Transitioning to NGSS

What STEAM really means..

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Sessions Goals

- Three dimensions
- Introduce the practices
- Creating discourse and using multiple resources.
- Understand the 5 E Model

MS.Chemical Reactions

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Students who demonstrate understanding can:

MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. [Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]

MS-PS1-5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. [Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.]

MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.* [Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.] [Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education:*

Science and Engineering Practices

Developing and Using Models
Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop a model to describe unobservable mechanisms. (MS-PS1-5)

Analyzing and Interpreting Data
Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
- Analyze and interpret data to determine similarities and differences in findings. (MS-PS1-2)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. (MS-PS1-6)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence
- Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS1-2)

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- Laws are regularities or mathematical descriptions of natural phenomena. (MS-PS1-5)

Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter
- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2) *(Note: This Disciplinary Core Idea is also addressed by MS-PS1-3.)*

PS1.B: Chemical Reactions
- Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2),(MS-PS1-5) *(Note: This Disciplinary Core Idea is also addressed by MS-PS1-3.)*
- The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5)
- Some chemical reactions release energy, others store energy. (MS-PS1-6)

ETS1.B: Developing Possible Solutions
- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. *(secondary to MS-PS1-6)*

ETS1.C: Optimizing the Design Solution
- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. *(secondary to MS-PS1-6)*
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. *(secondary to MS-PS1-6)*

Crosscutting Concepts

Patterns
- Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2)

Energy and Matter
- Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5)
- The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6)

Connections to other DCIs in this grade-band: **MS.PS3.D** (MS-PS1-2),(MS-PS1-6); **MS.LS1.C** (MS-PS1-2),(MS-PS1-5); **MS.LS2.B** (MS-PS1-5); **MS.ESS2.A** (MS-PS1-2),(MS-PS1-5)

Articulation across grade-bands: **5.PS1.B** (MS-PS1-2),(MS-PS1-5); **HS.PS1.A** (MS-PS1-6); **HS.PS1.B** (MS-PS1-2)(MS-PS1-5),(MS-PS1-6); **HS.PS3.A** (MS-PS1-6); **HS.PS3.B** (MS-PS1-6); **HS.PS3.D** (MS-PS1-6)

Common Core State Standards Connections:

ELA/Literacy –

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions *(MS-PS1-2)*
RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS1-6)
RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS1-2),*(MS-PS1-5)*
WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS1-6)

Mathematics –

MP.2	Reason abstractly and quantitatively. (MS-PS1-2),(MS-PS1-5)
MP.4	Model with mathematics. (MS-PS1-5)
6.RP.A.3	Use ratio and rate reasoning to solve real-world and mathematical problems. *(MS-PS1-2)*,(MS-PS1-5)
6.SP.B.4	Display numerical data in plots on a number line, including dot plots, histograms, and box plots. *(MS-PS1-2)*
6.SP.B.5	Summarize numerical data sets in relation to their context (MS-PS1-2)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.
The section entitled "Disciplinary Core Ideas" is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.

Grade Level/Band & Title

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Performance Expectations Describe student knowledge after instruction.

Foundation Boxes list the SEP's, DCI's and XCC's aligned with the PE's

Top Connections Box: Assists development sequence. Provides articulation of DCI"s

Bottom Connection Box: Common Corfe Standards either previous or concurrent to instruction.

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Three Dimensions Intertwined

Disciplinary Core Ideas

Science & Engineering Practices

Crosscutting Concepts

Lessons must have all three dimensions

NGSS will require contextual application of the 3 dimensions by students.

Focus is on how and why as well as what.

Coordinated Practices

- Students learn science best by engaging in the practices of science.
- Classrooms can productively be considered scientific communities, where students engage in sustained investigations involving a full set of coordinated practices.

