Introduction: Scientific Methods

In Alberta's New Science Curriculum for Grades 1-3

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Treaty Acknowledgement

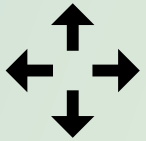
In the spirit of reconciliation, we want to acknowledge that this gathering is taking place on traditional lands across the province of Alberta, home to many diverse First Nations, Métis and Inuit peoples. We acknowledge that this land is a traditional meeting ground giving voice to its original peoples and the story of creation of this country in a way that history has forgotten.

Agreement

Position:
Nothing reflects on your abilities

Productive Struggle:
Work through struggle:

- Creatively
- Collaboratively
- Taking Risks
- With Perseverance



Situation:
If something isn't right think of how to make it right for your context

TQS:

2. A teacher engages in career-long professional learning and ongoing critical reflection to improve teaching and learning

a) collaborating with other teachers to build personal and collective professional capacities and expertise;

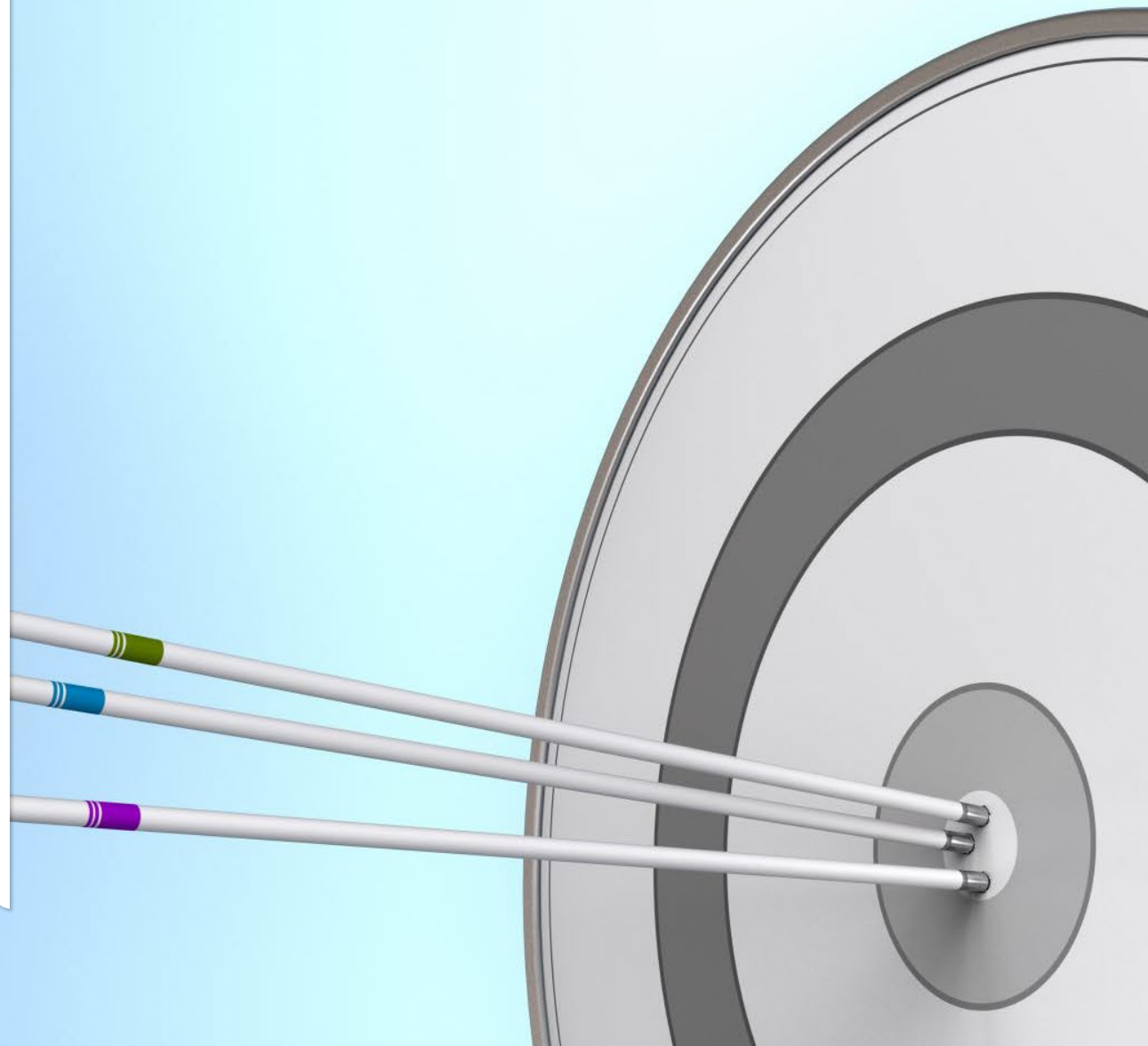
Agenda

1. Background: Science as a Discipline

2. Unpack: Scientific Methods briefly at each grade level as they relate to the investigation cycle

3. Classroom examples of common skills for grades 1-3.

4. Resources will be translated into French.



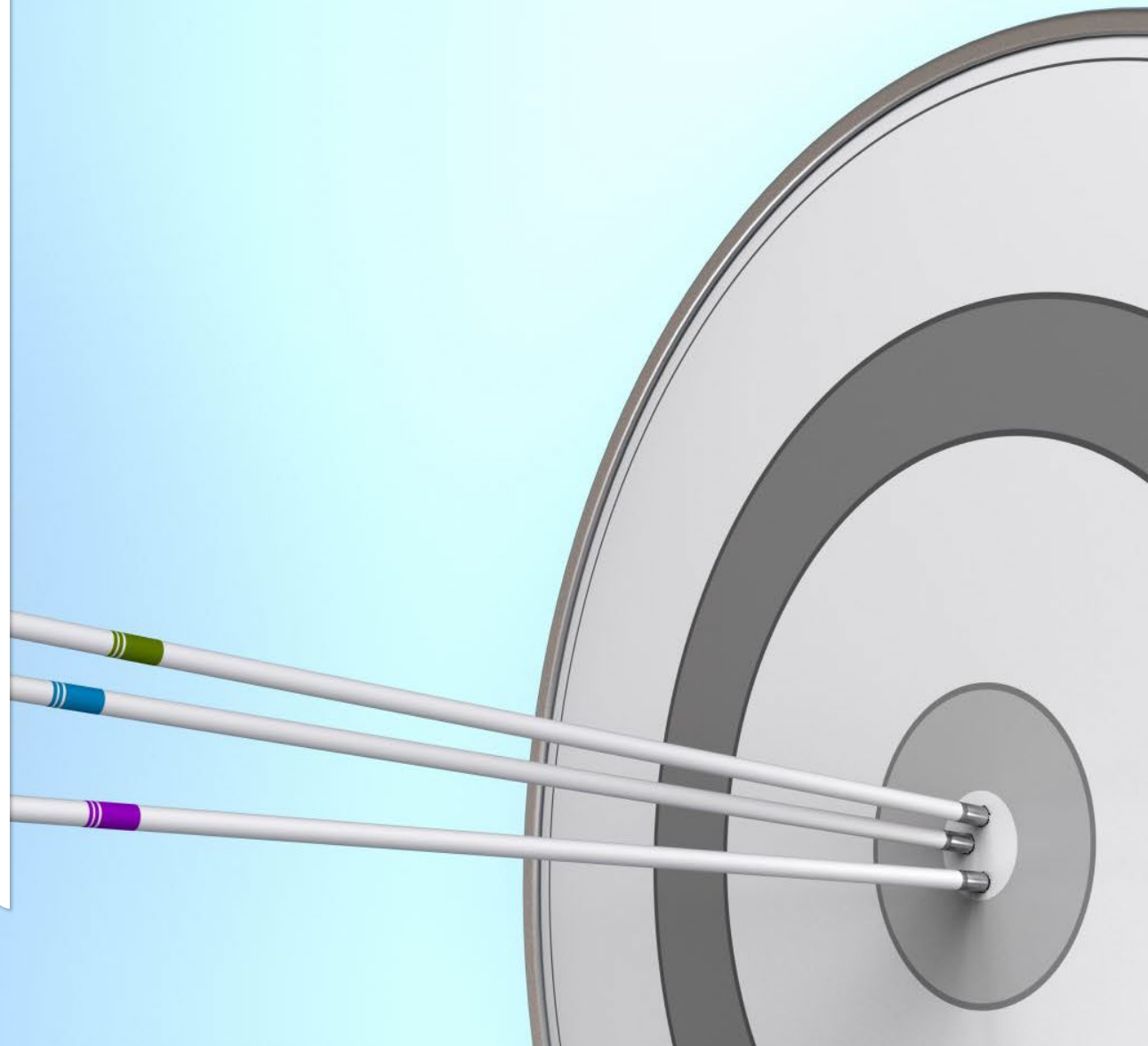
Key Learnings

1. Science uses methods of investigations to build knowledge and understanding of natural world

2. Each grade learning outcome & KUSPS unwraps deeper layer of focus of the investigations

3. Understand that students will build on aspects of investigations at each grade level that continues to the next grade

4. There are criteria to help primary students develop foundational aspects of an investigation that will carry through to upper elementary



Kindergarten & Grade 1

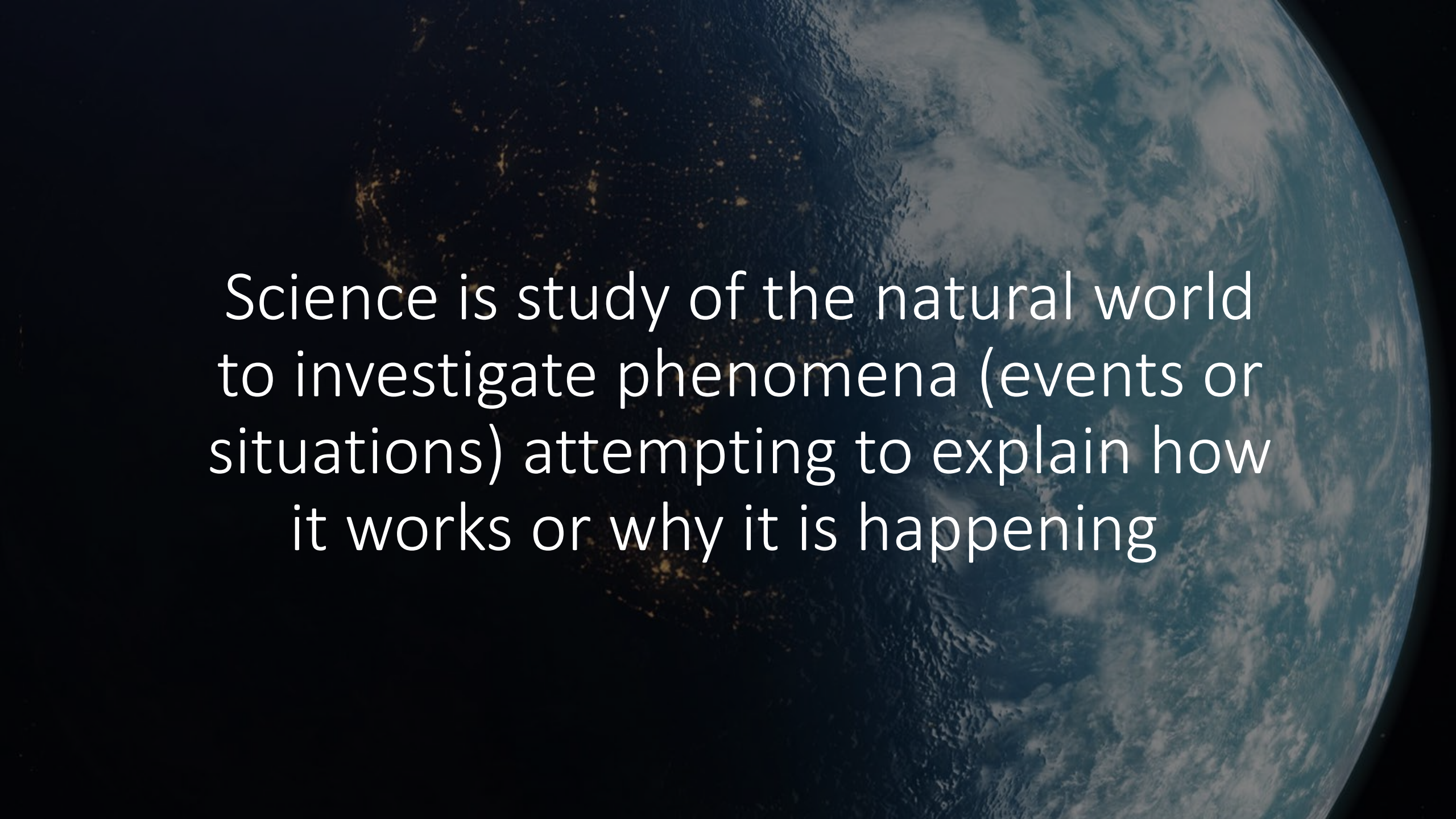
Kindergarten

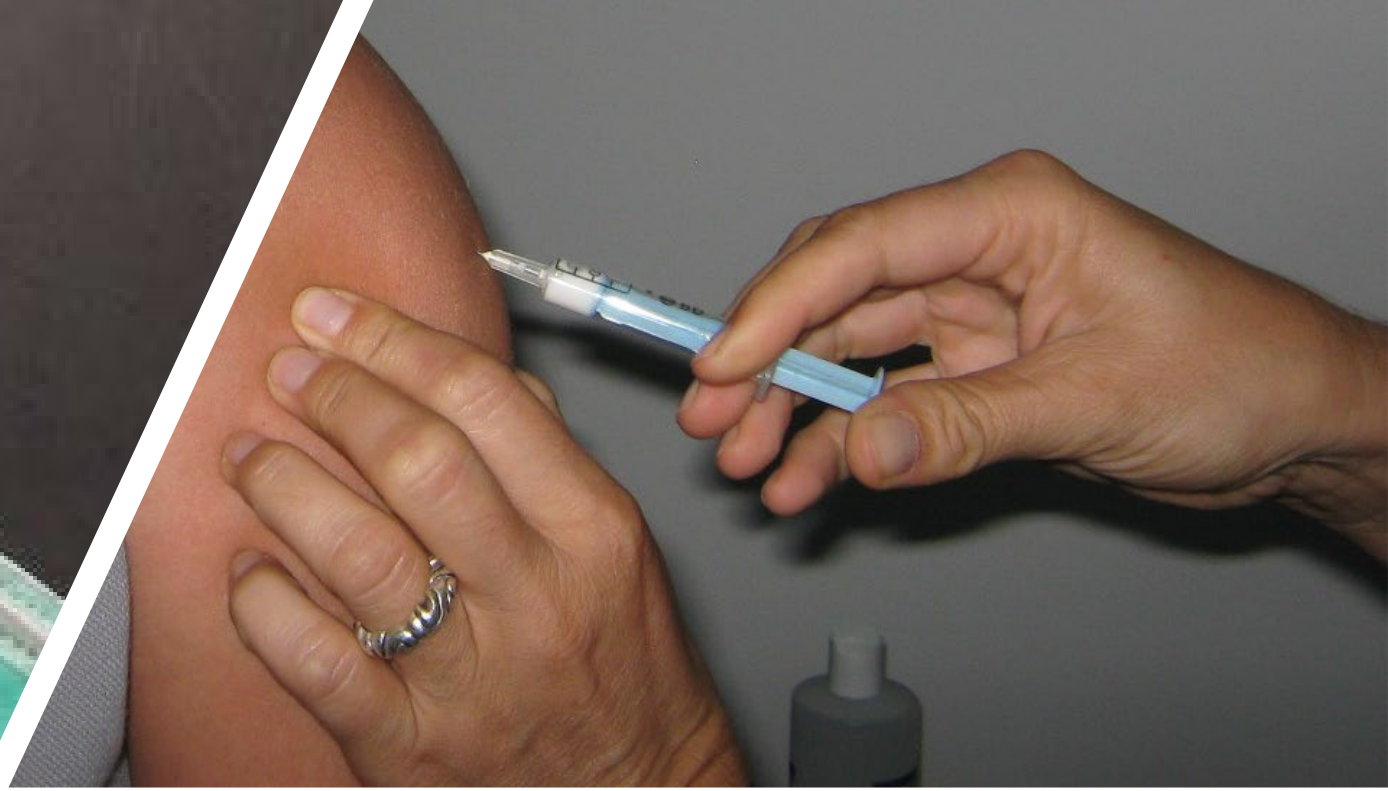
- No Scientific Method

- Computer Science Learning Outcome:
- Children interpret instructions in various environments
- Lends to following sequence of instructions in an investigation.

