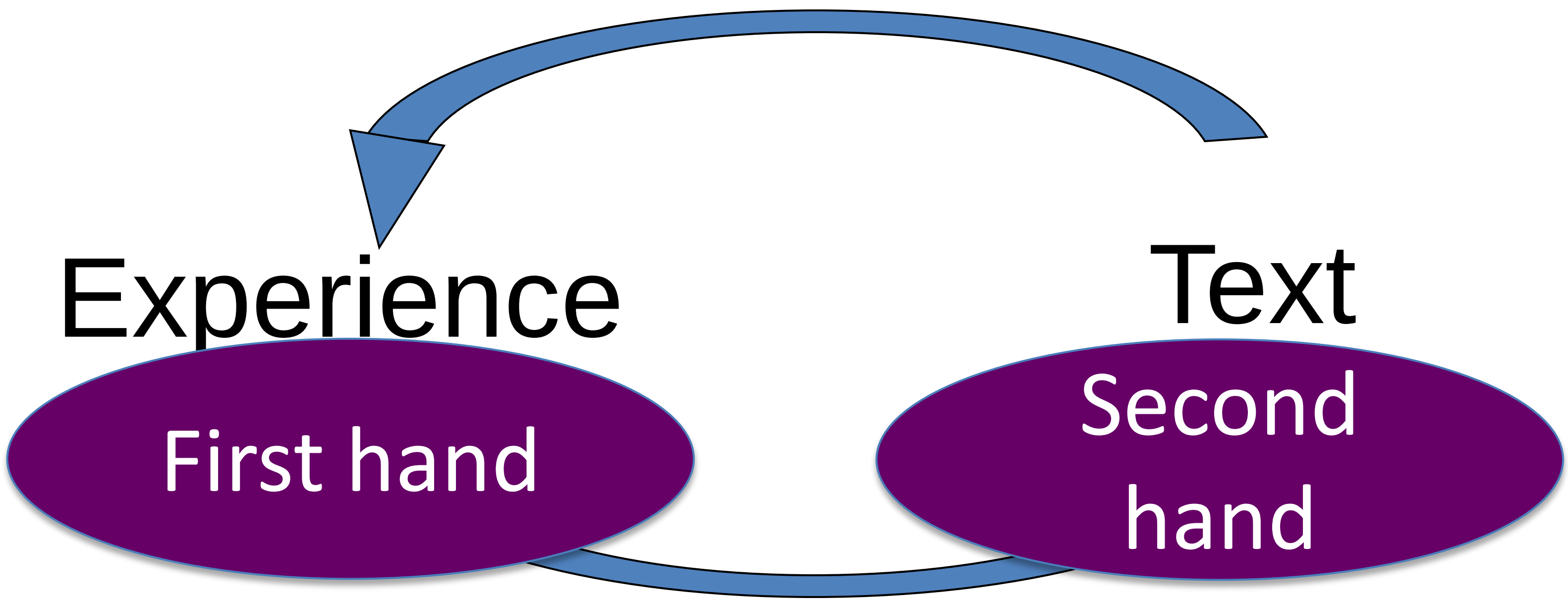
Literacy and Language for Science

P. David Pearson
UC Berkeley

Guiding Principle 1: Engage students in firsthand and secondhand investigations to make sense of the natural world.



How to prevent text from undermining inquiry…

- Make reading and writing inherent acts of inquiry
- Authentic purposes for reading…

Authenticity in Science: Why scientists read…

Provide Context	Scientists read to situate research
Deliver Content	Scientists read to acquire new knowledge
Modeling	Scientists replicate others' procedures and experiments
Supporting Second-hand Investigations	Scientists read and interpret others' data and findings
Supporting Firsthand Investigations	Scientists use reference materials to guide their inquiry

Guiding Principle 2:
Engage students through multiple learning modalities

Fully integrated approaches

Inquiry-Only Approaches		Text-Only Approaches
	Do It	
	Talk It	
Hands-On Ex	**Read It**	Reading
Discussior	**Write It**	Writing

