ADAC

Instructional Resources for Scientific Thinking & Sensemaking

Eight practical routines you can use with the science curriculum and instructional materials you already have. Use this resource after the webinar to choose a routine based on the scientific thinking students need to do next.

These routines are designed to help middle school students think and act like scientists as they explore phenomena, work with evidence, develop explanations, communicate ideas, and revise their thinking. They can be used with existing curriculum and instructional materials; they are not tied to a particular program or unit.

Across all eight routines, a useful UDL planning question is:

> *What scientific thinking do students need to do, what might unnecessarily get in the way, and how can I reduce those barriers without reducing the thinking?*

The UDL Guidelines emphasize designing multiple means of Engagement, Representation, and Action & Expression in response to predictable learner variability.

Entering a Phenomenon & Planning Investigations	Making Sense of Evidence	Developing and Revising Explanations
Notice → Wonder → Initial Idea Surface observations, questions, and current thinking. **Predict → Observe → Explain** Make thinking visible and reconcile predictions with evidence. **Question → Evidence Needed → Investigation Plan** Move from wondering to determining what evidence is needed.	**Pattern → Evidence → Interpretation** Identify relationships and determine what the evidence might mean. **Compare → Connect → Explain** Use similarities and differences to identify meaningful relationships.	**Model → Test → Revise** Represent an explanation and improve it as new evidence emerges. **Claim → Evidence → Challenge → Revise** Construct and strengthen explanations through evidence and critique. **I Used to Think → Evidence That Changed My Thinking → Now I Think** Reflect on how evidence has influenced understanding.

1. Notice → Wonder → Initial Idea

What the routine is

A routine for helping students enter a phenomenon, observe carefully, generate questions, and put an initial scientific idea on the table.

Students distinguish among:

- what they observe;
- what they wonder;
- and what they currently think might be happening.

The initial idea is tentative. It gives students something they can investigate, test, and revise later.

When to use it

Use when introducing a

- a new phenomenon;
- an investigation;
- an image, video, specimen, demonstration, or model;
- an unexpected investigation result;
- or a new piece of evidence.

It is especially useful near the beginning of a learning sequence when you want to surface students' experiences and existing ideas before providing explanations.

How to set it up in a middle school classroom

Choose a phenomenon students can observe and begin reasoning about without requiring extensive background knowledge or specialized vocabulary first.

Provide:

- a clear image, video, demonstration, object, or other observable event;
- a shared figuring-out question;
- time for students to think independently;
- a place to record notices, wonders, and ideas;
- and opportunities to compare thinking with partners or small groups.

Plan in advance which observations or questions may be useful to bring into a whole-class discussion.

Steps

1. Notice
Students observe silently and record what they see.
Prompt: *What do you notice?*

2. Wonder
Students generate questions.
Prompt: *What does this make you wonder?*

3. Share and compare
Students compare observations and questions with others.

4. Develop an initial idea
Students respond: What might be happening? What makes you think that?

5. Identify what is needed next
Ask: *What evidence or information could help us investigate this idea?*

UDL considerations

- Begin with an accessible, observable phenomenon that allows for different starting points.
- Use more than one way to make the phenomenon perceptible when appropriate—visuals, spoken descriptions, objects, captions, or diagrams.
- Give individual think time before requiring class participation.
- Allow students to record ideas with words, sketches, annotations, or oral language.
- Avoid making formal scientific vocabulary a prerequisite for contributing an idea.
- Treat initial ideas as ideas to investigate rather than answers to judge.
- Use curiosity and authentic phenomena to support engagement while keeping the scientific goal visible.

2. Predict → Observe → Explain

What the routine is

A routine that asks students to make a reasoned prediction, observe what actually happens, and then use the difference between expectation and evidence to develop an explanation.

The purpose is not to see who predicts correctly. The prediction makes students' thinking visible and gives them a reason to attend carefully to evidence.

When to use it

Use with:

- demonstrations;
- investigations;
- simulations;
- short videos;
- physical models;
- or events with an observable outcome.

It is particularly useful when students are likely to hold different ideas or when the outcome may be surprising.

How to set it up in a middle school classroom

Identify an event for which students can make a meaningful prediction.

Before the event:

- show enough information for students to reason;
- ask for a prediction and a reason;
- and record several different predictions without confirming them.

Then conduct or reveal the event so students can observe the outcome directly.

Steps

1. Predict

Ask: *What do you think will happen? Why?*

2. Share reasoning

Students compare predictions and reasons.

3. Observe

Conduct or show the event. Ask students to record what actually happened.

4. Compare

Ask: *How did the observation compare with your prediction?*

5. Explain

Ask: *How might we explain what happened?*

6. Identify next evidence

If appropriate: What else would we want to investigate before we are confident in this explanation?