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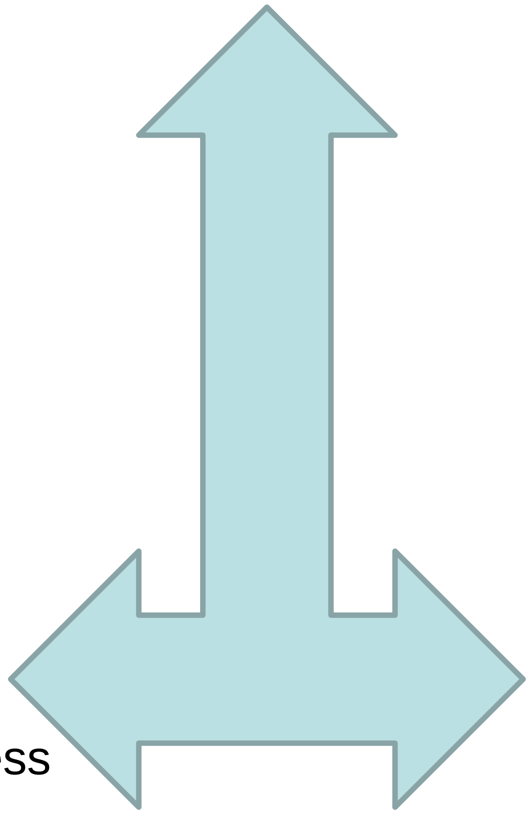
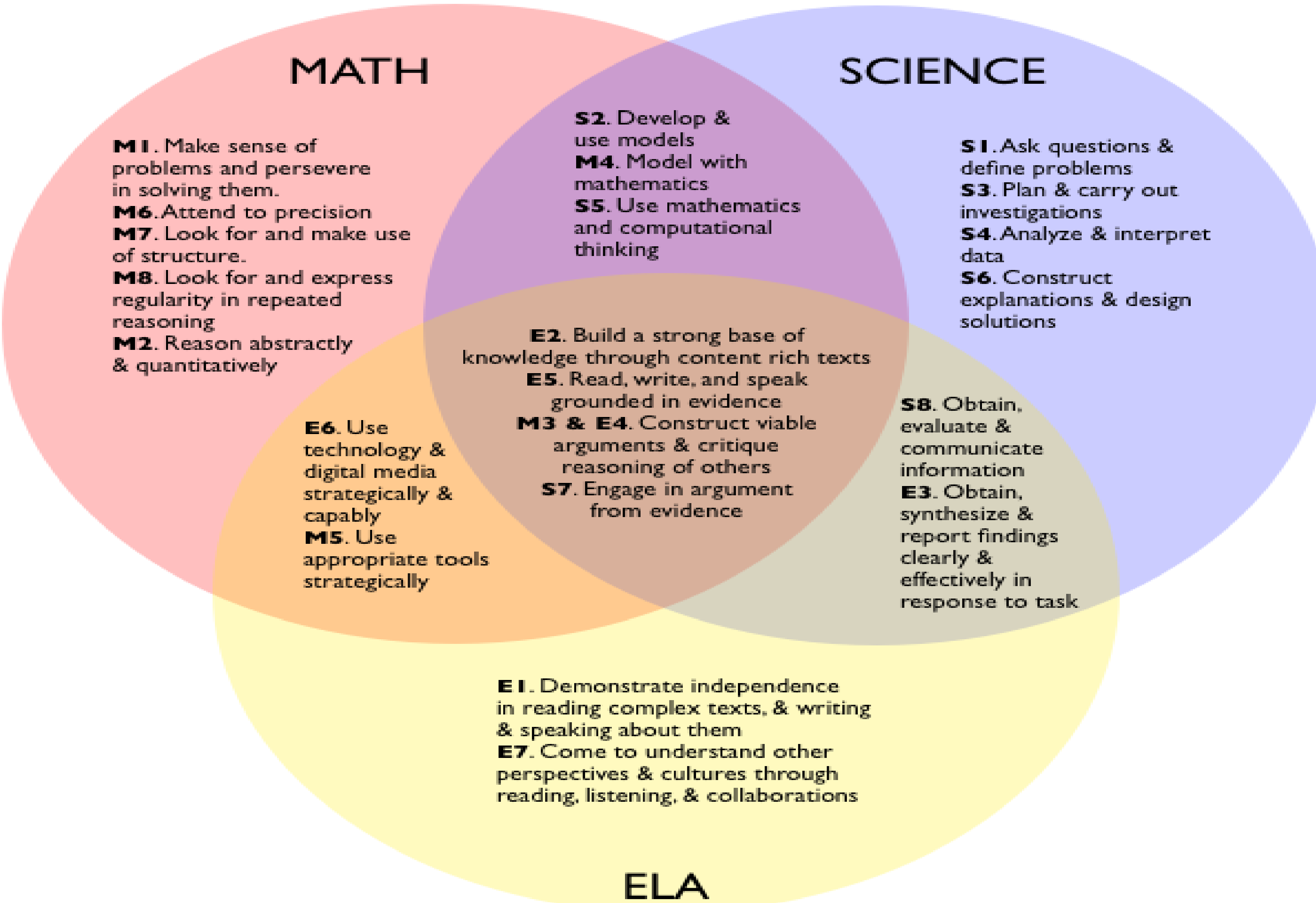
Math, Science, ELA and SS

- Most people think:



- Successful people know:

Practice Commonalities



Taking it into the classroom

- Instructors need to help make the scientific investigation meaningful, not rote steps.
- Create a need for the investigation through rich questions applied to phenomena.
- Engage cooperation.
- Instructors need to support multiple aspects of doing the work.
- Supporting social interactions that help get the work done.
- Supporting discourse in communicating to get the work done.