First hand supports second hand supports first hand supports…

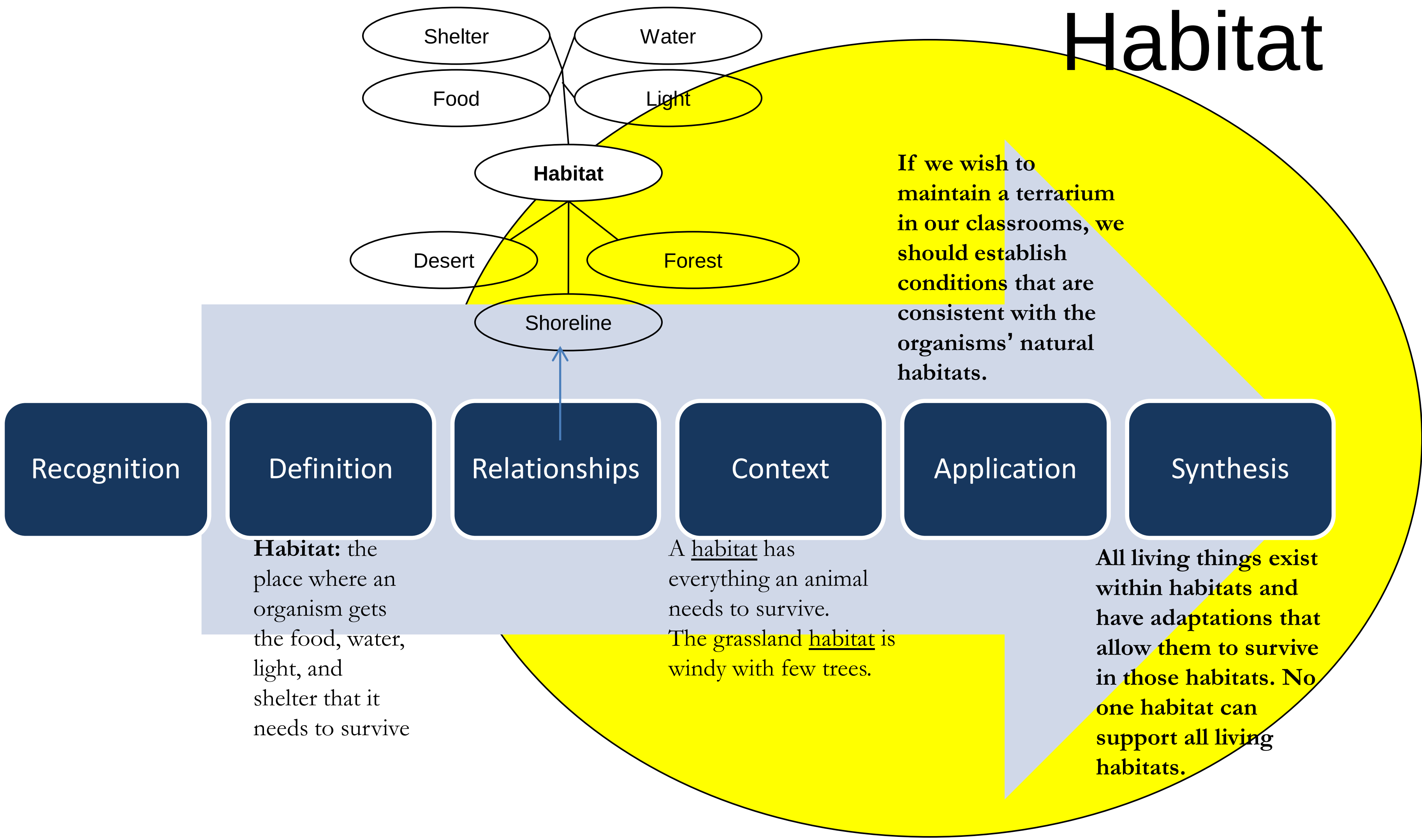
- Typical progression in a topical unit:
  - Read-Discuss-Investigate-Discuss-Investigate-Write-Investigate-Read-Discuss and Write
- Whatever comes second benefits from what came first…

Guiding Principle 3: Capitalize on Synergies Between Science and Literacy

Synergy 1: Words ARE Concepts

- Learning the academic language of science means forming rich conceptual networks of words and the ideas they represent
- Word knowledge at its most mature is conceptual knowledge
- Words are labels for concepts and ideas
- Excellent vocabulary instruction is nearly indistinguishable from excellent instruction for concept development

Words are Concepts



Vocabulary as conceptual networks Vocabulary as labels for our knowledge

decomposers are organisms that live in the soil and breakdown dead organisms

plants are organisms that live in the soil

organisms are living
ch as plants
als

decom
nutrier

is where
ism lives
what it
survive

most roots
in the soil w
absorb nutr

ns are
and
that help an
animal survive

You acquire new vocabulary as the natural by-product of acquiring new knowledge.

of a structure which is an adaptation

structures

behaviors

Teaching Words as Concepts

- Repeated opportunities for exposure and practice
- Teach words as networks of related concepts
- Teach words through text, talk, and experience

Write it

Do it

Read it

Talk it

Synergy 3: Science is a Discourse

- Science is all about language…but language is more than words. Science is a discourse involving ways of talking, writing, knowing, and being.
- Learning science includes learning the ways that scientists describe, explain, predict, synthesize, and argue
- Ways of communicating in science are different from those of everyday life

Astronomy is not the sun, moon and stars; it is a way of talking about the sun, moon and stars. Paul Goodman, early 1970s.