UDL considerations

- Make prediction a low-risk opportunity to reveal thinking, not a test of prior knowledge.
- Make the event clearly perceptible and allow students to replay or revisit evidence when possible.
- Separate what happened from why it happened.
- Provide options for predicting through writing, drawing, modeling, or discussion.
- Use optional language supports such as “I predict ___ because ___.”
- Normalize predictions that do not match the evidence; they create productive opportunities for revision.
- Maintain the same scientific expectation for all learners even when response formats or supports vary.

3. Pattern → Evidence → Interpretation

What the routine is

A routine for helping students move from seeing information to using evidence to make scientific meaning.

Students identify a pattern, locate the specific evidence supporting it, and consider what the pattern might mean.

When to use it

Use when students are working with:

- graphs;
- tables;
- investigation results;
- maps;
- photographs;
- observations;
- measurements;
- or multiple sources of data.

It works especially well when students can identify individual data points but need support seeing larger relationships.

How to set it up in a middle school classroom

Select a data set that contains patterns relevant to the phenomenon students are investigating.

Before students begin:

- clarify how the representation is organized;
- explain unfamiliar labels, units, or symbols;
- remove information that is not needed;
- and identify a framing question that gives students a reason to analyze the evidence.

Do not point out the pattern you want students to discover.

Steps

1. Find a pattern

Ask: *What repeats, changes, or appears related?*

2. Compare ideas

Students share patterns with partners or groups.

3. Locate evidence

For each pattern ask: *What specific data make you say that?*

4. Interpret

Ask: *What might this pattern mean?*

Students can use:

We notice _____.
Our evidence is ______.
We think this might mean ______.

5. Connect to the larger question

Ask: *How does this pattern help us make progress on what we are trying to figure out?*

UDL considerations

- Use clear labels, readable displays, and accessible graph or table design.
- Explain the structure of unfamiliar representations without interpreting the data for students.
- Allow annotation, circling, highlighting, or marking directly on the evidence.
- Use prompts that help novices attend to important features and relationships.
- Chunk large data sets when the volume of information is not the intended challenge.
- Provide optional reasoning frames while preserving the requirement to identify and interpret evidence.
- Ensure the scaffold helps students know how to look, without telling them what to conclude.

4. Compare → Connect → Explain

What the routine is

A routine that helps students use comparison as a tool for scientific reasoning.

Students identify important similarities and differences, determine which relationships matter, and use them to develop an explanation.

When to use it

Use when students have two or more:

- conditions;
- organisms;
- systems;
- investigation results;
- graphs;
- models;
- photographs;
- before/after observations;
- or competing examples.

It is especially useful when an important scientific relationship becomes clearer through contrast.

How to set it up in a middle school classroom

Select two or more representations or cases that students can examine side-by-side.

Be clear about the larger question students are trying to answer.

Consider giving students a simple organizer with three prompts:

Compare: What is similar or different?
Connect: Which relationship might matter?
Explain: How could it help explain the phenomenon?

Steps

1. Compare

Students identify similarities and differences.

2. Select

Ask: *Which difference or similarity seems scientifically important?*

3. Connect

Ask: *What relationship do you see?*

4. Explain

Ask: *How might this relationship help explain what is happening?*

5. Share and build

Groups compare explanations and build on one another's reasoning.

UDL considerations

- Place representations side-by-side rather than relying on memory.
- Use consistent labels, scales, and visual organization when possible.
- Clarify what students are comparing without identifying the important relationship for them.
- Allow students to compare through speech, writing, annotation, tables, or diagrams.
- Provide organizational supports when comparing many variables.
- Use partner or small-group talk before requiring whole-class explanations.
- Make the scientific comparison and explanation the challenge—not navigating unnecessarily complicated materials.

5. Model → Test → Revise

What the routine is

A routine in which students create a representation of their current explanation, test it against evidence, and revise it as their understanding develops. It helps students experience models and explanations as tools for thinking, not just final products.

When to use it

Use during:

- phenomenon-based units;
- investigations;
- systems thinking;
- causal explanation development;
- physical science interactions;
- ecosystem models;
- Earth system models;
- or any sequence in which students receive new evidence over time.

How to set it up in a middle school classroom

Clarify what students' models need to help explain.

Depending on the learning goal, models might include:

- important components;
- interactions;
- movement of matter or energy;
- forces;
- cause-and-effect relationships;
- or changes over time.

Provide a way for students to preserve their initial thinking so revisions remain visible.

Then introduce evidence that can support, challenge, or extend the model.

Steps

1. Model

Students represent their current explanation.

2. Explain the model

Ask: *How does your model explain what we observed?*

3. Test

Introduce new evidence.
Ask: *Does this evidence fit the model?*

4. Identify changes

Ask: *What does the evidence support? What does it challenge?*

5. Revise

Students add, remove, reorganize, or clarify parts of their models.

6. Explain the revision

Ask: What changed and why?

UDL considerations

- Allow appropriate forms of representation such as diagrams, physical models, annotations, written explanations, or digital models.
- Keep common scientific success criteria across different formats.
- Provide organizational scaffolds for complex systems.
- Introduce evidence progressively rather than overwhelming students with all information at once.
- Let students modify an existing model instead of repeatedly starting over.
- Normalize revision as a central practice of science.
- Distinguish the quality of scientific thinking from artistic skill or writing fluency.