What is Science?

Purpose of Discipline


Science is study of the natural world to investigate phenomena (events or situations) attempting to explain how it works or why it is happening



EDUCATIONAL JOURNEY OF OUR STUDENTS

Curriculum Subject Introduction: Science

….Scientifically literate citizens are equipped to evaluate sources of information encountered in daily life.

WHAT IS SCIENTIFIC LITERACY?

PISA defines scientific literacy as developing competencies in 3 areas of science:

Content Knowledge – conceptual understanding(science ideas) in the various disciplines in science

Procedural Knowledge – Understanding the inquiry process of science (Skills) and **being able to do investigations**

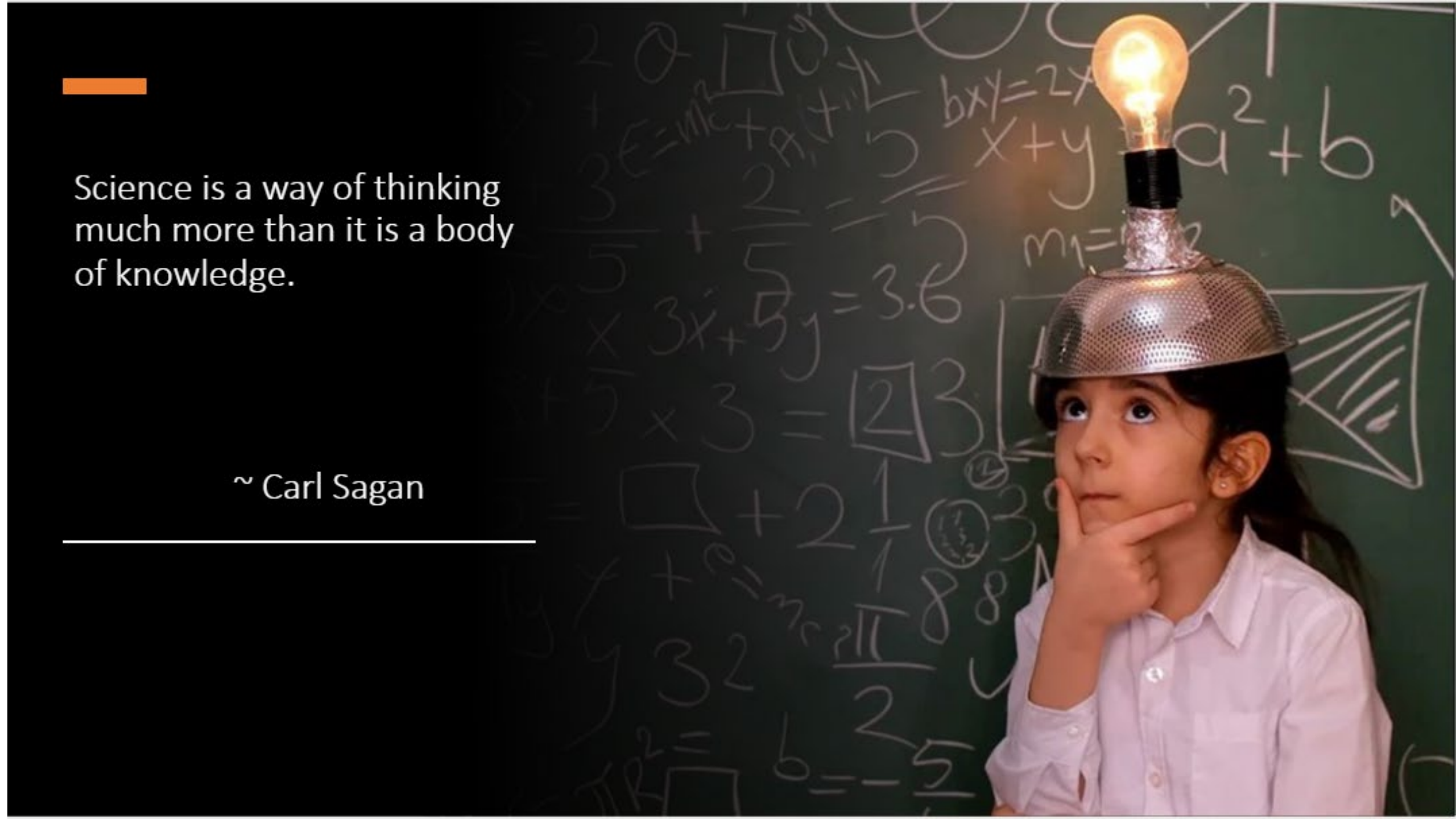
Scientific Methods

Epistemic Knowledge (Name & Know) – Understanding how knowledge is built in Science e.g. how claims are generated, meaning of foundational practices: theory, hypothesis, data etc.

OECD (2019), "PISA 2018 Science Framework", in PISA 2018 Assessment and Analytical Framework, OECD Publishing, Paris

Science is a way of thinking much more than it is a body of knowledge.

~ Carl Sagan



A lot has changed since 1996:

- Cognitive and Developmental Psychology: How students Learn
- Defining Scientific Literacy
- Science of Reading: Importance of background knowledge on reading comprehension
- Research in Science Education

Our science instruction and resources used should reflect these changes.

Students Need Both "Hands On" Investigations & Text

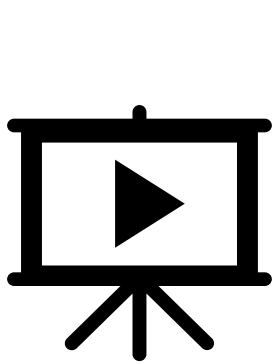
- Research in science education indicates that students learn best when there is a combination of hands-on investigations and texts to make sense of science ideas and significantly improves conceptual knowledge in students
- Classrooms who use **both** significantly **outperform** those that only use straight investigations **or** only use text

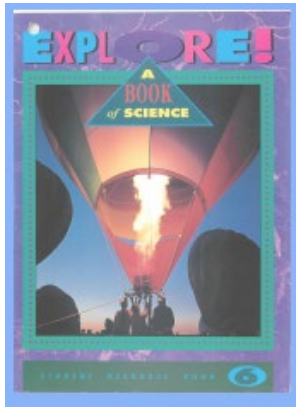
(Palinscar, Magnusson, Marano, Ford & Brown, 1998; Cervetti, Barber, Dorph, Pearson & Goldschmidt, 2012; Wang & Herman, 2005)

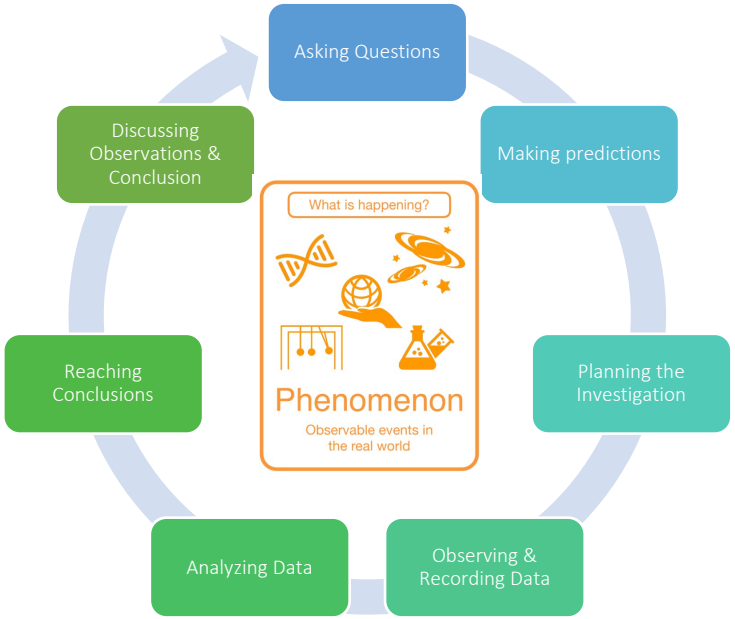
Traditional Instruction Sequence

Explain

Explore





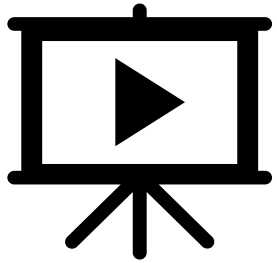


Flip the Sequence

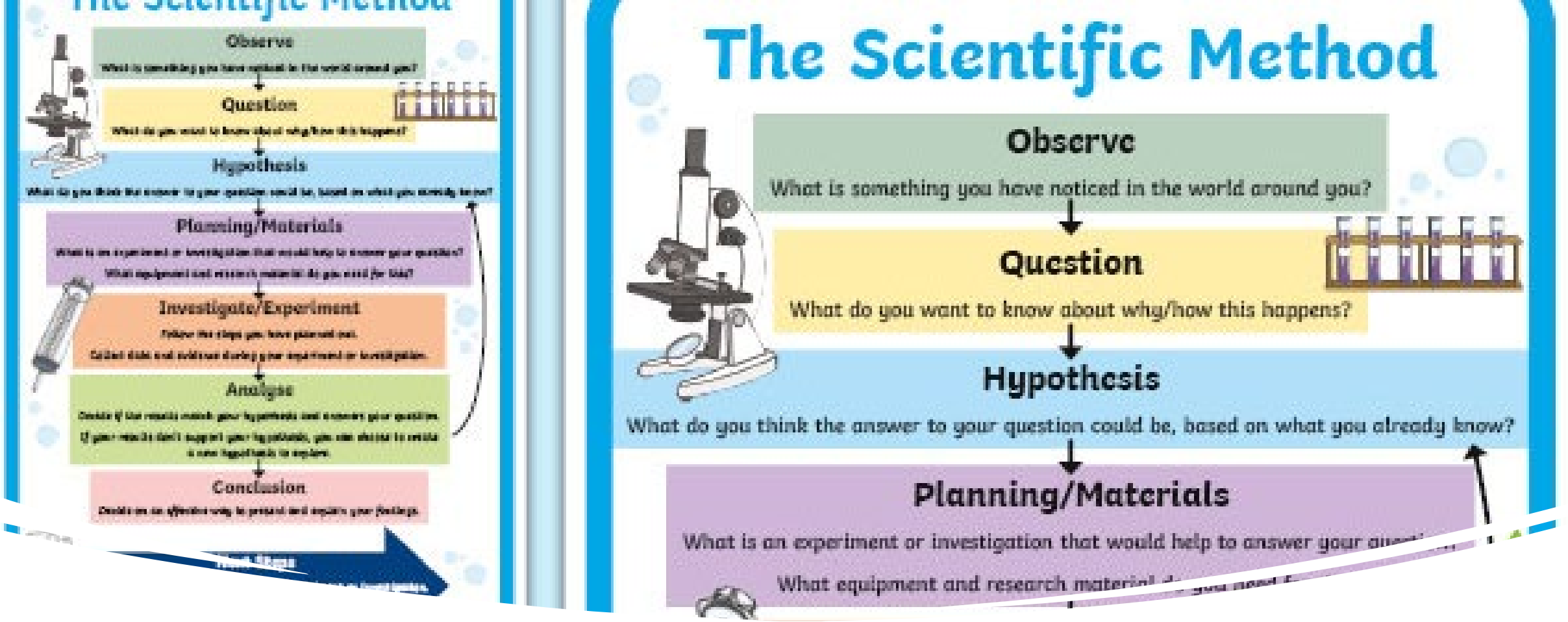
Brown P. (2020). *Instructional sequence matters grades 3-5 : explore before explain*. National Science Teaching Association

Explore

Explain



Unpacking the Scientific Methods



Traditional Approach

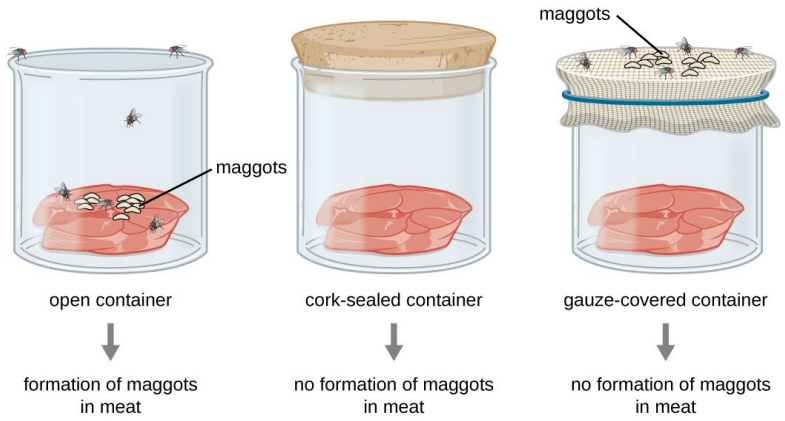
- not the only method to investigating phenomena
- Investigations grades 1 onwards
- Controlled experiments start in grade 5

Investigations in Science

Descriptive Investigations

Comparative Investigations

Experimental Investigations



Scientific Investigations & Experimental Investigations

Investigations

- Purpose – a question is posed
- Does not require complete scientific method
- Hypothesis not necessary

Experimental Investigations

- Purpose – a question is posed
- Involves testing dependent and Independent variables to confirm or refute a hypothesis
- Classic scientific method

Subject Introduction Science:

Scientific Methods

Students will have opportunities to integrate these skills into all other areas of the Science curriculum._

1 . Matter

2. Energy

3. Earth Systems

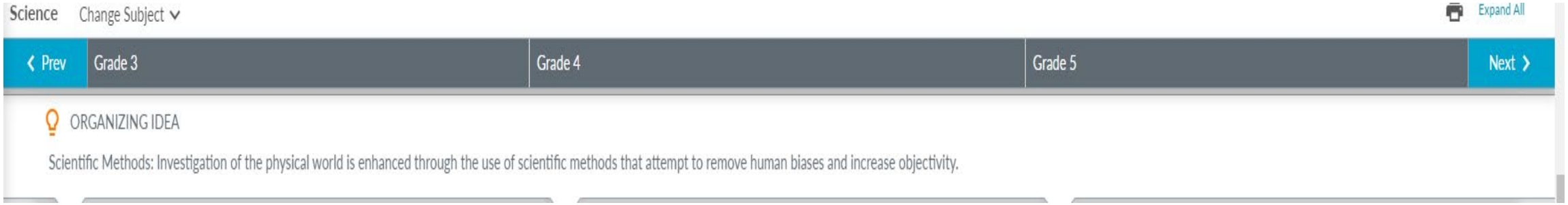
4. Living Systems

Use the methods to help build knowledge & understanding of the Learning Outcomes in each grade level

Grades 1-3

Unpacking The Scientific Methods

By Grade 12



Scientific Method: Investigation of the physical world is enhanced through the use of scientific methods that attempt to remove human biases and increase objectivity.

