Mapping and the Science and Technology/Engineering Framework

The Nature of Science Examples (page 3)

- Weather in North America generally moves from west to east.
- The sun appears to move each day from the eastern horizon to the western horizon.

Skills of Inquiry Example (page 6 and 7):

- Select and use appropriate tools and technology.

Guiding Principles Examples (pages 9 through 15)

- Guiding Principle III (page 10) states that: Science and technology/engineering are integrally related to mathematics
- Guiding Principle IV: An effective program in science and technology/engineering addresses student's prior knowledge and misconceptions.

Learning Standard Examples

- Grades 6 - 8, Earth and Space Science, Standard 1**,** (page 29): Recognize, interpret, and be able to create models of the earth's common physical features in various mapping representations, including contour maps.
- Grade 9 or 10, Earth and Space Science, Standard 1.7, (page 31): Provide examples of how the unequal heating of the earth and the Coriolis Effect influences global circulation patterns, and show their impact on Massachusetts weather and climate, e.g. convection cells, trade winds, Westerlies, polar easterlies, land/sea breezes, mountain/valley breezes.
- Grades 6 - 8, Earth and Spaces Science, Standard 10, (page 30): Compare and contrast properties of objects in the solar system (i.e., sun, planets, and moons) to those on Earth (i.e., gravitational force, distance from the sun, speed, movement, temperature, and atmospheric conditions**).**
- Grade 9 or 10, Earth and Space Science, Standard 4.5, (page 35): Compare and contrast the rotation and revolution of orbiting bodies*…..*
- Grade 9 or 10, Earth and Space Science, Standard 4.6**,** (page 35): Explain Kepler's Laws of Motion.
- Physical Science, Grades 3-5, (page 58): Explain how electromagnets can be made, and give examples of how they are used.
- Physics, Grade 9 or 10, Standard 1.2 (page 68): Illustrate how to represent vectors graphically and be able to add them graphically.
- Physics, Grade 9 or 10, Standard 1.3 (page 68): Distinguish between, and solve problems involving velocity, speed, and constant acceleration.
- Physics, Grade 9 or 10, Broad Concept, (page 69): Stationary and moving charge particles result in the phenomenon known as electricity and magnetism.

The Historical and Social Context for Science and Technology/Engineering: An example of a topic for cited in Appendix V, (page 119):

- Major theories that changes humans' view of their place in the world, e.g., the Copernican revolution and Darwin's Theory of Evolution.

Mapping and the Mathematics Framework

The introduction page 1 quotes Voltaire who once said; *"When we cannot use the compass of mathematics or the torch of experience. It is certain that we cannot take a single step forward*."

One Guiding Philosophy of the Mathematic Framework (pages 5 and 6) states: *"Mathematics is not a collection of separate strands or standards. Rather, it is an integrated field of study. Students develop a perspective of the mathematics field as an integrated whole by understanding connections within and outside of the discipline. It is important for teachers to demonstrate the significance and relevance of the subject by encouraging students to explore the connections that exist within mathematics, with other disciplines, and between mathematics and students' own experiences."*

Guiding Principles of the Mathematics Frameworks described on pages 7 though 10 are relevant mapping include**:**

- Technology is an essential tool in a mathematics education.
- Assessment of student learning should take many forms to inform instruction and leaning.

The Geometry Strand

- "Ancient people, in their efforts to manage their lands, conduct commerce, and describe natural forms and patterns, began to study abstract shapes and standard units of measurement to communicate with each other."
- "Students can also apply methods developed in the geometric context to make sense of fractions and variables, construct graphs and other representations of data, and make and interpret maps, blueprints, and schematic drawings."

The Measurement Strand

- Students gain understanding of ratio and proportion in the middle grades, and apply their newfound knowledge to making scale drawings and maps that accurately reflect the dimensions of the landscape or the objects they represent."

The Number Sense and Operations Strand

Broad Concepts

- Understand numbers, ways of representing numbers, relationships among numbers, and number systems.
- Compute fluently and make reasonable estimates.

