High School Content Expectations: Pre-MME Expectations




Expectations for Success with the MME

v.9.09

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MICHIGAN Education

Expectations for Success on the Michigan Merit Exam

This document provides information about the High School Content Expectations (HSCE) that MAY be assessed on the Michigan Merit Exam (MME) beginning with the spring of 2010, as required by School Aid Act 1079, Act 94 of 1979, 388.1704b, Section 104b.

There is no required sequence for offering opportunities to earn required Michigan Merit Curriculum (MMC) high school credits in English Language Arts, Mathematics, Science, and Social Studies. Districts are free to design and offer courses in any order that allows students to meet the HSCE that define the required MMC credits.

Districts are expected to base credit assignment, at least in part, on assessments designed to indicate that students have met the expectations that define the credit (using Secondary Credit Assessments [SCA] or district common assessments).

While ALL content expectations are to be taught and tested at the classroom, building, and/or district levels, NOT ALL content expectations are assessed on the MME. The MME assesses a high percentage of Michigan's High School Standards, requiring students to demonstrate knowledge and skill aligned with content expectations designated as MME-assessable.

The content expectations listed in the chart below are those that MAY be assessed on the MME, and thus represent content knowledge and skill that should be taught before students take the MME. After reviewing the list of MME-assessable HSCE, districts may want to find ways to incorporate some expectations from credits that have been assigned to Grade 11 into earlier courses.

Beginning in the spring of 2010, the following HSCE will be eligible for inclusion on the MME. The MME-assessable HSCE are listed by core area and credit. A short description of the percentage of high school standards and the HSCE identified as MME-assessable in the four core content areas of ELA, Mathematics, Science, and Social Studies follows. Each section includes a link to a version of the formatted HSCE document, highlighted to indicated the MME-assessable HSCE for each content area.

Information regarding Michigan HSCE assessed on the ACT and WorkKeys is available at http://www.act.org/education/statematch/

English Language Arts – 100% of Michigan High School ELA Standards are eligible for inclusion on the MME (ACT English, Reading, Writing, or WorkKeys assessments). Within these Standards, 41 ELA HSCE have been assessed or identified by ACT and the MDE as eligible for inclusion on the MME, representing 45% of the 91 ELA expectations. Items appearing on the ACT's assessments measure different content expectations every year.
MME-Assessable ELA HSCE

Mathematics – 100% of Algebra 1, 100% Geometry and 67% of Algebra II HSCE are identified as MME-assessable; 26 of 39 Algebra II HSCE, (as defined in the 9/09 revision of the Algebra II Course/Credit Requirements), are MME-assessable. The MME assesses 117 of 161 (73%) Mathematics HSCE and 10 of 13 (77%) Michigan High School Mathematics Standards.
MME-Assessable Mathematics HSCE

Science – 100% of Essential Science HSCE are MME-assessable, representing HSCE from each Science discipline and approximately 60% of required HSCE. The MME assesses all 16 High School Science Standards. MME-Assessable Science HSCE

Social Studies – 83% of United State History & Geography HSCE; 76% of World History & Goegraphy HSCE; 52% of Civics HSCE; 45% of Economics HSCE are MME-assessable, representing 137 of 230 (60%) Social Studies HSCE. The MME assesses 45 of 50 (90%) Michigan High School Social Studies Standards. The High School Social Studies Curriculum-Assessment Alignment Documents available October 2009, provide detailed information about the scope of the expectations and assessment classification.
MME-Assessable Social Studies HSCE

Expectations for Success on the Michigan Merit Exam

The content expectations listed below are those that MAY be assessed on the MME, and thus represent content knowledge and skill that should be taught before students take the MME.

ELA	Mathematics			Science		Social Studies	
41 of 91 (45%) of Total ELA HSCE	117 of 161 (73%) of Total Mathematics HSCE			191 Essential Science HSCE 63% of Required (w/BP) 58% of Required (w/BC)		137 of 230 (60%) of Total Social Studies HSCE	
Strand 1 Standard 1.1 CE 1.1.1 CE 1.1.2 CE 1.1.3 CE 1.1.4 CE 1.1.5 CE 1.1.6 CE 1.1.7 Standard 1.3 CE 1.3.1 CE 1.3.2 CE 1.3.3 CE 1.3.4 CE 1.3.5 CE 1.3.9 Standard 1.4 CE 1.4.3 CE 1.4.4 CE 1.4.5 **Strand 2** Standard 2.1 CE 2.1.1 CE 2.1.2 CE 2.1.3 CE 2.1.4 CE 2.1.5 CE 2.1.6 CE 2.1.7 Standard 2.2 CE 2.2.1 Standard 2.3 CE 2.3.1 CE 2.3.2 CE 2.3.3 CE 2.3.4 **Strand 3** Standard 3.1 CE 3.1.1 CE 3.1.2 CE 3.1.3 CE 3.1.4 CE 3.1.7 CE 3.1.8 CE 3.1.9 Standard 3.2 CE 3.2.3 **Strand 4** Standard 4.1 CE 4.1.1 CE 4.1.2 CE 4.1.4 CE 4.1.5 Standard 4.2 CE 4.2.1 **41** Total	**Algebra 1 (A1)** Standard L1 L1.1.1-5 L1.2.2 L1.2.4 Standard L2 L2.1.1 L2.1.2 L2.1.4 Standard A1 A1.1.1-3 A1.2.1-4 A1.2.6 A1.2.8 Standard A2 A2.1.1-7 A2.2.1-3 A2.3.1-3 A2.4.1-3 Standard A3 A3.1.1 A3.1.2 A3.1.3 A3.1.4 A3.2.1 A3.2.4 A3.2.5 A3.3.1 A3,3,2 A3.3.3 A3.3.4 A3.3.5 A3.4.1 A3.4.2 A3.4.3 A3.5.1 A3.5.2 A3.5.3 Standard S2 S2.1.1 S2.1.2 S2.1.3 S2.1.4 S2.2.1 S2.2.2 **59** Total	**Geometry (G)** Standard L1 L1.1.6 L1.2.3 Standard L2 L2.3.1 Standard L3 L3.1.1 L3.1.2 L3.1.3 L3.2.1 L3.2.2 L3.2.3 L3.2.4 L3.3.1 L3.3.2 L3.3.3 Standard G1 G1.1.1 G1.1.2 G1.1.3 G1.1.4 G1.1.5 G1.1.6 G1.2.1 G1.2.2 G1.2.3 G1.2.4 G1.2.5 G1.3.1 G1.3.2 G1.3.3 G1.4.1 G1.4.2 G1.4.3 G1.4.4 G1.5.1 G1.5.2 Standard G2 G2.1.1 G2.1.2 G2.1.3 G2.2.1 G2.2.2 G2.3.1 G2.3.2 G2.3.3 G2.3.4 G2.3.5 Standard G3 G3.1.1-3 G3.2.1 G3.2.2 **48** Total	**Algebra 2 (A2)** Standard L1 L1.2.1 Standard L2 L2.1.5 Standard A1 A1.1.1 A1.1.4 A1.1.5 A1.1.6 A1.2.2 A1.2.5 A1.2.7 A1.2.8 A1.2.9 Standard A2 A2.1.1 A2.1.2 A2.1.3 A2.1.6 A2.1.7 A2.2.1 A2.2.2 A2.2.3 A2.3.1 A2.3.3 A2.4.1 A2.4.2 A2.4.3 Standard A3 A3.6.1 A3.6.2 26 Total **10** new in A2 16 already listed in A1, or G	**Earth Science (E)** Standard E1 E1.1 A-E E1.2 A-E Standard E2 E2.1 A-C E2.2 A-D E2.3 A E2.4 A, B Standard E3 E3.1 A, B E3.2 A-C E3.3 A-C E3.4 A-C Standard E4 E4.1 A-C E4.2 A, B E4.3 A-F Standard E5 E5.1 A E5.2 A-D E5.3 A-D E5.4 A-D 55 Total **45** w/o 1.1 and 1.2	**Physics (P)** Standard P1 P1.1 A-E P1.2 A-E Standard P2 P2.1 A-F P2.2 A-D Standard P3 P3.1 A P3.2 A-C P3.3 A P3.4 A-D P3.6 A-C P3.7 A, B Standard P4 P4.1 A, B P4.2 A-D P4.3 A-C P4.4 A-C P4.5 A-E P4.6 A-D P4.8 A, B P4.9 A-C P4.10 A-D P4.12 A-C 67 Total **57** w/o 1.1 and 1.2	**WHG (W)** Era 4 W4.1.2 W4.1.3 W4.2.1-3 W4.3.1 W4.3.3 Era 5 W5.1.2 W5.2.1 W5.2.2 W5.3.1-4 Era 6 W6.1.1-5 W6.2.1-4 W6.3.1-3 Era 7 W7.1.1-3 W7.2.1-3 W7.3.1-4 Era 8 W8.1.1 W8.1.2 W8.1.4 W8.2.1 W8.2.3 **41** Total	**Civics (C)** Standard C1 C1.1.1-2 C1.2.1-2 Standard C2 C2.1.1-3 C2.2.1 Standard C3 C3.1.1-4 C3.1.6 C3.2.1 C3.2.3 C3.3.1-3 C3.3.5 C3.4.1-4 C3.5.1-4 C3.5.7 Standard C4 C4.1.1-2 C4.2.1 C4.2.4 Standard C5 C5.1.1 C5.2.1-2 C5.3.1-4 C5.3.7 C5.4.1 C5.5.1-2 **43** Total
				Biology (B) Standard B1 B1.1 A-E B1.2 A-E Standard B2 B2.1 A-C B2.2 A-E B2.3 A-C B2.4 A-C B2.5 A-D Standard B3 B3.1 A-D B3.2 A-C B3.3 A B3.4 A-C B3.5 A-C Standard B4 B4.1 A, B B4.2 A-E B4.3 A-C Standard B5 B5.1 A, B B5.2 A-C **57** Total w/ 1.1 and 1.2	**Chemistry (C)** Standard C1 C1.1 A-E C1.2 A-E Standard C2 C2.2 A, B Standard C3 C3.3 A, B C3.4 A, B Standard C4 C4.2 A, B C4.3 A, B C4.8 A-D C4.9 A C4.10 A, B Standard C5 C5.2 A-C C5.4 A, B C5.5 A, B C5.7 A-E C5.8 A-C 42 Total **32** w/o 1.1 and 1.2	**USHG (U)** Era 6 U6.1.1-5 U6.2.1-4 U6.3.2 U6.3.3 Era 7 U7.1.1-3 U7.2.1-4 Era 8 U8.1.1 U8.1.2 U8.2.1 U8.2.2 U8.2.4 U8.3.1 U8.3.3 U8.3.4 Era 9 U9.1.1 U9.1.2 U9.2.1 U9.2.2 **30** Total	**Economics (E)** Standard E1 E1.1.1 E1.1.2 E1.3.1-3 E1.4.2-4 Standard E2 E2.1.1 E2.1.4 E2.1.6 E2.1.9 E2.2.1 E2.2.3-5 Standard E3 E3.1.2 E3.1.5 E3.1.6 E3.2.1 E3.2.2 E3.2.4 E3.2.5 **23** Total

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High School Content Expectations

MATHEMATICS

- Quantitative Literacy and Logic
- Algebra and Functions
- Geometry and Trigonometry
- Statistics and Probability

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**Grade Level Content Expectations Committee*

Welcome to Michigan's High School Mathematics Content Standards and Expectations

Why Develop Content Standards and Expectations for High School?

In 2004, the Michigan Department of Education embraced the challenge to initiate a "high school redesign" project. Since then, the national call to create more rigorous learning for high school students has become a major priority for state leaders across the country. The Cherry Commission Report highlighted several goals for Michigan including the development of high school content expectations that reflect both a rigorous and a relevant curricular focus. Dovetailing with this call to "curricular action" is Michigan's legislative change in high school assessment. The Michigan Merit Exam, based on rigorous high school learning standards, is to be fully implemented by 2007.

Given these two catalysts, the Michigan Department of Education's Office of School Improvement led the development of high school content expectations for English Language Arts and Mathematics. Content area work groups of academicians chaired by a nationally known scholar in the respective field, were commissioned to conduct a scholarly review and identify content standards and expectations. These content standards and expectations have gone through an extensive field and national review and are presented to educators in this document.

An Overview

The expectations contained in this document reflect best practices and current research in the teaching and learning of mathematics. They build from the *Michigan Mathematics Curriculum Framework Standards and Benchmarks* (1996), the *Career and Employability Skills Content Standards and Benchmarks* (2001), and extend the *Michigan K-8 Mathematics Grade Level Content Expectations* (2004) as appropriate for grades 9-12. These standards and expectations represent a vision for a rigorous and relevant high school experience for all Michigan students over the next five to ten years. Special attention has been paid to national research and support for the skills that prepare students for successful post-secondary engagement and the workplace.

The standards and expectations are closely aligned with national standards as described in ACT's *College Readiness Standards*®, American Diploma Project's *Ready or Not: Creating a High School Diploma That Counts* (2004), the National Council of Teachers of Mathematics *Principles and Standards for School Mathematics* (2000), and the National Assessment Governing Board's *Mathematics Framework* for the 2003 *National Assessment of Educational Progress* (NAEP). Students whose work is guided by these standards and expectations will be prepared both for college and for the workplace.

Curriculum and Assessment

This document is intended to support conversations at the school and district level that result in rigorous and relevant curriculum that incorporates these content expectations.

As stakeholders (i.e., teachers, administrators, school board members, parents, community members, students, local legislative representatives) work with these standards, they should consider the following questions:

- How are these content standards and expectations reflected in our curriculum and instruction already?
- Where do we need to strengthen our curriculum and instruction to more fully realize the intent of these standards and expectations?
- What opportunities do these standards and expectations present to develop new and strengthen existing curriculum, leading to instructional excellence?
- How do we implement these standards and expectations taking into account what we know about our students, school, and community?
- How will we assess the effectiveness with which our students and schools are meeting these standards and content expectations?
- How can we use school-based assessments (e.g., student portfolios, school-based writing assessments, teacher or classroom research, district-level assessments) to make data-driven decisions about teaching and learning?

Through conversations about questions such as these, and building upon the multitude of existing strengths in our current high schools, voices of all stakeholders will participate in the important and continuing process of shaping instructional excellence in Michigan schools and preparing students in Michigan schools for college and the workplace.

Mathematics

Mathematical understandings and skills are essential elements for meaningful participation in the global information society. US expectations in mathematics for high school students have not kept pace with expectations in high-achieving countries around the world. And, expectations about who can do mathematics in the US have led to inequitable and unacceptably low opportunities to learn for students living in poor and urban communities. In Michigan, the K-8 Mathematics Grade Level Expectations represent a major step forward in raising expectations in mathematics for all students. These high school expectations assume the ambitious foundation of the K-8 GLCEs and are intended to equip all students with a solid background for continued postsecondary study in any area, as well as with skills and knowledge essential for the workplace. It is essential to hold high expectations in mathematics for all students for completion of high school, whether they will enter the workforce or go on to postsecondary education.

The high school mathematics content expectations are organized in four strands: Quantitative Literacy and Logic, Algebra and Functions, Geometry and Trigonometry, and Statistics and Probability. The topics within each strand have been arranged to show mathematical growth and to illustrate mathematical trajectories of ideas that build on one another, when possible. The expectations in these four strands, are not mapped into course arrangements in this document. Such mapping, whether to traditional course titles like Algebra I, Geometry, or Algebra II, or into courses that integrate the material, is a complex process.

Decisions about the inclusion of topics were based on the following five criteria:

- how well the topic connects to other mathematical areas
- the mathematical centrality of the topic
- the standing of the topic as a cultural accomplishment
- the relevance of the topic for secondary school students
- the importance of the topic in the workplace or for informed citizenship

There is a strong emphasis on mathematical reasoning throughout all of these strands. It is also important for high school students to become successful in applying mathematical concepts and processes to solve complex problems. Technological advances affect what is possible to learn, and what is necessary to learn, in high school mathematics, and these expectations reflect this trend.

These four strands are fundamentally interconnected and also arranged to reflect the sequencing and emphases in the mathematical ideas that are central to high school.

Understanding the Organizational Structure

The expectations in this document are divided into four strands with multiple standards within each, as shown below. The skills and content addressed in these standards will, in practice, be woven together into a coherent, integrated Mathematics curriculum. The standards are comprehensive and are meant to be used as a guide to curriculum development.

