Patterns High School Science

Vertical Articulation and Resource Guide

[Patterns Science Sequence Design Principles]

Table of Contents

[Patterns Science Sequence Design Principles]

[Writing Supports and Articulation]

[Academic Discourse Protocols]

[Collaboration: Group Roles Slides]

[Crosscutting Concept (CCC) Articulation]

[Vocabulary Translation Support]

Writing Supports and Articulation

Constructing Explanations		
Data Discussion Pre-write (Template): Prior to constructing an explanation (conclusion) for a lab report, students should engage in a data discussion to orient to the data, make sense of the pattern, and discuss applications and limitations.		
Physics	**Chemistry**	**Biology**
Support 0: Conclusion with Description of Parts Support 1: Graphic Organizer Template for Conclusion Writing Graphic Organizer Template for CER Writing Support 2: Physics Conclusion Resource Sheet Physics CER Resource Sheet Support 3: Lab Report Checklist with Examples and Sentence Frames	Support 0: Conclusion with Description of Parts (and here is the version w/o limitations) Support 1: Graphic Organizer Template for Conclusion Writing Graphic Organizer Template for Conclusion Writing - No Mathematical Model Support 2: Conclusion Resource Sheet (and w/o Limitations) CER Resource Sheet	Support 0: Conclusion with Description of Parts Support 1: Graphic Organizer Template for Conclusion Writing Graphic Organizer Template for Conclusion Writing - No Mathematical Model Support 2: Conclusion Resource Sheet CER Resource Sheet Support 3: Full Lab Report Checklist - Biology

Arguing from Evidence (Argumentation) These resources are most applicable when students are writing arguments that specifically address an opposing viewpoint, or counterclaim, and then develop rebuttals to those counterclaims.
Support 1: Graphic Organizer for ArgumentativeWriting Support 2: Resource Sheet for Argumentative Writing

Academic Discourse Protocols

Each of the protocols below are intended to support student engagement in the scientific and engineering practices (SEPs). By focusing on a limited set of protocols across their course sequence, students can focus more on what they are talking about, versus how to conduct the protocol.

In these SEP-centered conversations, students will also use crosscutting concepts (CCCs) and Disciplinary Core Ideas (DCIs) to question, sense-make, and communicate ideas. Critical to the success of every one of these protocols is the establishment of a classroom culture where students feel included, safe, and positively affirmed as scientists and engineers. Work to establish classroom norms that support a culture of mutual respect and academic accountability. Additionally, teachers can utilize these Talk Moves Resources to support their own practice in encouraging and reflecting on equitable talk.

Strategy	**Description**	**Focal Science and Engineering Practices**
Creating a Driving Question Board - Unit opener slides template	At the beginning of a unit, after exposing students to the anchoring phenomenon in some way (e.g. a video, article, design challenge request for proposals, picture, etc.), use the Driving Question protocol to have students generate questions that will drive what questions they need to investigate throughout the unit in order to explain the phenomenon (science) or develop a solution to the problem (engineering).	Asking Questions
A/B Partner Protocol	In this protocol from Activate Learning (IQWST), where pairs of students share ideas and questions, restate ideas, and clarify thinking in a structured A/B talk protocol. Students use the protocol twice, so both partners have a turn at each role.	Constructing Explanations Modeling Reflecting on the use of SEPs in class investigation or activity
Stronger and Clearer: Student Template Slideshow Template	In this protocol from Jeff Zwiers, students practice making their **explanations** stronger and clearer. This is an excellent protocol for supporting CER/Constructing Explanations. ● Before lining up, the teacher gives students a high-level	Constructing Explanations

	prompt that will require them to have a claim, evidence, and reasoning to explain their thinking. ● Students prewrite a few ideas at their desks ● Follow slideshow protocol so rotating student pairs practice their explanations and repeat in 3-4 rounds to strengthen and clarify their explanations. ● Students return to desk and write a final paragraph, incorporating the ideas and language they practiced for a stronger and clearer explanation.	
Board Meeting (small groups) ● Board Meeting - 2 variations	Protocols that students can use to share whiteboards with other students.	Analyzing and Interpreting Data Using Mathematics and Computational Thinking
Board Meeting (whole group) ● Board meeting discussion slide show ● Ways to facilitate a board meeting ● Student Cards for Discussion - sentence starters	A structured data discussion protocol where students draw graphs on whiteboards, organize boards, then discuss the patterns and their meaning.	Analyzing and Interpreting Data Using Mathematics and Computational Thinking
Data Discussions ● 0L - Data Discussion Template ● Discussion Prompts for Facilitators & Participants ● Ways to facilitate a data discussion	Graphic organizers to structure student sense-making of the phenomenon. Students develop an understanding of the phenomenon by connecting the experience, the graph, and the mathematical model ("walking the triangle").	Analyzing and Interpreting Data Using Mathematics and Computational Thinking
Roving Paragraph ● Slideshow	This is a process you can use to support student writing (CER, argumentation, etc.). Each slide has a sentence starter that the teacher writes. For each round, the students write a sentence, read it (and previous sentences in later rounds) to their partner, and their partner reads theirs, then	Constructing Explanations Engaging in Argument from Evidence

	they revise together, and thank each other. With this quick revision process, student writing is rapidly iterated.	Obtaining, Evaluating, and Communicating Information
Flash Debate: • Student Flash Debate Organizer Template (starts with anticipatory guide and then follows with the debate process) • Slideshow	Teacher Guide To follow up the debate with an argumentative writing piece: use this Graphic Organizer for Argumentative CER Writing Support 2: Resource Sheet for Argumentative CER Writing	Engaging in Argument from Evidence

