classroom discourse.
Scientific curiosity includes asking questions, a desire for knowledge, and the commitment that natural curiosity about the natural world. Scientific and engineering practices are expressions of disciplined curiosity.

Effective and authentic science education should therefore reflect student ideas and what are the effects on classroom discourse?

Student thinking:

Scientific curiosity:

Scientific curiosity: A framework was developed that draws on

Teacher 33 – the two activities were not conceptually connected

What are the effects on classroom discourse?

Student thinking: returning to previous student ideas

Scientific curiosity: purpose of activity

Scientific curiosity: evidence & authority

Level 1

School science (hands-on)

Teacher or curriculum materials as authority

Scientific curiosity: evidence & authority

Collecting data, identifying patterns, or making guesses without explicit links to the question or claim

Level 2

Level 3

Confirmation of science facts and theories

Student thinking: responsiveness to student ideas

Level 1

Scientific curiosity: purpose of activity

Answering questions or determining hidden mechanisms

Level 2

Collecting data, identifying patterns, or making guesses without explicit links to the question or claim

Scientific curiosity: evidence & authority

Directly linking physical evidence to predictions or claims

Video examples for teachers’ responses to students’ questions

Object of curiosity

Student thinking:

Scientific curiosity: purpose of activity

Answering questions or determining hidden mechanisms

Scientific curiosity: evidence & authority

Involve students in developing or "problematizing" the procedures

Scientific curiosity & student thinking; questions

Scaffolding curiosity: teacher’s response encourages scientific sense-making (principles, hypotheses, etc.)

Validating curiosity: teacher’s response indicates question is worthy or interesting but not followed up on

Scientific curiosity & student thinking; questions

L1: No reference to why the investigation was being conducted.

Scientific curiosity: evidence & authority

Starts students' ideas

L2: Scaffolds students' predictions by linking their initial ideas to the procedure (i.e. BTB won’t change color if the ethanol is evaporating).

L3: Frames activity as a chance to "apply knowledge [from soda water faking investigation] to a more complex scenario... what happens when ethanol burns."

Teacher 12: "Off script" 60 times – probing often focused on distinguishing between matter & energy or "what do you mean by...?"

Teacher 33: Three discourse levels are proposed, with one representing the lowest

A COMPARISON OF PRACTICE

A classroom with high learning gains and a classroom with low learning gains were selected to systematically compare using this framework.

Enactment of the ethanol burning investigation:

Teacher 12 – scaffolding students in applying observations from the investigation to determine the reactants and products of the

Teacher 33 – students’ ideas involving the students (and

Doesn’t return to previous ideas or references previous ideas without any connections

Teacher 3: goes "off script" 60 times – probing often focused on distinguishing between matter & energy or "what do you mean by...?"

Teacher 12: "Off script" 60 times – probing often focused on distinguishing between matter & energy or "what do you mean by...?"

Teacher 33 – the two activities were not conceptually connected

Scientific curiosity: purpose of activity

Learning gains indicated differences in classroom discourse. Previous analysis of clinical interviews of students conducted by Carbon TIME teachers indicated differences in their curiosity about student thinking. Student assessment data indicated differences in learning gains between classrooms. These patterns lead to the following questions:

1. How do Carbon TIME teachers represent scientific curiosity in the classroom and encourage and scaffold students’ scientific curiosity? 2. How do teachers differ in their expression of curiosity about student thinking, and what are the effects on classroom discourse? 3. To what extent are teachers’ curiosity practices in the clinical interviews reflective of their classroom teaching practices?

DATA SOURCES AND METHODS

Data sources: Videos of 13 teachers implementing Carbon TIME activities in their classrooms & transcripts of the clinical interviews they conducted with students.

Methods: A grounded theory approach to coding was used.

1. Initial open coding – described two objects of teachers’ curiosity
2. Constant comparative analysis – attributes for each category
3. Intermediate coding – values (tentative discourse levels)

A framework was developed that draws on Zuss’ association of curiosity with communities of practice and Inan’s characterization of curiosity as a linguistic skill to conceptualize the curiosity practices represented in classroom discourse.

Level 3: Student: "If you use a heat lamp would that be the same as the sun?" Teacher 24 responds "Perfect question. Is it the light or the heat that might be the energy source. How could you test that?" Discuss experiment to test light vs. heat as energy source for plant growth.

Level 2: During procedural instructions student asks if BTB will burn. Teacher 39 tells them no because it is water based, but later allows them to test this for themselves. Students report to teacher "you were right." No conceptual connections to organic/inorganic or sense-making is supported.

Level 1: Student asks if giving a plant sugar water will help it grow. Teacher 11 explains it is too large to enter cells. Other students suggest spraying it on leaves or using powdered sugar. Teacher says "Thanks for playing" but the plant will just have to feed itself through photosynthesis and moves on.

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INTRODUCTION & RESEARCH QUESTIONS

Classroom discourse is co-created by teachers and students. Teachers play prominent roles due to their positions of authority, but the drive to master scientific knowledge and practices must ultimately come from the students themselves. Rigorous and responsive teaching as well as learning for understanding are supported by disciplined curiosity.

Scientific and engineering practices are expressions of disciplined curiosity about the natural world. Scientific curiosity includes asking questions, a desire for knowledge, and the commitment that natural phenomena are explainable using scientific principles and models. Effective and authentic science education should therefore reflect scientific curiosity.

Formative assessment and responsiveness to students’ ideas require another kind of disciplined curiosity: curiosity about student thinking. Previous analysis of clinical interviews of students conducted by Carbon TIME teachers suggested differences in their curiosity about student thinking. Student assessment data indicated differences in learning gains between classrooms. These patterns lead to the following questions:

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The Role of Scientific Curiosity and Curiosity about Student Thinking in Classroom Discourse

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