STRAND 1 **Quantitative Literacy and Logic (L)**	**STRAND 2** **Algebra and Functions (A)**	**STRAND 3** **Geometry and Trigonometry (G)**	**STRAND 4** **Statistics and Probability (S)**
STANDARDS (and number of core expectations in each standard)			
L1: Reasoning About Numbers, Systems and Quantitative Situations (13) L2: Calculation, Algorithms, and Estimation (13) L3: Mathematical Reasoning, Logic, and Proof (10)	A1: Expressions, Equations, and Inequalities (16) A2: Functions (16) A3: Families of Functions (27)	G1: Figures and Their Properties (29) G2: Relationships Between Figures (10) G3: Transformations of Figures in the Plane (5)	S1: Univariate Data-Examining Distributions (9) S2: Bivariate Data—Examining Relationships (6) S3: Samples, Surveys, and Experiments (3) S4: Probability Models and Probability Calculation (4)
Recommended Quantitative Literacy and Logic Expectations (3)	*Recommended Algebra and Functions Expectations (5)*	*Recommended Geometry and Trigonometry Expectations (3)*	*Recommended Statistics and Probability Expectations (6)*

Core and Recommended Expectations

The expectations in this document represent what all Michigan high school graduates should know and be able to do in mathematics. With a focused and coherent set of **required core expectations,** teachers can provide both the breadth of mathematical experiences required for students to succeed in an increasingly competitive world economy, and also provide the depth required for mastery of fundamental mathematical ideas. There should be far less of the review and revisiting of topics that is typical in the high school mathematics curriculum. With a deep understanding of these expectations, students will make connections among fundamental mathematical ideas, and will be well-situated to use their mathematical knowledge and quantitative skills across the curriculum.

At the end of each strand, a set of **recommended expectations** is listed. These extensions represent content that is desirable and valuable for all students, but attention to these items should not displace or dilute the curricular emphasis of any of the core expectations. Teachers are encouraged to incorporate the recommended expectations into their instruction when their students have a solid foundation and are ready for enrichment or advanced learning.

Updates

This 11/07 version of the High School Mathematics Content Expectations updates the original 8/06 version by:

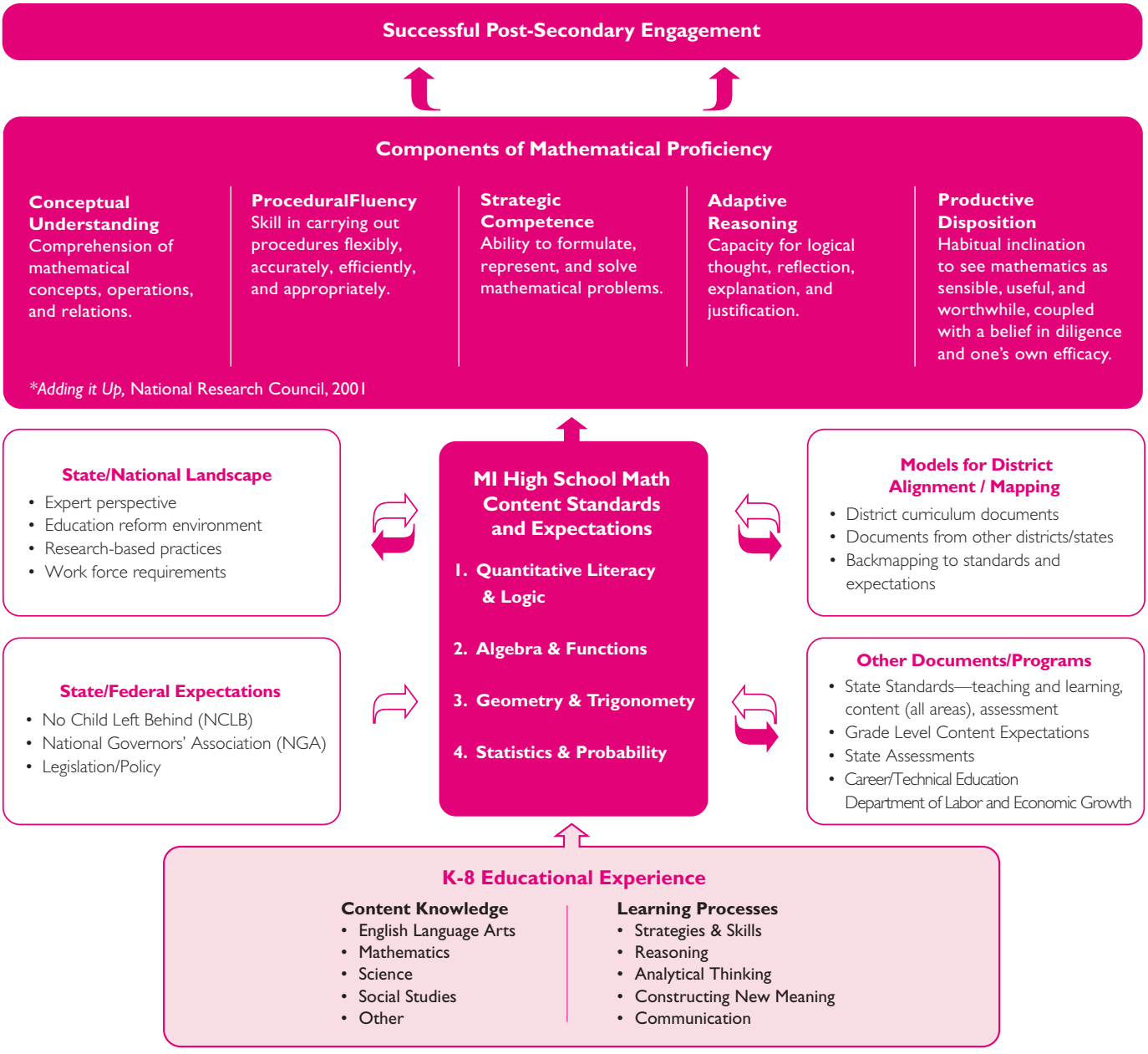
- Moving Standard A3-Mathematical Modeling to A2.4. All the topics dealing with individual function families are now in A3.
- Combining Standards L2 and L3 into one standard; Standard L4 is now L3.
- Making minor changes to some expectations to improve understanding.
- Removing examples from the expectations. More extensive examples can be found in the clarification companion documents.

Preparing Students for Successful Post-Secondary Engagement

As educators use these standards and expectations to develop rigorous and relevant units of instruction, powerful and engaging learning activities, and challenging high school curricula, it is critical to keep in mind that content knowledge alone will not provide adequate preparation for success in entry-level university courses or entry-level positions in today's workforce.

Successful post-secondary engagement requires that students must be able to apply knowledge in new situations; to solve problems by generating new ideas; to make connections between what they read and hear in class, the world around them, and the future; and through their work, develop leadership qualities while still in high school.

Therefore, educators must model for and develop in students the cognitive skills and habits of mind that will result in mathematical proficiency and successful post-secondary engagement.



STRAND 1: QUANTITATIVE LITERACY AND LOGIC (L)

"In an increasingly complex world, adults are challenged to apply sophisticated quantitative knowledge and reasoning in their professional and personal lives. The technological demands of the workplace, the abundance of data in the political and public policy context, and the array of information involved in making personal and family decisions of all types necessitate an unprecedented facility not only with fundamental mathematical, statistical, and computing ideas and processes, but with higher-order abilities to apply and integrate those ideas and processes in a range of areas." [1]

The Michigan Grade Level Content Expectations in Mathematics for grades K-8 prescribe a thorough treatment of number, including strong emphasis on computational fluency and understanding of number concepts, to be completed largely by the sixth grade. The expectations in this Quantitative Literacy and Logic strand provide a definition of secondary school quantitative literacy for all students and emphasize the importance of logic as part of mathematics and in everyday life. They assume fluency (that is, efficiency and accuracy) in calculation with the basic number operations involving rational numbers in all forms (including percentages and decimals), without calculators. Mathematical reasoning and logic are at the heart of the study of mathematics. As students progress through elementary and middle school, they increasingly are asked to explain and justify the thinking underlying their work. In high school, students peel away the contexts and study the language and thought patterns of formal mathematical reasoning. By learning logic and by constructing arguments and proofs, students will strengthen not only their knowledge and facility with mathematics, but also their ways of thinking in other areas of study and in their daily lives.

Connections and applications of number ideas and logic to other areas of mathematics, such as algebra, geometry, and statistics, are emphasized in this strand. Number representations and properties extend from the rational numbers into the real and complex numbers, as well as to other systems that students will encounter both in the workplace and in more advanced mathematics. The expectations for calculation, algorithms and estimation reflect important uses of number in a range of real-life situations. Ideas about measurement and precision tie closely to geometry.

[1] Estry, D. & Ferrini-Mundy, J. (January, 2005). Quantitative Literacy Task Force Final Report and Recommendations. East Lansing, Michigan State University

STANDARD L1: REASONING ABOUT NUMBERS, SYSTEMS, AND QUANTITATIVE SITUATIONS

Based on their knowledge of the properties of arithmetic, students understand and reason about numbers, number systems, and the relationships between them. They represent quantitative relationships using mathematical symbols, and interpret relationships from those representations.

L1.1 Number Systems and Number Sense

L1.1.1 Know the different properties that hold in different number systems and recognize that the applicable properties change in the transition from the positive integers to all integers, to the rational numbers, and to the real numbers.

L1.1.2 Explain why the multiplicative inverse of a number has the same sign as the number, while the additive inverse of a number has the opposite sign.

L1.1.3 Explain how the properties of associativity, commutativity, and distributivity, as well as identity and inverse elements, are used in arithmetic and algebraic calculations.

L1.1.4 Describe the reasons for the different effects of multiplication by, or exponentiation of, a positive number by a number less than 0, a number between 0 and 1, and a number greater than 1.

L1.1.5 Justify numerical relationships

L1.1.6 Explain the importance of the irrational numbers $\sqrt{2}$ and $\sqrt{3}$ in basic right triangle trigonometry, and the importance of π because of its role in circle relationships.

L1.2 Representations and Relationships

L1.2.1 Use mathematical symbols to represent quantitative relationships and situations.

L1.2.2 Interpret representations that reflect absolute value relationships in such contexts as error tolerance.

L1.2.3 Use vectors to represent quantities that have magnitude and direction, interpret direction and magnitude of a vector numerically, and calculate the sum and difference of two vectors.

L1.2.4 Organize and summarize a data set in a table, plot, chart, or spreadsheet; find patterns in a display of data; understand and critique data displays in the media.

L1.3 Counting and Probabilistic Reasoning

L1.3.1 Describe, explain, and apply various counting techniques; relate combinations to Pascal's triangle; know when to use each technique.

L1.3.2 Define and interpret commonly used expressions of probability.

L1.3.3 Recognize and explain common probability misconceptions such as "hot streaks" and "being due."

STANDARD L2: CALCULATION, ALGORITHMS, AND ESTIMATION

Students calculate fluently, estimate proficiently, and describe and use algorithms in appropriate situations (e.g., approximating solutions to equations). They understand the basic ideas of iteration and algorithms.

L2.1 Calculation Using Real and Complex Numbers

L2.1.1 Explain the meaning and uses of weighted averages.

L2.1.2 Calculate fluently with numerical expressions involving exponents; use the rules of exponents; evaluate numerical expressions involving rational and negative exponents; transition easily between roots and exponents.

L2.1.3 Explain the exponential relationship between a number and its base 10 logarithm and use it to relate rules of logarithms to those of exponents in expressions involving numbers.

L2.1.4 Know that the complex number i is one of two solutions to $x^2 = -1$.

L2.1.5 Add, subtract, and multiply complex numbers; use conjugates to simplify quotients of complex numbers.

L2.2 Sequences and Iteration

L2.2.1 Find the nth term in arithmetic, geometric, or other simple sequences.

L2.2.2 Compute sums of finite arithmetic and geometric sequences.

L2.2.3 Use iterative processes in such examples as computing compound interest or applying approximation procedures.

L2.3 Measurement Units, Calculations, and Scales

L2.3.1 Convert units of measurement within and between systems; explain how arithmetic operations on measurements affect units, and carry units through calculations correctly.

L2.3.2 Describe and interpret logarithmic relationships in such contexts as the Richter scale, the pH scale, or decibel measurements; solve applied problems.

L2.4 Understanding Error

L2.4.1 Determine what degree of accuracy is reasonable for measurements in a given situation; express accuracy through use of significant digits, error tolerance, or percent of error; describe how errors in measurements are magnified by computation; recognize accumulated error in applied situations.

L2.4.2 Describe and explain round-off error, rounding, and truncating.

L2.4.3 Know the meaning of and interpret statistical significance, margin of error, and confidence level.

STANDARD L3: MATHEMATICAL REASONING, LOGIC, AND PROOF

Students understand mathematical reasoning as being grounded in logic and proof and can distinguish mathematical arguments from other types of arguments. They can interpret arguments made about quantitative situations in the popular media. Students know the language and laws of logic and can apply them in both mathematical and everyday settings. They write proofs using direct and indirect methods and use counterexamples appropriately to show that statements are false.

L3.1 Mathematical Reasoning

L3.1.1 Distinguish between inductive and deductive reasoning, identifying and providing examples of each.

L3.1.2 Differentiate between statistical arguments (statements verified empirically using examples or data) and logical arguments based on the rules of logic.

L3.1.3 Define and explain the roles of axioms (postulates), definitions, theorems, counterexamples, and proofs in the logical structure of mathematics. Identify and give examples of each.

L3.2 Language and Laws of Logic

L3.2.1 Know and use the terms of basic logic.

L3.2.2 Use the connectives "not," "and," "or," and "if…, then," in mathematical and everyday settings. Know the truth table of each connective and how to logically negate statements involving these connectives.

L3.2.3 Use the quantifiers "there exists" and "all" in mathematical and everyday settings and know how to logically negate statements involving them.

L3.2.4 Write the converse, inverse, and contrapositive of an "if…, then…" statement. Use the fact, in mathematical and everyday settings, that the contrapositive is logically equivalent to the original, while the inverse and converse are not.

L3.3 Proof

L3.3.1 Know the basic structure for the proof of an "if…, then…" statement (assuming the hypothesis and ending with the conclusion) and that proving the contrapositive is equivalent.

L3.3.2 Construct proofs by contradiction. Use counterexamples, when appropriate, to disprove a statement.

L3.3.3 Explain the difference between a necessary and a sufficient condition within the statement of a theorem. Determine the correct conclusions based on interpreting a theorem in which necessary or sufficient conditions in the theorem or hypothesis are satisfied.

RECOMMENDED:

***L1.2.5** Read and interpret representations from various technological sources, such as contour or isobar diagrams.

***L2.1.7** Understand the mathematical bases for the differences among voting procedures.

***L2.2.4** Compute sums of infinite geometric sequences.

STRAND 2: ALGEBRA AND FUNCTIONS (A)

In the middle grades, students see the progressive generalization of arithmetic to algebra. They learn symbolic manipulation skills and use them to solve equations. They study simple forms of elementary polynomial functions such as linear, quadratic, and power functions as represented by tables, graphs, symbols, and verbal descriptions.

In high school, students continue to develop their "symbol sense" by examining expressions, equations, and functions, and applying algebraic properties to solve equations. They construct a conceptual framework for analyzing any function and, using this framework, they revisit the functions they have studied before in greater depth. By the end of high school, their catalog of functions will encompass linear, quadratic, polynomial, rational, power, exponential, logarithmic, and trigonometric functions. They will be able to reason about functions and their properties and solve multistep problems that involve both functions and equation-solving. Students will use deductive reasoning to justify algebraic processes as they solve equations and inequalities, as well as when transforming expressions.

This rich learning experience in Algebra will provide opportunities for students to understand both its structure and its applicability to solving real-world problems. Students will view algebra as a tool for analyzing and describing mathematical relationships, and for modeling problems that come from the workplace, the sciences, technology, engineering, and mathematics.

STANDARD A1: EXPRESSIONS, EQUATIONS, AND INEQUALITIES

Students recognize, construct, interpret, and evaluate expressions. They fluently transform symbolic expressions into equivalent forms. They determine appropriate techniques for solving each type of equation, inequality, or system of equations, apply the techniques correctly to solve, justify the steps in the solutions, and draw conclusions from the solutions. They know and apply common formulas.

A1.1 Construction, Interpretation, and Manipulation of Expressions

- **A1.1.1** Give a verbal description of an expression that is presented in symbolic form, write an algebraic expression from a verbal description, and evaluate expressions given values of the variables.
- **A1.1.2** Know the definitions and properties of exponents and roots transition fluently between them, and apply them in algebraic expressions.
- **A1.1.3** Factor algebraic expressions using, for example, greatest common factor, grouping, and the special product identities.
- **A1.1.4** Add, subtract, multiply, and simplify polynomials and rational expressions.
- **A1.1.5** Divide a polynomial by a monomial.
- **A1.1.6** Transform exponential and logarithmic expressions into equivalent forms using the properties of exponents and logarithms, including the inverse relationship between exponents and logarithms.

A1.2 Solutions of Equations and Inequalities

- **A1.2.1** Write equations and inequalities with one or two variables to represent mathematical or applied situations, and solve.
- **A1.2.2** Associate a given equation with a function whose zeros are the solutions of the equation.
- **A1.2.3** Solve linear and quadratic equations and inequalities including systems of up to three linear equations with three unknowns. Justify steps in the solution, and apply the quadratic formula appropriately.
- **A1.2.4** Solve absolute value equations and inequalities, and justify steps in the solution.
- **A1.2.5** Solve polynomial equations and equations involving rational expressions, and justify steps in the solution.

