Understanding Science Project
Literacy Framework
Force and Motion 2007-08

Project Overview

The ultimate goal of the *Understanding Science Project* is to improve student learning in science classrooms. To achieve this, the Project develops and supports the use of professional development materials that engage science teachers in deep reflection on their own and other teachers' practices. Participants who engage in the professional development courses enhance their knowledge of science content as well as ways in which to engage students in the learning of that content. In essence, the *Understanding Science Project* is about using literacy strategies to teach science.

The *Understanding Science Project* recognizes the interdependent relationship between science teaching and learning and literacy. Everything teachers and students do in their science classrooms is mediated by language – whether spoken, written, heard, or read. Moreover, there are particular ways of talking and writing associated with science. Accordingly, the project's work is guided by the following core beliefs:

1. All **students** (a) have the capacity to learn science and develop high levels of proficiency in the literacy demands associated with being scientifically literate, and (b) bring a variety of resources to the task of becoming scientifically literate.
2. Science **teachers** have the responsibility to teach academic literacy—especially as it relates to science content and discourse presented orally and graphically (including words, diagrams, charts, and graphs).
3. Science **classrooms** are a rich context for language and literacy development, which can be achieved through mindfully facilitated interaction between and amongst teachers and students.

The *Understanding Science Project* is particularly concerned with issues of equity and access and, as a key pedagogical emphasis, focuses on science teaching and learning for English Learners (ELs). ELs are diverse in many ways, such as native language, level of proficiency in that language, country of origin, and length of time in the United States. The project's issues and strategies focus on ELs whose level of proficiency in English is intermediate or above, but research has shown that the *Understanding Science* approach benefits ELs as a group, across all levels.

Framework Overview

The *Understanding Science* Literacy Framework presents connections between the project's approach to science teaching and learning and literacy. In the Framework, this relationship is made concrete in terms of observable outcomes for teachers, classrooms, students in general, and English Learners (ELs) in particular. Using a matrix format, the framework presents these categories of outcomes crossed with the four critical features of the project's professional development approach:

exploration of scientific meanings, development of academic language, focus on student thinking, and critical analysis of practice. Integrated within the Literacy Framework are the following understandings and approaches:

Assumptions

- Everything teachers and students do in their classrooms is mediated by language.
- All academic language is not the same.
- *Understanding Science* professional development needs to engage teachers in looking at their own practice through new lenses.

Progression

In terms their focus on literacy development, *Understanding Science* professional development activities cycle through iterative phases of identifying and exploring:

1. ***Language Demands*** (e.g., speaking, reading, writing)
2. ***Text Types*** (e.g., oral presentations, textbook chapters, lab report)
3. ***Learning Routines*** (i.e., focused instructional strategies)

High Priority Difficulties

With respect to literacy development, the *Understanding Science Project* pays specific attention to these *challenges* that are of particular importance for English Learners:

a. Understanding questions, directions, procedures, and explanations (e.g., vocabulary, textual contexts, taken-for-granted assumptions, jargon)
b. Articulating understanding
c. Ability to engage in extensive interaction (e.g., exploratory/sense-making talk)
d. Using and parsing scientific registers (formal, objective, use of passive voice)
e. Distinguishing and using the discourse patterns of science investigation (describing, comparing, classifying)
f. Using the discourse patterns associated with scientific reasoning (basing claims on evidence, inferring, predicting, testing)
g. “Fatigue Factor” (mental duress due to combined cognitive, social, emotional burdens)

Student-Based Resources

Students enter the science classroom with different *experiences* of the physical world, different *ways of explaining* everyday processes in nature, different *cultural stories* about science phenomena, and different *linguistic resources* for talking about what they observe and experience. Such differences can be sources of misunderstanding if students and teachers are not aware of how each of these can shape understanding differently. Or they can be important resources for teachers and students, particularly in class discussions of how people interpret phenomena, how they predict, infer, and judge, and what makes scientific procedures for doing these things particular. The *Understanding Science* approach helps teachers become aware of how their experiences shape the way they learn and the potential for misunderstandings based on assumptions that are not shared.

Guiding Principles and Learning Routines

In addressing the above challenges and incorporating students' own resources, *Understanding Science* work is guided by principles known to foster learning for all students and to be particularly effective with English Learners. These guiding principles are associated instructional approaches referred to as "learning routines." For *Understanding Science* purposes, learning routines are instructional strategies that are: (a) *generic* in that they can be used in a variety of contexts (e.g., applied to reading text or responding to questions), (b) *specific* in terms of having a particular protocol that outlines their use, and (c) *metacognitive* in that they promote reflection by learners on their own learning.

