Revised Draft MA *Science & Technology/ Engineering Standards*

Bedford School Committee

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MASSACHUSETTS DEPARTMENT OF
ELEMENTARY AND SECONDARY
EDUCATION

Session Goals

- Overview of revised STE standards
- How Bedford is planning the transition
- A closer look at a standard
- The Science and Engineering Practices

Think-Pair-Share

- How does this:

Become this:

- Share with neighbor

Think-Pair-Share

- Did you cite…
  - Water
  - Soil
  - Minerals
  - Air
  - Carbon Dioxide

- Minds of Our Own (1997)
- Also check out A Private Universe (1987)

Annenberg Learner (www.learner.org)

Why is Science, Technology, and Engineering important?

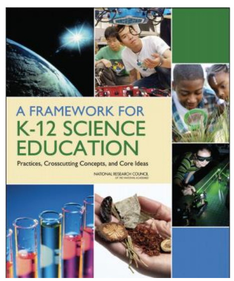
- Understanding science and engineering issues and decisions in our life
  - E.g., Our changing world: climate change; natural gas pipelines; renewable energy designs; weather challenges; inventing new technology to help mankind
- Readiness for the future!
- Note: *Science* **always** includes technology/engineering (Science = STE)

TOYOTA
South Carolina flooding: 18 dams breached,
CNN - 2 hours ago
Local firms show off drones and bots for law enforcement
The Big Unchill
The Arctic ice is melting faster than ever recorded, the warmth tied to the emissions of modern life. But it is the ancient ways at the top of the world that are most at risk.
EFFECT
How a 3-D-printer changed a 4-year-old's heart and life
Self-driving truck hits the highway in world first
Carbon credits
Sea-level rise
Dawn chorus decline
Car exhaust blamed

EEC Pre-K development

ESE State Revision Process

2009	2010	2011	2012	2013	2014	2015
Established Panel		Established NGSS Adv Group			Draft posted	Public comment



NEXT GENERATION SCIENCE STANDARDS

Public input

(and 100+ presentations & awareness sessions)

Why revise?

- Update the science
  - Last full set of standards developed in 2001
- Preparation for post-secondary success
  - STE contributes to college & career readiness (CCR)
  - Student preparation for STEM-focused jobs and postsecondary opportunities*
- Integration of practices with concepts
  - Necessary skills for CCR
  - Increases rigor of student expectations
  - Reinforces mathematics and literacy standards

2001/06 Massachusetts STE Curriculum Frameworks
(The State Perspective)

- Multi-grade strands that were inconsistent between districts or even schools
- Primarily content based - we presented the facts
- "Inquiry" was in the framework, taught separately and had many different meanings
- Passive Verbs – identify, recognize, give examples
- Minimal Engineering content
- Did not develop scientific reasoning-students are unable to make sense of the world around them

BEDFORD AHEAD OF THE CURVE

A BRIEF HISTORY OF SCIENCE IN BEDFORD SINCE 2001

- Curriculum revisions to incorporate writing and analysis skills
  - Content in context and applied by students
- Developed rubrics for incorporating science reports and critical thinking
- Developing emphasis on practices - students learn skills that could be transferred to other disciplines and provide a strong foundation for further studies.
- Early on – incorporated methods to have students demonstrate understanding of concepts and applications (Inquiry part of all units – not it's own unit)
- Incorporated Engineering Process Course, Robotics, Upgraded Drafting to incorporate CAD and 3-D design.
- Major curriculum work linking concepts to the real world we live in
- Examined scope and sequence of curriculum – looking at methods to identify and incorporate writing and analysis.
- Sixth grade focus on science practices began in 2002.
- Practices incorporated into the curriculum in all grades.
- Linking content to the real world
- Examined scope and sequence mapping k-12 to examine where misconceptions may arise and formulate common vocabulary

Our goal is to keep ahead of the wave of changes, develop inquisitive students, and provide them with the needed skills for success to be life long learners.

2015 Revised Massachusetts STE Standards

- Balance Core Ideas with Practices.
- STE Practices make sure that students can reason scientifically and technologically about the world.
- Practices are integrated with content that can be applied in relevant real world situations.
- There is significant overlap between the STE practices and MATH and ELA practices.