A1.2.6 Solve power equations and equations including radical expressions, justify steps in the solution, and explain how extraneous solutions may arise.

A1.2.7 Solve exponential and logarithmic equations, and justify steps in the solution.

A1.2.8 Solve an equation involving several variables (with numerical or letter coefficients) for a designated variable. Justify steps in the solution.

A1.2.9 Know common formulas and apply appropriately in contextual situations.

A1.2.10 Use special values of the inverse trigonometric functions to solve trigonometric equations over specific intervals.

STANDARD A2: FUNCTIONS

Students understand functions, their representations, and their attributes. They perform transformations, combine and compose functions, and find inverses. Students classify functions and know the characteristics of each family. They work with functions with real coefficients fluently. Students construct or select a function to model a real-world situation in order to solve applied problems. They draw on their knowledge of families of functions to do so.

A2.1 Definitions, Representations, and Attributes of Functions

A2.1.1 Determine whether a relationship (given in contextual, symbolic, tabular, or graphical form) is a function and identify its domain and range.

A2.1.2 Read, interpret, and use function notation and evaluate a function at a value in its domain.

A2.1.3 Represent functions in symbols, graphs, tables, diagrams, or words and translate among representations.

A2.1.4 Recognize that functions may be defined by different expressions over different intervals of their domains; such functions are piecewise-defined.

A2.1.5 Recognize that functions may be defined recursively. Compute values of and graph simple recursively defined functions.

A2.1.6 Identify the zeros of a function, the intervals where the values of a function are positive or negative, and describe the behavior of a function as x approaches positive or negative infinity, given the symbolic and graphical representations.

A2.1.7 Identify and interpret the key features of a function from its graph or its formula(e).

A2.2 Operations and Transformations

A2.2.1 Combine functions by addition, subtraction, multiplication, and division.

A2.2.2 Apply given transformations to basic functions and represent symbolically.

A2.2.3 Recognize whether a function (given in tabular or graphical form) has an inverse and recognize simple inverse pairs.

A2.3 Representations of Functions

A2.3.1 Identify a function as a member of a family of functions based on its symbolic or graphical representation; recognize that different families of functions have different asymptotic behavior.

A2.3.2 Describe the tabular pattern associated with functions having constant rate of change (linear); or variable rates of change.

A2.3.3 Write the general symbolic forms that characterize each family of functions.

A2.4 Models of Real-world Situations Using Families of Functions

A2.4.1 Identify the family of function best suited for modeling a given real-world situation.

A2.4.2 Adapt the general symbolic form of a function to one that fits the specification of a given situation by using the information to replace arbitrary constants with numbers.

A2.4.3 Using the adapted general symbolic form, draw reasonable conclusions about the situation being modeled.

STANDARD A3: FAMILIES OF FUNCTIONS

Students study the symbolic and graphical forms of each function family. By recognizing the unique characteristics of each family, they can use them as tools for solving problems or for modeling real-world situations.

A3.1 Lines and Linear Functions

A3.1.1 Write the symbolic forms of linear functions (standard, point-slope, and slope-intercept) given appropriate information, and convert between forms.

A3.1.2 Graph lines (including those of the form $x = h$ and $y = k$) given appropriate information.

A3.1.3 Relate the coefficients in a linear function to the slope and x- and y-intercepts of its graph.

A3.1.4 Find an equation of the line parallel or perpendicular to given line, through a given point; understand and use the facts that non-vertical parallel lines have equal slopes, and that non-vertical perpendicular lines have slopes that multiply to give -1.

A3.2 Exponential and Logarithmic Functions

A3.2.1 Write the symbolic form and sketch the graph of an exponential function given appropriate information.

A3.2.2 Interpret the symbolic forms and recognize the graphs of exponential and logarithmic functions; recognize the logarithmic function as the inverse of the exponential function.

A3.2.3 Apply properties of exponential and logarithmic functions.

A3.2.4 Understand and use the fact that the base of an exponential function determines whether the function increases or decreases and understand how the base affects the rate of growth or decay.

A.3.2.5 Relate exponential and logarithmic functions to real phenomena, including half-life and doubling time.

A3.3 Quadratic Functions

A3.3.1 Write the symbolic form and sketch the graph of a quadratic function given appropriate information.

A3.3.2 Identify the elements of a parabola (vertex, axis of symmetry, direction of opening) given its symbolic form or its graph, and relate these elements to the coefficient(s) of the symbolic form of the function.

A3.3.3 Convert quadratic functions from standard to vertex form by completing the square.

A3.3.4 Relate the number of real solutions of a quadratic equation to the graph of the associated quadratic function.

A3.3.5 Express quadratic functions in vertex form to identify their maxima or minima, and in factored form to identify their zeros.

A3.4 Power Functions

A3.4.1 Write the symbolic form and sketch the graph of power functions.

A3.4.2 Express direct and inverse relationships as functions and recognize their characteristics.

A3.4.3 Analyze the graphs of power functions, noting reflectional or rotational symmetry.

A3.5 Polynomial Functions

A3.5.1 Write the symbolic form and sketch the graph of simple polynomial functions.

A3.5.2 Understand the effects of degree, leading coefficient, and number of real zeros on the graphs of polynomial functions of degree greater than 2.

A3.5.3 Determine the maximum possible number of zeros of a polynomial function, and understand the relationship between the *x*-intercepts of the graph and the factored form of the function.

A3.6 Rational Functions

A3.6.1 Write the symbolic form and sketch the graph of simple rational functions.

A3.6.2 Analyze graphs of simple rational functions and understand the relationship between the zeros of the numerator and denominator and the function's intercepts, asymptotes, and domain.

A3.7 Trigonometric Functions

A3.7.1 Use the unit circle to define sine and cosine; approximate values of sine and cosine; use sine and cosine to define the remaining trigonometric functions; explain why the trigonometric functions are periodic.

A3.7.2 Use the relationship between degree and radian measures to solve problems.

A3.7.3 Use the unit circle to determine the exact values of sine and cosine, for integer multiples of $\pi/6$ and $\pi/4$.

A3.7.4 Graph the sine and cosine functions; analyze graphs by noting domain, range, period, amplitude, and location of maxima and minima.

A3.7.5 Graph transformations of basic trigonometric functions (involving changes in period, amplitude, and midline) and understand the relationship between constants in the formula and the transformed graph.

RECOMMENDED:

***A1.1.7** Transform trigonometric expressions into equivalent forms using basic identities such as $\sin^2\theta + \cos^2\theta = 1$ and $\tan^2\theta + 1 = \sec^2\theta$

***A2.2.4** If a function has an inverse, find the expression(s) for the inverse.

***A2.2.5** Write an expression for the composition of one function with another; recognize component functions when a function is a composition of other functions.

***A2.2.6** Know and interpret the function notation for inverses and verify that two functions are inverses using composition.

***A2.4.4** Use methods of linear programming to represent and solve simple real-life problems.

STRAND 3: GEOMETRY AND TRIGONOMETRY (G)

In Grades K–5, students study figures such as triangles, rectangles, circles, rectangular solids, cylinders, and spheres. They examine similarities and differences between geometric shapes. They learn to quantify geometric figures by measuring and calculating lengths, angles, areas and volumes. In Grades 6-8, students broaden their understanding of area and volume and develop the basic concepts of congruence, similarity, symmetry and the Pythagorean Theorem. They apply these ideas to solve geometric problems, including ones related to the real world.

In Grades 9–12, students see geometry developed as a coherent, structured subject. They use the geometric skills and ideas introduced earlier, such as congruence and similarity, to solve a wide variety of problems. There is an emphasis on the importance of clear language and on learning to construct geometric proofs. In this process, students build geometric intuition and facility at deductive reasoning. They use elements of logic and reasoning as described in the Quantitative Literacy and Logic strand, including both direct and indirect proof presented in narrative form. They begin to use new techniques, including transformations and trigonometry. They apply these ideas to solve complex problems about two- and three-dimensional figures, again including ones related to the real world. Their spatial visualization skills will be developed through the study of the relationships between two- and three-dimensional shapes.

STANDARD G1: FIGURES AND THEIR PROPERTIES

Students represent basic geometric figures, polygons, and conic sections and apply their definitions and properties in solving problems and justifying arguments, including constructions and representations in the coordinate plane. Students represent three-dimensional figures, understand the concepts of volume and surface area, and use them to solve problems. They know and apply properties of common three-dimensional figures.

G1.1 Lines and Angles; Basic Euclidean and Coordinate Geometry

G1.1.1 Solve multistep problems and construct proofs involving vertical angles, linear pairs of angles supplementary angles, complementary angles, and right angles.

G1.1.2 Solve multistep problems and construct proofs involving corresponding angles, alternate interior angles, alternate exterior angles, and same-side (consecutive) interior angles.

G1.1.3 Perform and justify constructions, including midpoint of a line segment and bisector of an angle, using straightedge and compass.

G1.1.4 Given a line and a point, construct a line through the point that is parallel to the original line using straightedge and compass. Given a line and a point, construct a line through the point that is perpendicular to the original line. Justify the steps of the constructions.

G1.1.5 Given a line segment in terms of its endpoints in the coordinate plane, determine its length and midpoint.

G1.1.6 Recognize Euclidean geometry as an axiom system. Know the key axioms and understand the meaning of and distinguish between undefined terms, axioms, definitions, and theorems.

G1.2 Triangles and Their Properties

G1.2.1 Prove that the angle sum of a triangle is 180° and that an exterior angle of a triangle is the sum of the two remote interior angles.

G1.2.2 Construct and justify arguments and solve multistep problems involving angle measure, side length, perimeter, and area of all types of triangles.

G1.2.3 Know a proof of the Pythagorean Theorem, and use the Pythagorean Theorem and its converse to solve multistep problems.

G1.2.4 Prove and use the relationships among the side lengths and the angles of 30º- 60º- 90º triangles and 45º- 45º- 90º triangles.

G1.2.5 Solve multistep problems and construct proofs about the properties of medians, altitudes, perpendicular bisectors to the sides of a triangle, and the angle bisectors of a triangle. Using a straightedge and compass, construct these lines.

G1.3 Triangles and Trigonometry

G1.3.1 Define the sine, cosine, and tangent of acute angles in a right triangle as ratios of sides. Solve problems about angles, side lengths, or areas using trigonometric ratios in right triangles.

G1.3.2 Know and use the Law of Sines and the Law of Cosines and use them to solve problems. Find the area of a triangle with sides a and b and included angle θ using the formula Area = (1/2) $ab\sin\theta$.

G1.3.3 Determine the exact values of sine, cosine, and tangent for 0°, 30°, 45°, 60°, and their integer multiples and apply in various contexts.

G1.4 Quadrilaterals and Their Properties

G1.4.1 Solve multistep problems and construct proofs involving angle measure, side length, diagonal length, perimeter, and area of squares, rectangles, parallelograms, kites, and trapezoids.

G1.4.2 Solve multistep problems and construct proofs involving quadrilaterals using Euclidean methods or coordinate geometry.

G1.4.3 Describe and justify hierarchical relationships among quadrilaterals.

G1.4.4 Prove theorems about the interior and exterior angle sums of a quadrilateral.

G1.5 Other Polygons and Their Properties

G1.5.1 Know and use subdivision or circumscription methods to find areas of polygons.

G1.5.2 Know, justify, and use formulas for the perimeter and area of a regular n-gon and formulas to find interior and exterior angles of a regular n-gon and their sums.

G1.6 Circles and Their Properties

G1.6.1 Solve multistep problems involving circumference and area of circles.

G1.6.2 Solve problems and justify arguments about chords and lines tangent to circles.

G1.6.3 Solve problems and justify arguments about central angles, inscribed angles, and triangles in circles.

G1.6.4 Know and use properties of arcs and sectors and find lengths of arcs and areas of sectors.

G1.7 Conic Sections and Their Properties

G.1.7.1 Find an equation of a circle given its center and radius; given the equation of a circle, find its center and radius.

G1.7.2 Identify and distinguish among geometric representations of parabolas, circles, ellipses, and hyperbolas; describe their symmetries, and explain how they are related to cones.

G1.7.3 Graph ellipses and hyperbolas with axes parallel to the *x*- and *y*-axes, given equations.

G1.8 Three- Dimensional Figures

G1.8.1 Solve multistep problems involving surface area and volume of pyramids, prisms, cones, cylinders, hemispheres, and spheres.

G1.8.2 Identify symmetries of pyramids, prisms, cones, cylinders, hemispheres, and spheres.

STANDARD G2: RELATIONSHIPS BETWEEN FIGURES

Students use and justify relationships between lines, angles, area and volume formulas, and 2- and 3-dimensional representations. They solve problems and provide proofs about congruence and similarity.

G2.1 Relationships Between Area and Volume Formulas

G2.1.1 Know and demonstrate the relationships between the area formula of a triangle, the area formula of a parallelogram, and the area formula of a trapezoid.

G2.1.2 Know and demonstrate the relationships between the area formulas of various quadrilaterals.

G2.1.3 Know and use the relationship between the volumes of pyramids and prisms (of equal base and height) and cones and cylinders (of equal base and height).

G2.2 Relationships Between Two-dimensional and Three-dimensional Representations

G2.2.1 Identify or sketch a possible three-dimensional figure, given two-dimensional views. Create a two-dimensional representation of a three-dimensional figure.

G2.2.2 Identify or sketch cross sections of three-dimensional figures. Identify or sketch solids formed by revolving two-dimensional figures around lines.

G2.3 Congruence and Similarity

G2.3.1 Prove that triangles are congruent using the SSS, SAS, ASA, and AAS criteria, and that right triangles, are congruent using the hypotenuse-leg criterion.

G2.3.2 Use theorems about congruent triangles to prove additional theorems and solve problems, with and without use of coordinates.

G2.3.3 Prove that triangles are similar by using SSS, SAS, and AA conditions for similarity.

G2.3.4 Use theorems about similar triangles to solve problems with and without use of coordinates.

G2.3.5 Know and apply the theorem stating that the effect of a scale factor of k relating one two-dimensional figure to another or one three-dimensional figure to another, on the length, area, and volume of the figures is to multiply each by k, k^2, and k^3, respectively.

STANDARD G3: TRANSFORMATIONS OF FIGURES IN THE PLANE

Students will solve problems about distance-preserving transformations and shape-preserving transformations. The transformations will be described synthetically and, in simple cases, by analytic expressions in coordinates.

G3.1 Distance-preserving Transformations: Isometries

G3.1.1 Define reflection, rotation, translation, and glide reflection and find the image of a figure under a given isometry.

G3.1.2 Given two figures that are images of each other under an isometry, find the isometry and describe it completely.

G3.1.3 Find the image of a figure under the composition of two or more isometries and determine whether the resulting figure is a reflection, rotation, translation, or glide reflection image of the original figure.

G3.2 Shape-preserving Transformations: Dilations and Isometries

G3.2.1 Know the definition of dilation and find the image of a figure under a given dilation.

G3.2.2 Given two figures that are images of each other under some dilation, identify the center and magniture of the dilation.

Recommended:

*G1.4.5 Understand the definition of a cyclic quadrillateral and know and use the basic properties of cyclic quadrilaterals.

*G1.7.4 Know and use the relationship between the vertices and foci in and ellipse, the vertices and foci in a hyperboia, and the directrix and focus in a parabola, interpret these relationships in applied contexts.

*G3.2.3 Find the image of a figure under the composition of a dilation and an isometry.

STRAND 4: STATISTICS AND PROBABILITY (S)

In Kindergarten through Grade 8, students develop the ability to read, analyze, and construct a repertoire of statistical graphs. Students also examine the fundamentals of experimental and theoretical probability in informal ways. The Basic Counting Principle and tree diagrams serve as tools to solve simple counting problems in these grades.

During high school, students build on that foundation. They develop the data interpretation and decision-making skills that will serve them in their further study of mathematics as well as in their coursework in the physical, biological, and social sciences. Students learn important skills related to the collection, display, and interpretation of both univariate and bivariate data. They understand basic sampling methods and apply principles of effective data analysis and data presentation. These skills are also highly valuable outside of school, both in the workplace and in day-to-day life.

In probability, students utilize probability models to calculate probabilities and make decisions. The normal distribution and its properties are studied. Students then use their understanding of probability to make decisions, solve problems, and determine whether or not statements about probabilities of events are reasonable. Students use technology when appropriate, including spreadsheets. This strong background in statistics and probability will enable students to be savvy decision-makers and smart information-consumers and producers who have a full range of tools in order to make wise choices.

STANDARD S1: UNIVARIATE DATA – EXAMINING DISTRIBUTIONS

Students plot and analyze univariate data by considering the shape of distributions and analyzing outliers; they find and interpret commonly-used measures of center and variation; and they explain and use properties of the normal distribution.