Teaching the Language of Science

- Instead of avoiding scientific terminology and register in classrooms, we embrace it
- Using science terminology in investigating, reading, discussing, and writing about science -- because this is what scientists do
- Learning the language of argumentation by comprehending, critiquing, and constructing oral and written arguments

Mutual Embeddedness

- We fully embed language and literacy practices in the service of acquiring knowledge and inquiry in science
- We fully embed science content and practices in the service of enhancing the inquiry skills of literacy…
- Reading, writing, and oral language are always about reading and writing something in particular…

Beyond Literacy as Reading and Writing

Sarah Michaels
Clark University
NRC Literacy for Science Workshop
Dec. 9, 2013

Literacy as Disciplined Reasoning

through text and talk

Each of these new standards documents – the Common Core and NGSS – emphasizes a core set of disciplinary practices.

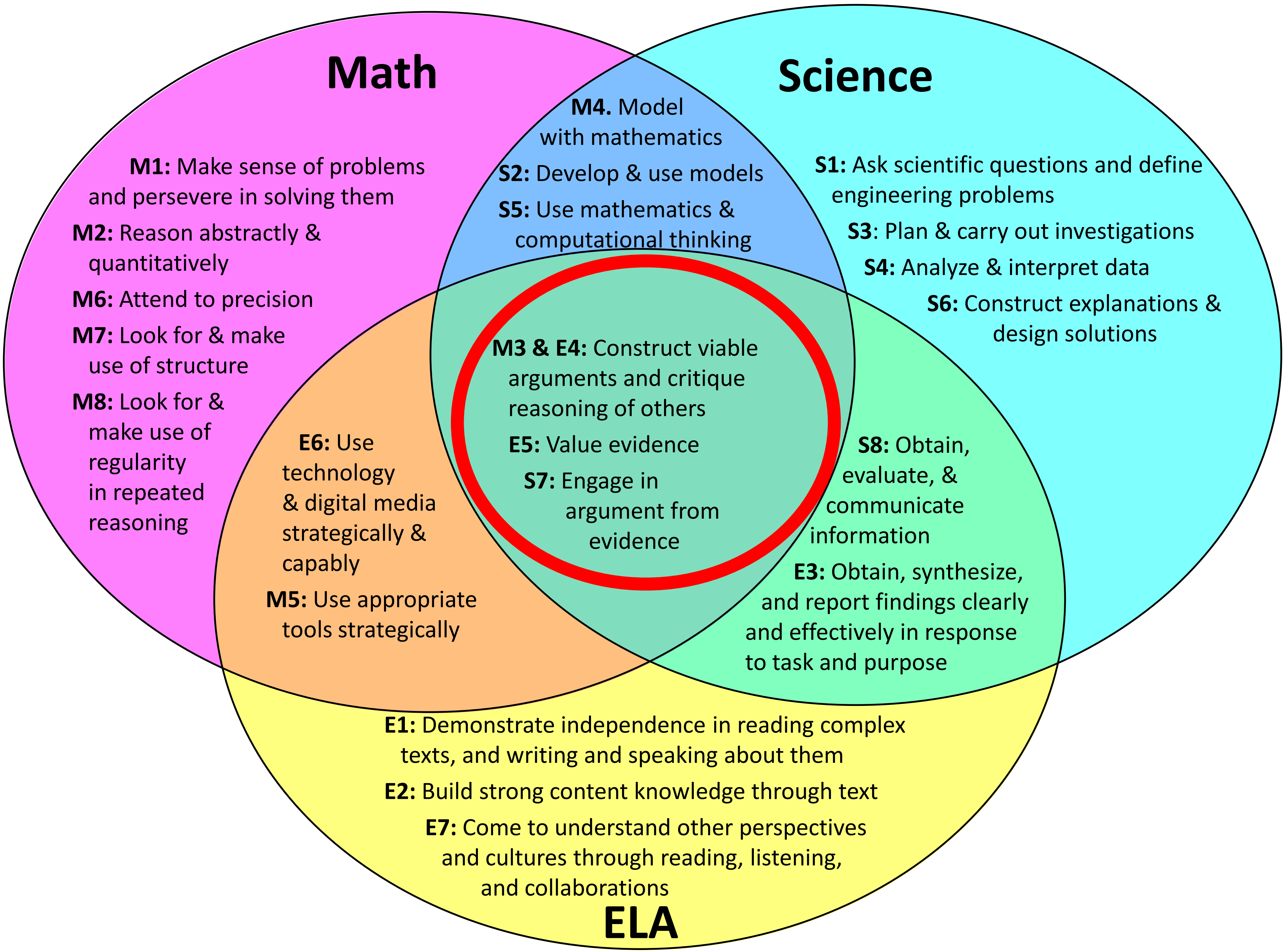
The "Practice" Turn

An Examination of “Practices”