Socratic Seminar:
• Folder of Resources (AVID)
 	
• Student Resources:
  ○ Student Discussion Debrief
  ○ Sentence Frames
	Description and Guidelines
	
	Teacher Troubleshooting Guide
	
	Slideshow template
		Constructing Explanations
		
		Obtaining, Evaluating, and Communicating Information

Philosophical Chairs:
• Folder of Resources (AVID)
 	
• Student Resources:
  ○ PC Student Report
  ○ PC Student Evaluation and Reflection
	Description and Guidelines
	
	Teacher Troubleshooting Guide
		Engaging in Argument from Evidence

Collaboration: Group Roles Slides

Teachers can explicitly teach collaboration among group members by assigning roles to students in each lab/project/activity, rotating roles so that students experience developing their skills in each area. Teachers can copy/paste the appropriate group role slide into the inquiry, engineering and activity slideshow of their choice.

Inquiry Roles:

- Lead Investigator-This student reads directions to the group, keeps the group on task, and manages/keeps track of time.
- Manager-This student gathers supplies, ensures safety procedures are followed, asks questions/gets clarification from peers/teacher, and ensures lab station is clean before leaving.
- Technician (may need more than one)-This student coordinates data collection, accurately measures values, performs calculations as needed, and communicates the results with the Quality Control Specialist.
- Quality Control Specialist-This student accurately records data for the group and provides the data to group members (even ones who are absent).

Engineering Roles:

- Lead Engineer-This student reads directions to the group, keeps the group on task, manages/keeps track of time, and gathers group input on possible solutions.
- Manager-This student gathers project supplies, ensures safety procedures are followed, asks questions/gets clarification from peers/teacher, and ensures project station is clean before leaving.
- Technician-This student coordinates data collection, accurately measures values, performs calculations as needed, and communicates the results with the Quality Control Specialist.
- Quality Control Specialist-This student accurately records data for the group, provides the data to group members (even ones who are absent), and communicates results to the class.

Activity Roles:

- Communications Director-This student asks questions/gets clarification from peers first, then teacher encourages all group members to participate, and shares out with class, as needed.
- Manager-This student reads directions to the group, keeps the group on task, and manages/keeps track of time.
- Technician-This student gathers activity supplies and returns them, conducts activity procedures, and checks calculations, as needed.
- Quality Control Specialist- This student ensures that observations/data are recorded by all group members, guides consensus building and ensures that all group members’ responses to activity prompts and questions are accurate and high-quality.

Crosscutting Concept (CCC) Articulation

CCC	Physics	Chemistry	Biology
Patterns	Students utilize patterns mainly by mathematically modeling an investigated phenomenon and using this model to predict a system's future behavior and inform engineering design decisions. Patterns of focus are: ● Horizontal Line ● Proportional ● Linear ● Quadratic ● Inverse Proportional ● Inverse Square	Students utilize macroscopic data to explain and predict phenomena that are accounted for by microscopic interactions. Patterns are explained by utilizing knowledge of chemical and physical properties and utilized to make engineering design decisions. Patterns of focus are: ● Proportional ● Linear ● Inverse ● Exponential (negative) ● Logarithmic ● Trends in physical and chemical properties (e.g. periodic table trends)	Students use mathematical models, apply statistics, and utilize knowledge of biological interactions to explain and develop causal accounts of biological phenomena occurring within and between biochemical and ecosystem-level scales. Students use these accounts to explain the range in which patterns apply in living systems. Patterns of focus are: ● Linear ● Exponential (positive) ● Complex patterns (e.g. Gaussian Curve and predator-prey interactions) ● Summary statistics (e.g. standard deviation) and statistical hypothesis testing (e.g. t-test)
Cause and Effect	Cause and effect are the underlying basis for both the design of experiments (i.e. what to vary and what to keep constant) and the reasoning for choosing an optimal design to solve a problem. Further, the practice of mathematical modeling is often built upon a cause and effect relationship.	Cause and effect is the foundation upon which average bulk scale behavior is explained through a focus on atomic and micro-scale interactions that are more variable. Further, discussion of the mathematical model students create describes the system and must explicitly account for the cause and effect relationship.	Students inquire with the idea that biological systems are difficult to control, and thus cause and effect can only be established through careful experimental design and statistical analysis. The differences between causation and correlation are explored.

