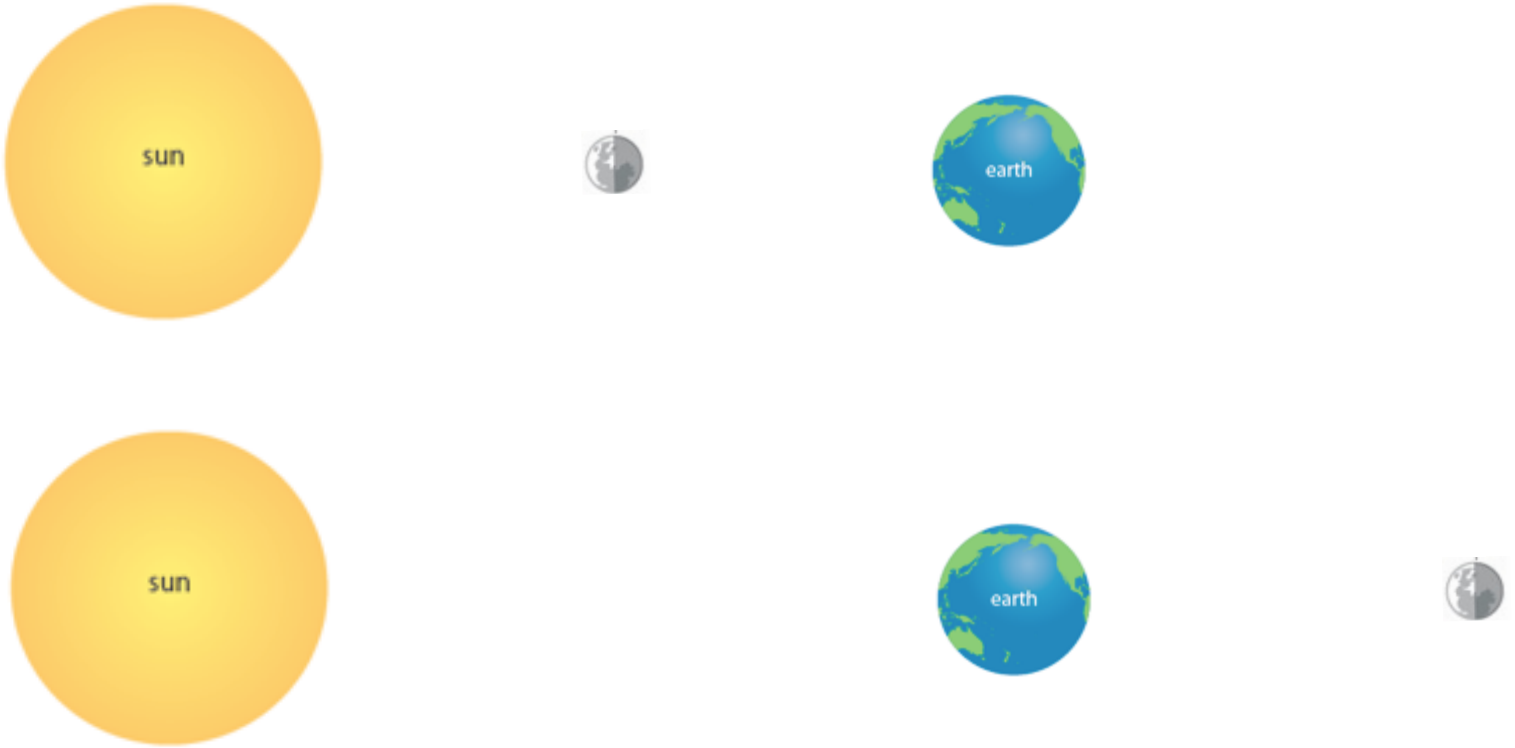
Tides
cause
Celestial Movements
To understand tides, you must understand the movements and interactions of the earth, moon, & sun

Kinesthetic Moon Model

Spring Tides



Neap Tides