Science Change Subject

Expand All

Prev | Grade 1 | Grade 2 | Grade 3 | Next

ORGANIZING IDEA

Scientific Methods: Investigation of the physical world is enhanced through the use of scientific methods that attempt to remove human biases and increase objectivity.

Grade 1

GUIDING QUESTION

What is investigation?

LEARNING OUTCOME

Students engage in and describe investigation.

KNOWLEDGE

The skills and knowledge required to carry out an investigation can be learned.

Investigations can be sparked by curiosity.

Investigations are carried out by a variety of individuals or groups, such as

- teachers
- students
- scientists
- police
- doctors

Steps followed during an investigation include

- asking questions

UNDERSTANDING

Investigations are carried out to try to understand the world.

SKILLS & PROCESSES

Ask a question sparked by curiosity.

Predict the answer to a question.

Describe steps of an investigation.

Demonstrate safety and respect during investigations.

Grade 2

GUIDING QUESTION

What methods and processes can be used in scientific investigation?

LEARNING OUTCOME

Students examine investigation and explain how it is influenced by purpose.

KNOWLEDGE

Investigations are conducted for purposes such as

- answering questions
- building knowledge
- satisfying curiosity
- problem solving

Procedures scientists use to guide investigations include

- asking questions
- making predictions
- planning the investigation
- observing and recording data
- analyzing data
- reaching conclusions
- discussing observations and

UNDERSTANDING

Investigations involve carrying out procedures for a purpose.

SKILLS & PROCESSES

Explore various purposes for conducting an investigation.

Describe procedures of an investigation.

Develop questions for the purpose of an investigation.

Grade 3

GUIDING QUESTION

How can investigation help to deepen understanding in science?

LEARNING OUTCOME

Students relate investigation to building knowledge.

KNOWLEDGE

Techniques that can be used to improve the accuracy of data include choosing appropriate tools, carefully measuring, and demonstrating objectivity.

Accuracy of data refers to the correctness of a recorded observation.

Objectivity is an attempt to remove the influence of personal thoughts, feelings, and expectations.

Data can come from many sources, such as

UNDERSTANDING

Investigations build on previous knowledge by supporting or contradicting existing knowledge.

SKILLS & PROCESSES

Reflect on how conducting an investigation contributes to building knowledge.

Collect data using techniques to improve the accuracy of data.

Analyze data collected during investigations.

Compare the trustworthiness of sources of data.

Develop new questions for further inv

Contact Us

Assessment

Learning Outcomes

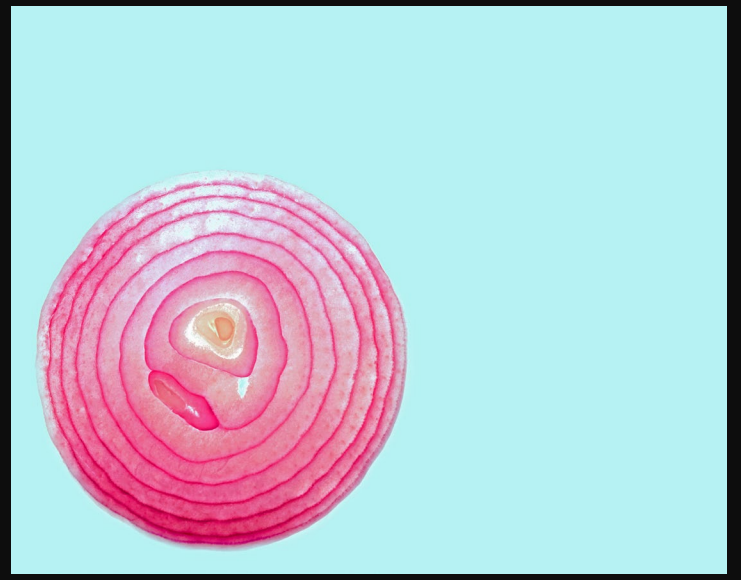
- Students Know, Understand and Do
- Assess and report on

KUSPS

- Ongoing Learning Outcome is broken down
- Teach ALL KUSPS
- Formatively assess MOST KUSPS not all
- Provide feedback to students

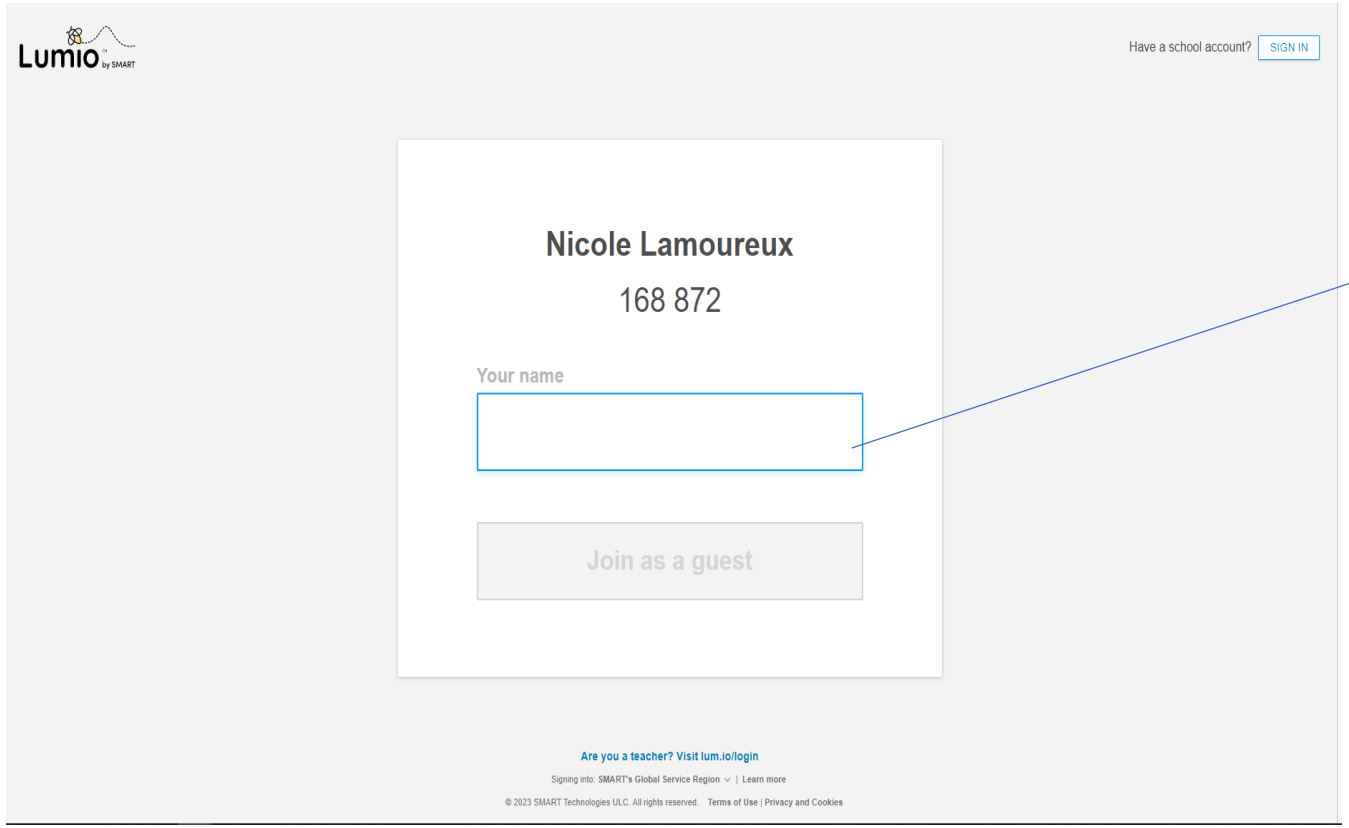
Scientific Method Ongoing Process:

Unpacking Layers of the Process through the grades



Processing Work: 10-15 minutes in LUMIO

Click Link in Chat. It will open a new tab or screen

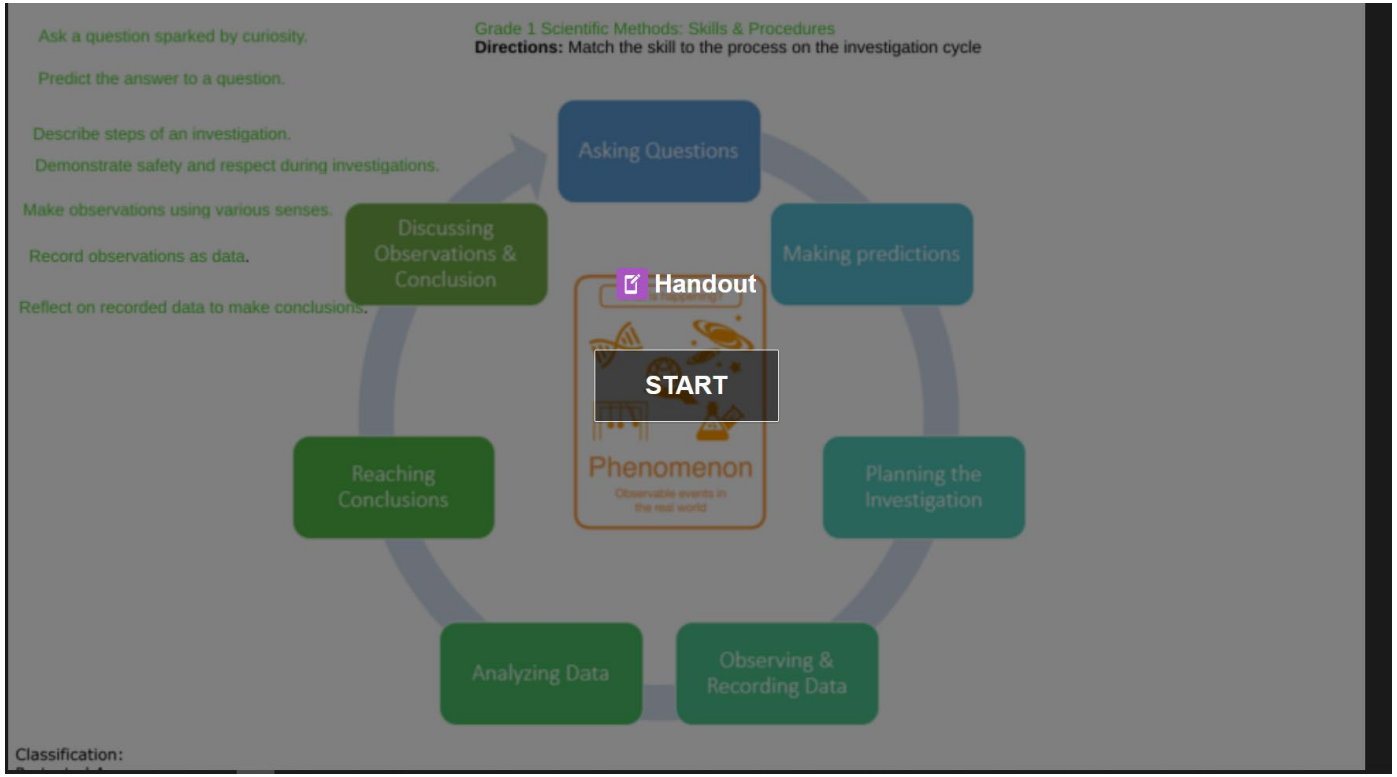


Type your first name & Click "Join as a Guest"

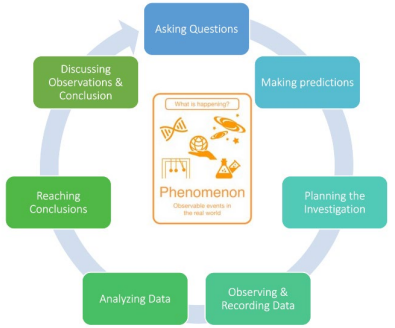
I have the presentation on teacher led so I have control of the screen.

Processing Work: 10-15 minutes in LUMIO

I will present but at some point this screen will pop up. It means you will be doing some interactive work. Click start to join.



Science Method Process:
Building Investigation skills from grades1-3



Grade 1

What is Investigation?

Make Predictions

Record Observations

Make Conclusions (answers to questions)

Grade 2

Examine Investigation and explain how it relates to its purpose

Develop questions for the purpose of an investigation

Make Predictions

Record Observations

Determine if data relates to purpose of investigation

Observations and data should be similar

Collaborate to put data on a single chart

Make conclusions

Grade 3

Students relate investigation to knowledge building

Develop questions for the purpose of investigating

Collect data using techniques to improve the accuracy of data.

Analyze data collected during investigations.

Compare the trustworthiness of sources of data.

Reflect on how conducting an investigation contributes to building knowledge.

Develop new questions for further investigations.