S1.1 Producing and Interpreting Plots

S1.1.1 Construct and interpret dot plots, histograms, relative frequency histograms, bar graphs, basic control charts, and box plots with appropriate labels and scales; determine which kinds of plots are appropriate for different types of data; compare data sets and interpret differences based on graphs and summary statistics.

S1.1.2 Given a distribution of a variable in a data set, describe its shape, including symmetry or skewness, and state how the shape is related to measures of center (mean and median) and measures of variation (range and standard deviation) with particular attention to the effects of outliers on these measures.

S1.2 Measures of Center and Variation

S1.2.1 Calculate and interpret measures of center including: mean, median, and mode; explain uses, advantages and disadvantages of each measure given a particular set of data and its context.

S1.2.2 Estimate the position of the mean, median, and mode in both symmetrical and skewed distributions, and from a frequency distribution or histogram.

S1.2.3 Compute and interpret measures of variation, including percentiles, quartiles, interquartile range, variance, and standard deviation.

S1.3 The Normal Distribution

S1.3.1 Explain the concept of distribution and the relationship between summary statistics for a data set and parameters of a distribution.

S1.3.2 Describe characteristics of the normal distribution, including its shape and the relationships among its mean, median, and mode.

S1.3.3 Know and use the fact that about 68%, 95%, and 99.7% of the data lie within one, two, and three standard deviations of the mean, respectively in a normal distribution.

S1.3.4 Calculate *z*-scores, use *z*-scores to recognize outliers, and use *z*-scores to make informed decisions.

STRAND 4: STATISTICS AND PROBABILITY (CONT.)

STANDARD S2: BIVARIATE DATA – EXAMINING RELATIONSHIPS

Students plot and interpret bivariate data by constructing scatterplots, recognizing linear and nonlinear patterns, and interpreting correlation coefficients; they fit and interpret regression models, using technology as appropriate.

S2.1 Scatterplots and Correlation

S2.1.1 Construct a scatterplot for a bivariate data set with appropriate labels and scales.

S2.1.2 Given a scatterplot, identify patterns, clusters, and outliers. Recognize no correlation, weak correlation, and strong correlation.

S2.1.3 Estimate and interpret Pearson's correlation coefficient for a scatterplot of a bivariate data set. Recognize that correlation measures the strength of linear association.

S2.1.4 Differentiate between correlation and causation. Know that a strong correlation does not imply a cause-and-effect relationship. Recognize the role of lurking variables in correlation.

S2.2 Linear Regression

S2.2.1 For bivariate data that appear to form a linear pattern, find the least squares regression line by estimating visually and by calculating the equation of the regression line. Interpret the slope of the equation for a regression line.

S2.2.2 Use the equation of the least squares regression line to make appropriate predictions.

STANDARD S3: SAMPLES, SURVEYS, AND EXPERIMENTS

Students understand and apply sampling and various sampling methods, examine surveys and experiments, identify bias in methods of conducting surveys, and learn strategies to minimize bias. They understand basic principles of good experimental design.

S3.1 Data Collection and Analysis

S3.1.1 Know the meanings of a sample from a population and a census of a population, and distinguish between sample statistics and population parameters.

S3.1.2 Identify possible sources of bias in data collection and sampling methods and simple experiments; describe how such bias can be reduced and controlled by random sampling; explain the impact of such bias on conclusions made from analysis of the data; and know the effect of replication on the precision of estimates.

S3.1.3 Distinguish between an observational study and an experimental study, and identify, in context, the conclusions that can be drawn from each.

STANDARD S4: PROBABILITY MODELS AND PROBABILITY CALCULATION

Students understand probability and find probabilities in various situations, including those involving compound events, using diagrams, tables, geometric models and counting strategies; they apply the concepts of probability to make decisions.

S4.1 Probability

S4.1.1 Understand and construct sample spaces in simple situations.

S4.1.2 Define mutually exclusive events, independent events, dependent events, compound events, complementary events and conditional probabilities; and use the definitions to compute probabilities.

STRAND 4: STATISTICS AND PROBABILITY (CONT.)

S4.2 Application and Representation

S4.2.1 Compute probabilities of events using tree diagrams, formulas for combinations and permutations, Venn diagrams, or other counting techniques.

S4.2.2 Apply probability concepts to practical situations, in such settings as finance, health, ecology, or epidemiology, to make informed decisions.

RECOMMENDED:

***S3.1.4** Design simple experiments or investigations to collect data to answer questions of interest; interpret and present results.

***S3.1.5** Understand methods of sampling, including random sampling, stratified sampling, and convenience samples, and be able to determine, in context, the advantages and disadvantages of each.

***S3.1.6** Explain the importance of randomization, double-blind protocols, replication, and the placebo effect in designing experiments and interpreting the results of studies.

***S3.2.1** Explain the basic ideas of statistical process control, including recording data from a process over time.

***S3.2.2** Read and interpret basic control charts; detect patterns and departures from patterns.

***S4.1.3** Design and carry out an appropriate simulation using random digits to estimate answers to questions about probability; estimate probabilities using results of a simulation; compare results of simulations to theoretical probabilities.

Office of School Improvement

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High School Content Expectations

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- World History and Geography
- United States History and Geography
- Civics
- Economics

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Welcome to Michigan's High School Social Studies Content Standards and Expectations

Why Develop Content Standards and Expectations for High School?

In 2004, the State Board of Education and the Michigan Department of Education embraced the challenge to initiate a "high school redesign" project. Since then, the national call to create more rigorous learning for high school students has become a major priority for state leaders across the country. The Cherry Commission Report highlighted several goals for Michigan including the development of high school content expectations that reflect both a rigorous and a relevant curricular focus. Dovetailing with this call to "curricular action" is Michigan's legislative change in high school assessment. The Michigan Merit Exam, based on rigorous high school learning standards, was implemented in 2007 and will be fully aligned with these expectations by 2010.

The Michigan Department of Education's Office of School Improvement led the development of K-12 content expectations. Content area work groups submitted drafts to a web-based state wide review. Following the web based review, a scholarly review by experts outside of Michigan was completed to identify the national stature of the document and make recommended changes. The content standards and expectations presented in this document reflect the ideas expressed in the extensive field and national reviews, and input from the State Board of Education.

The High School Content Expectations (HSCE) establish what every student is expected to know by the end of high school. Social Studies High School Content Expectations are not a social studies curriculum nor are they intended to limit what is taught. They are meant to be used as a guide for both curriculum development and assessment of learning, and the Michigan Merit exam.

Creating Social Studies Expectations with a National Perspective

The content expectations contained in this document reflect best practices and current research in the teaching and learning of social studies. They build from the *Michigan Social Studies Curriculum Framework Standards and Benchmarks* (1996) and include The Michigan State Board of Education's *Policy on Learning Expectations for Michigan Students* (2002). These standards and expectations represent a vision for a rigorous and relevant high school experience for all Michigan students over the next five to ten years. Special attention has been paid to national research and support for the skills that prepare students for successful post-secondary educational engagement and future roles in the work place, including the Standards for Success report *Understanding University Success.*

The standards and expectations are closely aligned with the following national standards and frameworks: *National Standards for Civics and Government* (1994); *National Content Standards in Economics* (1997); *National Geography Standards: Geography for Life*, (1994); *National Standards for History Basic Education* (1996); *National Standards for United States History: Exploring the American Experience*, (1993); *National Standards for World History: Exploring Paths to the Present,*(1993); National Assessment Governing Board's U.S. History, Civics, and Economics Frameworks for the 2006 NAEP Assessments, and Geography Framework for the 1994 and 2001 NAEP Assessments; and National Council for the Social Studies *Expectations of Excellence: Curriculum Standards for Social Studies,* (1994). Students whose work is guided by these standards and expectations will be prepared for responsible citizenship, post-secondary education, and the workplace.

The Challenges of Developing Content Expectations in Social Studies

At the national level and in just about every state, establishing standards and benchmarks in the social studies has been a challenging endeavor, filled with political and pedagogical controversy. Three enduring educational issues have challenged the creation of standards/content expectations to guide instruction and assessment in Michigan: (1) The challenge of integrating separate disciplines, (2) The challenge of representing both thinking and substance, and (3) The challenge of determining an effective K-12 scope and sequence.

First, while everyone recognizes that social studies is an amalgam of four or more disciplines including history, civics, economics and geography, there is no consensus concerning the appropriate mix of these or the appropriate place of each in the curriculum. Critical questions about the relationship among the content areas or even the relative amount of each area in the standards and eventually in the curriculum have not been resolved. Therefore, one critical challenge is to find ways to make connections within and across content areas.

Second, social studies educators face a problem in trying to reflect both disciplinary "thinking" and "substance" in standards documents. This is particularly true in history and civics where people want students to develop more sophisticated ways to think about contemporary issues and to draw upon specific knowledge of the past and the present in their thinking. So, standards and content expectations must include both thinking and knowledge expectations in such a combination that can effectively guide teachers, curriculum designers, and, of course, assessors.

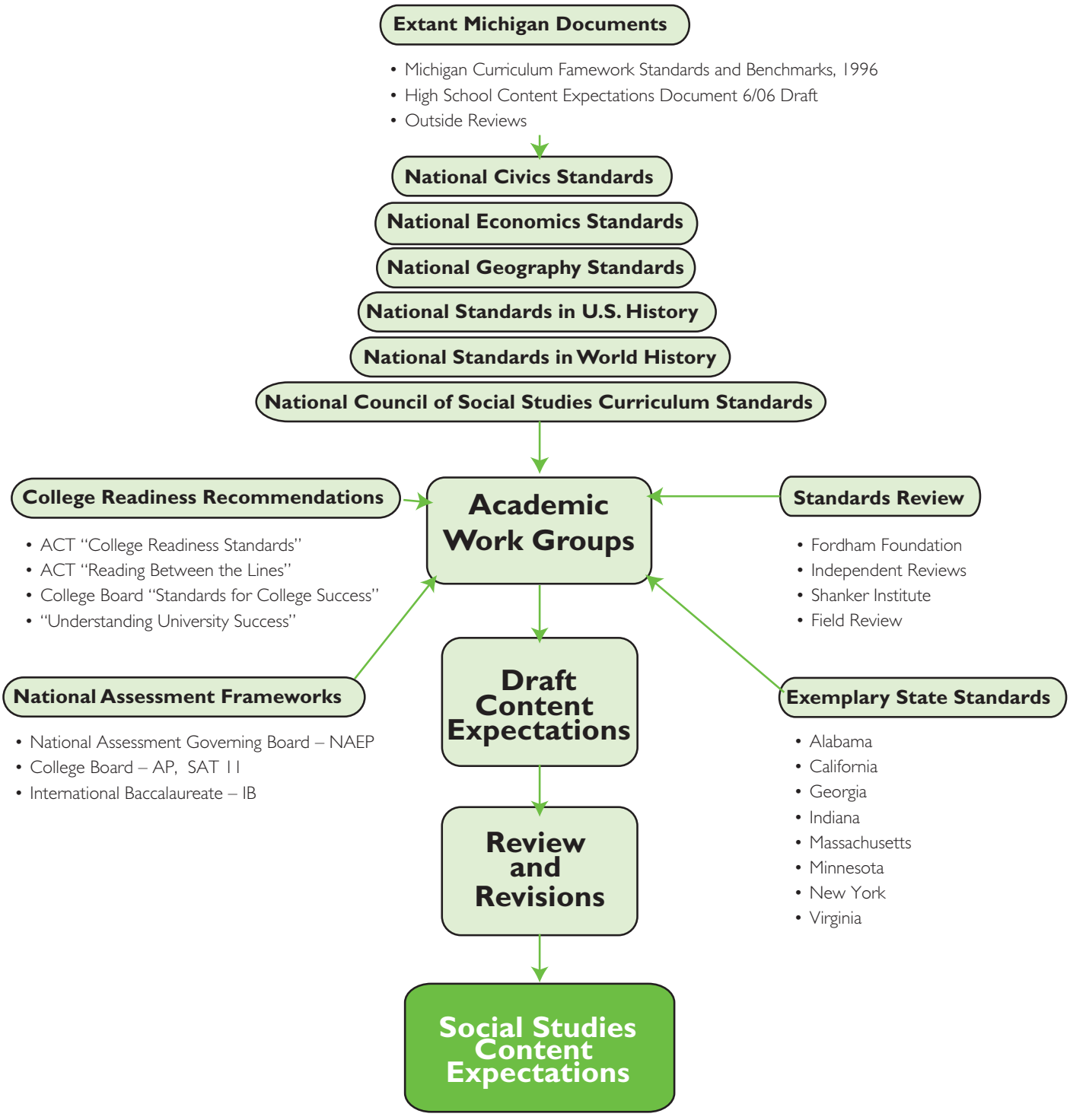
When standards documents stress "thinking" at the expense of "substance," teachers and educational critics often argue these appear vague and offer little guidance for deciding what content should be taught and tested. Teachers often complain that the mandated tests assess content not specified in standards or benchmarks.

On the other hand, standards that specify more substantive detail face their own critics who argue that such detail is too prescriptive and gives too much content to be effectively assessed in large-scale, multiple-choice dominated exams. A second challenge, therefore, is to provide more substance to meet the criticism that Michigan's standards were too vague without losing sight of the central purposes for offering social studies.

Finally, there is the challenge of creating a sensible and educationally sound K-12 scope and sequence. For many years, states required the full run of U.S. history in grades 5, 8 and 11. Critics argued this privileged breadth over depth, and urged dividing historical content into three sections for students to study in more depth in 5th, 8th and 11th grades. Still others argued that this arrangement was asking very young students(e.g., 5th graders) to study, remember, and be able to use very sophisticated concepts and events five or six years later when they were studying U.S. history in high school. Most advanced courses rely upon earlier grades to develop foundational skills and knowledge, but do not expect earlier grades to help students achieve the sophisticated study possible in high school. Thus they begin their studies of U.S. history at the "beginning." In short, social studies educators have developed three different and compelling patterns for structuring the scope and sequence in social studies.

The standards and expectations that follow represent the best efforts of the various writing and review committees to provide the integration, coherence, and the scope and sequence that will guide instruction and assessment in Michigan.

Process for Creating Content Expectations with a National Perspective



Understanding the Organizational Structure

The Grade Level Content Expectations for Grades K-8 and the High School Content Expectations for Social Studies are organized by discipline and standard using national standards structures as indicated in the chart below.

K-12 Organizational Chart

History

National Standards for Historical Thinking

H1 The World in Temporal Terms: Historical Habits of Mind
- 1.1 Temporal Thinking
- 1.2 Historical Analysis and Interpretation
- 1.3 Historical Inquiry
- 1.4 Historical Understanding
- 1.5 Historical Issues-Analysis and Decision Making

Themes Representing National Standards (K-4)

H2 Living and Working Together in Families and Communities, Now and Long Ago

H3 The History of Michigan and the Great Lakes Region

H4 The History of the United States

H5 The History of Peoples from Many Cultures Around the World

Eras Representing National Standards (5-12)

Global Analysis of World History Eras 1-8 from three pespectives
- *Cross-temporal/Global*
- *Interregional /Comparative*
- *Regional*

W1 Beginnings of Human Society

W2 Early Civilizations and Cultures and the Emergence of Pastoral Peoples

W3 Classical Traditions, World Religions, and Major Empires

W4 Expanding and Intensified Hemispheric Interactions

W5 Emergence of the First Global Age

W6 An Age of Global Revolutions

W7 Global Crisis and Achievement

W8 The Cold War and Its Aftermath (P3, P4)

Thematic Analysis of U.S. History Eras 1-9

U1 Beginnings to 1620

U2 Colonization and Settlement

U3 Revolution and the New Nation

U4 Expansion and Reform

U5 Civil War and Reconstruction

U6 The Development of an Industrial, Urban, and Global United States

U7 The Great Depression and World War II

U8 Post-World War II United States

U9 America in a New Global Age (P3, P4)

Geography

National Geography Standards

G1 The World in Spatial Terms: Geographical Habits of Mind
- 1.1 Spatial Thinking
- 1.2 Geographical Inquiry and Analysis
- 1.3 Geographical Understanding

G2 Places and Regions
- 2.1 Physical Characteristics of Place
- 2.2 Human Characteristics of Place

G3 Physical Systems
- 3.1 Physical Processes
- 3.2 Ecosystems

G4 Human Systems
- 4.1 Cultural Mosaic
- 4.2 Patterns of Human Settlement
- 4.3 Forces of Cooperation and Conflict
- 4.4 Economic Interdependence

G5 Environment and Society
- 5.1 Humans and the Environment
- 5.2 Physical and Human Systems

G6 Global Issues Past and Present
- 6.1 Global Topic Investigation and Issue Analysis (P2)

Civics/Government

National Civics Standards

C1 Conceptual Foundations of Civic and Political Life
- 1.1 Nature of Civic Life
- 1.2 Forms of Government

C2 Values and Principles of American Democracy
- 2.1 Origins
- 2.2 Foundational Values and Principles

C3 Structure and Functions of Government
- 3.1 Structure and Functions
- 3.2 Powers and Limits
- 3.3 State and Local Governments
- 3.4 System of Law and Laws
- 3.5 The Policy Process
- 3.6 Characteristics of Nation States

C4 Relationship of the United States to Other Nations and World Affairs
- 4.1 U.S. Foreign Policy
- 4.2 International Institutions and Affairs
- 4.3 Conflict and Cooperation Between and Among Nations

C5 Citizenship in the United States
- 5.1 The Meaning of Citizenship
- 5.2 Becoming a Citizen
- 5.3 Rights
- 5.4 Responsibilities
- 5.5 Dispositions

C6 Citizenship in Action
- 6.1 Civic Inquiry and Public Discourse (P3)
- 6.2 Participating in Civic Life (P4)

Economics

National Economics Standards (NAEP Categories)

E1 The Market Economy
- 1.1 Individual, Business, and Government Choices
- 1.2 Competitive Markets
- 1.3 Prices, Supply, and Demand
- 1.4 Role of Government

E2 The National Economy
- 2.1 Understanding National Markets
- 2.2 Role of Government in the United States Economy

E3 International Economy
- 3.1 Economic Systems
- 3.2 Economic Interdependence – Trade

E4 Personal Finance
- 4.1 Decision Making

Social Studies Knowledge, Processes, and Skills

K1 General Knowledge [College-Readiness]

P1 Reading and Communication [Close and Critical Reading; Analysis; Interpret Primary and Secondary Sources; Argumentation]

P2 Inquiry, Research, and Analysis [Information Processing; Conducting Investigations; Problem-Solving; Technology Use]

P3 Public Discourse and Decision Making
- P3.1 Identifying and Analyzing Public Issues
- P3.2 Discourse Regarding Public Issues
- P3.3 Persuasive Writing on a Public Issue

P4 Citizen Involvement

High School Content Expectations

The High School Standards and Content Expectations for Social Studies are organized by Course/Credit title. The expectations define specific disciplinary knowledge and skills for each course/credit, and include standards and expectations in two other important categories: General Social Science Knowledge and Processes and Skills for Social Studies. The structure is shown in the chart below.