Implications for curriculum and instruction

Shift in revised standards	Shift in curriculum & instruction
Relevance: Organized around core explanatory ideas that explain the world around us	The goal of teaching needs to shift from facts and concepts to explaining phenomena
Rigor: Central role for science and engineering practices *with* concepts	Inquiry- and design-based learning is not a separate activity; all STE learning should involve engaging in practices to build and use knowledge
Coherence: ideas and practices build across time and between disciplines	Teaching involves building a coherent storyline across time

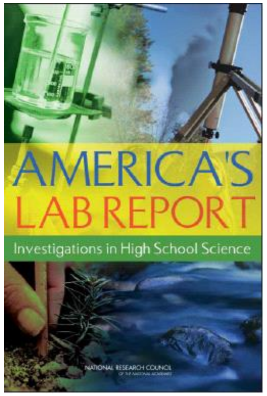
Adapted from: Brian Reiser, Northwestern University, 2013

Implications for Instruction

Science Instruction Will Involve Less	Science Instruction Will Involve More
Rote memorization of facts and terminology. Students expected to follow specific steps and procedures.	Facts and vocabulary are learned as needed. Developing explanations are supported by evidence based arguments and reasoning
Teachers leading and providing information to the whole class.	Students conducting investigations, solving problems, and engaging in discussions with teacher's guidance.
Preplanned outcomes for "cookbook" labs or hands-on activities. Scientific method expected to be followed and students arrive at the same conclusion about an experiment.	Multiple investigations driven by student's questions with a range of possible outcomes in which students analyze and interpret data that leads to a deep understanding of core scientific ideas
Worksheets and individual work. Posters and projects that teachers have outlined the parameters and determine the outcome.	Science journals, collaborative group projects, media presentations that demonstrate student understanding

Outcomes of integrating practices & content

- Better reflection of actual science and engineering
- Increased mastery of sophisticated subject matter
- Increased opportunities to engage in practices in authentic contexts
- Increased interest in STEM
    - America's Lab Report (NRC, 2005)



What Bedford is doing to transition to the revised STE standards?

- Middle School
  - Three year transitioning from the traditional subject based grade to a spiraled approach with culminating unit.
    - First year – grade 6 full spiral, 7 introduces Physical Science Unit to replace Gr. 8 Life Science Topic
    - Second Year – Grade 7 Full Spiral – Adds Earth Science Unit, Gr. 8 adds life science unit.
    - Third year – All grades full spiral.
  - Planning stage culminating unit – The 4th Quarter unit encompasses all units and integrates engineering/technology.
  - Tech and Science – Increase in design process and incorporating more programming and engineering skills
- MS and HS Developing a science and engineering process developmental skill rubric to document student development of the processes – supporting with a student "portfolio" and self analysis

What an STE standard looks like

7-MS-LS2-2
• **7.MS-LS2-2 Develop a model to describe cycling of matter among living and nonliving parts of an ecosystem including the role of photosynthesis and decomposition.** Clarification Statement: Emphasis is on a general understanding of cycling of matter in an ecosystem State Assessment Boundary: Cycling of specific atoms (such as carbon or oxygen), or the biochemical steps of photosynthesis and decomposition are not expected in state assessment

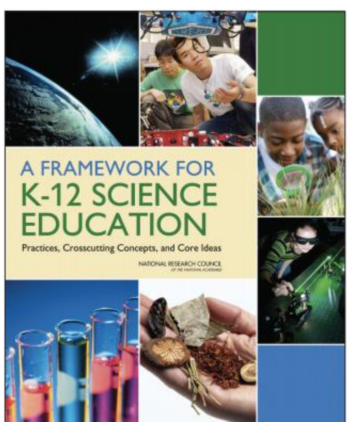
- Articulates expected performance/demonstration
- Does not limit curriculum and instruction to the included practice

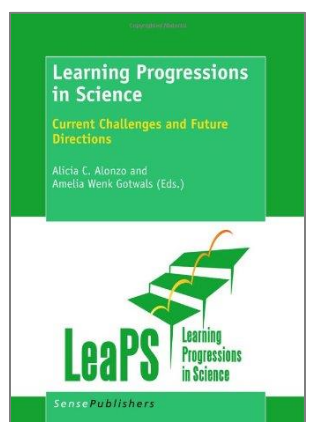
Core Ideas

- Key understandings that allow students to interpret and explain the world around them
  - Natural phenomena (e.g., pressure from gas, mass of a tree, carbon cycling, climate change)
  - Designed systems (e.g., energy systems, transportation systems)
- Progress in sophistication K-12

Coherent progressions of learning

- Vertical alignment through progressions of practices and concepts
- Draws on learning progression research
  - A Framework for K-12 Science Education (NRC, 2012)
  - Learning Progressions in Science: Current Challenges and Future Directions (Alonzo & Gotwals, 2012)
  - Learning Progressions in Science: An Evidence-Based Approach to Reform (CPRE, 2009)





