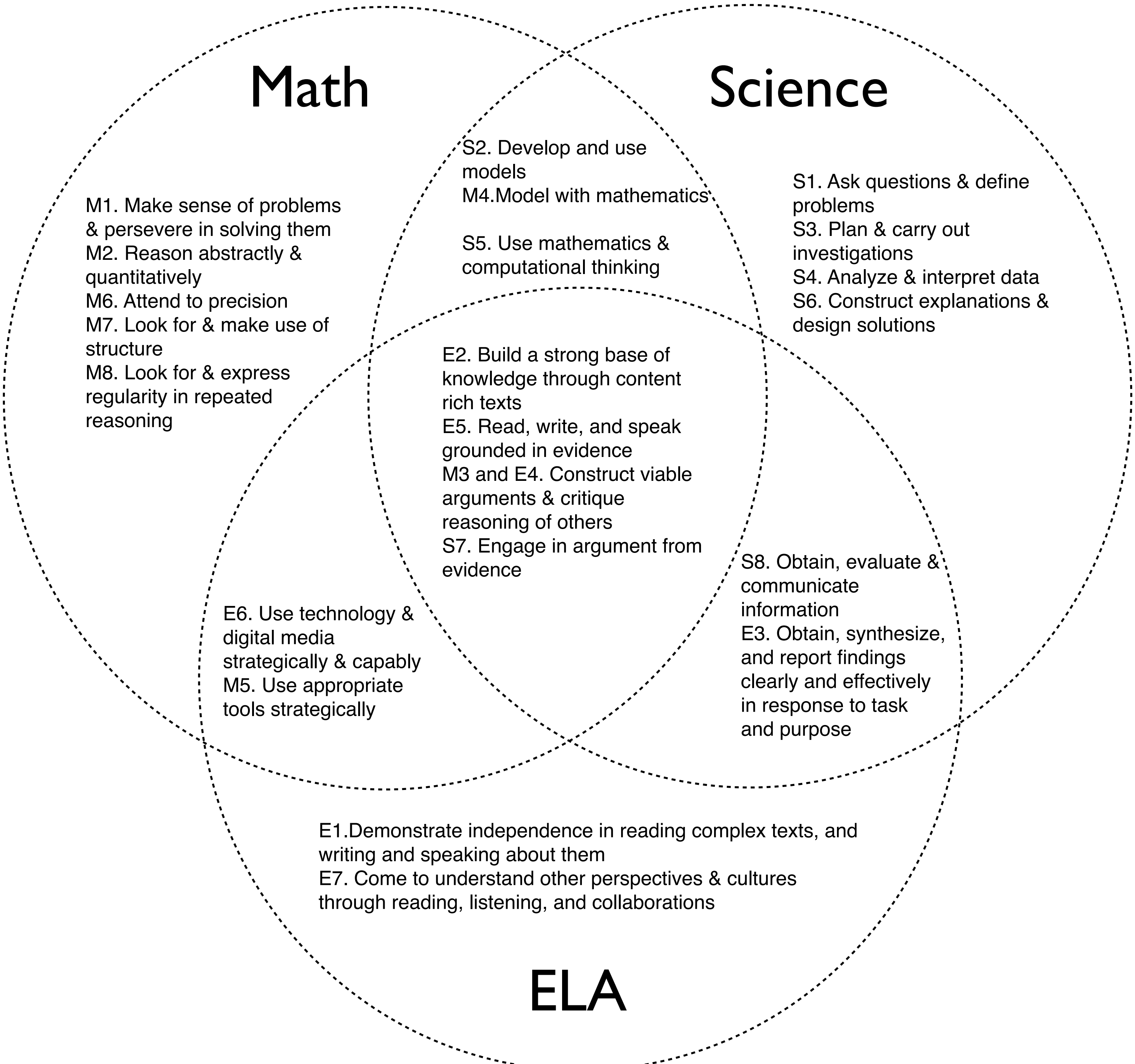
Relationships and Convergences Found in the Common Core State Standards in Mathematics (practices), Common Core State Standards in ELA/Literacy*(student portraits), and A Framework for K-12 Science Education (science & engineering practices)

These student practices and portraits are grouped in a Venn diagram. The letter and number set preceding each phrase denotes the discipline and number designated by the content standards or framework.
The Science Framework will be used to guide the production of the Next Generation Science Standards.