High School Social Studies Organizational Chart

World History and Geography	U.S. History and Geography	Civics	Economics
General Social Studies Knowledge, Processes, and Skills	***General Social Studies Knowledge, Processes, and Skills***	***General Social Studies Knowledge, Processes, and Skills***	***General Social Studies Knowledge, Processes, and Skills***
embedded in WHG expectations See pg. 20	embedded in USHG expectations See pg. 39	embedded in Civics expectations See pg. 52	embedded in Economics expectations See pg. 67
Disciplinary Knowledge	***Disciplinary Knowledge***	***Disciplinary Knowledge***	***Disciplinary Knowledge***
Historical and Geographical Knowledge and Perspective Historical and Geographical Analysis and Interpretation Global Analysis of World History Eras 4 – 8 from three perspectives: global, interregional, regional	Historical and Geographical Knowledge and Perspective Historical and Geographical Analysis and Interpretation Thematic Analysis of United States History Eras 6 – 9	Civics Knowledge Intellectual Skills Participatory Skills Civics Dispositions	Economics Knowledge Intellectual Skills Economic Literacy
F FOUNDATIONS WHG ERAS 1-3 **W4 WHG - Era 4** Expanding and Intensified Hemispheric Interactions, 300 – 1500 C.E./A.D. **W5 WHG - Era 5** The Emergence of the First Global Age, 15th – 18th Centuries **W6 WHG - Era 6** An Age of Global Revolutions, 18th Century – 1914 **W7 WHG - Era 7** Global Crisis and Achievement, 1900 – 1945 **W8 WHG - Era 8** The Cold War and Its Aftermath: The 20th Century Since 1945	**F FOUNDATIONS USHG ERAS 1-5** **U6 USHG - Era 6** The Development of an Industrial, Urban, and Global United States, 1870 – 1930 **U7 USHG - Era 7** The Great Depression and World War 11, 1920 – 1945 **U8 USHG - Era 8** Post-World War 11 United States, 1945 – 1989 **U9 USHG - Era 9** America in a New Global Age, 1980 – present	**C1 Conceptual Foundations of Civic and Political Life** **C2 Origins and Foundations of the Government of the United States of America** **C3 Government in the United States of America** **C4 The Relationship of the United States to Other Nations and World Affairs** **C5 Citizenship in the United States** **C6 Citizenship in Action**	**E1 The Market Economy** **E2 The National Economy** **E3 International Economy**

DESIGNING AN ALIGNED CURRICULUM

This document is intended to support dialogue at the school and district level that results in rigorous and relevant curriculum that will prepare students for college and the workplace. As stakeholders (e.g., teachers, administrators, school board members, parents, community members, students, local legislative representatives) work with these standards, they should consider the following questions:

- How are these content standards and expectations reflected in our curriculum and instruction already?
- Where might the curriculum and instruction be strengthened to more fully realize the intent of these standards and expectations?
- What opportunities do these standards and expectations present to develop new and strengthen existing curriculum, leading to instructional excellence?
- How might the standards and expectations be implemented as we take into account what we know about our students, school, and community?
- How might the effectiveness with which our students and schools are meeting the standards and content expectations be assessed?
- How might school-based assessments (e.g., student portfolios, school-based writing assessments, teacher or classroom research, district-level assessments) be used to make data-driven decisions about teaching and learning?

Through dialogue about questions such as these, and building upon the multitude of existing strengths in our current high schools, voices of all stakeholders will participate in the important and continuing process of shaping instructional excellence in Michigan schools and preparing students for college and the workplace.

In 2002, the Michigan State Board of Education adopted the *Policy on Learning Expectations*. These Expectations and the High School Content Expectations are intended to work together to prepare Michigan's students to face new challenges in an ever-changing world, and provide them with the knowledge and skills needed for future success and to be productive citizens. Students will be prepared to:

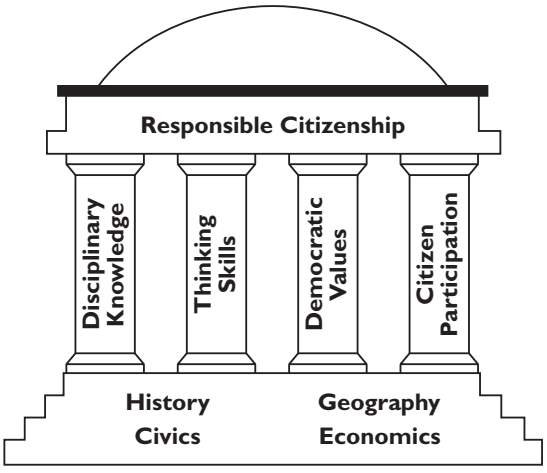
- Gather Information
- Understand Information
- Analyze Issues
- Draw and Justify Conclusions
- Organize and Communicate Information
- Think and Communicate Critically
- Learn and Consider Issues Collaboratively
- Learn Independently
- Create Knowledge
- Act Ethically

THE GOALS OF SOCIAL STUDIES

Social Studies is the integrated study of the social sciences to prepare young people to become responsible citizens. Responsible citizens display social understanding and civic efficacy. Social understanding includes knowledge of the human condition, how it has changed over time, the variations that occur in different physical environments and cultural settings, and the emerging trends that appear likely to shape the future in an interdependent world. Civic efficacy is the readiness and willingness to assume responsibilities of citizenship, knowing how, when, and where to make informed and reasoned decisions for the public good in a pluralistic, democratic society.

Michigan Social Studies

Curriculum Framework



Active Responsible Citizens

Our constitutional democracy requires active citizens. Responsible citizenship requires students to participate actively while learning in the classroom. Instruction should provide activities that actively engage students so that they simultaneously learn about civic participation while involved in the civic life of their communities, our state, and our nation. The social studies curriculum prepares students to participate in political activities, to serve their communities, and to regulate themselves responsibly.

The Responsible Citizen

- Uses knowledge of the past to construct meaningful understanding of our diverse cultural heritage and inform his/her civic judgments (Historical Perspective)
- Uses knowledge of spatial patterns on earth to understand processes that shape both the natural environments and the diverse societies that inhabit them (Geographic Perspective)
- Uses knowledge of American government and politics to make decisions about governing his/her community (Civic Perspective)
- Uses knowledge of the production, distribution and consumption of goods and services to make personal, career and societal decisions about the use of scarce resources (Economic Perspective)
- Uses methods of social science investigation to answer questions about society (Inquiry)
- Knows how, when, and where to construct and express reasoned positions on public issues (Public Discourse and Decision Making)
- Acts constructively to further the public good (Citizen Involvement)

Using Social Studies to Develop Digital-Age Proficiencies

The use of technology is critical for responsible citizenship. Citizens must know how to read and comprehend narratives from a variety of sources, understand and use data effectively, as well as know how to compile and present valid and reliable data. The development of vocabulary, critical to understanding and communication, is an important component of the social studies curriculum. Finally writing, especially expository, informational and persuasive writing, is an empowering skill needed by all citizens. The ability to clearly communicate one's ideas and reasoned viewpoints is the hallmark of a responsible citizen.

"The current and future health of America's 21st Century Economy depends directly on how broadly and deeply Americans reach a new level of literacy—21st Century Literacy—that includes strong academic skills, thinking, reasoning, teamwork skills, and proficiency in using technology." —21st Century Workforce Commission National Alliance of Business

In order to thrive in a digital economy, students will need digital-age proficiencies, including

- Basic, scientific, technological, financial, economic, and civic literacy
- Visual and information literacy
- Cultural literacy and global awareness
- Adaptability, ability to manage complexity, and self-direction
- Curiosity, creativity, and risk-taking
- Higher order thinking and sound reasoning
- Teaming and collaboration
- Personal and social responsibility
- Interactive communication
- Prioritizing, planning, and managing for results
- Effective use of real-world tools
- High quality results with real-world application

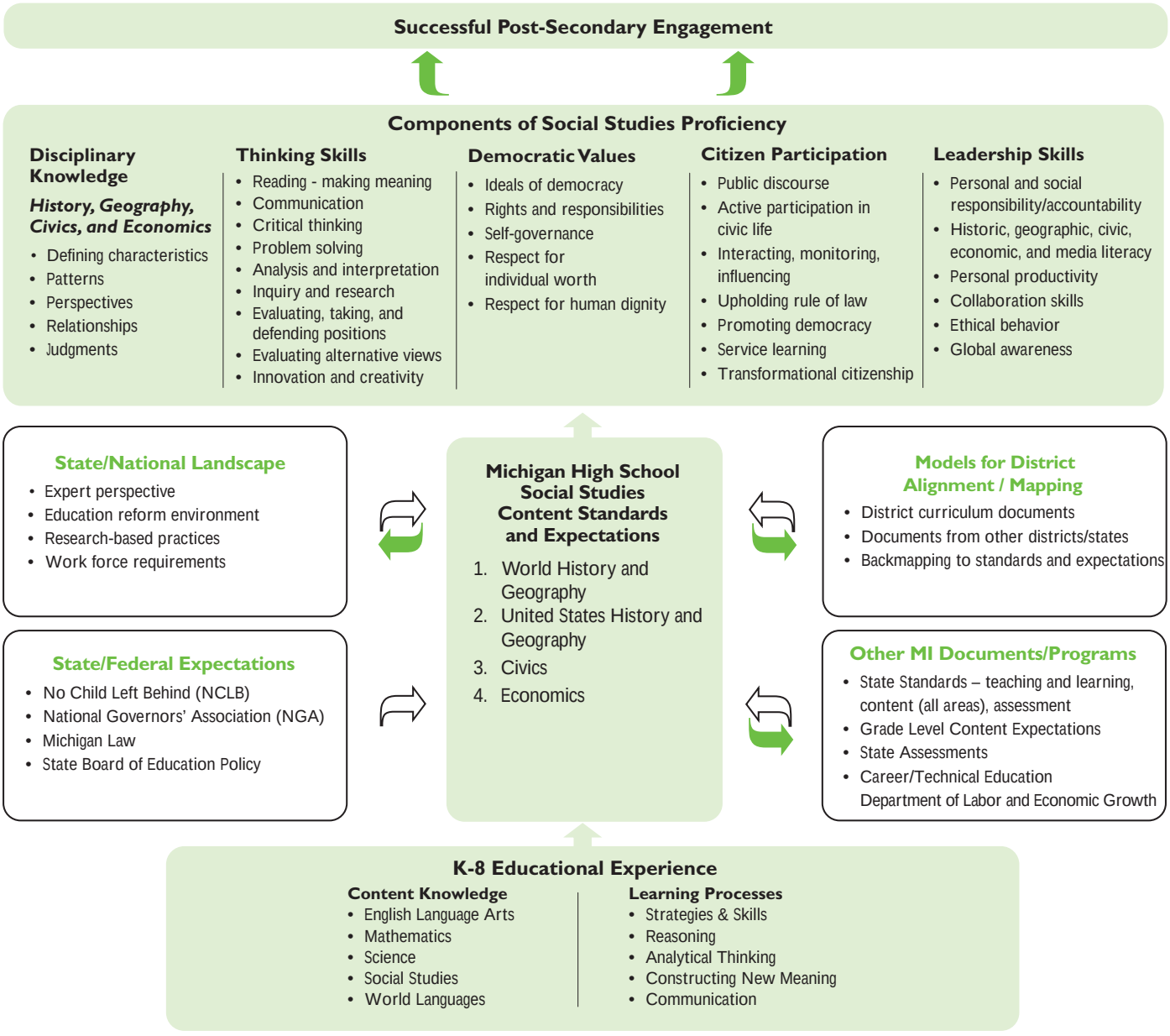
A companion document will address the correlation of social studies expectations with those of technology, reading, writing, mathematics, science, the arts, and the 21st Century Skills. Each of these subjects and literacies is necessary to reach the goal of the social studies curriculum — responsible citizenship.

Preparing Students for Successful Post-Secondary Engagement

As educators use these standards and expectations to develop rigorous and relevant units of instruction, powerful and engaging learning activities, and challenging high school curricula, it is critical to keep in mind that content knowledge alone will not provide adequate preparation for success in entry-level university courses or entry-level positions in today's workforce.

Successful post-secondary engagement requires that students must be able to apply knowledge in new situations; to solve problems by generating new ideas; to make connections between what they read and hear in class, the world around them, and the future; and through their work, develop leadership qualities while still in high school.

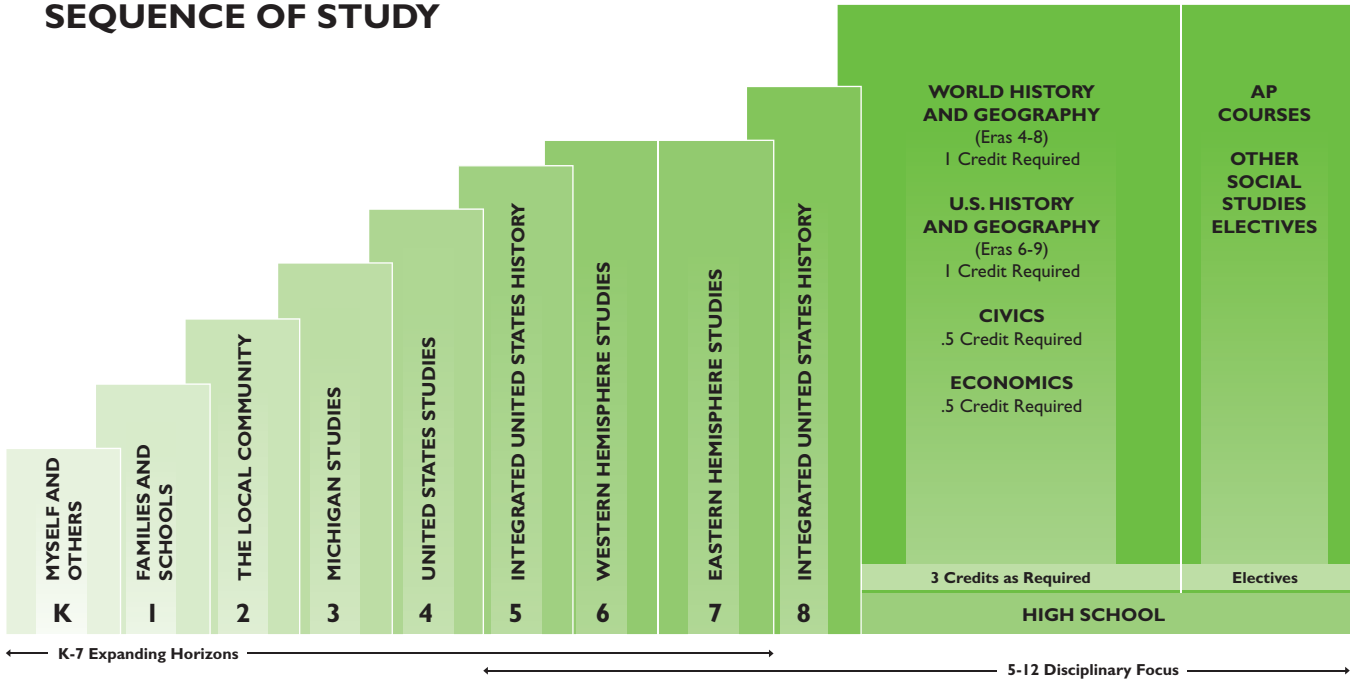
Therefore, educators must model for and develop in students the knowledge, skills, and dispositions that will result in responsible citizenship and successful post-secondary engagement.



