Patterns Approach High School Science Curriculum and Pedagogy Design Principles - Meaning Making Resources for ELLs

Eight design principles have intentionally shaped and guided the development of the Patterns Approach High School Science Curriculum and Pedagogical Approach for the Physics → Chemistry → Biology sequence of courses. The tables below expand on the design principles to emphasize meaning making resources for English language learners (ELLs).

Theoretical Background

The Contemporary Approaches: In science education the contemporary approaches could be powerful for all K-12 students but especially minoritized student groups, whose assets have traditionally not been recognized for science learning. One such group of minoritized students is the fast-growing population of multilingual learners in the U.S. K-12 context, who have often been excluded from meaningful STEM learning due to the common practice of remedial instruction to "fix" their perceived deficit with English. Despite this persistent remedial framing, multilingual learners bring cultural and linguistic resources that can be harnessed as assets to promote meaningful STEM learning (Lee,O., & Grapin, S., 2023).

Through students "doing science, using language," STEM and language are integrated. As Science and Engineering Practices are language intensive, the Patterns Approach capitalizes on language learning opportunities and demands with all students, especially ELLs or multilingual learners (identifying the students with an asset term). Language is a product, not a precursor or prerequisite for science learning (Lee, O., & Stephens, A. 2020).

The *Asset Approach: Local phenomena and problems cultivate the rich knowledge, experiences, and language. Engagement in science and engineering practices affords opportunities for multilingual learners to use a wide range of meaning-making resources, both linguistic and nonlinguistic, as they participate in goal-directed interactions to make sense of phenomena and problems. Not preteaching and frontloading vocabulary. Because contemporary conceptions in language education involve using language and other meaning-making resources for a purpose, they have been referred to as language-in-use* (Lee et al., 2013).

Guidance for the Meaning Making Resources for ELLs Tables

While all the Patterns Approach High School Science Design Curriculum and Pedagogy Design Principles apply to all students, 4 design principles are combined with contemporary approaches to language and science integration impactful for ELLs.

The Meaning Making Resource is named and broadly defined as follows:

1. **Identify Compelling Phenomena or Problems**
   Phenomena and design challenges are selected so that student scientists find relevance in the connection between their identities and lives and what is studied in the classroom.
2. **Engage Students in Language Rich Disciplinary Practices**
   The language rich disciplinary practices in content areas include constructing explanations, arguing from evidence, obtaining information. These and the other practices combine with disciplinary core ideas and crosscutting concepts to form 3-D learning.
3. **Engage Students in Productive Discourse and Interactions with Others**
   Student scientists make sense of the world through a systematic, collaborative process.
4. **Leverage Meaning-Making Resources**
   Science is taught in conjunction with language. Curriculum and instruction emphasize speaking, writing, interacting, reading, and listening, thereby increasing the academic language capacity of all students, and in particular Multilingual Learners.

The resources are further described in the unit context in three columns as follows:

- When are the opportunities in the unit?
- How does this opportunity support ELLs?
- What are the examples in Unit X? (i.e. how the resource is used in the task or unit).

Modalities	Registers	Interactions
Linguistic o Talk (oral language) o Text (written language) Visual o Drawing o Table o Graph o Chart o Equation o Gesture	Everyday talk and text ⟷ Specialized talk and text Precision: Do ELs communicate disciplinary meaning with exactness?	• One-to-one • One-to-small group • Small group-to-many • One-to-many Explicitness: Do ELs communicate disciplinary meaning beyond the “here and now”?

Figure 1: Language Instructional Shifts

Lee, O., & Grapin, S. (2023). English language proficiency standards aligned with content standards: How the Next Generation Science Standards and WIDA 2020 reflect each other. *Science Education*, 1–22. https://doi.org/10.1002/sce.21843
Lee, O., Quinn, H., & Valdés, G. (2013). Science and language for English language learners in relation to Next Generation Science Standards and with implications for Common Core State Standards for English language arts and mathematics. *Educational Researcher, 42*(4), 223-233. https://doi.org/10.3102%2F0013189X13480524
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Meaning Making Resources for ELLs - Patterns Physics Unit 3

Identify Compelling Phenomena or Problems

Phenomena and design challenges are selected so that student scientists find relevance in the connection between their identities and lives and what is studied in the classroom.