Science and Engineering Practices

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics, information and computer technology, and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Practices in Different Disciplines		
Math	**Science**	**English Language Arts**
M1. Make sense of problems and persevere in solving them. M2. Reason abstractly and quantitatively. M3. Construct viable arguments and critique the reasoning of others. M4. Model with mathematics. M5. Use appropriate tools strategically. M6. Attend to precision. M7. Look for and make use of structure. M8. Look for and express regularity in repeated reasoning.	S1. Asking questions (for science) and defining problems (for engineering). S2. Developing and using models. S3. Planning and carrying out investigations. S4. Analyzing and interpreting data. S5. Using mathematics, information and computer technology, and computational thinking. S6. Constructing explanations (for science) and designing solutions (for engineering). S7. Engaging in argument from evidence. S8. Obtaining, evaluating, and communicating information.	E1. They demonstrate independence. E2. They build strong content knowledge. E3. They respond to the varying demands of audience, task, purpose, and discipline. E4. They comprehend as well as critique. E5. They value evidence. E6. They use technology and digital media strategically and capably. E7. They come to understanding other perspectives and cultures.


Math
Science
ELA
M1: Make sense of problems and persevere in solving them
M2: Reason abstractly & quantitatively
M6: Attend to precision
M7: Look for & make use of structure
M8: Look for & make use of regularity in repeated reasoning
M4. Model with mathematics
S2: Develop & use models
S5: Use mathematics & computational thinking
S1: Ask scientific questions and define engineering problems
S3: Plan & carry out investigations
S4: Analyze & interpret data
S6: Construct explanations & design solutions
M3 & E4: Construct viable arguments and critique reasoning of others
E5: Value evidence
S7: Engage in argument from evidence
E6: Use technology & digital media strategically & capably
M5: Use appropriate tools strategically
S8: Obtain, evaluate, & communicate information
E3: Obtain, synthesize, and report findings clearly and effectively in response to task and purpose
E1: Demonstrate independence in reading complex texts, and writing and speaking about them
E2: Build strong content knowledge through text
E7: Come to understand other perspectives and cultures through reading, listening, and collaborations

At the core is:

- Value evidence
- Construct viable arguments
- Engage in argument from evidence
- Critique the reasoning of others

In order to learn HOW to *model*, or *analyze data*, or *use appropriate tools*,

students have to **participate** in these practices, with others,

primarily through talk, joint attention, and shared activity.

“Reasoning practices” have to be **enacted**, and for learners, most are enacted socially, through talk and writing.

“SOCIAL” does not just mean student-led group work.

Well-structured social interaction builds in time to think, read, and write —

as an individual and as a community —

making thinking public and available to each and every learner.

The challenge:

Building classroom cultures that support public reasoning;