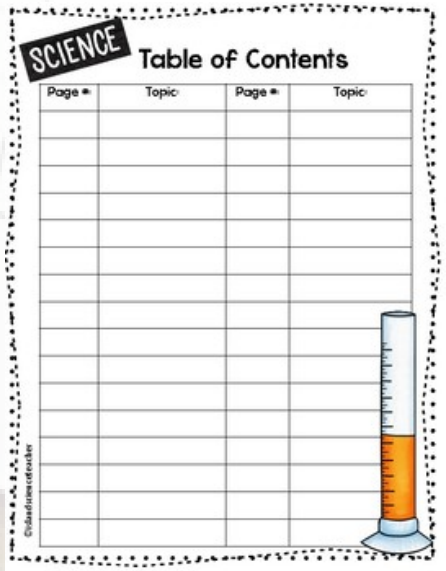
What does this look like in the Classroom? Common skills Grades 1-3

- Making Predictions
- Making & Recording Observations
- Make conclusions (inferences)

Review and set expectations in September

Student Books

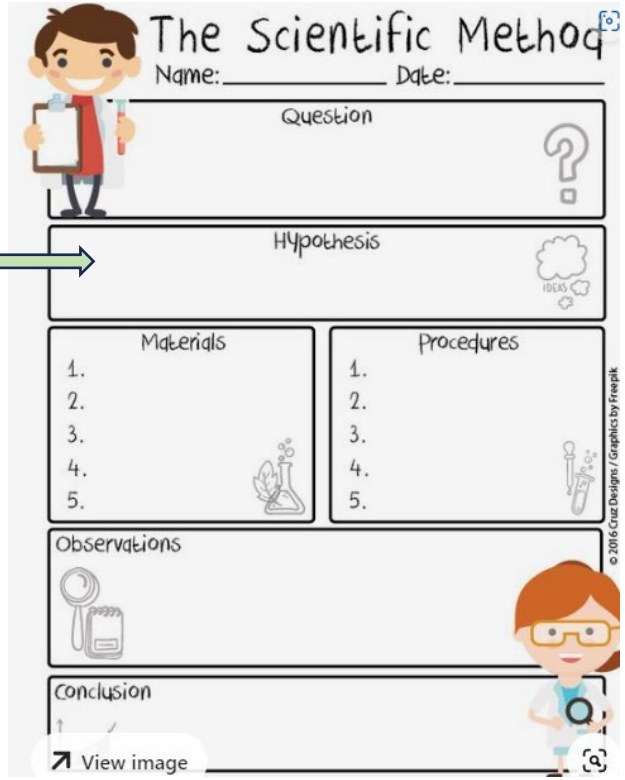
- Science Journal
- Table of Contents
- Graphic Organizers
- Glossary or Science Word Wall



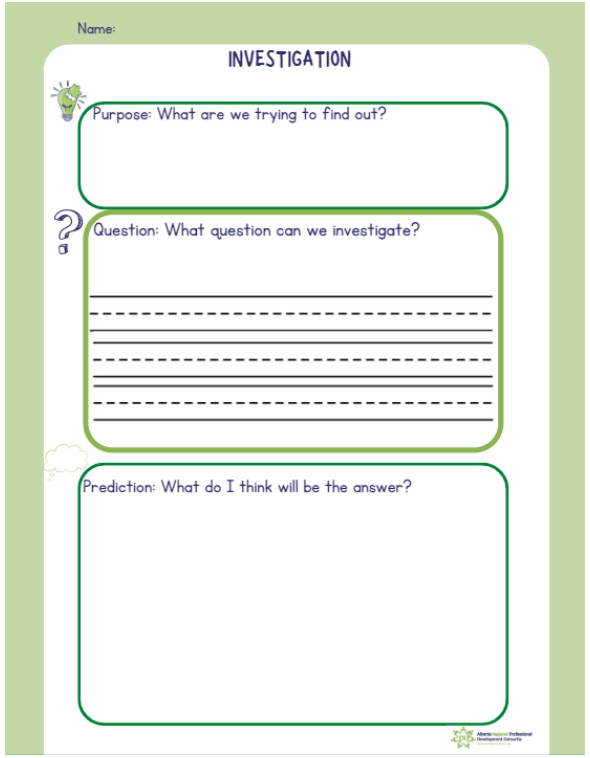
Graphic Organizers:
Ensure Alignment with Curriculum

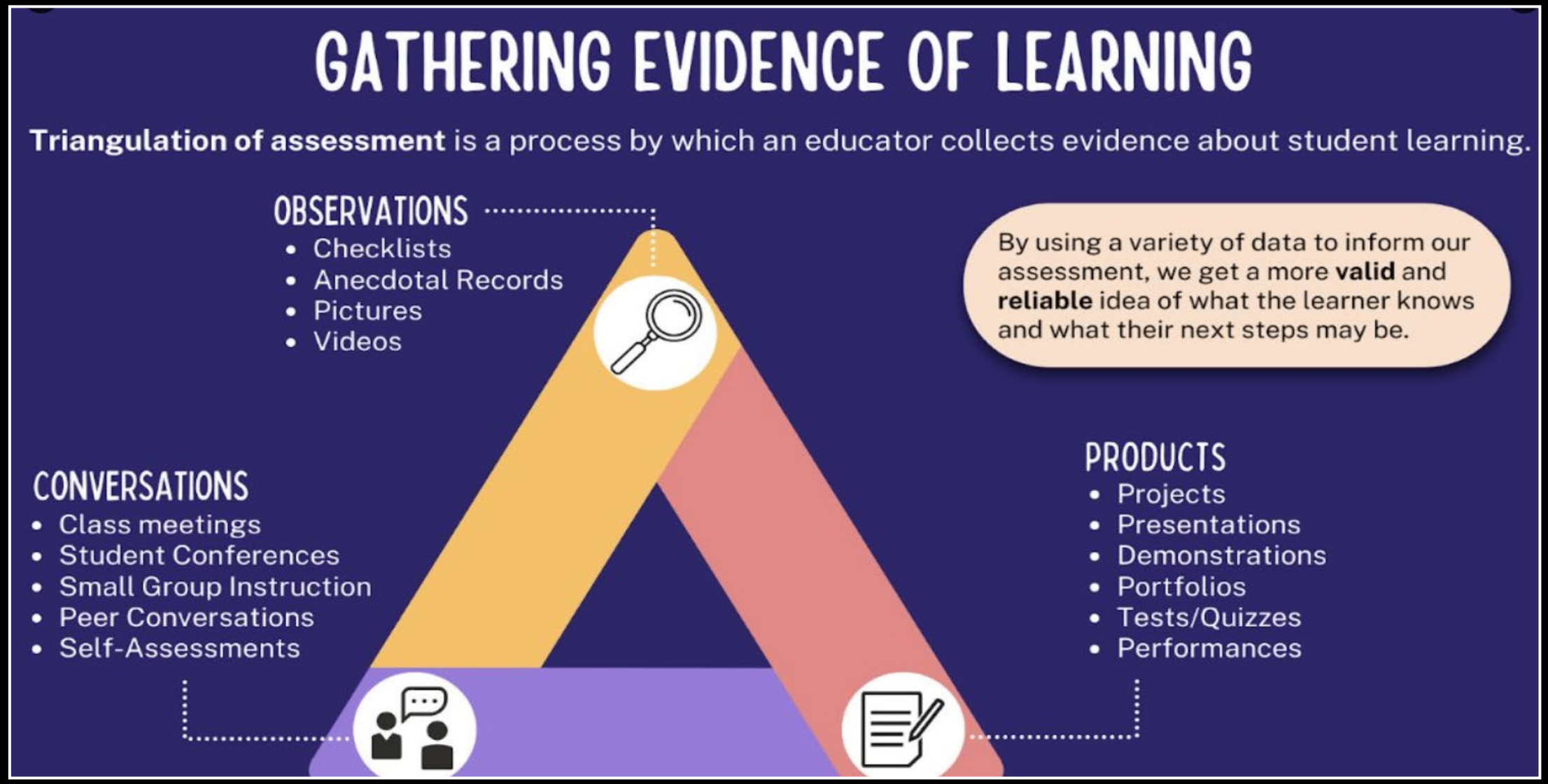
Not Part of Our Curriculum

Grade 6 Expectation.
Scientific Literacy use terms correctly



Grade 2 Investigation Organizer





@mme_hopkins

Teach and Assess Learning Outcomes in Scientific Methods

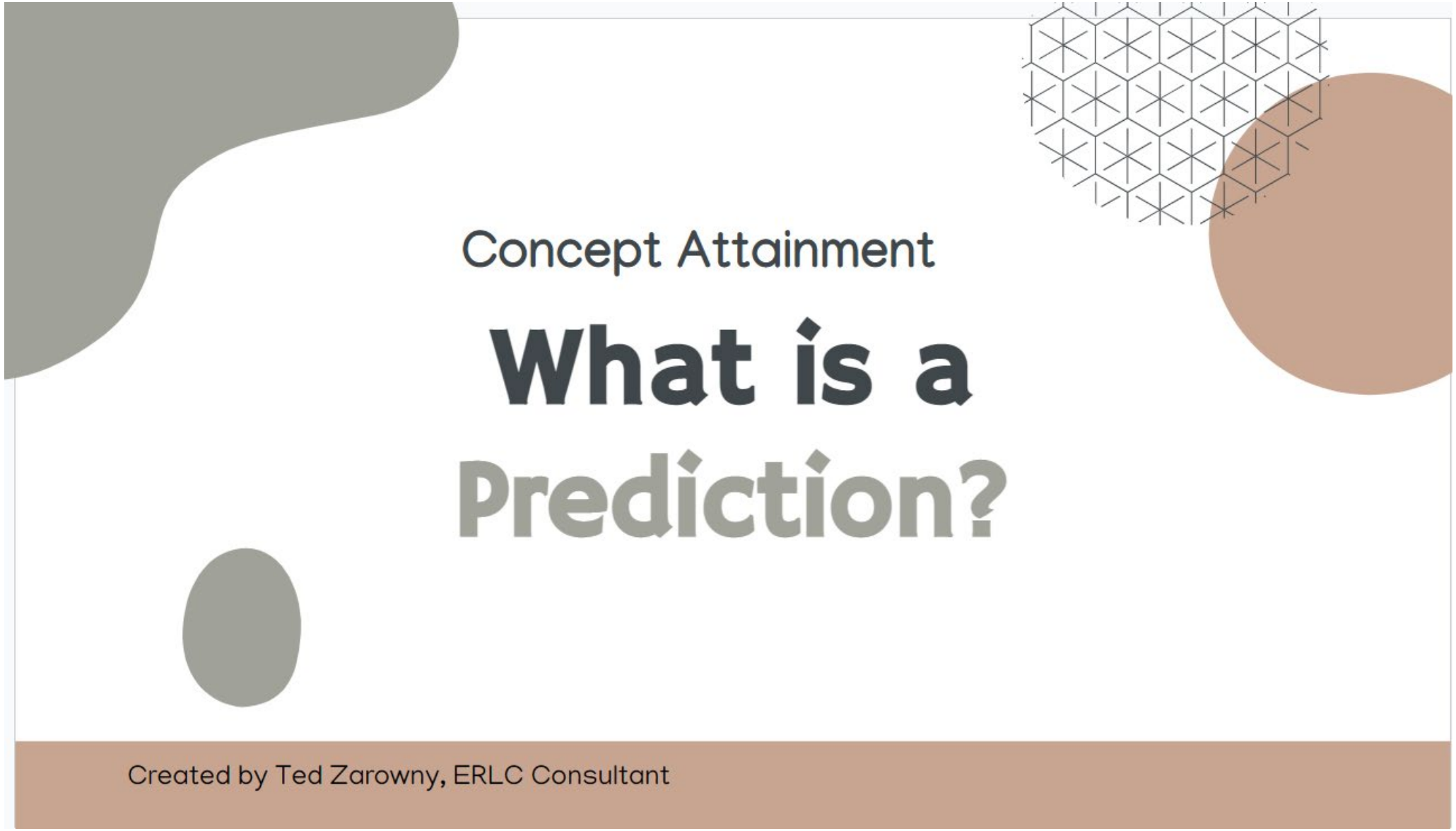
Making Predictions

- Teach & Assess in grade 1 & Continue to implement in other grades
- What is a prediction
- Introducing to students
- Teaching and assessing

Prediction

A likely answer to a question using what you know.

Prediction


Concept Attainment
What is a Prediction?
Created by Ted Zarowny, ERLC Consultant

Look at the images and then look at the "Yes" and "No" statements.

What do ll the "Yes" statements have in common?

Grade 1 Beginning of Year

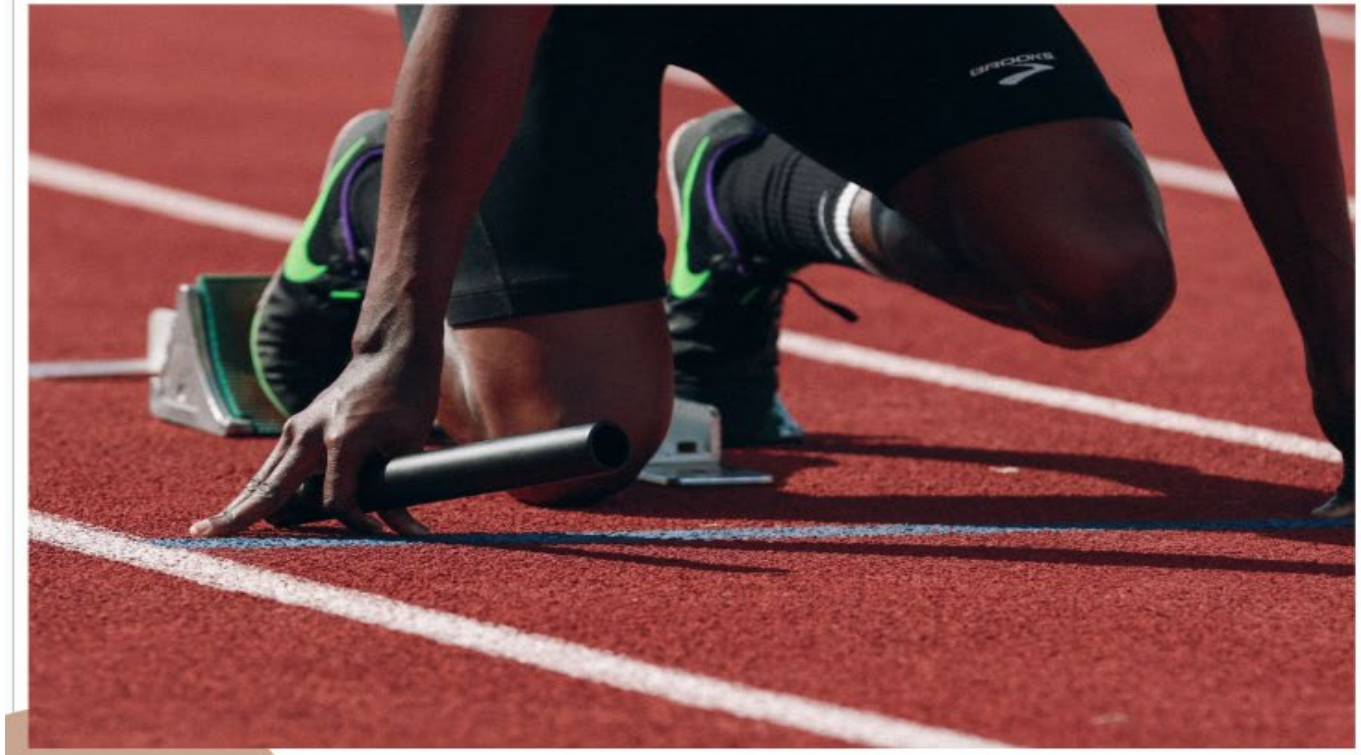


Photo by Braden Collum on Unsplash

YES: The runner is going to win the race .