Sources:
Common Core State Standards for English Language Arts & Literacy* in History/Social Studies, Science, and Technical Subjects, p7.
Common Core State Standards for Mathematical Practice p6-8.
A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas, ES-3 and chapter 3: 1-32.

Relationships and Convergences Found in the Common Core State Standards in Mathematics (practices), Common Core State Standards in ELA/Literacy*(student portraits), and A Framework for K-12 Science Education (science & engineering practices).

These student practices and portraits are grouped in a modified Venn diagram. The letter and number set preceding each phrase denotes the discipline and number designated by the content standards or framework. The Science Framework was used to guide the production of the Next Generation Science Standards.

Our team at *Understanding Language* wanted to examine the nature of the relationships and convergences of student expectations[1] found in and across the three sets of the new standards: (1) English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects, (2) Mathematics, and (3) Science. This short brief details the analysis of these student-centered expectations in and across the three disciplines and begins a discussion of language demands found in these new standards as well as their implications for students, teachers, and teacher educators.

I. **What is the relationship, if any, across these student-centered expectations**?

In this Venn diagram, our team has attempted to cluster practices and capacities that have similar tenets and/or significant overlaps in the student expectations. Likewise, we have placed practices and capacities within the disciplinary domains if there was not a significant overlap or relationship to another discipline. One could argue certain practices/capacities could be placed in other positions within the Venn diagram. These placements are not definitive and the intention of the Standards documents may not have conceptualized the three disciplinary areas in this manner.

II. **What are these student centered expectations and how are they represented in each of the disciplines?**

Each set of these student expectations in the three disciplines is represented in various forms. This section discusses the student expectations found in each discipline.

Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects

Found on page 7 of the ELA Standards, these student-centered expectations are "portrait of students who meet the standards." The student portrait detailed within the ELA standards is

[1] In the ELA Standards, student expectations are termed "portraits of students" whereas in the Mathematics and Science Standards, they are termed as student "practices."

termed student "capacities", not the same labeling as "practices" as seen in both the Mathematics and Science Standards. These ELA capacities include[2]:

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.

Within each of these capacities, there is explicit reference to what students are expected to do within the ELA discipline. E1 is the most broad and encompassing of the student capacities. Within E1, students are expected to: "*comprehend* and *evaluate* complex texts, … *construct* effective arguments, and *convey* … information. … *discern* a speaker's key points, *request* clarification, and *ask* relevant questions. [Students] *build* on others' ideas, *articulate* their own ideas, and *confirm* they have been understood. … [Students] *demonstrate* command of standard English and *acquire* and *use* a wide-ranging vocabulary. …" The italicized verbs (added by author) found in the E1 descriptor attend to the language demands expected from students. Within the Venn diagram, we've summarized capacity (E1) as the following, "Demonstrate independence in reading complex texts, and writing and speaking about them."

Capacity E2 is centered around building "strong content knowledge" "by engaging with works of quality and substance." This capacity sits clearly at the intersection of the three disciplines as the focus is on how students interact with and "gain both general knowledge and discipline-specific expertise" through reading, listening, writing, and speaking.

Capacity E3 has been paraphrased to "Obtain, synthesize, and report findings clearly and effectively in response to task and purpose." The intent of this paraphrase was to clarify *how* students would "respond to the varying demands of audience, task, purpose, and discipline."

Capacity E4 and E5 centers around the issue of argumentation and evidence. Students are expected to "question … assumptions and premises and assess the veracity of claims and soundness of reasoning (E4) [and] constructively evaluate others' use of evidence." This level of student engagement with the content cross-cuts all three disciplines. As seen in the Venn diagram, argumentation and reasoning from evidence are also highlighted in the Mathematics and Science Standards.