Learning Standards

- Grades 5- 6, 6.N.9**,** (page 25): Select and use appropriate operations to solve problems involving addition, subtraction, multiplication, division, and positive integer exponents with whole numbers, and with positive fractions, mixed numbers, decimals, and percents.
- Grades 5 - 6, 6.N.13**,** (page 25): Accurately and efficiently add, subtract, multiply, and divide (with double digit divisors) whole numbers and positive decimals.
- Grades 5 - 6, 6.N.16, (page 26): Estimate results of computations with whole numbers, and with positive fractions, mixed numbers, decimals, and percents. Describe reasonableness of estimates.
- Grades 7 - 8, 8.N.3, (page 62): Use ratios and proportions in the solution of problems, in particular, problems involving unit rates, scale factors, and rate of change.

Exploratory Concepts and Skills

Grades 7 - 8 (page 67)

- Investigate the meaning of significant digits.

The Patterns, Relations, and Algebra Strand

Broad Concepts

- Understand patterns, relations, and functions.
- Use mathematical models to represent and understand quantitative relationships**.**

Learning Standards

- Grades 3 - 4, 4.P.4, (page 32): Use pictures, models, tables, charts, graphs, words, number sentences, and mathematical notations to interpret mathematical relationships.
- Grades 5 - 6, 6.P.4**,** (page 34): Represent real situations and mathematical relationships with concrete models, tables, graphs, and rules in words and with symbols.
- Grades 7 - 8, 8.P.5, (page 63): Identify the slope of a line as a measure of its steepness and as a constant rate of change from its table of values, equation, or graph. Apply the concept of slope to the solution of problems.
- Grades 11 - 12, 12.P.4**,** (page 81): Demonstrate an understanding of trigonometric, exponential, and logarithmic functions.

The Geometry Strand

Broad Concepts

- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems.
- Use visualization, spatial reasoning, and geometric modeling to solve problems.

Learning Standards

- Grades 3 - 4, 4.G.2**,** (page 40): describe, model, draw, compare, and classify two- and three-dimensional shapes, e.g., circles, polygons - especially triangles and quadrilaterals - cubes, spheres, and pyramids.
- Grades 5 - 6, 6.G.9, (page 42): Match three-dimensional objects and their two-dimensional representations, e.g., nets, projections, and perspective drawings.
- Grades 7 - 8, 8.G.3**,** (page 64): Demonstrate an understanding of the relationships of angles formed by intersecting lines, including parallel lines cut by a transversal.
- Grades 9 - 10, 10.G.2, (page 74): Draw congruent and similar figures using a compass, straightedge, protractors, and other tools such as computer software. Make conjectures about methods of construction. Justify the conjectures by logical arguments.
- Grades 9 -10, 10.G.10, (page 74) and Geometry, G.G.16 (page 96): Demonstrate the ability to visualize solid objects and recognize their projections and cross0sections.
- Grades 11 - 12, 12.G.3, (page 83): Use the notion of vectors to solve problems. Describe addition of vectors and multiplication of a vector by a scalar, both symbolically and geometrically. Use vector methods to obtain geometric results.
- Grades 11 - 12, 12.G.5**,** (page 83): Apply properties of angles, parallel lines, arcs, radii, chords, tangents, and secants to solve problems.
- Geometry, High School, G.G.14, (page 96): Demonstrate an understanding of the relationship between geometric and algebraic representation of circles.

Exploratory Concepts and Skills

Grades 3 - 4 (page 40)
- Investigate two-dimensional representations of three-dimensional objects.

Grades 5 - 6 (page 42)
- Use manipulatives and technology to model geometric shapes.
- Recognize and apply geometric ideas and relationships in areas outside the mathematics classroom, such as art, science, and everyday life.

Grades 9 - 10 (page 76)
- Apply properties of chords, tangents, and secants to solve problems.

The Measurement Strand

Broad Concepts
- Understand measurable attributes of objects and the units, systems, and processes of measurement.

Learning Standards

- Grades 3 - 4, 4.M.5, (page 48): Identify and use appropriate metric and English units and tools (e.g., ruler, angle ruler, graduated cylinder, thermometer) to estimate, measure, and solve problems involving length, area, volume, weight, time, angle size, and temperature.
- Grades 7 - 8, 8.M.1**,** (page 65): Select, convert (within the same system of measurement), and use appropriate units of measurement or scale.
- Grades 7 - 8, 8.M.2, (page 65): Given the formulas, convert from one system of measurement to another. Use technology as appropriate.
- Grades 9 - 10, 10.M.4, (page 75): Describe the effects of approximate error in measurement and rounding on measurements and on computed values from measurements.
- Grades 11 - 12, 12.M.2, (page 83) and Geometry G.M.5, (page 97): Use dimensional analysis for unit conversion and to confirm that expressions and equations make sense.