NO: The runner is at the start line.

Grade 2 &3 Beginning of Year or as Grade 1 becomes more comfortable

YES: The snowman will melt in the spring because in the spring it gets warm and snow melts

NO: The snowman will walk away because I watched a cartoon and the snowman walked

Yes: The girl in the white shirt and red pants will catch the ball because it looks like the ball is falling towards her

No: The girl in the light blue shirt will catch the ball because I want her too.

All of the “Yes” statements are predictions. What is a prediction?

Introduce Vocabulary Card - Authoritative Explanations

Predict

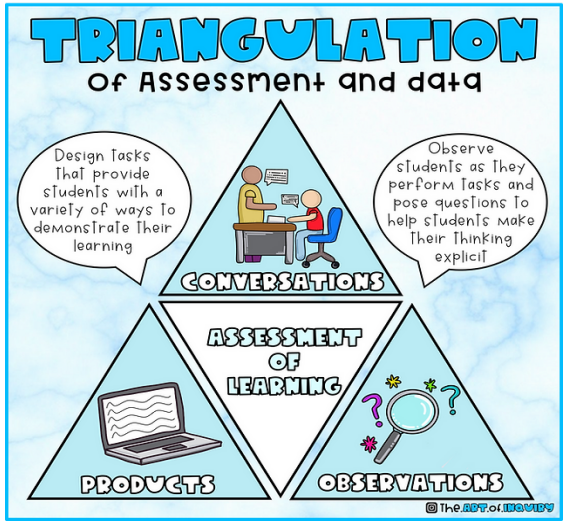
Likely answer to a question using what I know already about the topic

Teacher Assessing Predictions in Grade 1
Reviewing in Grades 2&3

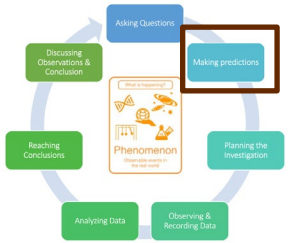
Based on what you learned about predictions, what criteria would you use to assess if your students are making good predictions?

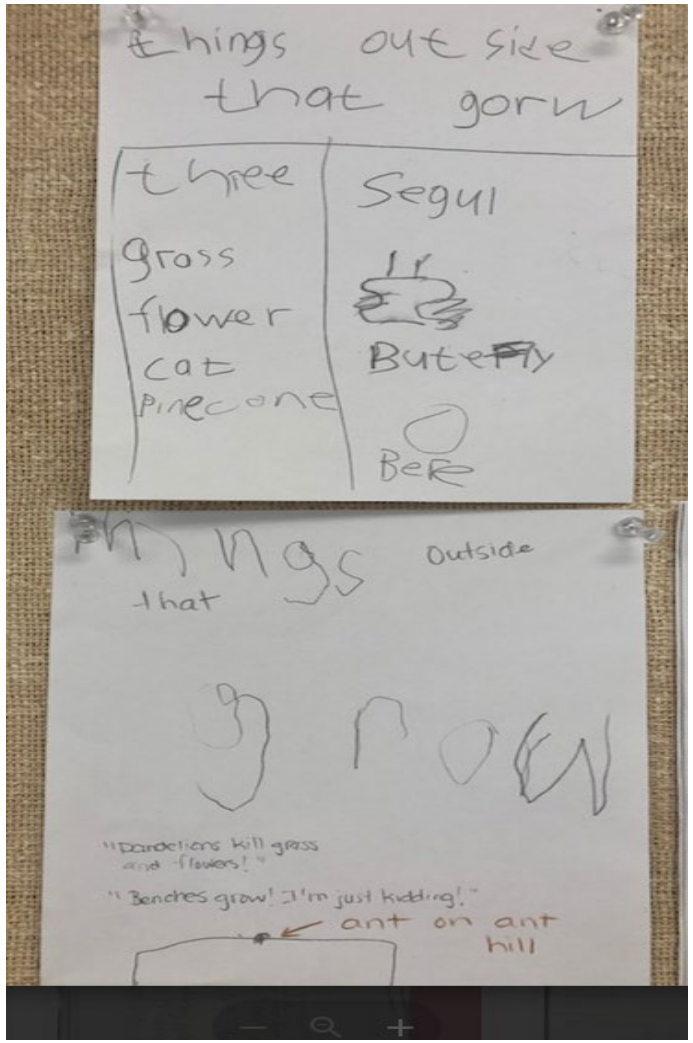
- See or hear from students **based on curriculum?**

KNOWLEDGE	SKILLS & PROCEDURES
A prediction is a likely answer to a question based on current understanding.	Predict the answer to a question.



Making predictions





Assessing Predictions:

Teacher **See or Hear** from students:

- ❑ Likely answer to the question based on what they know

Example:
Question:
What do you predict you will observe grows outside?

Student response can be written, verbal and/or pictorial

- ❑ I predict **I will see/observe** grass, birds and trees because when I go outside **<u>I see grass in the field and trees. trees get bigger and grass grows you need to cut it.</u>**

Teacher Need to prompt?

- What makes you think that?

Grade 1 Living Systems

Name:

My predictions of what I observe grows outside

I predict I will observe

because

Assessing Predictions: Criteria & Documenting

Science Methods knowledge
A prediction is a likely answer to a question based on current understanding **Science Methods Skills & Procedures:**Predict an answer to a question

Task:

Teacher Talk Prompts
For Interviews with Students or Observations of Performance during Task or Presentation

Doesn't have an answer to a question.
"Think about(bending) something in half is it still the same....?
"When you (insert action) something what happens to an object's (insert property)?

Shares answer only but doesn't elaborate how they know.
What makes you say that?
Think about what you know about (action)

Criteria Based on Curriculum:

1. **Student provides an answer to the question that is appropriate to the context.**

Note: predictions do not have to be correct. The purpose of an investigation is to confirm or change our initial thinking based on the data gathered.

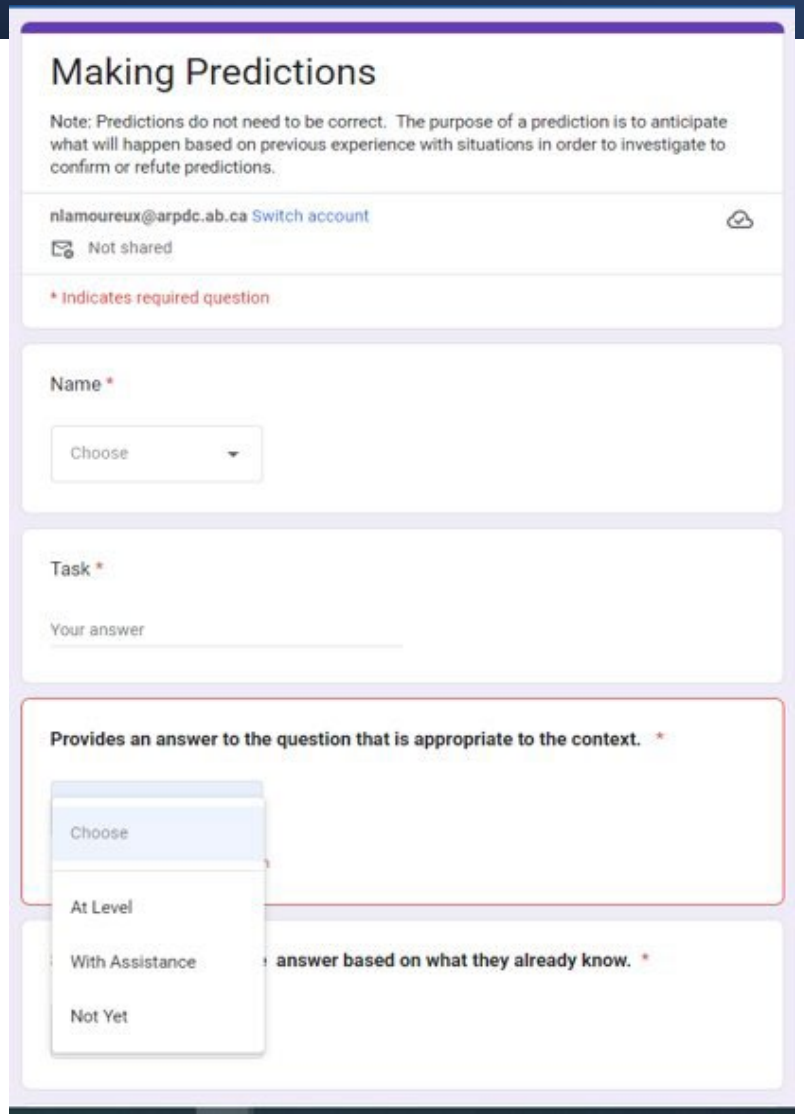
2. **Students shares the reason for the answer based on what they already know.**

Ex: I know that stretching the plasticine will make it longer because when I played with play dough before and it was longer when I stretched it.

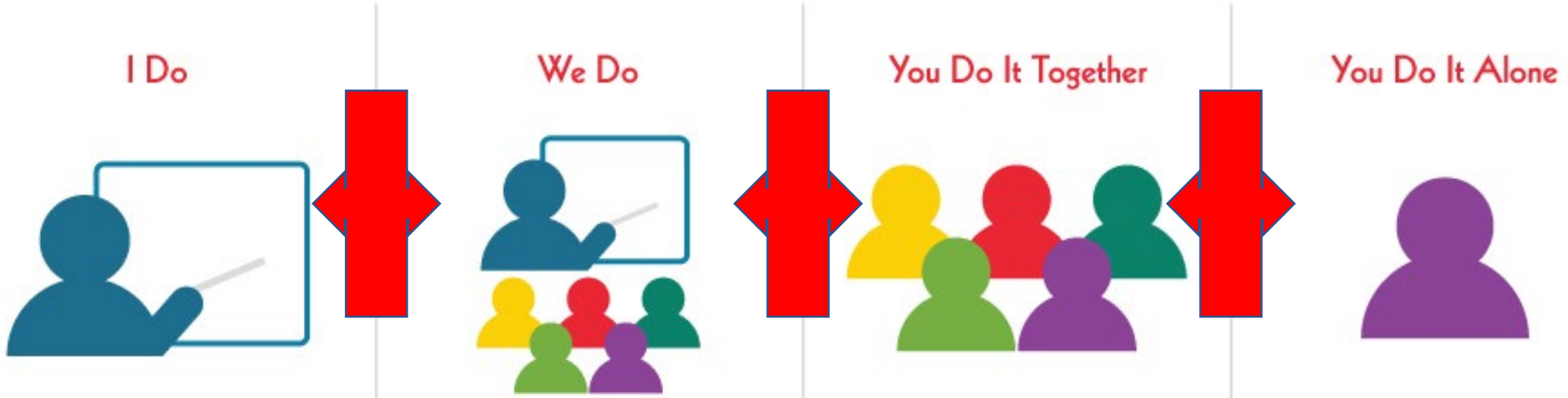
Criteria #	Not Yet	With Assistance	Independently
1			
2			

Adapted from Cooper & Catania 2022. Rebooting Assessment, Reproducible, pg 163

Turn Rubrics Into Google Forms



Teaching Predictions Throughout the Year



I Think

I model **Think Aloud** for students. Pause ask questions to engage

We Think Together

Think- Pair – Share on carpet or at desks. Teacher provides prompting & feedback

You Think Together

Student in partners or small groups. Teacher observes formatively assessing & feedback

You Think

Student works independently. Teacher observes formatively assessing & feedback

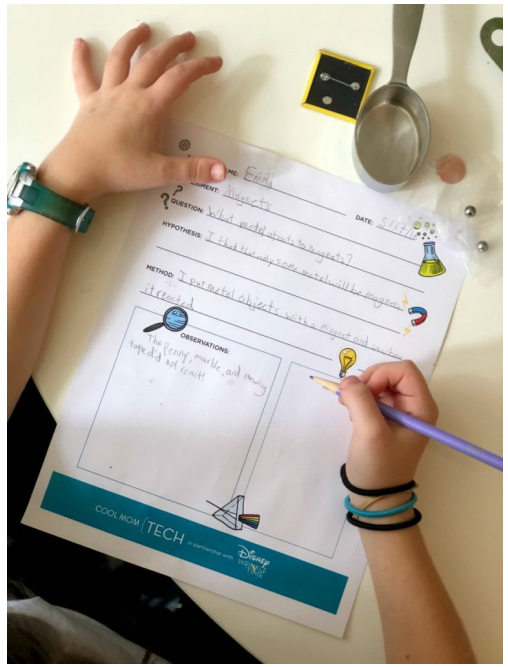
Making & Recording Observations

- Teach & Assess in grade Grades 1-3
- Foundations & Expectations
- Student challenges & Misconceptions

Accurately Recording Observations

Observations have certain characteristics. They need to be:

- ❑ Clear so when recorded, scientists can go back look at it to use as evidence
- ❑ Complete – have all necessary details to describe the situation, event, object well
- ❑ Accurate- need to represent what is actually seen, heard, smelled or touched as closely as possible. Measurements accurately recorded
- ❑ Objective- using standard tools to measure exactly. Not describe emotion or feeling
- ❑ Labeled and when appropriate use scientific vocabulary



Norris, S.P. 1984. *Defining observational competence.* Science Education 68 (2): 129–142.

Student Challenges and Misconceptions With Recording Observations

- ❑ Students think they will remember their observations so they do not write it down or label their observations
- ❑ Students often record inferences rather than observations ex. Grass is brown (observation) The grass died (inference)
- ❑ Students might not notice important details.
- ❑ Students sometimes like to attach emotion to their observations

Garcia-Mila, M., and C. Andersen. 2007. *Developmental change in notetaking during scientific inquiry.* International Journal of Science Education 29 (8): 1035–1058
Smith, B.K., and B.J. Reiser. 2005. *Explaining behavior through observational investigation and theory articulation*. The Journal of the Learning Sciences 14 (3): 315–360..