Making thinking visible and available –

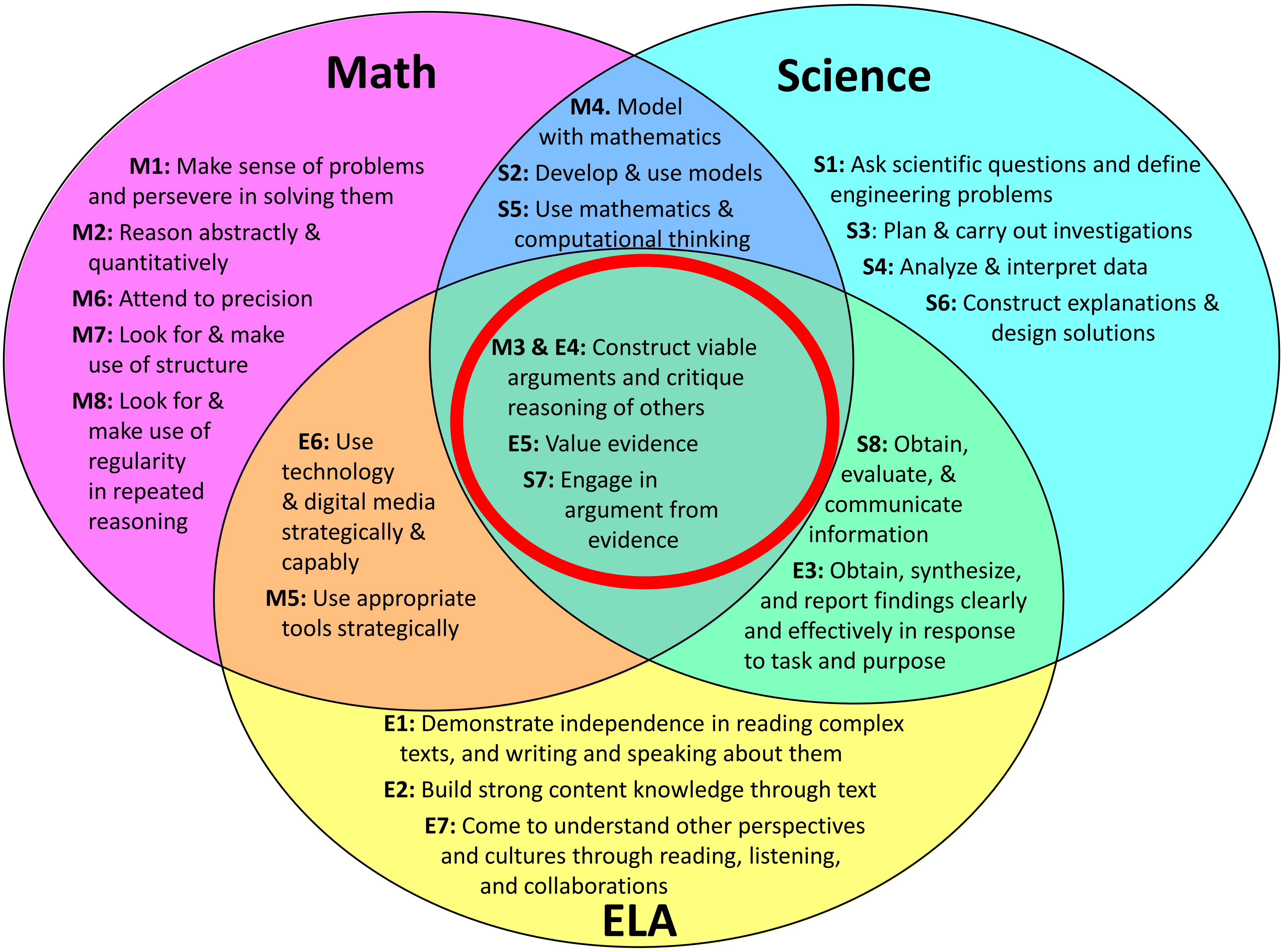
to self and others –

through language

(talk and text)

Bottom Line:

- Well-structured talk — discussion or guided, scaffolded reasoning talk — will have to become the new **foundation** for of all the “practices” in the Common Core and NGSS.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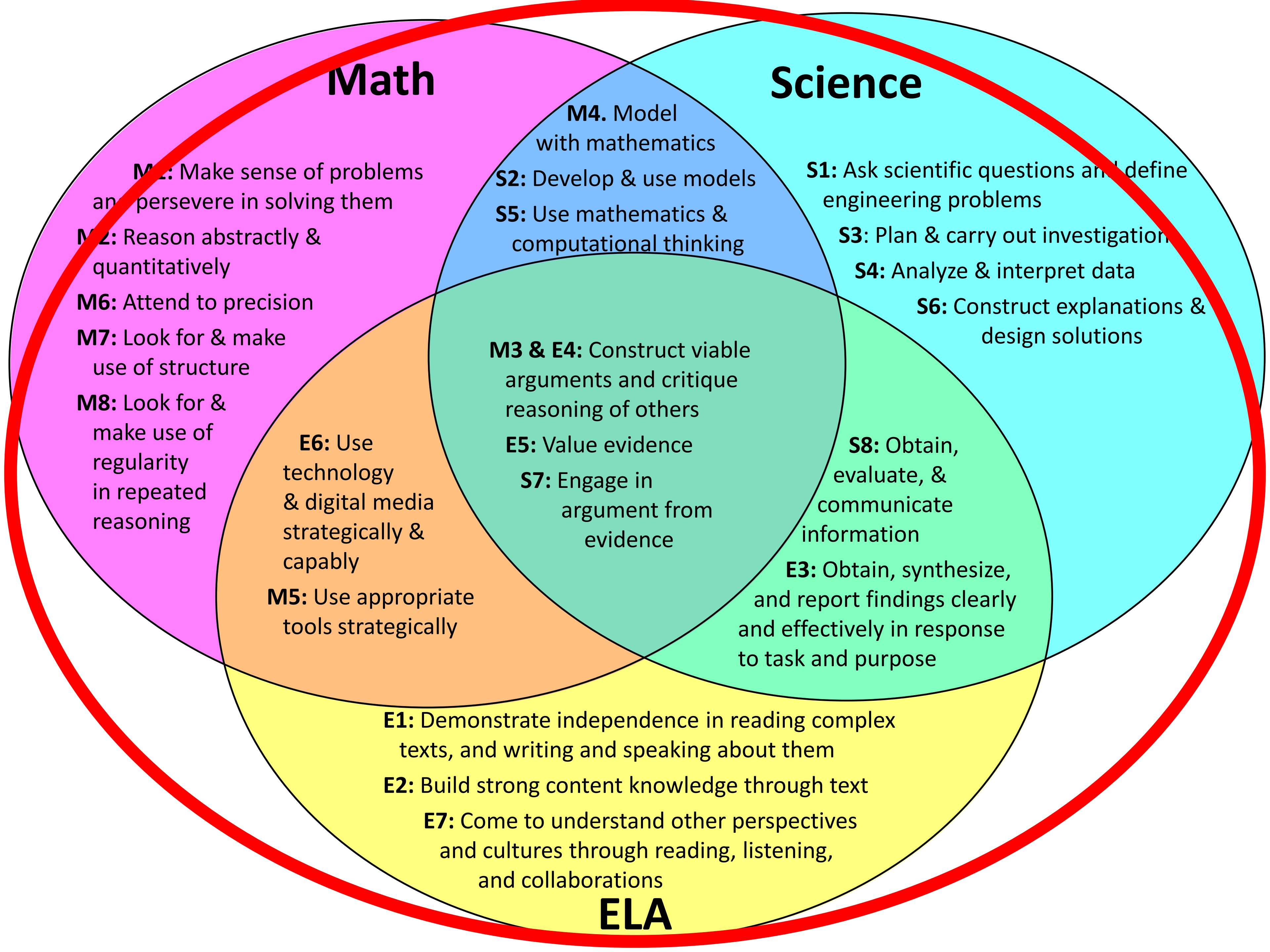
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This is not trivial.