Examples of guiding principles include:

- Engage students in extensive **interaction.**
- Determine and build on students' **prior understandings and background knowledge**.
- Engage students in the explicit development of **scientific vocabulary**.
- Engage students in the explicit development of **scientific discourse patterns**
- **Scaffold** students' verbal proficiency development.
- **Scaffold** students' conceptual development.
- Foster development of students' **metacognitive abilities and understandings**.

Framework Format

As seen on the following pages, the *Understanding Science* Literacy Framework is presented as a series of matrices, one for each of the project's five critical features for its professional development approach.

Understanding Science **CRITICAL FEATURE:**	1. **Exploration of Scientific Meanings**. Teachers discuss, investigate, and think carefully about the meaning of specific science concepts in each case, and how literacy plays a role in this understanding. To make meaning of the science, teachers use and reflect on multiple literacy practices as they: do hands-on investigations; observe, look for patterns, and draw conclusions; relate their observations and conclusions to “accepted” definitions, explanations and conventions; and figure out how the patterns and scientific phenomena extend and relate to other situations.
GUIDING QUESTIONS:	• What conclusions can you draw from your hands-on work? • In what ways do your observations and conclusions illuminate and/or cloud your understanding of the definitions, explanations, or conventions presented in the case? • In what ways do your observations and conclusions relate to one another? • How do your identified patterns and conclusions apply to other related situations? • How have language and literacy contributed to developing our understanding? (Consider listening, speaking, reading, and writing.) • How might English Learners contribute to and/or be challenged by this particular science content?

OUTCOMES

TEACHER	CLASSROOM	STUDENTS
Teachers grow towards having a(n): • Rich and accurate understanding of language and literacy demands related to making and expressing scientific understandings. • Rich and accurate understanding of the specific science concepts in each case and the connections between science concepts. • Deep array of scientific process skills that guide their learning and understanding of science. • High degree of confidence in teaching science and a positive	Classroom environment and events move towards the following goals: • Discussion and activities focus on the meaning of science concepts. • Instruction explicitly supports the development of students’ scientific thinking processes. • Instruction is closely linked to target content goals. • Targeted literacy activities support students as they talk and write about what they understand. • Discussion and activities focus on the connections between science	Students grow towards having a(n): • Ability to observe, look for patterns and draw conclusions. • Accurate understanding of science concepts in the cases and grade-level appropriate knowledge of science content. • Improved abilities to articulate conceptual understanding. • Accurate understanding of culturally and/or linguistically based resources they bring to the science concepts under study (e.g., everyday explanations of scientific

attitude toward learning and doing science.	concepts.	phenomena).

Understanding Science **CRITICAL FEATURE:**	2. **Development of Academic Language**. Teachers examine and discuss the academic language demands and usage present in each case, and identify opportunities for further development of academic language.
GUIDING QUESTIONS:	• What academic language was used by teachers? Students? How was it used? • What academic language was presented in written form? (Consider text and graphics.) How was it presented? • What opportunities are there for further development of academic language by teachers? Students? • How might teachers and students further their understanding of academic language? (Consider use of text and graphics.) • How might English Learners contribute to and/or be challenged by the academic language?

OUTCOMES

TEACHER	**CLASSROOM**	**STUDENTS**
Teachers grow toward having a(n): • Rich and accurate understanding of language and literacy demands related to the case's learning objectives and human interactions (intrapersonal, interpersonal, between persons) and artifacts such as text and graphics. • Identification of discourse structures that support scientific reasoning (e.g., classification, comparison/contrast, definition, inference, justification, sequence). • Identification of word learning strategies (e.g., use of context). • Identification of key vocabulary, noting different possible meanings for a given term. • Understanding of what it means to	Classroom environment and events move toward the following goals: • Explicit teaching and practice of discourse structures that support scientific reasoning. • Explicit teaching of word-learning strategies. • Explicit teaching of key vocabulary, noting different possible meanings for a given term. • Instructional practices include explicit teaching of and support for student development in talking, reading, and writing science (e.g., writing genres such as science lab report). • Students and teachers talk, read, and write science.	Students grow toward having an: • Ability to make appropriate use of discourse structures that support scientific reasoning. • Ability to make appropriate use of word learning strategies • Ability to make appropriate use of key vocabulary. • Ability to use culturally- and/or linguistically-based resources they bring to the development of academic language (e.g., romance language cognates with key science vocabulary such as theory/teoría).

talk, read, and write science.		