How Can We Support Students To Overcome These Challenges?

Co –Construct Criteria of Good Observations With Students:

- Students should be able to self-assess or peer assess observations using a rubric or checklist

TABLE 2.

Features of High-Quality Observation.

Recorded Observations

Clear	Observations should be neat and specific, so that you or another person can understand what is written or drawn. (For example, "the mustard plant" rather than "the plant."
Complete	Observation should describe all parts of the phenomenon of interest.
Accurate	Observations should include ONLY what is ACTUALLY seen. Drawing should include authentic colors, sizes, and shapes.
Includes Scientific Vocabulary	Drawn observations should have labels to identify the items. Written observations should use appropriate scientific language.
Objective	An observation should NOT state an opinion. Another person should be able to look at an object of interest and make the same observation. An objective statement is "the mustard seed is one millimeter across." A less objective observation is "the seed is really small."

Arias, A. and Davis, E. (2016) Making and Recording Observations. Science and Children April/May 2016

How Can We Support Students To Overcome These Challenges?

Co –Construct Criteria of Good Observations With Students:

- Students know expectation and can use the feedback from teacher in order to improve their learning

FIGURE 2.

Student work evaluated with the rubric.

Student Work	Category		Teacher Comments
	Complete	Proficient	*This is an accurate and clear drawing of a complete circuit. Next time, be sure to label your drawing.*
	Accurate	Proficient	
	Clear	Proficient	
	Labeled	Needs Improvement	
	Complete	Improving—one wire is missing.	*The circuit is missing a wire. Try the circuit again to find out where the wire goes and add it to your pictures along with labels.*
	Accurate	Improving—the wire needs to be a complete circuit.	
	Clear	Improving—it is difficult to tell what the lightbulb is.	
	Labeled	Needs improvement.	
	Complete	Proficient	*The drawing has all of the pieces needed to show a complete circuit. I cannot determine which is which and where the connections are. Can you draw the lightbulb and connections more clearly and label the parts of your drawing?*
	Accurate	Needs improvement—the wire needs to be touching the battery to be complete. The lightbulb is not larger than the battery.	
	Clear	Improving—it is difficult to determine what the picture is showing.	
	Labeled	Needs improvement.	

Arias, A. and Davis, E. (2016) Making and Recording Observations. Science and Children April/May 2016

Use of Sentence Stems To Support All Learners

Use sentence stems to support high quality observations such as:

I notice _____;
I observe _____;
I see _____;
The ____ measures _____. This is different from earlier observations because _____.

Word Banks to choose From :

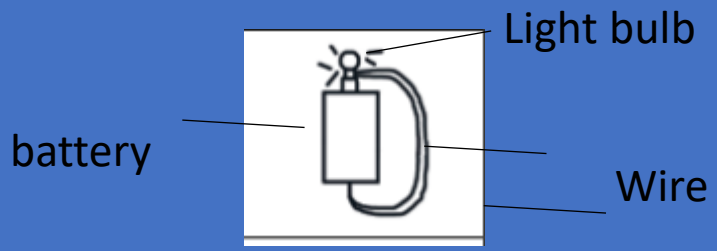
Cup, water, Hot , Cold, Freeze, liquid, solid

Arias, A. and Davis, E. (2016) Making and Recording Observations. Science and Children April/May 2016

How Can We Support Students To Overcome These Challenges?

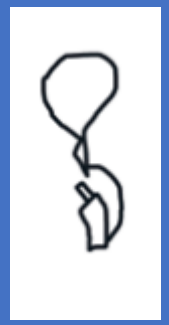
Examples

Electrical Circuit



Grade 3

Non Example



Grade 3

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Helping students Distinguish Between Observation and Inference

T- Chart to Separate Observation and Inference

Guide students to slow down:

1. Use words to describe (color, shape, amount, property) without naming.
2. Guessing game – can others guess (infer) what you are describing based on the attributes/features you use to describe the object?
3. X2 looking Routine – Look describe, look again add more descriptions

Observe: See, Hear, touch, Infer

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Making Conclusions

Define Conclusions

Whole Class

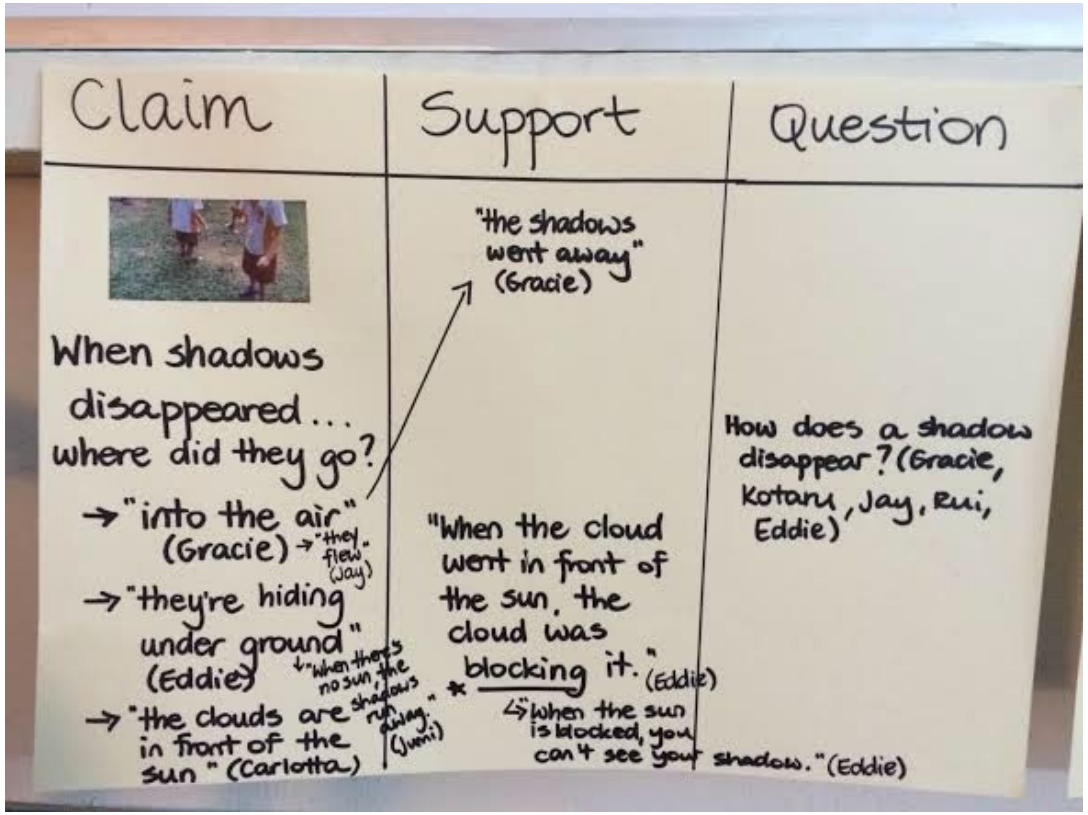
Using Models (pictures) to represent thinking

Conclusion

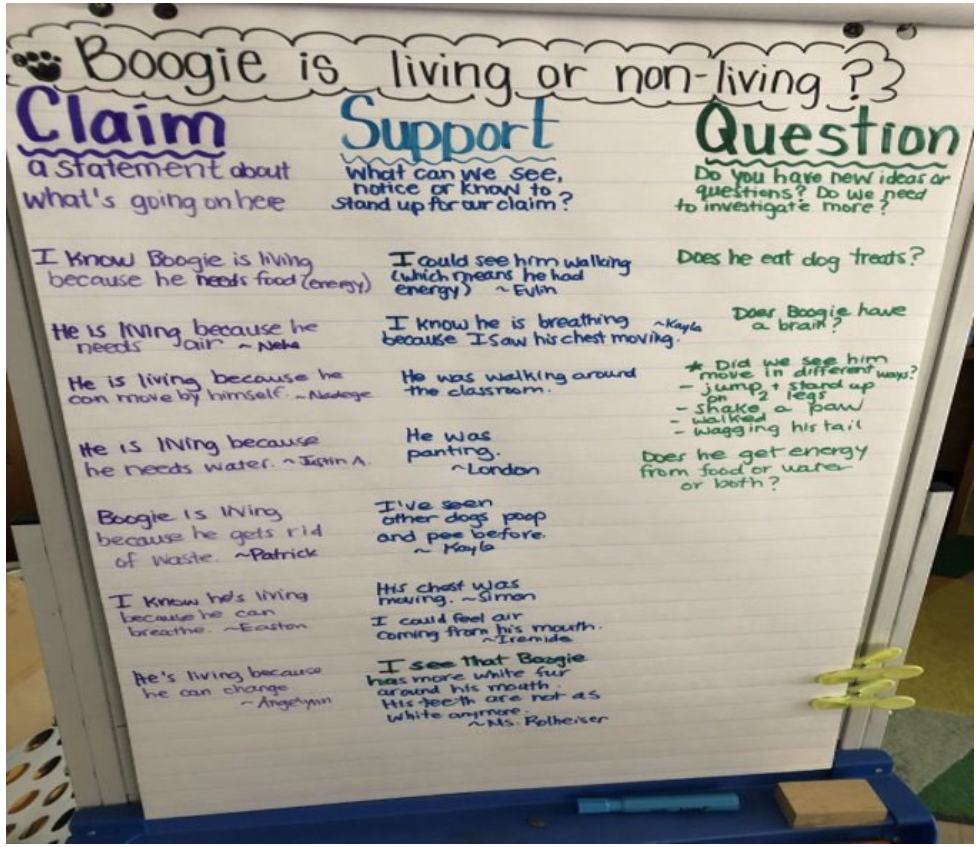
A statement (claim) that answers a question drawing support from data

Whole Class Discussion – Claim, Support Question

Grade 2 Energy Light



Grade 1 Living Systems

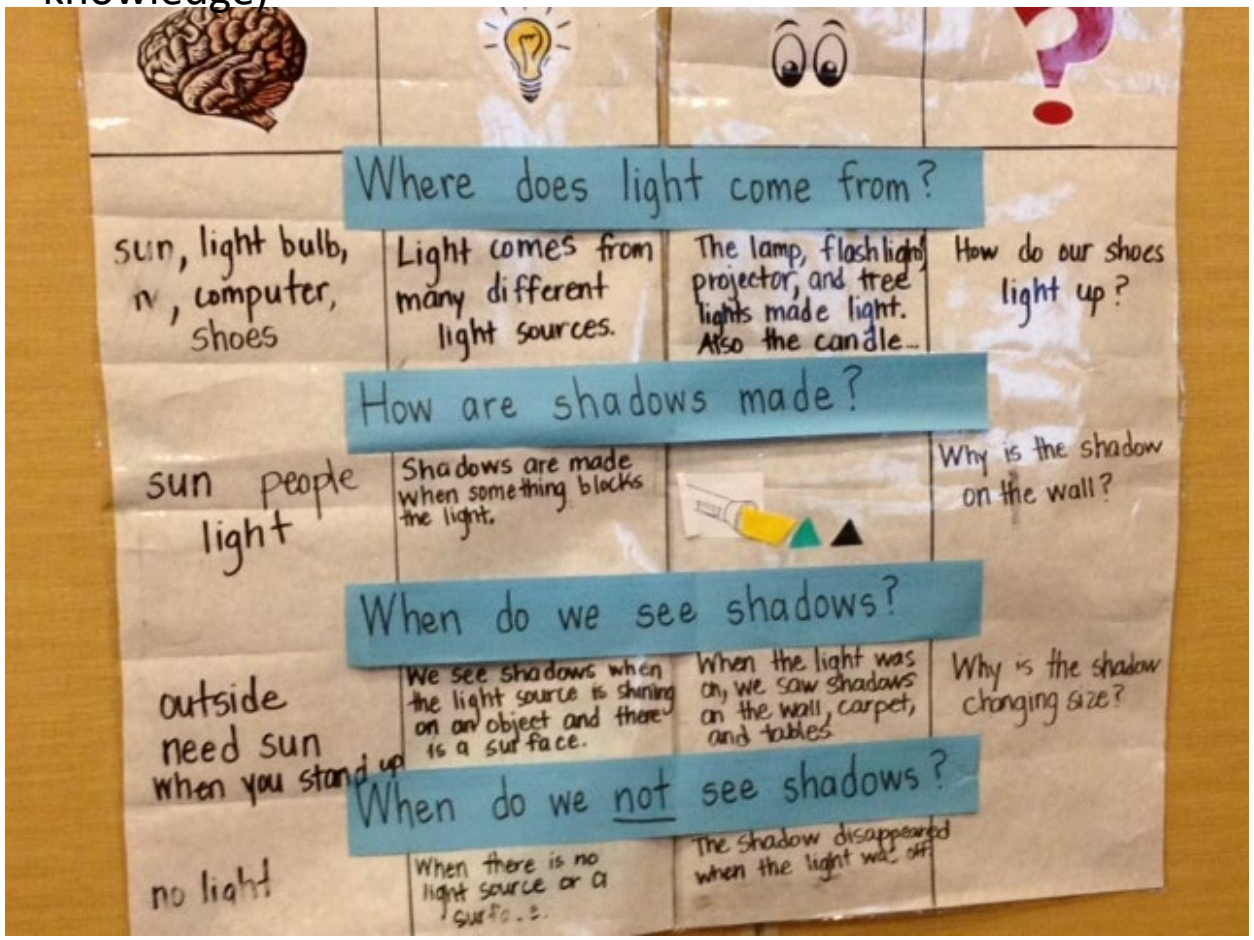


Whole Class : Learning Summary Tables

Know (Prior knowledge)

Learned (Claim)

Evidence (data)



Matter Grade 2: Light

Driving/Lesson Question:

K What we think we know about the phenomenon	L What we are learning	E Evidence (from our data)	W Wonderings	S Scientific Concepts and Words