6. Claim → Evidence → Challenge → Revise

What the routine is

A routine for helping students construct explanations and then strengthen them through critique.

Students develop a claim, support it with evidence, consider a question or challenge from others, and revise the claim or reasoning when appropriate.

When to use it

Use when students:

- have gathered enough evidence to make a tentative claim;
- are comparing possible explanations;
- are preparing for argumentation;
- are interpreting investigation results;
- or need practice evaluating whether evidence adequately supports an explanation.

How to set it up in a middle school classroom

Establish a clear norm: We challenge ideas—not people.

Give students access to the evidence they may need.

Teach or display several productive challenge questions, such as:

- Does all of the evidence fit?
- What evidence supports that?
- Could there be another explanation?
- How does that evidence connect to the claim?
- What additional evidence would make the claim stronger?

Steps

1. Claim

Ask: *What do you think the evidence helps us conclude?*

2. Evidence

Ask: *What evidence supports that claim?*

3. Reason

Students explain how the evidence connects to the claim.

4. Challenge

Another student asks a question or offers a counterexample.

5. Consider

Students determine whether the challenge affects the claim or reasoning.

6. Revise

Students strengthen, qualify, or change the explanation when needed.

UDL considerations

- Establish a classroom culture where critique is directed toward ideas.
- Provide individual think time before students publicly defend reasoning.
- Keep evidence visible and accessible during discussion.
- Provide optional critique stems for students who need language support.
- Allow students to reconsider a position rather than forcing them to defend an unsupported claim.
- Use small-group discussion as a lower-risk setting before whole-class argumentation.
- Separate language fluency, confidence, and speaking speed from the quality of scientific reasoning.

7. Question → Evidence Needed → Investigation Plan

What the routine is

A routine that helps students move from asking a scientific question to determining what evidence would help answer it and how that evidence might be collected.

It makes the logic of investigation design visible.

When to use it

Use:

- after students generate questions about a phenomenon;
- before planning investigations;
- when evaluating whether an investigation can answer a question;
- or when students need to understand why particular measurements or observations matter.

How to set it up in a middle school classroom

Begin with a phenomenon and one or more investigable questions.

Depending on students' experience, provide different levels of support:

- a completely open investigation;
- a set of possible tools;
- a list of measurable variables;
- several possible procedures to compare;
- or a partially completed investigation plan.

The goal is for students to reason about what evidence would actually help answer the question.

Steps

1. Identify the question

Ask: *What are we trying to figure out?*

2. Identify evidence needed

Ask: *What would we need to observe, measure, or compare to make progress on this question?*

3. Identify variables or conditions

Ask: *What might need to change? What might need to stay the same?*

4. Develop a plan

Ask: *What could we do to collect the evidence?*

5. Check the plan

Ask: *If we collected this evidence, would it actually help answer our question? Why?*

6. Revise as needed

Students improve the investigation before carrying it out.

UDL considerations

- Keep the phenomenon and investigation question visible throughout planning.
- Offer levels of scaffolding appropriate to students' experience with investigation design.
- Allow students to sketch or diagram an investigation rather than relying only on procedural writing.
- Provide tools, checklists, or planning templates to support organization.
- Give students meaningful choices when multiple valid investigation approaches exist.
- Reduce demands unrelated to the learning goal while preserving decision-making about evidence.
- Use collaborative planning so students can learn from different ideas and strategies.

8. I Used to Think → Evidence That Changed My Thinking → Now I Think

What the routine is

A reflection routine that helps students make changes in understanding visible and connect those changes to evidence or learning experiences.

It positions revision as an expected part of science learning.

When to use it

Use:

- after an investigation;
- after analyzing evidence;
- after a model revision;
- at the end of a lesson or learning sequence;
- after an explanation discussion;
- or whenever students have had an opportunity to reconsider an earlier idea.

How to set it up in a middle school classroom

Preserve students' earlier thinking so they have something concrete to revisit.

This could be:

- an initial model;
- a notebook entry;
- a prediction;
- a class chart;
- a claim;
- or an earlier written explanation.

Then provide quiet reflection time before discussion.

Steps

1. Revisit

Students examine what they thought earlier.

2. Describe previous thinking

I used to think...

3. Identify evidence or experience

Evidence or an experience that affected my thinking was...

4. Describe current thinking

Now I think...

5. Explain the change

My thinking changed because...

6. Identify what remains unresolved

I still wonder...

UDL considerations

- Give private think/write time before public sharing.
- Allow reflection through writing, speaking, drawing, annotation, or revising a previous model.
- Do not require students to change an idea if the evidence strengthened their original thinking.
- Focus reflection on evidence and reasoning, not on whether students were initially “right.”
- Keep earlier work available so students can see their own progress.
- Use prompts and templates to support monitoring of learning.
- Value unresolved questions as evidence of continued scientific thinking.