Scale, Proportion, & Quantity	Scale, proportion, and quantity are routinely incorporated through considering the scale a model works to accurately describe the system; proportion and reasoning the interpretation of the constant (A-value), and in applying models to new contexts.	Students use orders of magnitude to understand how a model at one scale relates to a model at another scale. Dimensional analysis and stoichiometry are used as tools to make predictions and to make sense of very small and very large numbers.	Students encounter more abstract applications of scale, proportion, and quantity, (e.g. the amount of information in a genome and the diversity of life on earth). Scale is explored conceptually and comparatively to generate questions, provide evidence, and reason. Mathematical models involving scale (e.g. population growth) are used to make predictions and infer impacts on interacting variables.
Systems & System Models	Systems of study are typically concrete, directly observable, and easily manipulated (e.g. creating waves on a slinky).	Systems of study are typically more abstract, indirectly observable, and manipulated with a limited range of potential variables (e.g. measuring changes in temperature to calculate reaction energy).	Systems of study are often difficult to define, highly complex, indirectly observable, and/or manipulated with a wide range of potential variables (e.g. measuring changes in biodiversity to determine the effects of ecological factors).
Energy & Matter	Students often approach investigations through tracking flows of a few types of energy in everyday objects (matter).	Students often approach investigations through tracking flows of a few types of energy in substances (matter) to observe changes or stability in a system at a bulk scale to model interactions at the atomic level.	Students approach investigations by tracking complex flows of energy in, through, and out of living matter. Students observe changes to biomass and energy. Changes to energy and matter flows/cycle stability are explained with biochemical, physiological, ecological, and evolutionary concepts.
Structure and Function	Structure and function operate at both the physical and mathematical levels. For example, an ultrasound	Atomic properties are created by the arrangement of protons, neutrons and electrons. These	The function of biological systems is driven by biomolecular structures that govern

	machine's function is determined by both the structures of sound waves and the form and materials of construction.	properties determine how molecules and compounds are formed. Molecular and ionic properties are determined by the arrangement of atoms and the resulting electrostatic attractions.	interactions. For example, mutations in genes can generate modifications in protein structure which cause changes in their functionality. Also, the structures of adaptations are linked to functionality and this relationship is evolutionary.
Stability and Change	Students start the year investigating phenomena that have controlled changes or stability in the system of study and move to observing more complex situations / models where a single variable may cause feedback loops that stabilize or destabilize a system (e.g. a change of CO_2 in the atmosphere causes a change in the amount of energy stored in the Earth system).	Reactions are the change in the organization of atoms. These changes are governed by electrostatic interactions and control the macroscale changes like rate of reaction, thermochemistry, and equilibrium.	Students investigate changes in various types of biological systems, from ecosystem to individual, observed changes to the stability of these systems can be explained by physical and biological concepts. These systems tend to be more complex than those investigated in earlier courses (e.g. feedback loops in human physiology).

Vocabulary Translation Support

Glossaries for ELLs/MLLs, from the Metropolitan Center for Research on Equity and Transformation in Schools

We envision these translated science glossaries would be available to students who speak languages other than English at home throughout each course. In this way, they will have a single resource they can use flexibly to find the accurate content translation for the discipline they are learning.

- **High School Physics**
  Albanian, Arabic, Bengali, Burmese, Chinese (simplified), Chinese (traditional), Dutch, Farsi, French, Fulani, Greek, Haitian, Hindi, Italian, Karen, Kinyarwanda, Malay, Mandinka, Nepali, Pashto, Polish, Portuguese, Punjabi, Russian, Slovak, Spanish, Swahili, Tagalog, Thai, Tibetan, Turkish, Twi, Ukrainian, Urdu, Uzbek, Vietnamese, Wolof
- **High School Chemistry**
  Albanian, Arabic, Bengali, Burmese, Chinese (simplified), Chinese (traditional), Dutch, Farsi, French, Fulani, Greek, Haitian, Hindi, Italian, Karen, Kinyarwanda, Korean, Malay, Mandinka, Nepali, Pashto, Polish, Portuguese, Punjabi, Russian, Slovak, Spanish, Swahili, Tagalog, Thai, Tibetan, Turkish, Twi, Ukrainian, Urdu, Uzbek, Vietnamese, Wolof
- **High School Biology**
  Albanian, Arabic, Bengali, Bosnian, Burmese, Chinese (simplified), Chinese (traditional), Dutch, Farsi, French, Fulani, Greek, Haitian, Hindi, Italian, Japanese, Karen, Khmer, Kinyarwanda, Korean, Malay, Mandinka, Nepali, Pashto, Polish, Portuguese, Punjabi, Russian, Slovak, Spanish, Swahili, Tagalog, Thai, Tibetan, Turkish, Twi, Ukrainian, Urdu, Uzbek, Vietnamese, Wolof