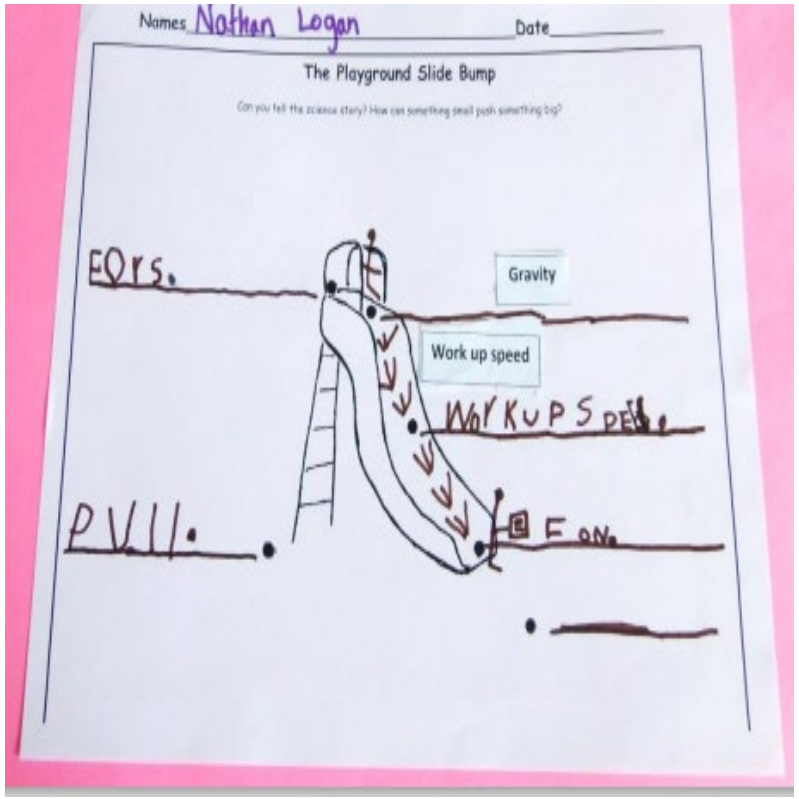
KLEW Chart to be used during investigations to guide inquiry

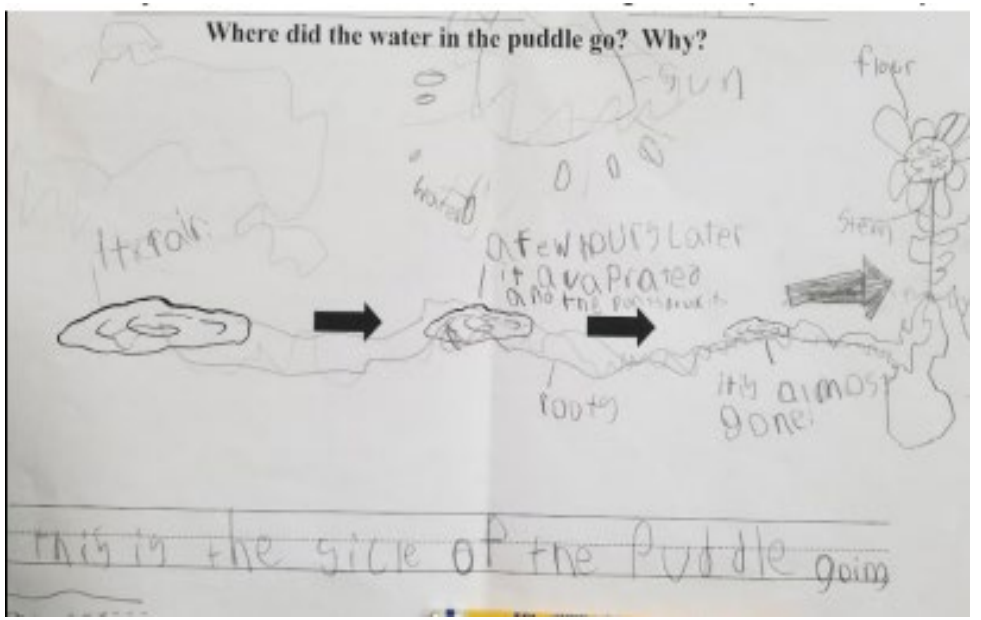
What do we Think we Know?	What are we Learning?	What is our Evidence?	What are we Wondering?
Students share about the subject Can see areas of misconceptions; helps in deciding needed inquiry	Students make a claim about their findings after explorations... Every item must also show evidence	Students must give evidence for each claim	Teacher records questions heard during the investigations and asks for other questions after class discussions These may become new testable questions

Pictures as scientific models: Making Conclusion

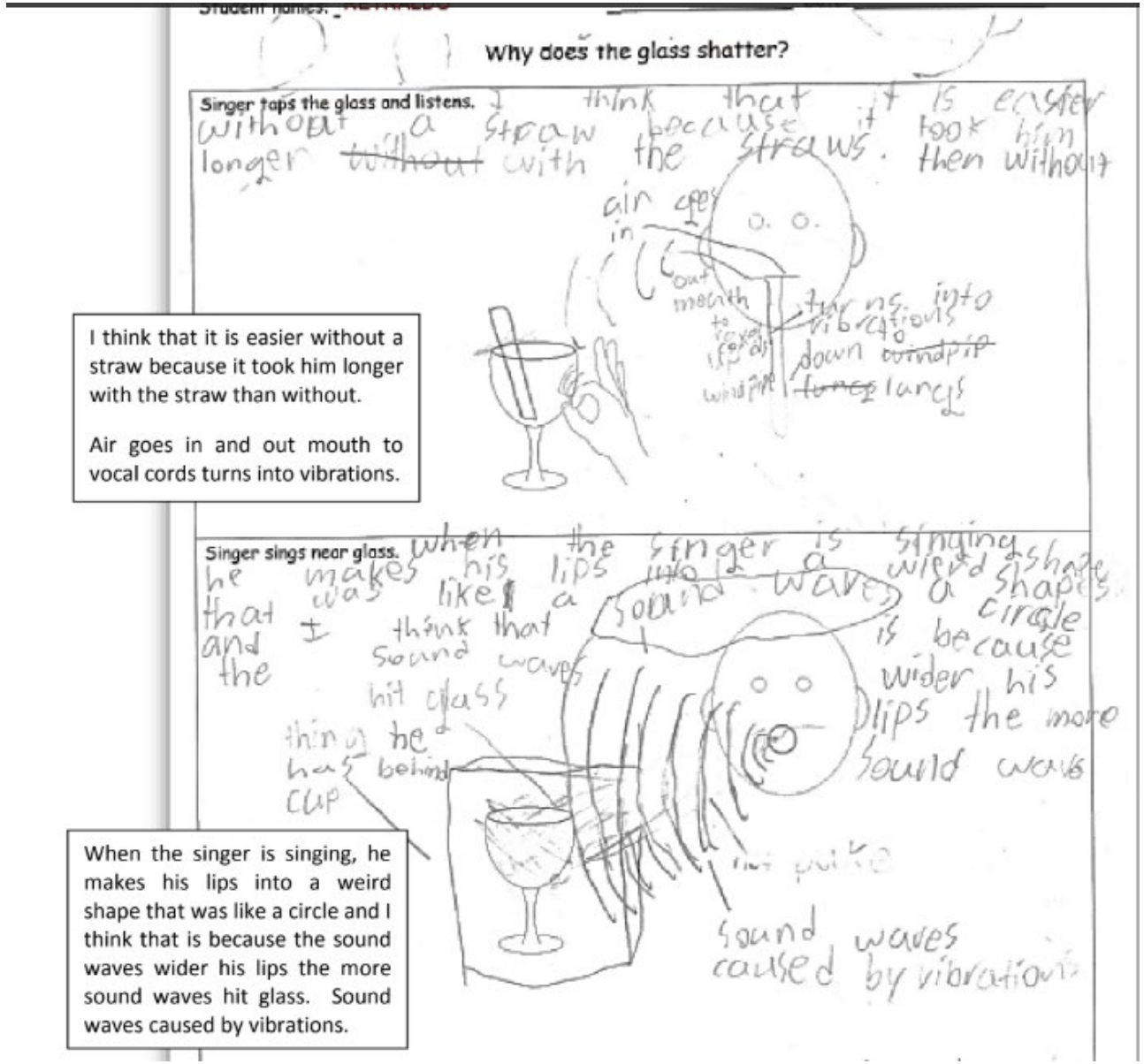
Use of symbols (arrows)

provide word cards





Grade 2 & 3

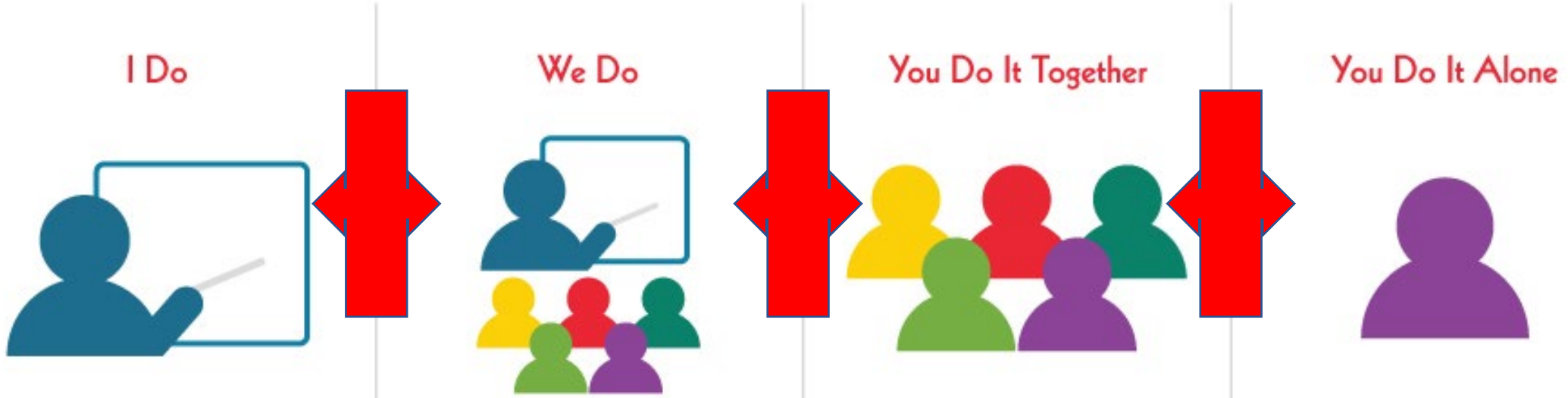

Why does the glass shatter?
Singer taps the glass and listens.
I think that it is easier without a straw because it took him longer with the straw than without.
Air goes in and out mouth to vocal cords turns into vibrations.
Singer sings near glass.
When the singer is singing, he makes his lips into a weird shape that was like a circle and I think that is because the sound waves wider his lips the more sound waves hit glass. Sound waves caused by vibrations.

Reaching All Learners: Multimodal Representation

Students can demonstrate skills in the scientific method multiple ways:

- Draw pictures and describe orally
- Write paragraphs
- Record using video

Teaching Conclusions Throughout the Year



I Think

I model **Think Aloud** for students. Pause ask questions to engage

We Think Together

Think- Pair – Share on carpet or at desks. Teacher provides prompting & feedback

You Think Together

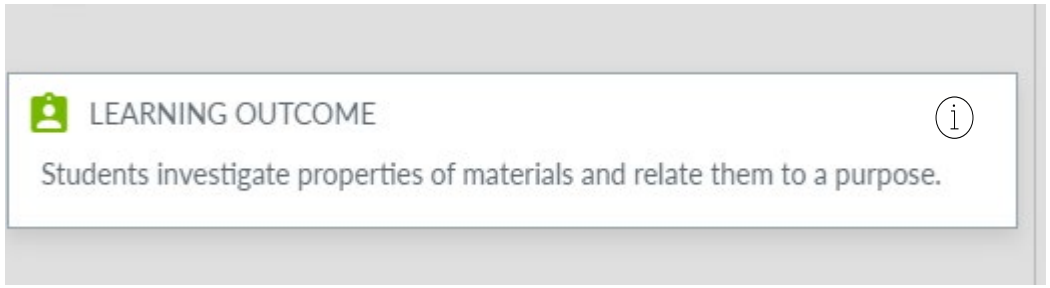
Student in partners or small groups. Teacher observes formatively assessing & feedback

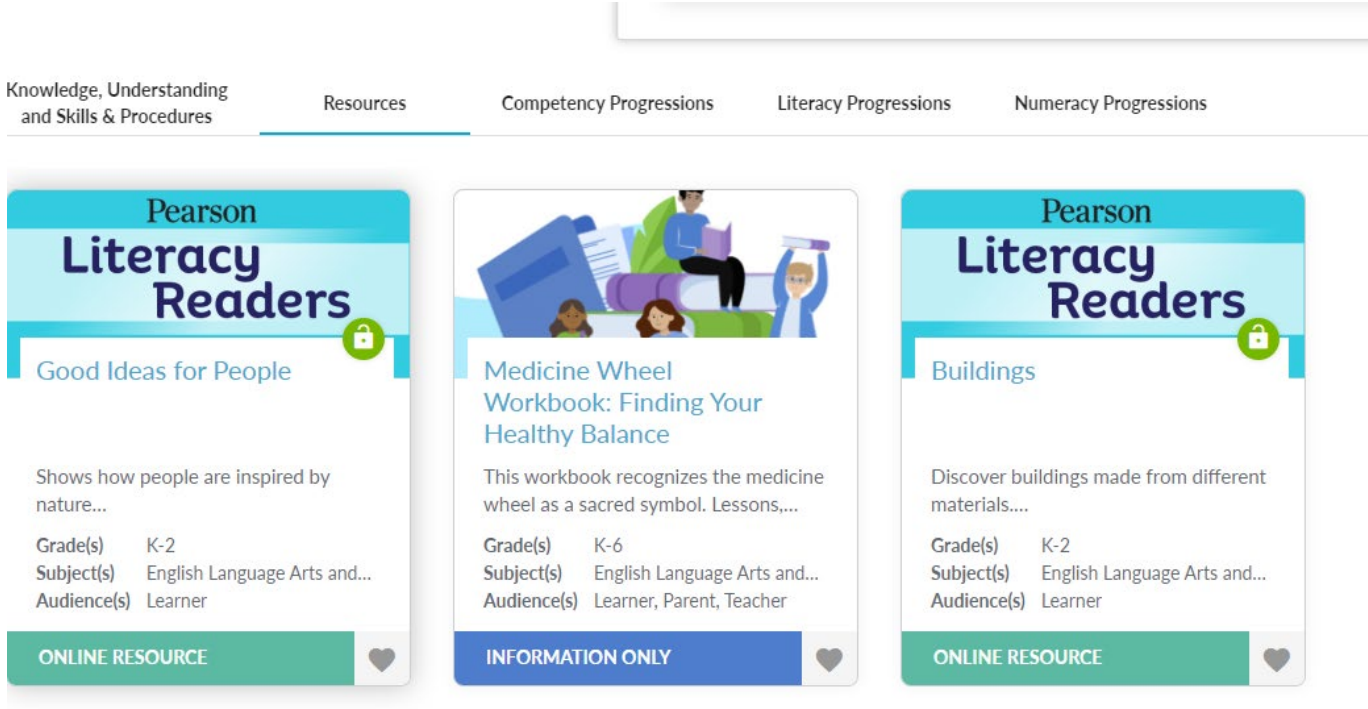
You Think

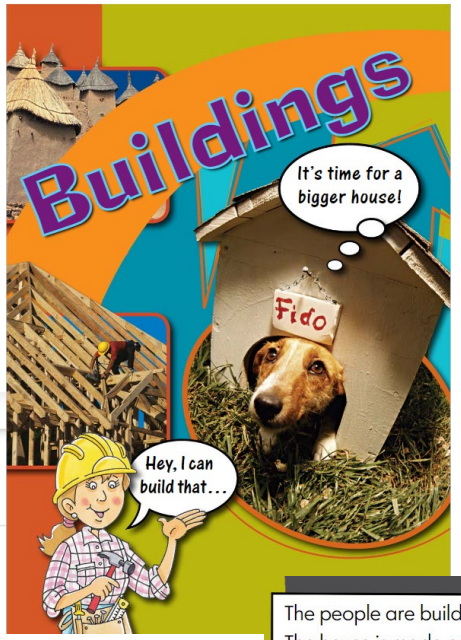
Student works independently. Teacher observes formatively assessing & feedback