Michigan High School Social Studies

WORLD HISTORY AND GEOGRAPHY

SEQUENCE OF STUDY



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MICHIGAN Department of Education

WORLD HISTORY AND GEOGRAPHY

World history and world geography are the fastest growing sections of the social studies curriculum. A recent federal study showed that the percentage of American students taking world history or world geography has risen faster than any other class in the social studies.[1] In 2005, over 77% of American seniors had taken World History in high school, a significant increase from the 60% who had World History on their high school transcripts in 1990. During that time, the number of high school students who had taken World Geography increased from 21% to 31%. The growth in Advanced Placement (AP) exams in geography and world history offers another dramatic indication of the impact of the world on the curriculum in the United States. The College Board created an AP Human Geography course in 2001 and the number of exams has risen from 3,000 then to over 21,000 in 2006. Even more impressive has been the growth of AP World History that accommodated around 21,000 students with its first world history exam in 2002; by 2007, more than 100,000 had taken the AP World History exam.[2]

Clearly, there is a growing recognition in our global age that American students must understand more than just the history and geography of the United States because today citizenship in our democracy demands global understanding. With its new high school requirement in World History and Geography, Michigan joins the majority of states in increasing its emphasis on learning more about the world and its history.

However, recent national studies also reveal great variation in the quality and content of courses in world history and geography. Recent national studies found that many states' world history standards were quite vague, often organized around themes with little substantive content, or with an emphasis on European history while neglecting content on Asia, Africa, Latin America, or the Middle East.[3] Another analysis of the world history standards in the fifty states showed some states created their world history courses by taking a Western Civilization course and simply adding a unit or two on China, Africa, or India to a course in European history. Other states took a global and comparative regional approach.[4] In developing its World History and World Geography programs, for example, the College Board took a global and comparative approach. In short, calling a course or requirement "world history and geography" does not ensure that students will engage in a quality study of the world's history and geography.

Michigan's World History and Geography takes a global and comparative approach to studying the world and its past to develop greater understanding of the development of worldwide events, processes, and interactions among the world's people, cultures, societies, and environment. The content expectations build upon the very best and most highly regarded standards, benchmarks, and courses in history and geography. The expectations are organized using both time and space to engage students in cross-temporal and cross-regional studies. Integrating geography and history, the content expectations are organized within historical eras and different geographic scales. That is, within each era students work at three interconnected spatial scales: the global, interregional and regional. Just as a photographer uses multiple lenses—close-up, wide-angle, and zoom—to tell pictorial stories, these content expectations ask teachers and students to study the world's history and geography through several different lenses to understand the whole most completely.[5]

Since the content expectations use both geography and history, it is vital that Michigan teachers understand the major features of geography and history to understand the design of these expectations.

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[1]Sean Cavanagh, "World History and Geography Gain Traction in Class: Seeds of Internationally Themed Lessons Were Planted in the 1980s," *Education Week*, March 21 2007, 10.

[2]Robert B. Bain and Tamara L. Shreiner, "Issues and Options in Creating a National Assessment in World History," The History Teacher 38, no. 2 (2005): 241-72.

[3]Kathleen Kennedy Manzom, "Most States Earn Poor Grades for World-History Standards," Education Week, June 14 2006, 12; Walter Russell Mead, The State of State World History Standards (Washington, DC: Fordham Foundation, 2006) Geography: an Integrative, Disciplined Study

[4]Bain and Shreiner, "Issues and Options"

[5]David Christian, This Fleeting World: A Short History of Humanity (Great Barrington, MA: Berkshire Publishing, 2008)

Geography: an Integrative, Disciplined Study

Geography is an integrative discipline that brings together the physical and human dimensions of the world in the study of people, places, and environments. The content of geography is the Earth's surface and the processes that result in natural environments, the relationships between people and environments, and the ways that people use and view places both near and far. Geography is important because the world facing students in the 21st century is more crowded, the maintenance of a sustainable physical environment more challenging, and the global economy more competitive and interconnected. Comprehending issues and making decisions about local places, regions, the world, and the diverse environments and the economies require competencies with geography from the local to global scale.

The purpose for studying world geography is to foster the development of citizens who will actively seek and systematically use a spatial perspective in viewing the world. The spatial perspective is the ability to view the patterns and dynamic processes on Earth. Those patterns and processes occur as webs of relationships within the natural world and between the natural world and the activities of human societies. A spatial perspective enables an individual to visualize, comprehend, and ask questions about why the human and physical systems occur in particular patterns and combinations, where they are on Earth's surface, why they are there, and what are the consequences for people and the environment? For example, large amounts of the world's petroleum resources are located near the Persian Gulf. They are at that location due to Earth's physical processes in the past, and this impacts the present. For example, availability and cost of petroleum are affected by the political, economic, territorial, and military events that occur in and near the Persian Gulf Region.

The study of geography as a discipline is approached two ways. One is as a regional study in which Earth is examined by areas that share a similar criterion or continuity. For example, a regional criterion may be geopolitical. Examples include Michigan as a state and Canada as a country, each with its particular geopolitical boundaries and legal jurisdictions. The second approach is systematic geography. The Earth is examined by topics that share common attributes, but may occur in different regions. Examples include urbanization and the spatial structure and function of cities. Most cities have a central business district, satellite business centers in the suburbs and social, economic, and ethnic residential patterns that spread across urban space. At times regional and systematic geographic studies merge, such as the study of migration to urban centers in Mexico, Central, and South America. A similar study of migration could be completed for Africa or Asia. Among the systematic topics are human/cultural, economic, historical, physical, and political geography. Geographic studies may be based on continents, groups of countries, an individual country, or a region within a country. The criteria for a region may include religion, language, and/or ethnicity. The spatial pattern of topics may cross political boundaries and connect continents, such as Islam within Africa, Europe, and Asia.

Geography bridges the social and physical sciences by asking questions and seeking answers to those questions through inquiry. In doing so, students apply skills and develop habits of mind that they will be able to use in the diverse societies and workplaces of the community, nation, and the world. Maps, satellite images of Earth, Geographic Information Systems (GIS), Geographic Positioning Systems (GPS), and other resources on the World Wide Web provide valuable information about the spatial patterns on Earth. The tools of modern geography are based on modern technology. The technology is the means to explore the world and inquire about the spatial patterns and dynamic processes that shape the world in which we live.

History: an Integrative, Disciplined Study

History is an integrative discipline that studies change and continuity over time in people, places, and environments. The content of history consists of human beings and how, at different times and in different places, people and their cultures and societies have changed and developed. Historians study the past to understand the present, drawing upon a vast storehouse of information about human behavior, relationships between people and environments, and the ways that people developed solutions to meet their perceived problems. World history is important for students in the 21st century, because of the role the past plays in shaping the present. As a philosopher once remarked, "We live our lives forward, but we understand them backwards."

Like geography, history also seeks to foster citizens who actively and systematically investigate the world and its relationships. The disciplined study of history requires students to develop important questions, conduct inquiry, evaluate and develop historical arguments. Like all disciplines, historical study begins with problems, questions and curiosities. Historians wonder about how things came to be the way they are, or how interpretations of the past influence action in the present. History, however, requires the ability to engage in investigations using different types of evidence and data, including those generated by other disciplines such as economics and geography. The study of history requires students to analyze and use a wide range of sources – such as public and private documents, numerical data and maps – to develop the most accurate picture of the past possible. Studying history also requires students to analyze and evaluate conflicting interpretations and assess past examples of change over time. History thus provides frequent opportunities to engage in reasoned debate, to assess the merits of competing claims about the present and the past, and to consider the world from different perspectives. It helps students understand the complexity involved in most changes while attending to the continuities often obscured by dramatic change. Students studying history also learn to make reasoned arguments, supported by facts and evidence, and informed by competing perspectives.

History, thus, not only helps us use facts to understand the context and background of our institutions, cultures and societies, it also helps increase our ability to analyze change, evaluate others' interpretations, and develop and improve our own. It draws on a wide range of information and approaches to investigate the dynamic historical processes and interpretations that shape the world in which we live.

The World in Time and Space: Michigan's Content Expectations

Michigan's World History and Geography content expectations encourage students to work with and across different scales of time and space to:

- Investigate global patterns and developments over time while connecting more local patterns to larger interregional and global patterns.
- Employ different analytical schemes, including global, regional, national and local to understand developments over time.
- Compare within and among regions and societies, and across time.
- Develop an understanding of the historical and geographic context of human commonalities and differences, particularly in considering claims of universal standards or of cultural diversity.

In their studies students will focus on five large historical and geographic patterns

- The causes, consequences, and patterns of changes in human governance systems and changes over time.
- The causes, consequences, and patterns of interactions among societies and regions, including trade, war, diplomacy, and international institutions.
- The impact of demographic, technological, environmental, and economic changes on people, their culture, and their environment.
- Causes, consequences, and patterns of cultural, intellectual, religious and social changes across the world, and among and within societies.
- The relationship between the environment and global and regional developments in population, settlement, economy, and politics.

Two complementary frameworks organize the content expectations. Using time, the K-12 expectations are presented in eight, overlapping historical eras. The high school expectations begin with a short set of foundational expectations, and include ERAs 4-8 and conclude with a set of contemporary global issues.

Foundational Expectations – Expectations to establish necessary background to begin high school study

Era 4 Expanding and Intensified Hemispheric Interactions, 300 to 1500 C.E./A.D.
Era 5 The Emergence of the First Global Age, 15th to 18th Centuries
Era 6 An Age of Global Revolutions, 18th Century to 1914
Era 7 Global Crisis and Achievement, 1900 to 1945
Era 8 The Cold War and its Aftermath: The 20th Century Since 1945
Contemporary Global Issues

Using *space*, three different spatial scales– global, interregional, and regional– also structure the content expectations.

Global Expectations focus on large-scale patterns occurring in several areas of the globe, such as the collapse or decline of empires, growth of trade networks, war, industrialism, and the diffusion of religions or philosophies. Expectations at this level also include comparisons that span across time (or eras) such as comparing the growth of world religions before 1500 C.E./A.D. with growth after 1500 or comparing the agricultural economic system of the 17th century with the industrial economic system of the 18th century.

Interregional expectations focus on interregional patterns and comparisons across space within a particular era. Examples of interregional patterns include trade networks prior to 1500 C.E./A.D., the trans-Atlantic slave system, and the unification of Eurasia under the Mongols. These expectations also include cross-spatial comparisons such as comparing the social and economic impacts of industrialism in particular regions of the world and comparing 20th century independence movements in India, Africa, and Southeast Asia.

Regional expectations focus on events within a particular region such as Latin America through the 18th century, the Russian Revolution, or the rise of Fascism in Europe.

Although the expectations are divided into eras and spatial scales for the purpose of organization, teachers and students must not see lines between eras and spatial scales as fixed. These are not absolute compartments but rather fluid, nested categories used to help organize content expectations. Teachers and students should be able to move, for example, from a global look at trade networks in the 10th century to an interregional look, to a look at the impact of trade in regions such as South Africa, Japan, or Cuba. The connections between *and among* these temporal eras and spatial scales are the most important features of world history and geography. To help suggest connections among and between expectations, there are many cross references to help teachers and students make connections across time and space.

Conclusion:

As Michigan students study World History and Geography, they will learn about the human experience over time and space. They will encounter powerful and sometimes conflicting ideas while learning about people and events in different places and times. They will investigate our diverse and common traditions, and work to understand the complex interactions among various environmental, human and social forces that have influenced and continues to influence us. Studying World History and Geography connects us to people and events across time and space, illuminating the range and depth of human experience on grand as well as local scales.

This offers Michigan teachers and students both rewards and challenges. We should harbor no illusions about the challenges awaiting teachers and students engaged in such global study. Historical and geographic literacy demands that students learn to read critically, analyze and evaluate arguments, decide which positions, given the evidence, are more or less plausible, better or worse. While learning about the facts, events and significant developments, historical and geographic study asks students to consider what they know, how they know it, and how confidently or tentatively they are "entitled" to hold their views.

It is equally important to remember the pleasures that such study can provide both teachers and students. A disciplined study of World History and Geography helps us to locate ourselves and our society among other peoples and societies in the world. It prepares us to take up the challenges of life in the 21st century by enabling us to understand the world that we encounter daily and developing the habits of mind essential for democratic citizenship. Using history and geography, teachers can fill the class with enduring human dramas and dilemmas, grand successes and equally grand tragedies, fascinating mysteries, and an amazing cast of characters involved in events that exemplify the best and worst of human experience. In what other field of study can students experience such a range of possibilities and get to know so many people and places?

The study of world history and geography is well worth our efforts because it is so vital. Learning about a world that we can traverse in hours and communicate across within minutes is now essential for every individual. Understanding the world's peoples, cultures, and societies and the story of our past is no longer a luxury but a necessity for Americans in the 21st century. As citizens, our students need the best understanding of the world and its past we can give them. A disciplined study of world history and geography promotes exactly the type of reasoned thought our students deserve and democratic societies so desperately need.

Using the World History and Geography HSCE: Things to Remember

There are a number of important considerations for teachers to keep in mind as they use these World History and Geography expectations to plan instruction. It is important to remember that this document:

Integrates Geography and History – In meeting these expectations, students will use the content and habits of mind of both history and geography to study the world's past and present. This document employs both temporal and spatial schemes to present the content expectations. The spatial structure is embedded within the temporal scheme. To make geography more visible as a tool for studying the past, National Geography Standards are referenced after expectations where appropriate.

Uses historical and geographic thinking – All of the expectations require students to think – analyze, evaluate, compare, contrast, argue – using history's and geography's habits of mind. In meeting the expectations, students will use historical and geographic thinking to analyze and interpret information in developing their understanding. Students will gather, analyze and use information and evidence in their thinking. In identifying specific events and patterns, these expectations do not intend to stress memory over meaning, or coverage over understanding. While knowledge of specific names, places, dates, and facts is essential for world historical and geographical study, high quality teaching and learning demands a great deal more than just the mastery of discrete collections of facts.

Requires active, disciplined inquiry – In using history and geography's habits of mind, students should engage in active, disciplined inquiry, analysis, and argumentation. Learning history and geography involves purposeful investigations within a community that has established goals, standards, criteria, and procedures for study.[6] It entails learning how to read, write, and use history and geography to understand and participate in the world around us. This calls upon students to frame important historical and geographic problems and questions concerning cause and effect, continuity and change, place and time; to locate and analyze appropriate evidence and data; and to determine significance in building reasoned and evidenced-based interpretations, arguments, or decisions. In short, historical and geographic inquiry provides Michigan students with the kind of reasoned and informed decision making that should characterize each citizen's participation in American society.

Represents Content Expectations and not Pedagogical Organization – This document lists content expectations for students. It does not establish a suggested organization for teaching or learning this content. For example, this document does not present expectations in a suggested instructional sequence. Further, individual expectations do not represent single lessons, a day's worth of instruction, or even a unit. Michigan teachers and curriculum coordinators will combine expectations to structure meaningful learning experiences for their students. For example, a teacher could use a compelling historical or geographic issue or problem to organize weeks of study, while coherently employing many content expectations.

Differentiates between required and suggested content – The expectations specify teachable content in two different ways. On numerous occasions, the expectations will offer *examples* for teachers to help clarify teachable content. Typically, these examples or suggestions appear in parentheses. The document always identifies such optional content with an "e.g." or "for example." These are simply suggestions and teachable options. Teachers may use other examples to meet the expectations. In short, these examples are not required content. In other places, the expectations identify specific content that students should study. This content is never preceded by "e.g." or "for example." Unlike the optional examples, a statewide assessment might assess the required content.

[6]Linda S. Levstik and Keith C. Barton, Doing History: Investigating with Children in Elementary and Middle Schools (Mahwah, NJ: Lawrence Erlbaum, 2000):13.