Exploratory Concepts and Skills

Grades 3 - 4 (page 48)
- Investigate the use of protractors to measure angles.
- Identify common measurements of turns, e.g., 360° in one full turn, 180° in a half turn, 90° in a quarter turn
- Understand that measurements are approximations and investigate how differences in units affect precision.

Grades 7 - 8 (page 67)
- Investigate formulas to determine the circumference and area of circles, and the perimeter and area of polygons.

The Data Analysis, Statistics, and Probability Strand

Broad Concepts

- Formulate questions that can be addresses with data and collect, organize, and display relevant data to answer them.
- Select and use appropriate statistical methods to analyze data.
- Develop and evaluate inferences and predictions that are based on data.

Learning Standards

- Algebra I, AID.3**,** (page 94): Describe and explain how the relative sizes of a sample and the populations affect the validity of the predictions from a set of data (10.D.3)

Exploratory Concepts and Skills

Grades 11 - 12 (page 85)

- Design surveys and apply random sampling techniques to avoid bias in the data collection.

Mapping and the History and Social Science Framework

Overarching themes that are useful in designing and implementing history and social science curriculums are described on pages 9, 10, and 11 of the History and Social Science Framework. Two themes relate to the study of mapping.

- The effects of geography on the history of civilizations and nations.
- The development of scientific reasoning, technology, and formal education over time and their effects on people's health, standards of living, economic growth, government, religious beliefs, communal life, and the environment.. .

Concepts and Skills

- Grade 1, History and Geography**, (**page 15): Describe a map as a representation of a space, such as a classroom, the school, the neighborhood, town, city, state, country, or world.
- Grade 2, History and Geography, (page 17)**:** Describe how maps and globes depict geographical direction in different ways.
- Grade 3, History and Geography**,** (page 17): Use cardinal directions, map scales, legends, and titles to locate places on contemporary maps of New England, Massachusetts, and the local community. (page 19)
- Grade 4 and Grade 5, History and Geography**,** (page 22 and 27)**:** Use map and globe skills to determine absolute locations (latitude and longitude) of places studied.
- Grade 4, History and Geography, (page 22)**:** Interpret a map using information from its title, compass rose, scale and legend.
- Grade 5, History and Geography, (page 27): Identify the location of the North and South Poles, the equator, the prime meridian, Northern, Southern, Eastern, and Western Hemisphere.
- Grade 5, History and Geography, (page 27): Distinguish between political and topographical maps and identify specialized maps that show information such as populations, income, or climate change.

Concepts and Skills (continued)

- Grade 6, Concepts and Skills, History and Geography**,** (page33): Use map skills learned in prekindergarten to grade five to interpret different kinds of projections, as well as topographic, landform, political, population, and climate maps.
- Grade 6, Concepts and Skills, History and Geography**,** (page 34): Identify what time zones are, when and how the precise measurement of longitude was scientifically and historically determines, the function and location of the international date line, and the function of the Royal Observatory in Greenwich, England, and give examples of differences in time in countries in different parts of the world
- Grades 8 -1 2, History and Geography**,** (pages 44 to 46): Apply the skills of prekindergarten through grade seven.

Learning Standards

- Grade 5, 5.3, (page 28): Explain why trade routes to Asia had been closed in the 15th century and trace the voyages of at least four explorers
- Grade 6, A.1, .2,and .3; WA.1, .2,and .3; CSA.1, .2,and .3; SEAO.1, .2,and .3; NEA.1, .2,and .3; E.1, .2,and .3; and SAM.1, .2,and .3**,** (pages 35 to 41)**:** These learning standards refer to the use of maps of various regions of the world.
- Grade 7, 7.7, 7.12, 7.17, 7.19, 7.24, and 7.35, (pages 44 to 46) relate to the use of historical and modern maps of three different civilizations.

World History I, WHI.33, (page 55): Summarize how the Scientific Revolution and the scientific method led to new theories of the universe and describe the accomplishments of the leading figures of the Scientific Revolution including Bacon, Copernicus, Descartes, Galileo, Kepler, and Newton.

Curriculum and Standards Reference Example (page 99)

- Geography for Life: National Geography Standards, Washington, D.C., National Council for Geographic Education, 1994