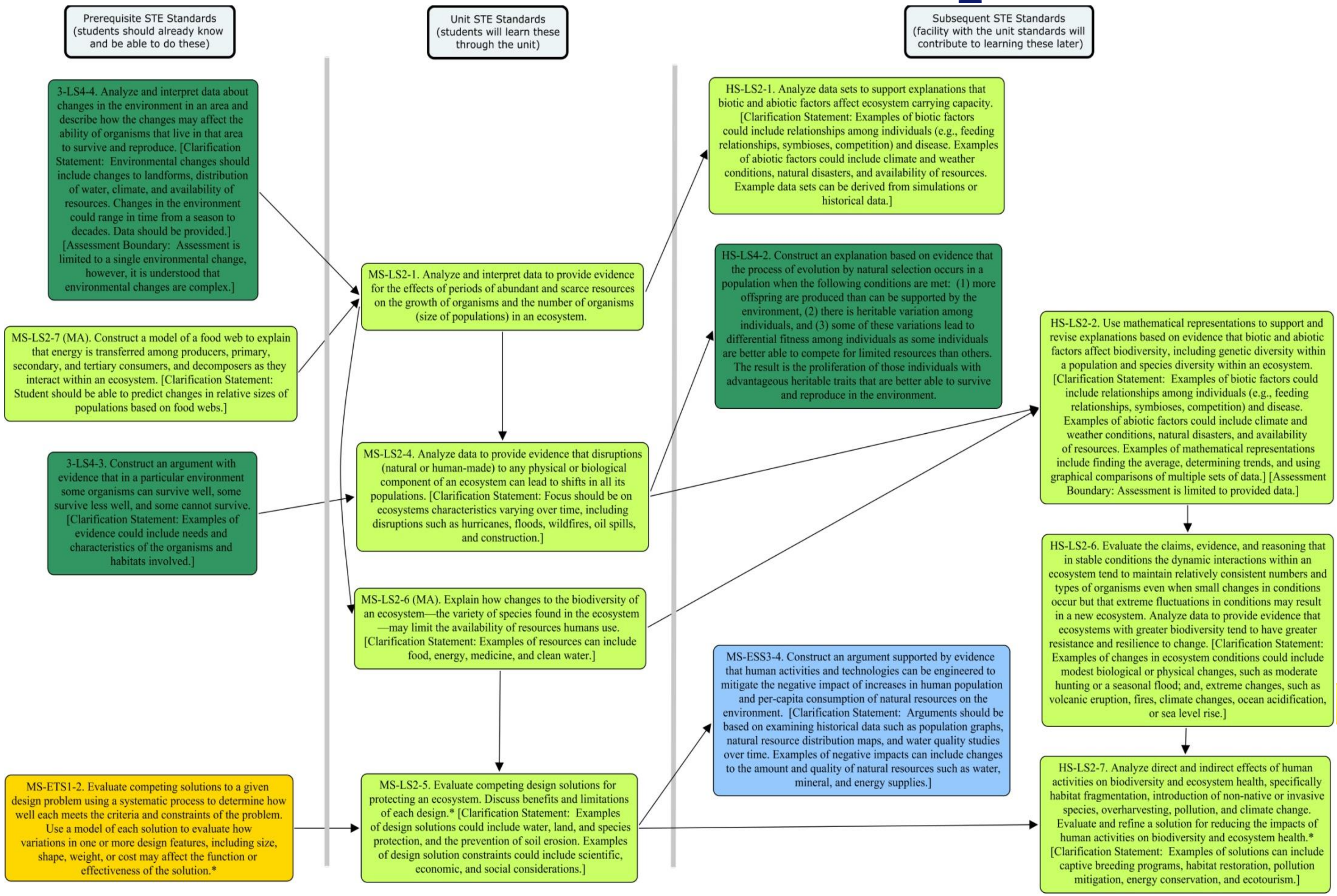
Origin of tree mass? 2001/2006 STE

- Gr. 3-5, LS #11: **Describe how energy derived from the sun is used by plants to produce sugars (photosynthesis)** and is transferred within a food chain from producers (plants) to consumers to decomposers.
- Gr. 6-8, LS #16: **Recognize that producers (plants that contain chlorophyll) use the energy from sunlight to make sugars from carbon dioxide and water through a process called photosynthesis.** This food can be used immediately, stored for later use, or used by other organisms.
- HS, LS 2.4: **Identify the reactants, products, and basic purposes of photosynthesis** and cellular respiration. Explain the interrelated nature of photosynthesis and cellular respiration in the cells of photosynthetic organisms.