This kind of “reasoning” discussion is not happening in most US classrooms.

Teachers tend to rely on recitation.

(Initiation – Response – Evaluation)

I-R-E

The problem:

The dominant form of talk in classrooms — recitation — does NOT support reasoning.

It does NOT support the building of arguments with evidence.

It does NOT support students to do the heavy lifting of explaining, critiquing, and building common ground.

Why has there been so little change?

We’ve failed to provide teachers with good professional learning opportunities around the complexities of orchestrating talk.

Most of the rules of thumb we’ve used have been at the wrong level.

In the past …

We’ve told teachers to:

- ask higher-order questions,
- use Bloom’s taxonomy,
- refrain from “known-answer” questions,
- step to the side and get the students to talk to one another.

It turns out that…

- None of these “rules of thumb” is at the right level for teachers — on the fly.
- What they need are moment-to-moment tools (talk moves) to help students extend their own reasoning, and to build on the thinking of others.

We have made significant progress in helping teachers orchestrate discussion and writing activities in the service of “making thinking visible” and available.

State-of-the-art PD with teachers:

Three elements:

1. A framework of shared goals for productive discussions, and a set of productive talk tools – talk moves and strategies – in the service of those goals.

State-of-the-art PD with teachers:

Three elements*:*

1. A framework of **shared goals** for thinking, and discussion **tools**

2. Challenging, coherent **content**

3. Collections of **classroom videos** with real teachers and students demonstrating extended talk in relevant content areas

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Focusing teachers on talk (in PD) is a “high-leverage” practice:

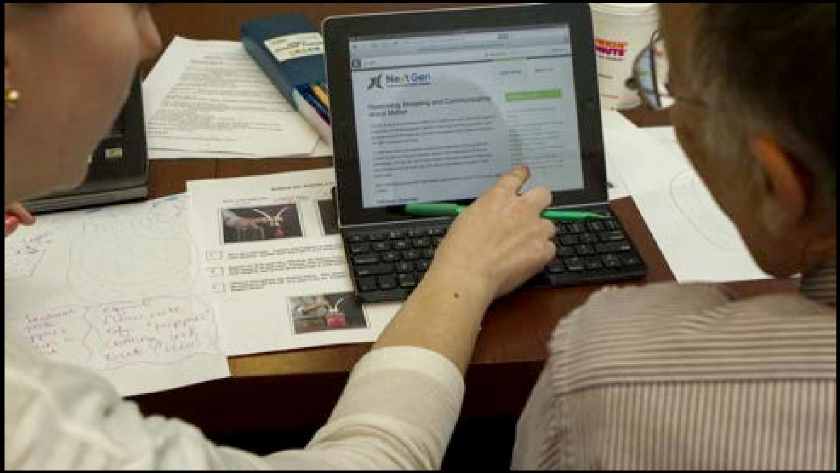
In order to facilitate a productive discussion, a teacher has to think deeply about:

- the disciplinary content,
- the learning goals and performance expectations of that particular lesson,
- the cognitive demands and affordances of the task or problem at hand, and
- their students as learners, what they know or might think they know, or might need to know.

It’s time to:

- join forces with our colleagues in other disciplines (who view literacy as reasoning);
- in helping teachers – across all subject domains – make the shift from recitation to reasoning.

Thank you!



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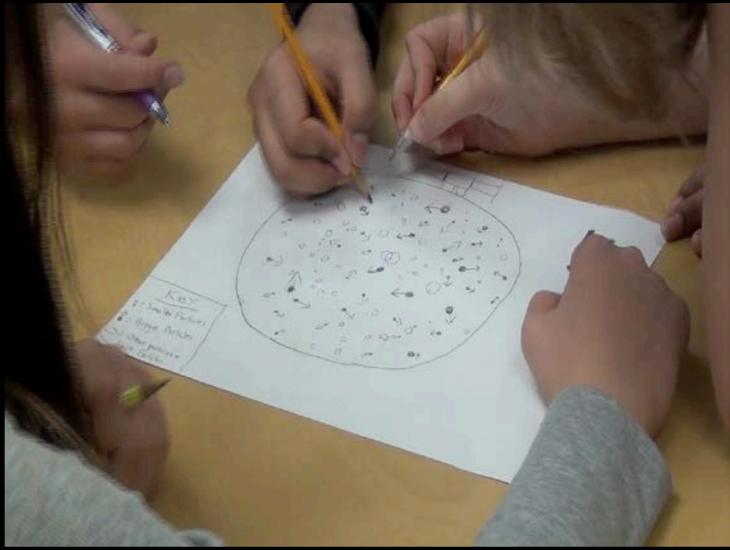

LANGUAGE & LITERACY FOR SCIENCE: THE TOOLS OF KNOWLEDGE PRODUCTION AND CRITIQUE

-or-

"There has been a change to your flight schedule, but don't worry . . . ."