Capacity E6 advantages the use of technology and digital media tools to support student learning and communications with others. These tools are meant to assist in amplified student learning, and provide addition access to rich content learning opportunities.

Capacity E7 is centered around the importance of perspective taking and diversity of cultures.

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[2] The numbering of these capacities has been added by the author for reference purposes.

Common Core State Standards for Mathematics: Standards for Mathematical Practice

In the new Mathematics Standards, the Standards for Mathematical Practice are detailed on pages 6-8. These practices "describe varieties of expertise that mathematics educators at all levels should seek to develop in their students." Stated on page 5, the content standards "are potential *points of intersections* between the Standards for Mathematical Content and the Standards for Mathematical Practice."

These mathematical practices include[3]:

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.

Similar to E1, students in practice M1 are expected to "*explain*… the meaning of a problem, *look for* entry points, … *analyze* givens…. *make conjectures*, … *plan a solution*, … *consider analogous problems*, … *try special cases*, … *monitor* and *evaluate* their progress…." Again, the italicized verbs and verb phrases (added by author) in the found in the M1 practice attend to the language demands expected from students.

Practice M2 describes the mathematical reasoning through the processes of *decontextualizing* and *contextualizing* flexibly in problem situations. The abstract and quantitative reasoning that is required in mathematics is not the same as it is described in ELA or Science. However, reasoning does entail meaning making, building connections as well as building understanding of the relationships among various parts the text provided. In mathematics, that text most likely revolves around the problem situation.

Practice M3 builds on practice M2 as students make sense of "stated assumptions, definitions, and previously established results in constructing arguments." Students are also expected to "reason inductively about data, making plausible arguments that take into account the context from which the data arose."

Practice M4 describes the use of modeling in mathematics. In mathematics, students "apply what they know [and] are comfortable making assumptions and approximations to simplify a complicated situation…." Mathematical models have significant implications in the science standards as science and engineering practices also explicit describes the development and use of models. Further discussion of these relationships can be found in part II.

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[3] The letter "M" in front of the numbers has been added by the author for reference purposes.

Practice M5 describes the use of tools "when solving a mathematical problem." The intent of the tools is to "explore and deepen their [students'] understanding of concepts." M5 overlaps most closely with E6 in using tools to access and extend learning opportunities.

Practices M6, M7, and M8 focuses on areas that are more specific to mathematics. Although one could argue that science and engineering practices include elements of the mathematic practices applied in their own context.

Next Generation Science Standards: Scientific and Engineering Practices

The analysis of the Scientific and Engineering Practices is derived from Chapter 3 of *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. These eight practices include[4]:

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.

The distinctive practices found in science and engineering relate to S1, S3, and S4. The work of asking questions and defining problems (S1), planning and carrying out investigations (S3), and analyzing and interpreting data (S4) are distinctive practices found in science and engineering.

Practice S2 attends to how scientists "construct mental and conceptual models of phenomenon" and serves as "a tool for thinking with, making predictions, and making sense of experience" (page 3-8). This practice is a broader conceptualization of modeling as it includes "mathematical representations" as one of may types of models that exist in science and engineering. Similar to mathematics, models do "contain approximations and assumptions that limit the range of validity of their application and the precision of their predictive power."

Practice S5 advantages mathematics and computational tools that clarifies and builds relationships and models among the various representations found in mathematics, science, and engineering. Again, practice S5 is a broader conceptualization of tool use that includes many of the ideas found in modeling in mathematics.

Practice S6 and S8 centers around getting students to synthesize their understanding and produce new knowledge for others.

In practice S7, "the production of knowledge is dependent on a process of reasoning that requires a scientist to make a justified claim about the world" (page 3-17). Practice S7 shares

[4] The letter "S" in front of the numbers has been added by the author for reference purposes.

the common feature of argumentation and reasoning with M3 and E4. While we are not claiming that the forms of argumentation in each discipline contain the same features, we are only making note that students are expected, in these new Standards, to *reason* and *make arguments* in each of the disciplines.