Origin of tree mass?
2015 Draft revised STE

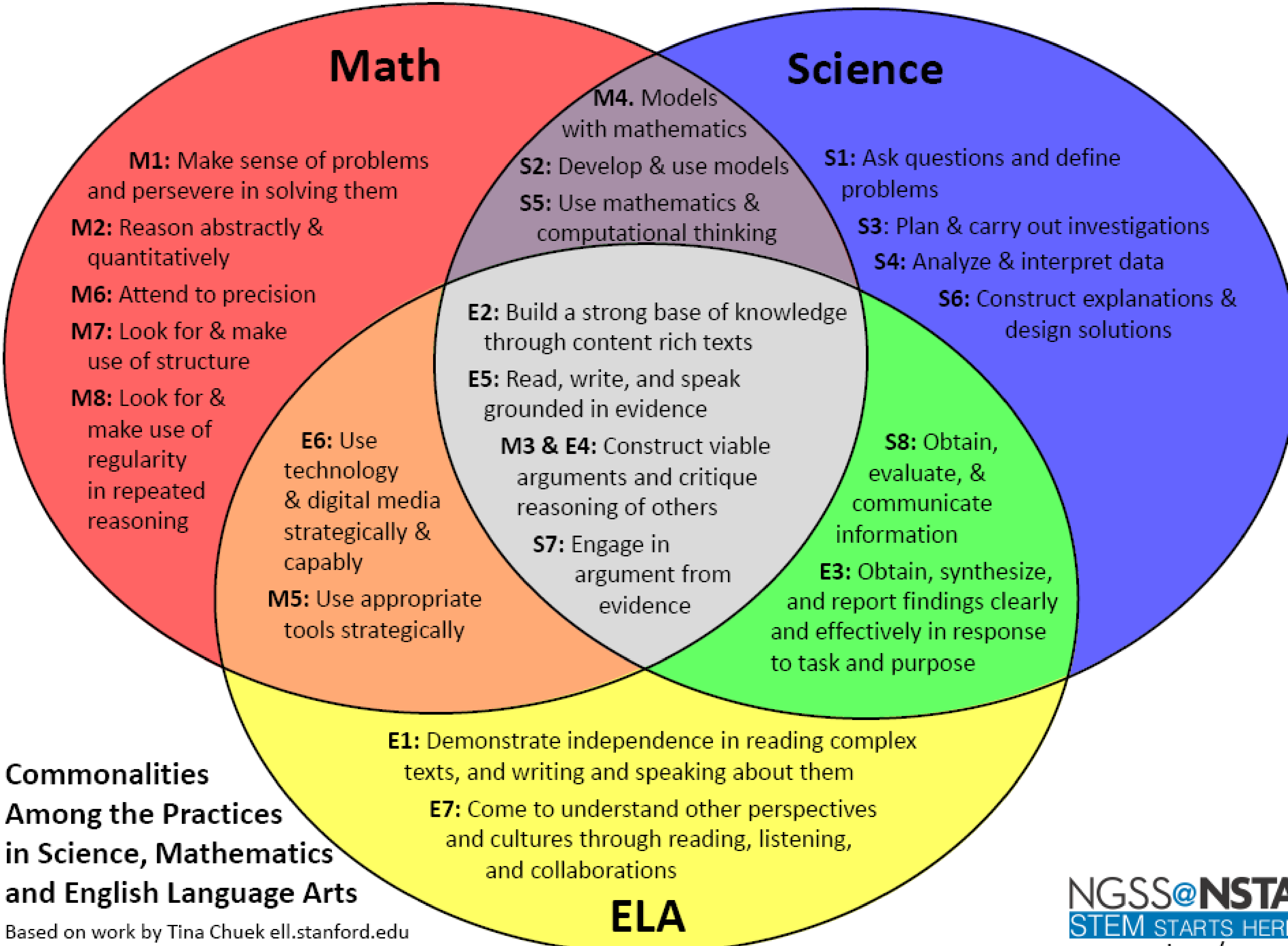
- 5-LS1-1. Support an argument with evidence that **plants get the materials they need for growth and reproduction chiefly through a process in which they use air, water, and energy from the sun to produce sugars and plant materials**.
- MS-LS2-3. Develop a model to describe the **cycling of matter among living and nonliving parts of an ecosystem including through the process of photosynthesis** and cellular respiration.
- HS-LS1-5. Use a model to illustrate **how photosynthesis uses light energy to transform carbon dioxide and water into oxygen and chemical energy stored in the bonds of glucose and other carbohydrates**.