Overview of High School World History and Geography

Lens/Frame	Foundations Review of Eras 1-3 (Grades 6 and 7)	Era 4 Expanding and Intensified Hemispheric Interactions	Era 5 The Emergence of the First Global Age	Era 6 Age of Global Revolutions	Era 7 Global Crisis and Achievement	Era 8 The Cold War and Its Aftermath	Contemporary Global Issues
	Beginnings to 650 C.E./A.D.	300-1500 C.E./A.D.	15th to 18th Centuries	18th Century to 1914	1900 to 1945	The 20th Century Since 1945	
Global or Cross-Temporal Expectations	F1 World Historical and Geographical "Habits of Mind" and Central Concepts F2 Systems of Human Organizations F3 Growth and Development of World Religions	Crisis in the Classical World World Religions Trade Networks and Contacts	Emerging Global System World Religions	Global Revolutions World-Wide Migrations and Population Changes Increasing Global Interconnections Changes in Economic and Political Systems Interpreting Europe's Increasing Global Power	Increasing Government and Political Power Comparative Global Power Twentieth Century Genocide Global Technology Total War	Origins of Cold War Cold War Conflicts End of Cold War Mapping the 20th Century	CG1 Population CG2 Resources CG3 Patterns of Global Interactions CG4 Conflict, Cooperation, and Security
Interregional or Comparative Expectations	F4 Regional Interactions	Growth of Islam and Dar al-Islam Unification of Eurasia under the Mongols The Plague	European Exploration/ Conquest and Columbian Exchange Trans-African and Trans-Atlantic Slave Systems	Political Revolutions Growth of Nationalism and Nation-States Industrialization Imperialism	World War I Inter-War Period World War II Revolutionary and/or Independence Movements	The Legacy of Imperialism Independence, Decolonization, Democratization Movements Middle East	
Regional Expectations		Africa to 1500 The Americas to 1500 China to 1500 The European System and the Byzantine Empire to 1500 Western Europe to 1500	Ottoman Empire to 1800 East Asia South Asia/India Russia, Europe, and Latin America through 18th Century	Europe East Asia Africa	Russian Revolution Europe and the Rise of Fascism and Totalitarian States Asia The Americas Middle East		

World History and Geography (WHG) Content Statement Outline

GENERAL SOCIAL SCIENCE KNOWLEDGE, PROCESSES, AND SKILLS *(listed on page 20)*

- K1 General Knowledge
- P1 Reading and Communication
- P2 Inquiry, Research, and Analysis
- P3 Public Discourse and Decision Making
- P4 Citizen Involvement

WORLD HISTORY AND GEOGRAPHY
Eras 4 – 8 Addressed in WHG HSCE

Foundations in WHG Eras 1 – 3 *(Review of content taught in Grades 6 and 7)*

- F1 World Historical and Geographical "Habits of Mind" and Central Concepts
- F2 Systems of Human Organizations
- F3 Growth and Development of World Religions
- F4 Regional Interactions

WHG Era 4 – Expanding and Intensified Hemispheric Interactions, 300-1500 C.E./A.D.

- 4.1 Crisis in the Classical World, World Religions, Trade Networks and Contacts
- 4.2 Growth of Islam and Dar al-Islam, Unification of Eurasia under the Mongols, The Plague
- 4.3 Africa to 1500, The Americas to 1500, China to 1500, The Eastern European System and the Byzantine Empire to 1500, Western Europe to 1500

WHG Era 5 – The Emergence of the First Global Age, 15th to 18th Centuries

- 5.1 Emerging Global System and World Religions
- 5.2 European Exploration/Conquest and Columbian Exchange, Trans-African and Trans-Atlantic Slave Systems
- 5.3 Ottoman Empire to 1800; East Asia, South Asia/India, Russia, Europe, and Latin America through 18th Century

WHG Era 6 – An Age of Global Revolutions, 18th Century-1914

- 6.1 Global Revolutions, World-Wide Migrations and Population Changes, Increasing Global Interconnections, Changes in Economic and Political Systems, Interpreting Europe's Increasing Global Power
- 6.2 Political Revolutions, Growth of Nationalism and Nation-States, Industrialization, Imperialism
- 6.3 Europe, East Asia, and Africa

WHG Era 7 – Global Crisis and Achievement, 1900-1945

- 7.1 Increasing Government and Political Power, Comparative Global Power, Twentieth Century Genocide, Global Technology, and Total War
- 7.2 World War I, Inter-War Period, World War II, Revolutionary and/or Independence Movements
- 7.3 Russian Revolution, Europe and the Rise of Fascism and Totalitarian States, Asia, The Americas, Middle East

WHG Era 8 – The Cold War and Its Aftermath: The 20th Century Since 1945

- 8.1 Origins of Cold War, Cold War Conflicts, End of Cold War, Mapping the 20th Century
- 8.2 The Legacy of Imperialism; Independence, Decolonization, and Democratization Movements; Middle East

Contemporary Global Issues 1 – 4 *(Population, Resources, Patterns of Global Interactions, Conflict, Cooperation, and Security)*

National Geography Standards *(as referenced after expectations where appropriate)*

The World in Spatial Terms: Geographical Habits of Mind

1. Tools, Technology, and Information Processing
2. Mental Maps
3. Spatial Organization on Earth's Surface

Places and Regions

4. Physical and Human Characteristics of Place
5. Creating Regions
6. Perceptions of Places and Regions

Physical Systems

7. Physical Processes
8. Ecosystems

Human Systems

9. Distribution and Migration of People
10. Cultural Mosaic
11. Economic Interdependence
12. Patterns of Human Settlement
13. Forces of Cooperation and Conflict

Environment and Society

14. Human Modification of the Environment
15. How Physical Systems Affect Human Systems
16. Resource Use and Distribution

Uses of Geography

17. Using Geography to Interpret the Past
18. Using Geography to Interpret the Present and Plan for the Future

Disciplinary Knowledge

(See page 18)

Historical and Geographic Knowledge and Perspective

Historical and Geographic Analysis and Interpretation

World History Themes

Historical and Geographic Changes

People, Cultures, and Ideas

Economic and Technological Changes

Changing Role of Global Powers

General Social Studies Knowledge, Processes, and Skills

K1 General Knowledge – embedded in WHG standards and expectations

K1.1 Know the defining characteristics of the disciplines of history and geography.
K1.2 Know that each discipline is subject to criticisms and limitations; be aware of the primary criticisms of history and geography.
K1.3 Understand and analyze temporal and spatial relationships and patterns.
K1.4 Understand historical and geographical perspectives.
K1.5 Understand the diversity of human beings and human cultures.
K1.6 Analyze events and circumstances from the vantage point of others.
K1.7 Understand social problems, social structures, institutions, class, groups, and interaction.
K1.8 Apply social studies concepts to better understand major current local, national, and world events, issues, and problems.
K1.9 Integrate concepts from at least two different social studies disciplines.
K1.10 Understand significant concepts, generalizations, principles, and theories of history and geography as disciplines.

Social Studies Procedures and Skills – embedded in WHG standards and expectations

P1 Reading and Communication – read and communicate effectively.

P1.1 Use close and critical reading strategies to read and analyze complex texts pertaining to social science; attend to nuance, make connections to prior knowledge, draw inferences, and determine main idea and supporting details.
P1.2 Analyze point of view, context, and bias to interpret primary and secondary source documents.
P1.3 Understand that diversity of interpretation arises from frame of reference.
P1.4 Communicate clearly and coherently in writing, speaking, and visually expressing ideas pertaining to social science topics, acknowledging audience and purpose.
P1.5 Present a coherent thesis when making an argument, support with evidence, articulate and answer possible objections, and present a concise, clear closing.

P2 Inquiry, Research, and Analysis – critically examine evidence, thoughtfully consider conflicting claims, and carefully weigh facts and hypotheses.

P2.1 Understand the scientific method of inquiry to investigate social scientific and historical problems.
P2.2 Read and interpret data in tables and graphs.
P2.3 Know how to find and organize information from a variety of sources; analyze, interpret, support interpretations with evidence, critically evaluate, and present the information orally and in writing; report investigation results effectively.
P2.4 Use multiple perspectives and resources to identify and analyze issues appropriate to the social studies discipline being studied.
P2.5 Use deductive and inductive problem-solving skills as appropriate to the problem being studied.

P3 Public Discourse and Decision Making – engage in reasoned and informed decision making that should characterize each citizen's participation in American society.

P3.1 Clearly state an issue as a question of public policy, trace the origins of an issue, analyze various perspectives, and generate and evaluate possible alternative resolutions.
P3.2 Deeply examine policy issues in group discussions and debates (clarify issues, consider opposing views, apply democratic values or constitutional principles, anticipate consequences) to make reasoned and informed decisions.
P3.3 Write persuasive/argumentative essays expressing and justifying decisions on public policy issues.

P4 Citizen Involvement

P4.1 Act out of respect for the rule of law and hold others accountable to the same standard.
P4.2 Demonstrate knowledge of how, when, and where individuals would plan and conduct activities intended to advance views on matters of public policy, report the results, and evaluate effectiveness.
P4.3 Plan and conduct activities intended to advance views on matters of public policy, report the results, and evaluate effectiveness.

Disciplinary Knowledge – embedded in WHG standards and expectations

Historical and Geographical Knowledge and Perspective

Know significant periods and events in world history; social, religious, and political movements; and major historical figures who influenced such movements.
Identify and define specific factual information, themes, movements, and general principles operating in world history and geography to deduce meaning and comprehend patterns.

Historical and Geographical Analysis and Interpretation

Distinguish value judgments in historical and geographical information, weigh evidence, synthesize information, apply knowledge, make judgments, formulate generalizations, and draw conclusions.

Global Analysis of World History Eras 4 – 8

WORLD HISTORY AND GEOGRAPHY

FOUNDATIONS WHG 1-3: BEGINNING THE HIGH SCHOOL WORLD HISTORY AND GEOGRAPHY COURSE/CREDIT

These foundational expectations are included to set the stage for the study of World History and Geography in High School and to help bridge the transition from Middle School Social Studies.

F1 World Historical and Geographical "Habits of Mind" and Central Concepts

Explain and use key conceptual devices world historians/geographers use to organize the past including periodization schemes (e.g., major turning points, different cultural and religious calendars), and different spatial frames (e.g., global, interregional, and regional)(National Geography Standard 2, p. 186)

F2 Systems of Human Organizations

Use the examples listed below to explain the basic features and differences between hunter-gatherer societies, pastoral nomads, civilizations, and empires, focusing upon the differences in their political, economic and social systems, and their changing interactions with the environment. (National Geography Standard 14, p. 212)

- Changes brought on by the Agricultural Revolution, including the environmental impact of settlements
- TWO ancient river civilizations, such as those that formed around the Nile, Indus, Tigris-Euphrates, or Yangtze
- Classical China or India (Han China or Gupta empires)
- Classical Mediterranean (Greece and Rome)

F3 Growth and Development of World Religions

Explain the way that the world religions or belief systems of Hinduism, Judaism, Confucianism, Buddhism, Christianity, and Islam grew, including

- spatial representations of that growth
- interactions with culturally diverse peoples
- responses to the challenges offered by contact with different faiths
- ways they influenced people's perceptions of the world. *(National Geography Standard 6, p. 195)*

F4 Regional Interactions

Identify the location and causes of frontier interactions and conflicts, and internal disputes between cultural, social and/or religious groups in classical China, the Mediterranean world, and south Asia (India) prior to 300 C.E. (National Geography Standards 3 and 13A, pp. 188 and 210)

WORLD HISTORY AND GEOGRAPHY

WHG ERA 4: EXPANDING AND INTENSIFIED HEMISPHERIC INTERACTIONS, 300 TO 1500 C.E./A.D.

4.1 Cross-temporal or Global Expectations

Analyze important hemispheric interactions and temporal developments during an era of increasing regional power, religious expansion, and the collapse of some empires.

4.1.1 **Crisis in the Classical World –** Explain the responses to common forces of change that led to the ultimate collapse of classical empires and discuss the consequences of their collapse. (See 4.3.3; 4.3.4; 4.3.5)

4.1.2 **World Religions –** Using historical and modern maps and other documents, analyze the continuing spread of major world religions during this era and describe encounters between religious groups including

- Islam and Christianity (Roman Catholic and Orthodox) – increased trade and the Crusades
- Islam and Hinduism in South Asia (See 5.3.3)
- continuing tensions between Catholic and Orthodox Christianity

(National Geography Standard 10, p. 203)

4.1.3 **Trade Networks and Contacts –** Analyze the development, interdependence, specialization, and importance of interregional trading systems both within and between societies including

- land-based routes across the Sahara, Eurasia and Europe
- water-based routes across Indian Ocean, Persian Gulf, South China Sea, Red and Mediterranean Seas

(National Geography Standard 11, p. 206)

4.2 Interregional or Comparative Expectations

Analyze and compare important hemispheric interactions and cross-regional developments, including the growth and consequences of an interregional system of communication, trade, and culture exchange during an era of increasing regional power and religious expansion.

4.2.1 **Growth of Islam and Dar al-Islam** [A country, territory, land, or abode where Muslim sovereignty prevails] – Identify and explain the origins and expansion of Islam and the creation of the Islamic Empire including

- The founding geographic extent of Muslim empires and the artistic, scientific, technological, and economic features of Muslim society
- diverse religious traditions of Islam — Sunni, Shi'a/Shi'ite, Sufi
- role of Dar al-Islam as a cultural, political, and economic force in Afro-Eurasia
- the caliphate as both a religious and political institution, and the persistance of other traditions in the Arab World including Christianity

(National Geography Standard 10, p. 203)

4.2.2 **Unification of Eurasia under the Mongols –** Using historical and modern maps, locate and describe the geographic patterns of Mongol conquest and expansion and describe the characteristics of the Pax Mongolica (particularly revival of long-distance trading networks between China and the Mediterranean world). *(National Geography Standard 11, p. 206)*

4.2.3 **The Plague –** Using historical and modern maps and other evidence, explain the causes and spread of the Plague and analyze the demographic, economic, social, and political consequences of this pandemic. (See 4.3.5) *(National Geography Standard 15, p. 215)*

4.3 Regional Expectations

Analyze important regional developments and cultural changes, including the growth of states, towns, and trade in Africa south of the Sahara, Europe, the Americas, and China.

4.3.1 **Africa to 1500 –** Describe the diverse characteristics of early African societies and the significant changes in African society by

- comparing and contrasting at least two of the major states/civilizations of East, South, and West Africa (Aksum, Swahili Coast, Zimbabwe, Ghana, Mali, Songhai) in terms of environmental, economic, religious, political, and social structures *(National Geography Standard 12, p. 208)*
- using historical and modern maps to identify the Bantu migration patterns and describe their contributions to agriculture, technology and language *(National Geography Standard 9, p. 201)*
- analyzing the African trading networks by examining trans-Saharan trade in gold and salt and connect these to interregional patterns of trade *(National Geography Standard 11, p. 206)*
- analyzing the development of an organized slave trade within and beyond Africa *(National Geography Standard 4, p. 190)*
- analyzing the influence of Islam and Christianity on African culture and the blending of traditional African beliefs with new ideas from Islam and Christianity *(National Geography Standard 10, p. 203)*

4.3.2 **The Americas to 1500 –** Describe the diverse characteristics of early American civilizations and societies in North, Central, and South America by comparing and contrasting the major aspects (government, religion, interactions with the environment, economy, and social life) of American Indian civilizations and societies such as the Maya, Aztec, Inca, Pueblo, and/or Eastern Woodland peoples. *(National Geography Standard 10, p. 203)*

4.3.3 **China to 1500 –** Explain how Chinese dynasties responded to the internal and external challenges caused by ethnic diversity, physical geography, population growth and Mongol invasion to achieve relative political stability, economic prosperity, and technological innovation. *(National Geography Standard 4, p. 190)*

4.3.4 **The Eastern European System and the Byzantine Empire to 1500 –** Analyze restructuring of the Eastern European system including

- the rise and decline of the Byzantine Empire
- the region's unique spatial location
- the region's political, economic, and religious transformations
- emerging tensions between East and West *(National Geography Standard 3, p. 188)*

4.3.5 **Western Europe to 1500 –** Explain the workings of feudalism, manoralism, and the growth of centralized monarchies and city-states in Europe including

- the role and political impact of the Roman Catholic Church in European medieval society
- how agricultural innovation and increasing trade led to the growth of towns and cities *(National Geography Standard 14, p. 212)*
- the role of the Crusades, 100 Years War, and the Bubonic Plague in the early development of centralized nation-states (See 4.2.3)
- the cultural and social impact of the Renaissance on Western and Northern Europe

WHG ERA 5 – THE EMERGENCE OF THE FIRST GLOBAL AGE, 15TH TO 18TH CENTURIES

5.1 Cross-temporal or Global Expectations

Analyze the global impact and significant developments caused by transoceanic travel and the linking of all the major areas of the world by the 18th century.

5.1.1 **Emerging Global System –** Analyze the impact of increased oceanic travel including changes in the global system of trade, migration, and political power as compared to the previous era. (See 4.1.3; 5.3.6) (*National Geography Standard 11, p. 207)*

5.1.2 **World Religions –** Use historical and modern maps to analyze major territorial transformations and movements of world religions including the expulsion of Muslims and Jews from Spain, Christianity to the Americas, and Islam to Southeast Asia, and evaluate the impact of these transformations/movements on the respective human systems. (See 4.1.2) (*National Geography Standard 9, pg. 202)*

5.2 Interregional or Comparative Expectations

Analyze the impact of oceanic travel on interregional interactions.