Elizabeth Birr Moje

University of Michigan

December 8-9-10-???, 2013

LANGUAGE & LITERACY *FOR* SCIENCE

- The natural sciences are discourse communities or cultures, dependent on oral and written language for producing, communicating, and evaluating knowledge
- Learning science is as much about learning how to use the language of science—both oral and written—as it is about learning concepts
    - Concepts can only be rendered through language
    - Practices depend on language to come to life

MOJE, 2013

LANGUAGE & LITERACY *FOR* SCIENCE

- To teach language and literacy *for* science, students need to *do* scientific inquiry; otherwise the language tools will have no meaning, no purpose, no value
- Teaching and literacy tools and practices *for* scientific inquiry will teach tools of knowledge production and critique:
  - Able to ask, "Is that right?" "How do they know?" "What kind of study could produce such findings?"
  - Able to communicate their ideas and arguments about the world in sophisticated ways

MOJE, 2013

HOW DO WE TEACH LANGUAGE & LITERACY *FOR* SCIENCE?

- Engage in the *practices* for generating and communicating knowledge unique to and shared across a space (e.g., a discipline);
- Elicit and engineer necessary domain knowledge, skills, and practices for meaning making;
- Examine what words, phrases, and symbols mean in a given subject-area or discipline and the ways that people use language in the discipline;
- Evaluate why, when, and how these "ways" are useful; and why, when, how and they are *not* useful.

MOJE, 2013

Engage

IN THE PRACTICES OF THE DISCIPLINE

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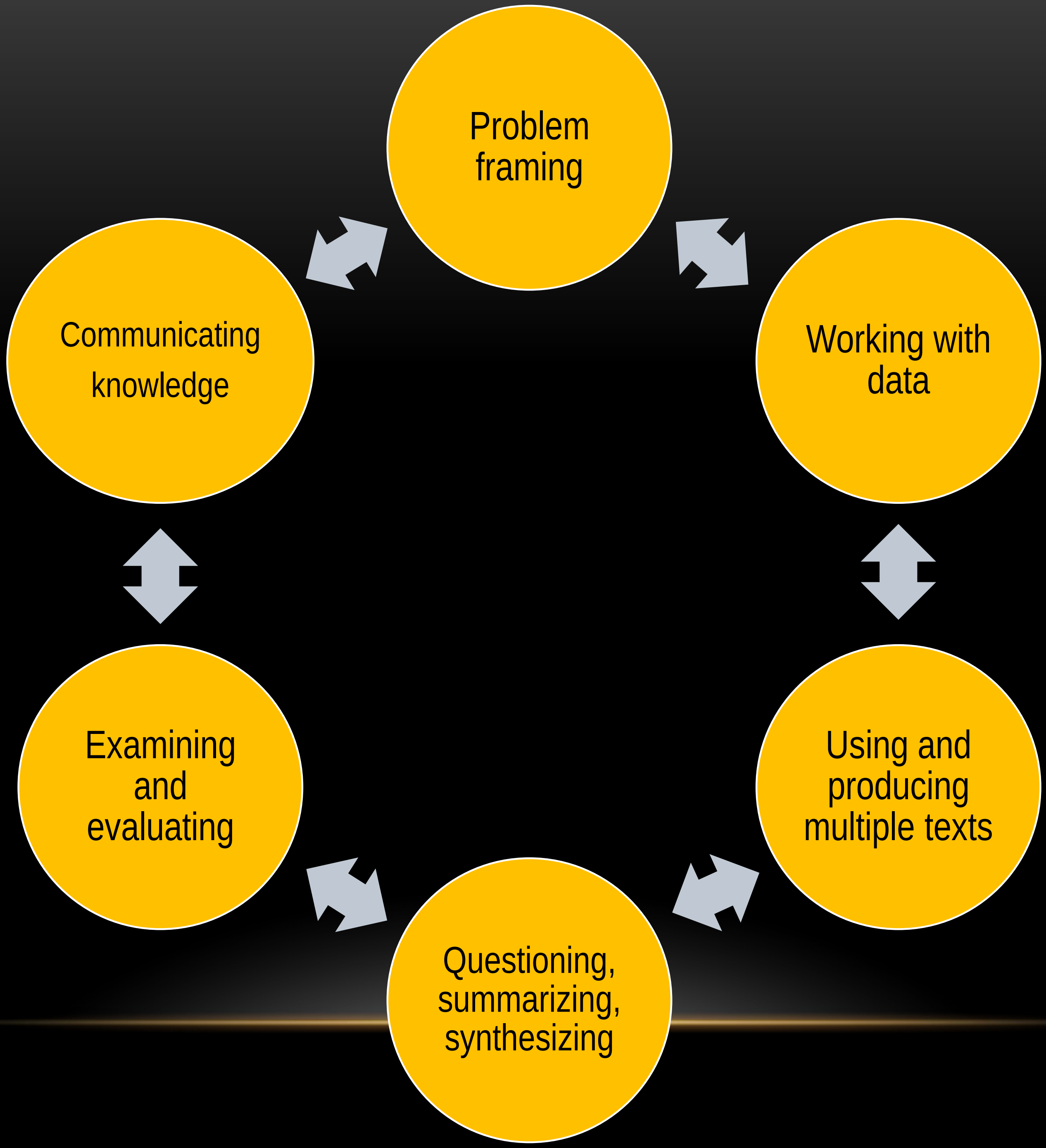
Problem framing
Working with data
Using and producing multiple texts
Questioning, summarizing, synthesizing
Examining and evaluating
Communicating knowledge