Overview and Assumptions



Science & 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 and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information



Commonalities Among the Practices in Science, Mathematics and English Language Arts

Based on work by Tina Chuek ell.stanford.edu

NGSS@NSTA
STEM STARTS HERE
www.nsta.org/ngss

Ask questions and define problems

- I can ask questions about what would happen if a variable is changed.
- I can identify scientific (testable) and non-scientific (non-testable)questions.
- I can ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.

Develop and Use Models

- I can identify limitations of models.
- I can use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.
- I can develop and/or use models to describe and/or predict phenomena.

Plan and Carry Out Investigations

- I can plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.
- I can evaluate appropriate methods and/or tools for collecting data.
- I can make predictions about what would happen if a variable changes.

Analyze and Interpret Data

- I can represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships.
- I can compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.
- I can analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation

Use Mathematics and Computational Thinking

- I can describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems.
- I can organize simple data sets to reveal patterns that suggest relationships.

Construct Explanations and Design Solutions

- I can construct an explanation of observed relationships (e.g., the distribution of plants in the back yard).
- I can use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
- I can identify the evidence that supports particular points in an explanation.

Engage in an Argument from Evidence

- I can compare and refine arguments based on an evaluation of the evidence presented.
- I can distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.
- I can construct and/or support an argument with evidence, data, and/or a model.

Obtain, Evaluate, and Communicate Information

- I can read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.
- I can compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.
- I can communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.

STE Standards Resources

- Revised Draft Standards (now open for public comment)
- FAQ
- Crosswalk of the 2001/2006 STE Standards and Revised 2015 STE Standards
- Matrix of the Science and Engineering Practices
- Matrix of Disciplinary Core Idea Progressions
- The Case for an Integrated, Grade-by-Grade Approach PreK-8
- Value of Crosscutting Concepts & Nature of Science in Curriculum

All Resources found on ESE website:
http://www.doe.mass.edu/stem/review.html

Resources

- Crosswalk
  - www.doe.mass.edu/stem/resources/Crosswalk-current.xlsx
- Strand maps
  - www.doe.mass.edu/stem/standards/StrandMaps.html
- STE MCUs (forthcoming) and rubric
  - www.doe.mass.edu/candi/model/files.html
  - www.doe.mass.edu/candi/model/rubrics/STE.docx
- Characteristics of an STE Classroom
  - www.doe.mass.edu/STEM/Standards-BasedClassroom.docx

Staying up to date/FAQ

www.doe.mass.edu/STEM/review.html

Mass.Gov

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Science, Technology Engineering, and Mathematics (STEM)

Review of the Science and Technology/Engineering Framework, 2009-2016

The review of the Massachusetts Science and Technology/Engineering (STE) Curriculum Framework started in spring, 2009, and is now anticipated to be completed SY 2015-16. This page is intended to provide an overview, timeline, and periodic updates on the review process, related documents, and drafts for public comment.

At the October ESE Board meeting the Department laid out the timeline for moving forward with revised Science and Technology/Engineering standards. The Department will make the draft revised standards public but will not be moving them forward to a public adoption process until the 2015-16 school year. This provides guidance on the key directions the revised STE standards will represent and illustrates that they support broader ESE initiatives, such as college and career readiness, while recognizing that many districts are already engaged in multiple major initiatives. Districts have the opportunity to do planning and curriculum work with the draft revised standards prior to formal adoption and implementation. It is important to note that the current STE standards remain in effect and the STE MCAS remains aligned to the current STE standards. Each district will make its own decision about whether and/or how to use the draft revised standards until formal adoption.

Draft Revised Science and Technology/Engineering Standards

- Frequently Asked Questions regarding the release of the MA Draft Revised Science and Technology/Engineering (STE) Standards
- MA Draft Revised Science and Technology/Engineering Standards (standards only)
- MA Draft Revised Science and Technology/Engineering Standards (with Foundation Boxes)
- Strand Maps of Draft Revised MA Science and Technology/Engineering Standards

Related Resources

- Matrix of the Science and Engineering Practices (from NGSS)
- Matrix of Disciplinary Core Idea Progressions
- Crosswalk of the 2001/2006 STE Standards and Draft Revised STE Standards: Organized by Current Standards
- Crosswalk of the 2001/2006 STE Standards and Draft Revised STE Standards: Organized by Draft Revised Standards
- The Case for an Integrated, Grade-by-Grade Approach PreK-8
- Value of Crosscutting Concepts & Nature of Science in Curriculum
- Presentation: Overview of the MA Draft Revised STE Standards (PPT)

www.doe.mass.edu/stem/review.html

Thank you!

Questions, Comments, or Requests:

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www.doe.mass.edu/stem/review.html