Practice 1: Asking Questions (Science) and Defining Problems (Engineering)

Questions are the engine that drive science and engineering. Asking scientific questions is essential to developing scientific habits of mind. It is a basic element of scientific literacy.

Science education should develop students' ability to ask well-formulated questions that can be investigated empirically.

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Practice 2: Developing and Using Models

Scientists and engineers construct conceptual and mental models of phenomena. Conceptual models are explicit representations that are in some ways analogous to the phenomena they represent. They include diagrams, physical replicas, math representations, analogies, and computer simulations / models.

Students should represent and explain phenomena using multiple kinds of models, learn to use modeling tools, and come to understand the limitations and level of precision of particular models. Always comparing the limitation of the model to the system in the natural world.

Interpreting can mean all the difference

- Teachers, coaches and principals' interpretations of the standards shape classroom practices. Spillane, et al, 2006

Using mathematics and computational thinking (MCC) Developing explanations (science) and designing solutions (engineering)

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- Through out the NGSS there is deliberate Math and ELA Common Core alignment.
- Once the investigation has taken place, the students will look at lots of data, will seek out more, and will begin to form conclusions, but will NOT YET have assembled all their ideas into arguments.
- Designing solutions from the data and research.

Engaging in argument (ELACC)
Obtaining, evaluating, and communicating information (ELACC)

- Supporting claims with evidence.
- Developing chains of cause and effect with multiple steps.
- Comparing alternative possible explanations.
- Using other students' critiques to clarify explanations (instructor can help…)

5 E's Model

Engage: activities capture the students attention, connect their thinking to the situation, and help them access current knowledge.

Exploration: Students investigate initial ideas and solutions in meaningful contexts.

Explanation: Based on an analysis of the exploration, students develop an explanation for the concept and practices. Their understanding is clarified and modified through the teacher's descriptions and definitions. Additional reading.

Elaboration: Students have opportunity to expand and apply their understanding of the concepts within new context and situations, real world application.

Evaluation: Students assess their understanding of the concepts, and teachers have the opportunity to assess student learning.

How does a seed become a full sized plant?

Where does the additional matter come from?

How is the energy from the sun used by the plant?

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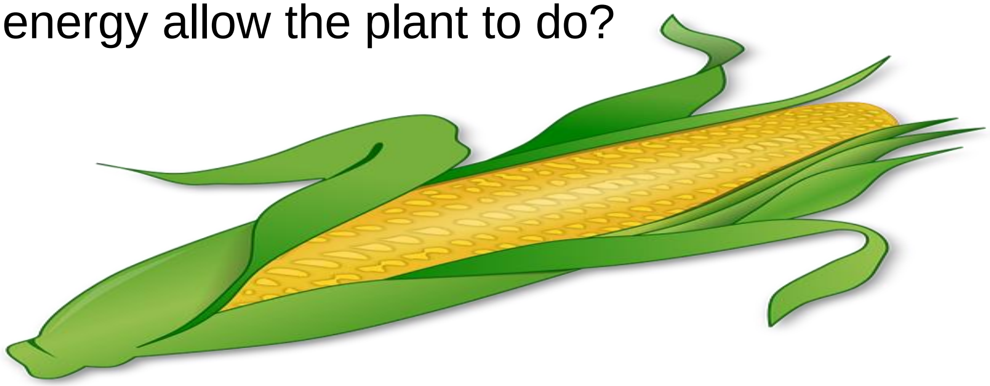
Engage

Examine the corn kernel. Only water has been provided.

With a partner, discuss surrounding the phenomena of a seed developing into
A full sized corn plant.

Where does the additional matter come from?
What are the needs of plants?
What does light energy allow the plant to do?



5 E Format based on the work of Bybee (BSCS)
*Translating the NGSS for Classroom Instruction (*NSTA Press, 2013)

Explore

Students are provided with materials to explore their own ideas:
Aquatic plants, indicator that shows presence of CO_2 in water,
Test tubes, stoppers, variety of light conditions.