Resources on NLA

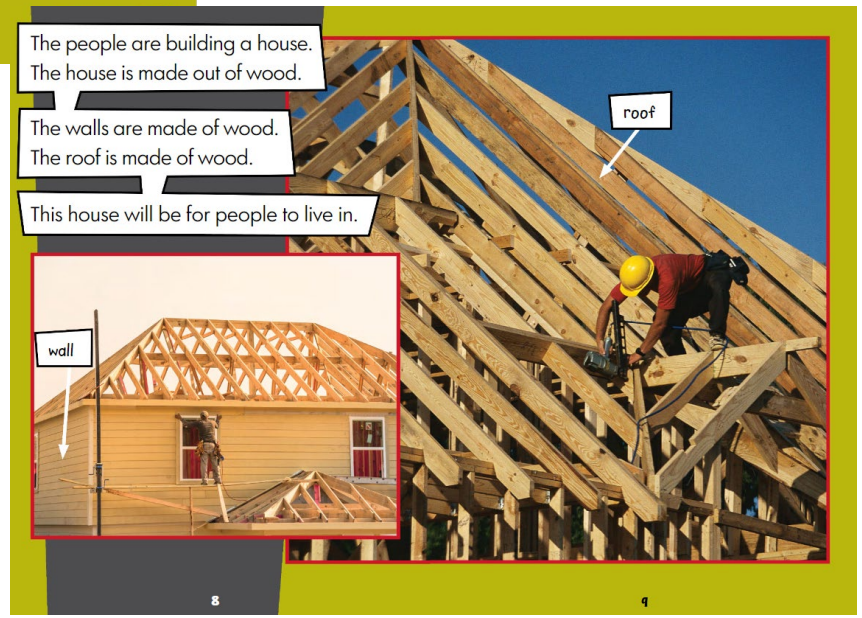
Resources on New Learn Alberta



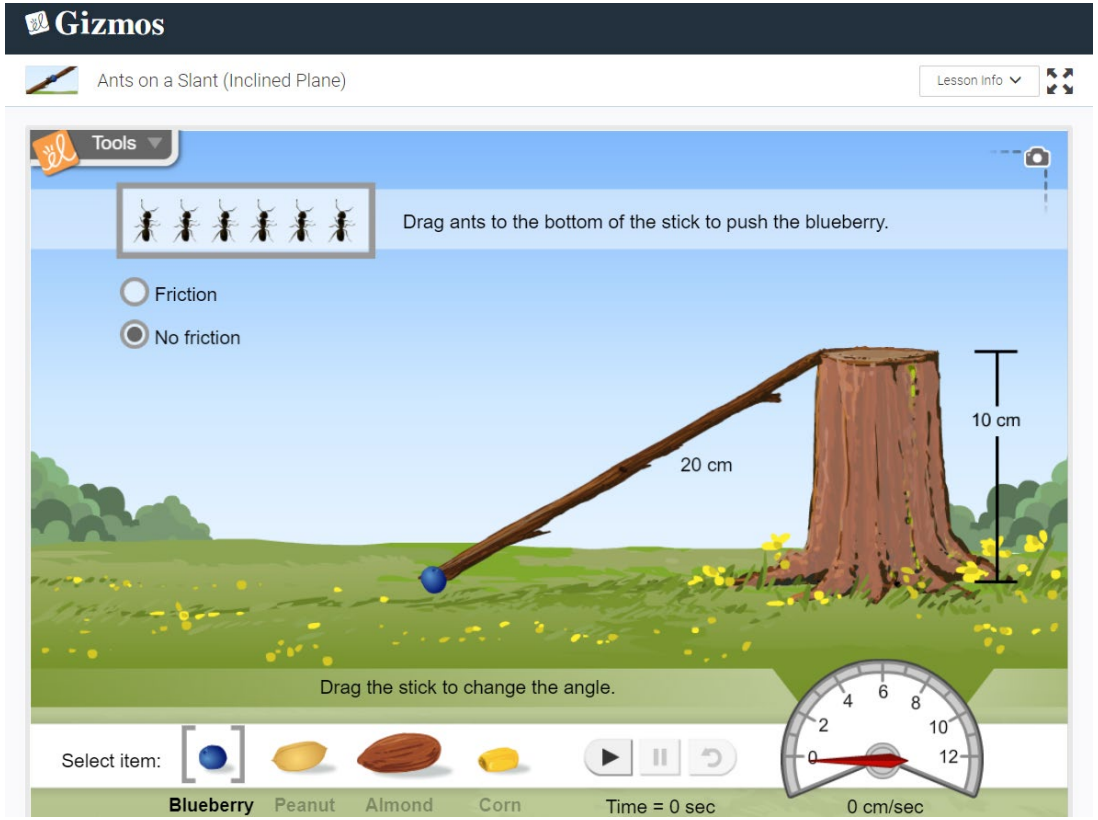




Pearson Literacy Readers

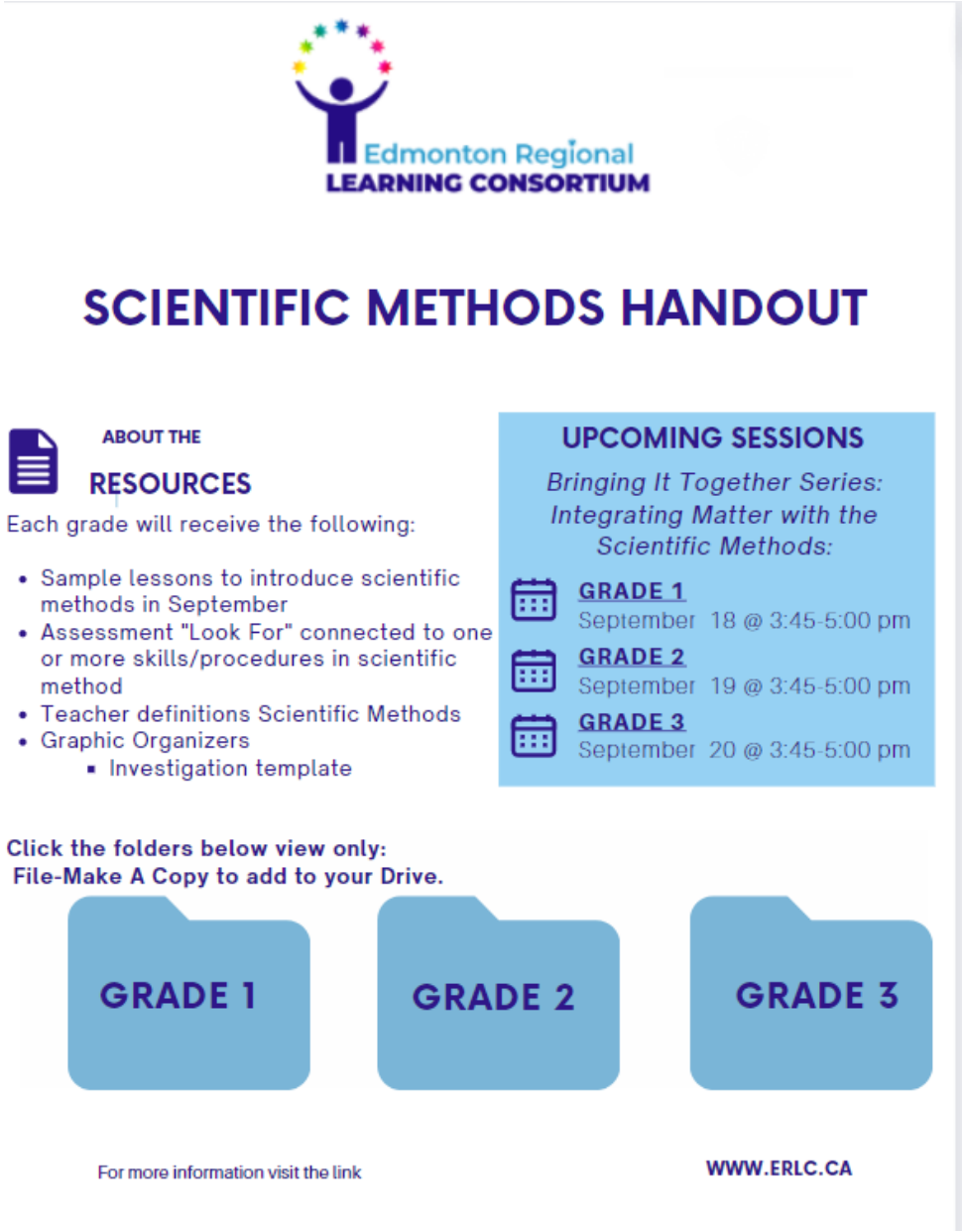


Gizmos Grade 3 Example



Teacher version contains:

- Student handout
- Teacher guide
- Answer Key
- Vocabulary Sheet



- Slides from Today
- Lesson Plans Intro Scientific Methods
- Grade specific assessment "Look Fors" 1 skill in scientific method
- Graphic organizer
  - Investigation template for grade

My September Sessions

Bringing It Together Series: Teaching & Assessing Sequence of Lessons Integrating Matter & Scientific Methods

Grade 1

How actions change the properties of objects

- Sept. 18 @ 3:45 – 5:00
- Resources to use in classroom

Grade 2

How the purpose of an object will influence the materials used

- Sept. 19 @ 3:45-5:00
- Resources to use in classroom

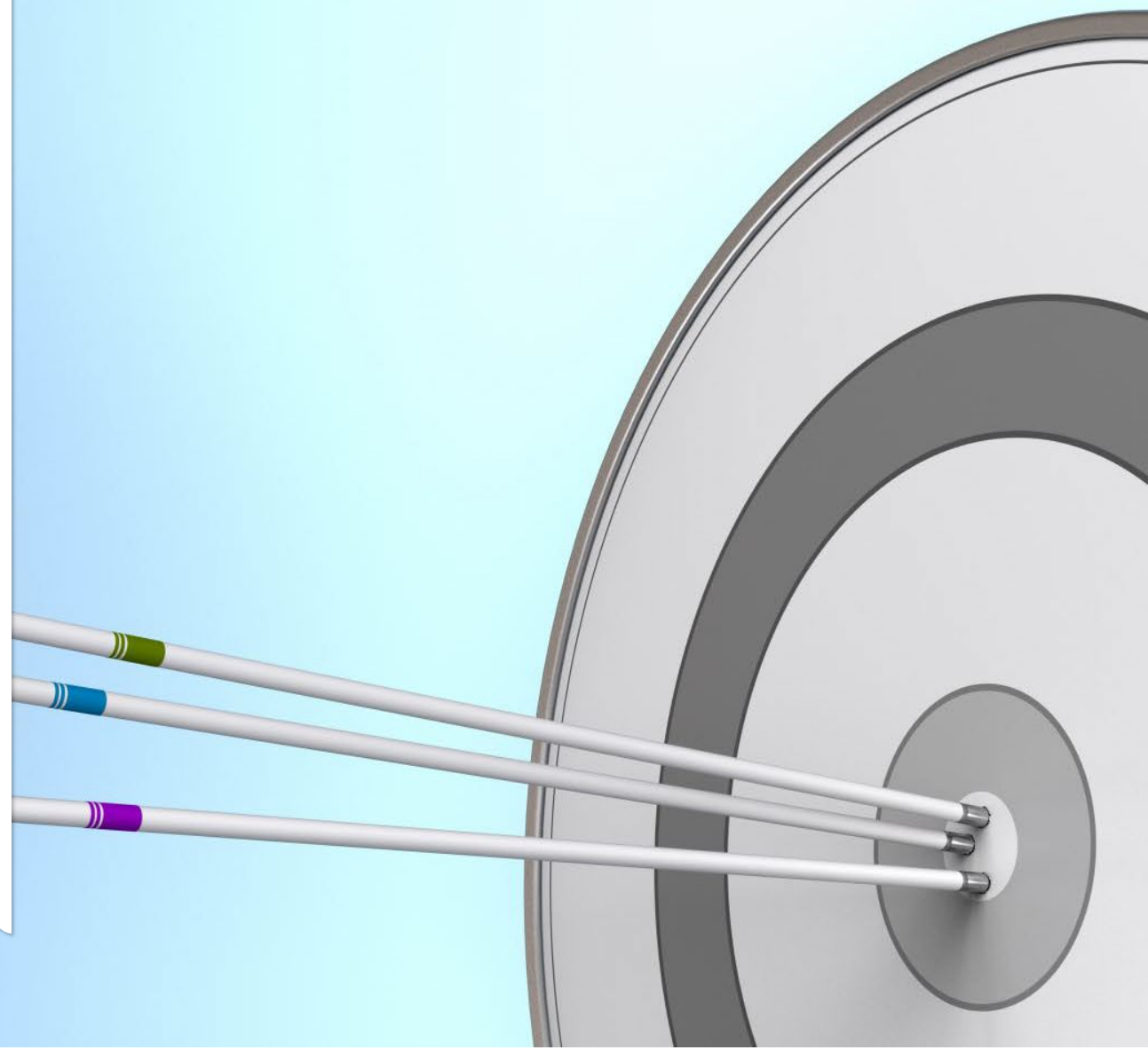
Grade 3

How matter can change states if it is heated or cooled

- Sept 20 @ 3:45-5:00
- Resources to use in classroom

Key Ideas

- ✓ Science uses methods of investigations to build knowledge and understanding of natural world
- ✓ Each grade learning outcome & KUSPS unwraps deeper layer of focus of the investigations
- ✓ There are criteria to develop skills & assess to help prepare students for next grades



Questions?

Thank you!

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