MOJE, 2013

Elicit and Engineer

NECESSARY KNOWLEDGE

MOJE, 2013

NECESSARY KNOWLEDGE

- Reading multiple texts often, closely, and critically *with students*
- Discussing and debating ideas in the texts, especially in relation to first-hard inquiry (see Magnusson & Palincsar)
- Questioning texts and others—engaging in community debate
- Analyzing data *together (scientists don't go it alone)*
- Writing to respond and analyze
- Reading others' writing and evaluating claims (a key practice in scientific inquiry)

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Examine

SCIENCE LANGUAGE AND PRACTICES

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DISCIPLINARY LANGUAGE

- Say, write, read, and define words and phrases
- Visualize words and phrases
- Discuss words and phrases
- Play with words and phrases
- Connect words and phrases to concepts

Evaluate

CLAIMS AND PRACTICES

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EVALUATE *CLAIMS AND PRACTICES*

- Explicit evaluation of differences in how claims and practices are rendered across disciplines and across daily life.
  - Close reading of each other's language (oral and written)
  - Museum walks and poster sessions
  - Expert visitors and conversations

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WHAT DOES THIS REQUIRE *OF TEACHERS*?

- Knowledge of *content concepts*
- Knowledge of *practices*
- *Knowledge of the texts* associated with producing that knowledge
- Time
  - Apprenticeship Process
  - Mentioning ≠ Learning

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WHAT DOES THIS REQUIRE *OF TEACHERS*?

- Skills and knowledge necessary to assess what students have learned about both content and literacy
- Knowledge of who children and youth are as people and how to teach them
  - Adolescent development
  - The roles of culture and social interaction in learning
  - Students' experiences, backgrounds, and uses of texts
  - Students' navigation across everyday and scientific discourse and learning communities

MOJE, 2013

IN SUM . . .

- Engage
- Elicit and Engineer
- Examine
- Evaluate
- Expect . . . Have high expectations, but also recognize that we must engage and support children and youth in learning literacy for science

THANK YOU!

FOR MORE INFORMATION AND ACCESS TO SOME PUBLISHED WORK:

WWW.UMICH.EDU\~MOJE

ADDITIONAL SLIDES TO SHOW IF EXAMPLES ARE NECESSARY

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EXAMINE LANGUAGE *AND PRACTICES*

- *Immune system overdrive responsible for cold symptoms* by Kate Melville
- The human rhinovirus (HRV) cops most of the blame for the sneezing and runny nose that we associate with the common cold, but in reality, it's not the virus but its ability to manipulate our genes that causes the most annoying cold symptoms. Now, for the first time, researchers have revealed how HRV hijacks our genes to trigger this overblown immune response, possibly opening the door for new therapeutic treatments for the common cold. "The study's findings are a major step toward more targeted cold prevention and treatment strategies while also serving as a valuable roadmap for the broader respiratory science community," the University of Calgary's David Proud, lead author of the study, told the American Journal of Respiratory and Critical Care Medicine.
- Source: American Thoracic Society, Procter & Gamble

CLAIMS AND PRACTICES

Historical argument

- Historical arguments are heavily data-based, but the data are not always apparent
  - Often a narrative structure
  - Only statistical data are offset in tables or graphs
  - Artifacts and narratives are woven into the larger argument
  - Footnotes
- *N.B.: Not true of all the social sciences, e.g., economics!*

Scientific argument

- Like historical arguments, natural scientific arguments are often data-based but the data may come in many forms:
  - Statistical/numerical, represented in tables and graphs
  - Models based on theoretical predictions
  - Observations recorded and tabulated over time

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