In groups, students develop a question to test and a method to gather
Data that will provide an answer.
Students predict the outcome.
1. Fill in 6 tubes with an equal amount of yellow Bromothymol blue.
Put a stock of elodea in 5 of the 6 tubes.
2. Put the test tube with no elodea out in the
Classroom light. Put 4 under ultra violet light and
One in the dark.
Hypothesize regarding the color of the Bromothymol blue.
I think the BB elodea in the dark will turn back blue.
Next day, see color of yellow BB in test tube with
No elodea, with elodea, and in the dark.

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Explain

Students observe the results of their test.

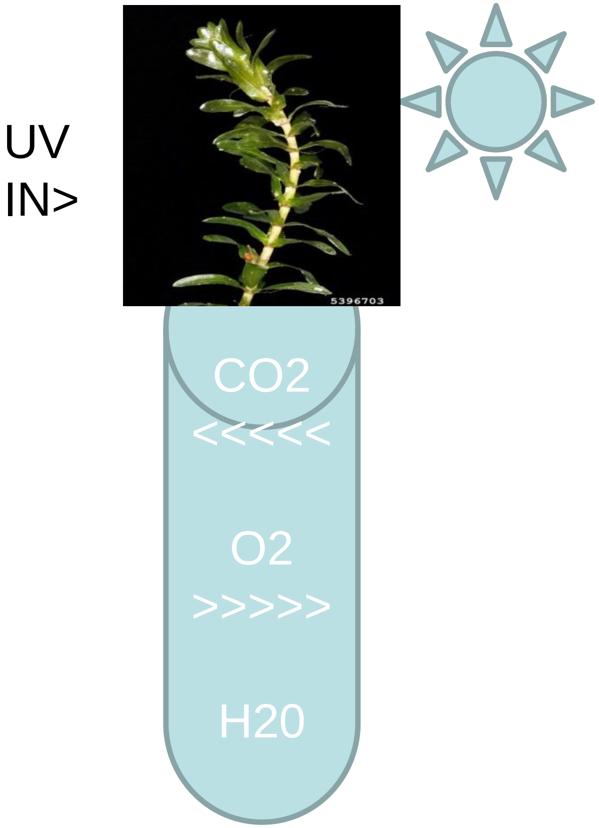
Using evidence from the results, students develop an explanation of what happened.

Groups extend their research by digging deeper into text to support or disprove their hypothesis.

The investigation findings and the text are combined by groups. Groups share Out their claims with supporting evidence.

Their idea is drawn in a model to make their understanding of the matter and Energy inputs/outputs visible.

Students record other questions about the phenomena that may develop.



Elaborate

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To understand the process of photosynthesis, students access resources that provide explanations.

Students watch a 4 minute Ted Ed Video of how photosynthesis allows plants To make molecules from substances in their environment.

Students use an online simulation of photosynthesis to further test and support their findings.

What if I reduce amount of water?
What if I increase mount of water?

Set up experiments testing the variables outside in the garden using natural settings, i.e.: shade, amount of water, air (can plant many seeds in small area to prove they need space… etc.

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Evaluate

CLAIMS	EVIDENCE

Claim: a statement believed to be true; Should answer a question or explain an idea.

Evidence: the data that proves or disproves your claim.
This can be quantitative or qualitative that you observe or gather from a reliable source.

Begin with: This focus was about:
My claim was:
I did the following activities:
My evidence is:
I learned:
I still wonder:

Was that 5 E lesson aligned?

PE: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

SEP
Construct Explanations and Design Solutions

DCI
Matter and Energy Flow In organisms

Energy in Chemical Process and Everyday life

XCC
Energy and Matter

Compared to old photosynthesis lesson

Assign reading and complete questions.

Teacher reviews process and explains input and output

Teacher directs students to memorize terms, etc.

Students complete a scripted lab activity to view the process occurring and collect data.

Give summative assessment that focus on recall and some explanations of what the process showed, why it is important.

Shifts

How will science education change with the NGSS?

Implications of the Vision of the Framework for K-12 Science Education and the Next Generation Science Standards

SCIENCE EDUCATION WILL INVOLVE LESS:	SCIENCE EDUCATION WILL INVOLVE MORE:
Rote memorization of facts and terminology	Facts and terminology learned as needed while developing explanations and designing solutions supported by evidence-based arguments and reasoning.
Learning of ideas disconnected from questions about phenomena	Systems thinking and modeling to explain phenomena and to give a context for the ideas to be learned
Teachers providing information to the whole class	Students conducting investigations, solving problems, and engaging in discussions with teachers' guidance
Teachers posing questions with only one right answer	Students discussing open-ended questions that focus on the strength of the evidence used to generate claims

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Questions/ Comments