When are the opportunities in the unit?	How does this opportunity support ELLs?	What are the examples in Unit 2?
Launch the unit with anchoring phenomenon that relates to students' home culture or experiences. The Patterns Approach to Physics anchors the students in compelling or everyday phenomenon	**Leverage student assets -** Students' existing capabilities, capacities, and funds of knowledge from home, neighborhood, community and/or culture are honored and built upon in new contexts.	Students design and test a bungee jump as a member of a company. Real life engineering jobs include: App Manager, Experimental Design Manager, and Expo Manager.
Real world transfer tasks within units build on developing science understanding.	Local phenomena capitalizes on cultural and linguistic resources that diverse student groups bring to the science classroom while contextualizing their learning needs in developing science understanding.	Task 4 Evaluating Published Materials: Students evaluate sources of information presented in different "real world" media by comparing observations of the media sources and what they know about energy transfers in a system.

Engage Students in Language Rich Disciplinary Practices

The language rich disciplinary practices in content areas include constructing explanations, arguing from evidence, obtaining information. These and the other practices combine with disciplinary core ideas and crosscutting concepts to form 3-D learning.

When are the opportunities in the unit?	How does this opportunity support ELLs?	What are the examples in Unit 2?
Three-dimensional learning - Tasks demand that students use SEPs, DCIs, and CCCs in tandem to explain phenomena and solve problems. The three dimensions are balanced across teaching, learning, and assessment. See: Yearlong Learning Targets to track Growth Over Time	Students make sense of phenomena and problems as scientists and engineers. They use and apply knowledge for a purpose, or knowledge-in-use. Students use language to engage in science and are motivated by the high interest generated during active learning.	<Many examples of 3-D learning in Physics. Should find examples that are especially good for ELLS. Ask Bradford>

Engage Students in Productive Discourse and Interactions with Others

Student scientists make sense of the world through a systematic, collaborative process.

When are the opportunities in the unit?	How does this opportunity support ELLs?	What are the examples in Unit 2?
• One-to-one • One-to-small group • Small group-to-many • One-to-many **Regular opportunities for facilitated discussion -** Rich discourse occurs frequently, in data discussions, class/group interaction, structured talk protocols, and other discourse opportunities.	Multilingual learners can communicate precise disciplinary meaning using less-than-perfect English because language acquisition is a product of doing science. Students change registers as they communicate in varied groups.	<add specific example of support for ELLs> Talk Protocol Flowchart (Adapted from STEM Teaching tools with talk protocols that are used in Patterns).

Leverage Meaning-Making Resources

Science is taught in conjunction with language. Curriculum and instruction emphasize speaking, writing, interacting, reading, and listening, thereby increasing the academic language capacity of all students, and in particular Multilingual Learners.

When are the opportunities in the unit?	How does this opportunity support ELLs?	What are the examples in Unit 3?
Language supports - Sentence starters and frames are provided for writing and speaking tasks. Link to Folder "O General Files"	Students are given multiple options to choose from, allowing them to move toward a more sophisticated use of scientific and academic language.	Sentence frame support for CER Writing a Conclusion - Description of Parts of a Conclusion Writing a Conclusion - Graphic Organizer Resource Sheet for Writing Lab Conclusions - Sentence Frames Lab Report - Checklist with sentence frames
As SEPs are language intensive, units capitalize on language learning opportunities and demands with all students, especially ELLs in three key areas: modalities, registers, and interactions (see Figure 1). Modalities: • Tasks include many opportunities for students to engage in science practices using multiple modalities. • Tasks guide students in using modalities strategically to communicate their ideas. Registers: • Tasks guide students in using specialized language to communicate their ideas with precision.	Modalities are not simply scaffolds or supports; they are the essential semiotic (i.e. sign and symbol) tools of the disciplines. In science, graphs, tables, and models are central to communicating scientific meanings. **Organizational resources -** In order to help students make their scientific thinking and understanding visible, a variety of organizational resources are used. Concept maps, models, sentence frames, and graphic organizers allow students to demonstrate scientific understanding according to their assets and to help develop emerging skills.	**Modalities:** Unit 3 system analysis is centered on graphic representation and modeling of complex energy ideas. Students with limited English can demonstrate understanding using these models. **Registers:** Physics Word Wall for Unit 3 - Template Physics Word Wall for Unit 3 - Student Work Jigsaw **Interactions:** Students investigate and model in engineering groups taking on the role of members of an engineering team.

• Word Wall of specialized language, NGSS aligned, used by students as support. Interactions • Tasks provide opportunities for students to engage in a range of meaningful and purpose-driven interactions. • Tasks guide students in adapting their language use to meet varying communicative demands.		
Access the previous knowledge as “knowledge in use” from their previous country.	Viewing knowledge of a second language as an asset.	Translations of science glossaries into multiple languages. See Science Sequence Articulation and Resource Guide jump to Vocabulary Translation Support