Understanding Science **CRITICAL FEATURE:**	3. **Focus on Student Thinking**. Teachers examine and interpret student work, talktalk, and behaviors in each case and how literacy plays a role across these endeavors.
GUIDING QUESTIONS:	• How are the students in this case thinking about the science? • What is important for students to know about these science concepts? • What makes the science concepts tricky or difficult? • What are the ways in which students commonly think about these science concepts? • What do varying levels of student understanding look like (e.g., rich, emerging, partial)? • How can you tell what students are thinking (in relation to symbolic, graphic and abstract sense-making)? • How have language and literacy contributed to developing and displaying student thinking? • What cultural and/or linguistic factors may be influencing how students are displaying their understanding?

OUTCOMES

TEACHER	**CLASSROOM**	**STUDENTS**
Teachers move toward: • Familiarity with the ways that students commonly think *and talk* about science. • Focusing attention on students' scientific thinking so that it becomes central to their teaching. • Clear understanding of what is important for students to know about the content and how they might express that (verbally, demonstration, in writing). • Articulating what makes the learning of science content tricky or difficult for students, including common student conceptions and the inherent ambiguities in science and how they are expressed.	Classroom environment and events move towards the following goals: • Instruction and assessment elicit student thinking and build on student understanding (for example, regardless of accuracy, students share their own ideas about science concepts). • Instruction and assessment deal directly with what is tricky or difficult about the science concepts themselves and in relation to literacy.	Students grow towards having a(n): • Clear understanding of what it means to conduct inquiry science. • Ability to use culturally- and/or linguistically-based resources they bring to the understanding of scientific phenomena (e.g., cultural stories about science). • Ability and confidence to explain their thinking. • Awareness of their own and others' logic. • Greater confidence and ability to demonstrate their understanding in different ways (verbally, in writing,

• A belief that there is usually logic to students' ideas (even when they are not entirely accurate). • Knowing what a range of student understanding looks like. • Rich and accurate understanding of language and literacy demands related to developing and displaying student thinking.	• Curriculum, instruction, and assessment are geared toward making student and reasoning understanding explicit. [what?? I don't follow this] • Curriculum addresses what is important for student to know about the content.	drawing, demonstrating). • Understanding that science is a dynamic process of experimentation and testing, and that 'wrong answers' can be sources of information. • Greater ability to make predictions, claims, and interpretations.

Understanding Science **CRITICAL FEATURE:**	4. **Critical Analysis of Practice**. Teachers analyze the instructional practices, activities, materials and/or scientific representations in each case with respect to curriculum, instruction, and assessment as well as literacy.
GUIDING QUESTIONS:	• What is the impact of the teacher's instruction on student learning? (Consider science content and literacy.) • To what extent does the instruction support student understanding of these concepts (in relation to symbolic, graphic, and abstract meaning)? • What is the relationship between the teacher's instructional goals, tasks, and assessments? To what extent are they aligned? • How do different assessment strategies and tasks reveal students' conceptual understanding? • To what extent do the curriculum, the assessment, and the teacher's instruction represent a coherent sequence of events? How does literacy support this? • What are specific ways of representing and formulating the difficult science concepts to make them comprehensible to students?

OUTCOMES

TEACHER	**CLASSROOM**	**STUDENTS**
Teachers' analysis of practice moves toward the following: • Analytical, complex, and detailed pedagogical reasoning. • Careful selection and implementation of new instructional practices, activities, and materials that better support student learning and address particular student conceptual and literacy-related difficulties. • Analysis of the language production demands and language development opportunities presented in instructional and assessment activities. • Deep, ongoing reflection about their instructional practices, activities, and materials. Deliberate planning	Classroom environment and events move towards the following goals: • Instructional practices and materials effectively illustrate, communicate, and develop the meaning of science concepts and literacy. • Instructional decisions are based on explicit learning objectives and adjusted as a result of ongoing analysis of student understanding. • Particular student conceptual difficulties are addressed in multiple ways (e.g., diagrams, graphs, tables, writing) and on multiple levels (e.g., graphic, symbolic, and abstract). • CIA are aligned with core science concepts. • CIA represent a coherent sequence of instruction.	Students grow towards having a(n): • Increased confidence in their ability to conduct science inquiry and its associated literacy practices. • Increased stamina for engaging in complex, academic science inquiry and the associated literacy practices.

to address the alignment of content, instruction, and assessment (CIA); instructional coherence; and particular student difficulties.	• CIA deal directly with what is tricky or difficult about the science concepts and literacy demands.	