5.2.1 **European Exploration/Conquest and Columbian Exchange –** Analyze the demographic, environmental, and political consequences of European oceanic travel and conquest and of the Columbian Exchange in the late 15th and 16th centuries by

- describing the geographic routes used in the exchange of plants, animals, and pathogens among the continents in the late 15th and the 16th centuries *(National Geography Standard 11, p. 206)*
- explaining how forced and free migrations of peoples (push/pull factors) and the exchange of plants, animals, and pathogens impacted the natural environments, political institutions, societies, and commerce of European, Asian, African, and the American societies *(See 5.3.5) (National Geography Standard 14, p. 212)*

5.2.2 **Trans-African and Trans-Atlantic Slave Systems –** Analyze the emerging trans-Atlantic slave system and compare it to other systems of labor existing during this era by

- using historical and modern maps and other data to analyze the causes and development of the Atlantic trade system, including economic exchanges, the diffusion of Africans in the Americas (including the Caribbean and South America), and the Middle Passage *(National Geography Standard 11, p. 206)*
- comparing and contrasting the trans-Atlantic slave system with the African slave system and another system of labor existing during this era (e.g., serfdom, indentured servitude, corvee labor, wage labor) *(See 5.3.5; 5.3.6) (See 4.3.1)*

5.3 Regional Content Expectations

Analyze the important regional developments and cultural changes in Asia, Russia, Europe and the Americas.

5.3.1 **Ottoman Empire through the 18th Century –** Analyze the major political, religious, economic, and cultural transformations in the Ottoman Empire by

- using historical and modern maps to describe the empire's origins (Turkic migrations), geographic expansion, and contraction *(National Geography Standard 13, p. 210)*
- analyzing the impact of the Ottoman rule

5.3.2 **East Asia through the 18th Century –** Analyze the major political, religious, economic, and cultural transformations in East Asia by

- analyzing the major reasons for the continuity of Chinese society under the Ming and Qing dynasties, including the role of Confucianism, the civil service, and Chinese oceanic exploration (See 4.3.3) (*National Geography Standard 5, p. 192)*
- analyzing the changes in Japanese society by describing the role of geography in the development of Japan, the policies of the Tokugawa Shogunate, and the influence of China on Japanese society *(National Geography Standard 4, p. 190)*

5.3.3 **South Asia/India through the 18th Century –** Analyze the global economic significance of India and the role of foreign influence in the political, religious, cultural, and economic transformations in India and South Asia including the Mughal Empire and the beginnings of European contact. (See 4.1.2) (*National Geography Standard 4, p. 190)*

5.3.4 **Russia through the 18th Century –** Analyze the major political, religious, economic, and cultural transformations in Russia including

- Russian imperial expansion and top-down westernization/modernization *(National GeographyStandard 13, p. 210)*
- the impact of its unique location relative to Europe and Asia *(National Geography Standard 3, p. 188)*
- the political and cultural influence (e.g., written language) of Byzantine Empire, Mongol Empire, and Orthodox Christianity *(National Geography Standard 10, p. 203)*

5.3.5 **Europe through the 18th Century –** Analyze the major political, religious, cultural and economic transformations in Europe by

- explaining the origins, growth, and consequences of European overseas expansion, including the development and impact of maritime power in Asia and land control in the Americas (See 5.2.1) (*National Geography Standard 13, p. 210)*
- analyzing transformations in Europe's state structure, including the rising military, bureaucratic, and nationalist power of European states including absolutism
- analyzing how the Renaissance, Reformation, Scientific Revolution, and the Enlightenment contributed to transformations in European society
- analyzing the transformation of the European economies including mercantilism, capitalism, and wage labor (See 5.2.2)

5.3.6 **Latin America through the 18th Century –** Analyze colonial transformations in Latin America, including

- the near-elimination of American Indian civilizations and peoples
- social stratifications of the population (e.g., peninsulares, creoles, mestizos)
- the regional and global role of silver and sugar
- resource extraction and the emerging system of labor (e.g., mita, slavery) (See 5.1.1, 5.2.2) (*National Geography Standard 12, p. 208)*

WHG ERA 6 – AN AGE OF GLOBAL REVOLUTIONS, 18TH CENTURY-1914

6.1 Global or Cross-temporal Expectations

Evaluate the causes, characteristics, and consequences of revolutions of the intellectual, political and economic structures in an era of increasing global trade and consolidations of power.

6.1.1 **Global Revolutions –** Analyze the causes and global consequences of major political and industrial revolutions focusing on changes in relative political and military power, economic production, and commerce. *(See 6.2.1; 6.2.3; 6.3.1; 6.3.2) (National Geography Standard 13, p. 210)*

6.1.2 **World-wide Migrations and Population Changes –** Analyze the causes and consequences of shifts in world population and major patterns of long-distance migrations of Europeans, Africans, and Asians during this era, including the impact of industrialism, imperialism, changing diets, and scientific advances on worldwide demographic trends. *(National Geography Standard 9, p. 201)*

6.1.3 **Increasing Global Interconnections –** Describe increasing global interconnections between societies, through the emergence and spread of ideas, innovations, and commodities including

- constitutionalism, communism and socialism, republicanism, nationalism, capitalism, human rights, and secularization *(National Geography Standard 10, p. 203)*
- the global spread of major innovations, technologies, and commodities via new global networks *(National Geography Standard 11, p. 206)*

6.1.4 **Changes in Economic and Political Systems –** Compare the emerging economic and political systems (industrialism and democracy) with the economic and political systems of the previous era (agriculture and absolutism). (See 5.3.5)

6.1.5 **Interpreting Europe's Increasing Global Power –** Describe Europe's increasing global power between 1500 and 1900, and evaluate the merits of the argument that this rise was caused by factors internal to Europe (e.g., Renaissance, Reformation, demographic, economic, and social changes) or factors external to Europe (e.g., decline of Mughal and Ottoman empires and the decreasing engagement of China and Japan in global interactions). (See 6.3.1; 6.3.2; 5.3.2) (*National Geography Standard 13, p. 210)*

6.2 Interregional or Comparative Expectations

Analyze and compare the interregional patterns of nationalism, state-building, and social reform and imperialism.

6.2.1 **Political Revolutions –** Analyze the Age of Revolutions by comparing and contrasting the political, economic, and social causes and consequences of at least three political and/or nationalistic revolutions (American, French, Haitian, Mexican or other Latin American, or Chinese Revolutions) *(National Geography Standard 13, p. 210)*

6.2.2 **Growth of Nationalism and Nation-states –** Compare and contrast the rise of the nation-states in a western context (e.g., Germany, Italy) and non-western context (e.g., Meiji Japan). (See 6.1.1; 6.3.1; 6.3.2) (*National Geography Standard 10, p. 203)*

6.2.3 **Industrialization –** Analyze the origins, characteristics and consequences of industrialization across the world by

- comparing and contrasting the process and impact of industrialization in Russia, Japan, and one of the following: Britain, Germany, United States, or France
- describing the social and economic impacts of industrialization, particularly its effect on women and children, and the rise of organized labor movements *(National Geography Standard 11, p. 206)*
- describing the environmental impacts of industrialization and urbanization *(National Geography Standard 14, p. 212)*

6.2.4 **Imperialism –** Analyze the political, economic, and social causes and consequences of imperialism by

- using historical and modern maps and other evidence to analyze and explain the causes and global consequences of nineteenth-century imperialism, including encounters between imperial powers (Europe, Japan) and local peoples in India, Africa, Central Asia, and East Asia *(National Geography Standard 16, p. 216)*
- describing the connection between imperialism and racism, including the social construction of race
- comparing British policies in South Africa and India, French polices in Indochina, and Japanese policies in Asia (See 7.3.3) (*National Geography Standard 13, p. 210)*
- analyze the responses to imperialism by African and Asian peoples (See 6.6.3) *(National Geography Standard 13, p. 210)*

Note: Teachers might also include the expansion of the United States in studying Imperialism (See for example, U.S. History and Geography expectation 6.2.1)

6.3 Regional Content Expectations

Analyze the important regional developments and political, economic, and social transformations in Europe, Japan, China, and Africa.

6.3.1 **Europe –** Analyze the economic, political, and social transformations in Europe by

- analyzing and explaining the impact of economic development on European society *(National Geography Standard 11, p. 206)*
- explaining how democratic ideas and revolutionary conflicts influenced European society, noting particularly their influence on religious institutions, education, family life, and the legal and political position of women
- using historical and modern maps to describe how the wars of the French Revolutionary and Napoleonic periods and growing nationalism changed the political geography of Europe and other regions (e.g., Louisiana Purchase) *(National Geography Standard 13, p. 210)*

6.3.2 **East Asia –** Analyze the political, economic, and social transformations in East Asia by

- explaining key events in the modernization of Japan (Meiji Restoration) and the impact of the Russo-Japanese War *(National Geography Standard 13, p. 210)*
- describing key events in the decline of Qing China, including the Opium Wars and the Taiping and Boxer Rebellions

6.3.3 **Africa –** Evaluate the different experiences of African societies north and south of the Sahara with imperialism (e.g., Egypt, Ethiopia and the Congo). *(National Geography Standard 16, p. 216)*

WHG ERA 7 – GLOBAL CRISIS AND ACHIEVEMENT, 1900-1945

7.1 Global or Cross-temporal Expectations

Analyze changes in global balances of military, political, economic, and technological power and influence in the first half of the 20th century.

7.1.1 **Increasing Government and Political Power –** Explain the expanding role of state power in managing economies, transportation systems, and technologies, and other social environments, including its impact of the daily lives of their citizens. (See 7.3.2) (*National Geography Standard 13, p. 210)*

7.1.2 **Comparative Global Power –** Use historical and modern maps and other sources to analyze and explain the changes in the global balance of military, political, and economic power between 1900 and 1945 (including the changing role of the United States and those resisting foreign domination). *(National Geography Standard 13, p. 210)*

7.1.3 **Twentieth Century Genocide –** Use various sources including works of journalists, journals, oral histories, films, interviews, and writings of participants to analyze the causes and consequences of the genocides of Armenians, Romas (Gypsies), and Jews, and the mass exterminations of Ukrainians and Chinese. (See 7.2.3)

7.1.4 **Global Technology –** Describe significant technological innovations and scientific breakthroughs in transportation, communication, medicine, and warfare and analyze how they both benefited and imperiled humanity. *(National Geography Standard 11, p. 206)*

7.1.5 **Total War –** Compare and contrast modern warfare and its resolution with warfare in the previous eras; include analysis of the role of technology and civilians. (See 7.2.1; 7.2.3) *(National Geography Standard 13, p. 210)*

7.2 Interregional or Comparative Expectations

Assess the interregional causes and consequences of the global wars and revolutionary movements during this era.

7.2.1 **World War I –** Analyze the causes, characteristics, and long-term consequences of World War I by

- analyzing the causes of the war including nationalism, industrialization, disputes over territory, systems of alliances, imperialism, and militarism
- analyzing the distinctive characteristics and impacts of the war on the soldiers and people at home (See 7.1.5)
- explaining the major decisions made in the Versailles Treaty and analyzing its spatial and political consequences, including the mandate system, reparations, and national self-determination around the globe

(National Geography Standard 13, p. 210)

7.2.2 **Inter-war Period –** Analyze the transformations that shaped world societies between World War I and World War II by

- examining the causes and consequences of the economic depression on different regions, nations, and the globe
- describing and explaining the rise of fascism and the spread of communism in Europe and Asia (See 7.3.1 and 7.3.2)
- comparing and contrasting the rise of nationalism in China, Turkey, and India

(National Geography Standard 10, p. 203)

7.2.3 **World War II –** Analyze the causes, course, characteristics, and immediate consequences of World War II by

- explaining the causes of World War II, including aggression and conflict appeasement that led to war in Europe and Asia (e.g., Versailles Treaty provisions, Italian invasion of Ethiopia, Spanish Civil War, rape of Nanjing, annexation of Austria & Sudetenland) *(National Geography Standard 13, p. 210)*
- explaining the Nazi ideology, policies, and consequences of the Holocaust (or Shoah) (See 7.3.2) *(National Geography Standard 10, p. 203)*
- analyzing the major turning points and unique characteristics of the war (See 7.1.5) *(National Geography Standard 17, p. 219)*
- explaining the spatial and political impact of the Allied negotiations on the nations of Eastern Europe and the world (See 8.1.4) *(National Geography Standard 13, p. 210)*
- analyzing the immediate consequences of the war's end including the devastation, effects on population, dawn of the atomic age, the occupation of Germany and Japan (See 7.1.5; 8.1) *(National Geography Standard 6, p.195)*
- describing the emergence of the United States and the Soviet Union as global superpowers (See 7.1.5; 8.1) *(National Geography Standard 6, p. 195)*

7.2.4 **Revolutionary and/or Independence Movements –** Compare two revolutionary and/or Independence movements of this era (Latin America, India, China, the Arab World, and Africa) with at least one from the previous era. (See 6.2.1). *(National Geography Standard 13, p. 210)*

7.3 Regional Content Expectations

Explain regional continuity and change in Russia, Asia, the Americas, the Middle East, and Africa.

7.3.1 **Russian Revolution –** Determine the causes and results of the Russian Revolution from the rise of Bolsheviks through the conclusion of World War II, including the five-year plans, collectivization of agriculture, and military purges. (*National Geography Standard 6, p. 195)*

7.3.2 **Europe and Rise of Fascism and Totalitarian States –** Compare the ideologies, policies, and governing methods of at least two 20th-century dictatorial regimes (Germany, Italy, Spain, and the Soviet Union) with those absolutist states in earlier eras. (See 5.3.5; 7.2.3)

7.3.3 **Asia –** Analyze the political, economic, and social transformations that occurred in this era, including *(National Geography Standard 13, p. 210)*

- Japanese imperialism
- Chinese nationalism, the emergence of communism, and civil war (See 7.2.2)
- Indian independence struggle

7.3.4 **The Americas –** Analyze the political, economic and social transformations that occurred in this era, including

- economic imperialism (e.g., dollar diplomacy)
- foreign military intervention and political revolutions in Central and South America
- nationalization of foreign investments

(*National Geography Standard 13, p. 210)*

7.3.5 **Middle East –** Analyze the political, economic, and social transformations that occurred in this era, including

- the decline of the Ottoman Empire
- changes in the Arab world including the growth of Arab nationalism, rise of Arab nation-states, and the increasing complexity (e.g., political, geographic, economic, and religious) of Arab peoples
- the role of the Mandate system
- the discovery of petroleum resources

(*National Geography Standard 13, p. 210)*

WHG ERA 8 – THE COLD WAR AND ITS AFTERMATH: THE 20TH CENTURY SINCE 1945

8.1 Global and Cross-temporal Expectations

Analyze the global reconfigurations and restructuring of political and economic relationships in the Post-World War II era.

8.1.1 **Origins of the Cold War –** Describe the factors that contributed to the Cold War including the differences in ideologies and policies of the Soviet bloc and the West; political, economic, and military struggles in the 1940s and 1950s; and development of Communism in China. (See 7.2.3) (*National Geography Standard 13, p. 210)*

8.1.2 **Cold War Conflicts –** Describe the major arenas of conflict, including

- the ways the Soviet Union and the United States attempted to expand power and influence in Korea and Vietnam
- ideological and military competition in THREE of the following areas: Congo, Cuba, Mozambique, Angola, Nicaragua, Guatemala, Bolivia, Chile, Indonesia, and Berlin
- the arms and space race

(National Geography Standard 13, p. 210)

8.1.3 **End of the Cold War –** Develop an argument to explain the end of the Cold War and its significance as a 20th-century event, and the subsequent transitions from bi-polar to multi-polar center(s) of power. *(National Geography Standard 13, p. 210)*

8.1.4 **Mapping the 20th Century –** Using post-WWI, post-WWII, height of Cold War, and current world political maps, explain the changing configuration of political boundaries in the world caused by the World Wars, the Cold War, and the growth of nationalist sovereign states (including Israel, Jordan, Palestine). (See 7.2.3) *(National Geography Standard 13, p. 210)*

8.2 Interregional or Comparative Expectations

Assess and compare the regional struggles for and against independence, decolonization, and democracy across the world.

8.2.1 **The Legacy of Imperialism –** Analyze the complex and changing legacy of imperialism in Africa, Southeast Asia, and Latin America during and after the Cold War such as apartheid, civil war in Nigeria, Vietnam, Cuba, Guatemala, and the changing nature of exploitation of resources (human and natural). *(National Geography Standards 11 and 16, pp. 206 and 216)*

8.2.2 **Independence, Decolonization, and Democratization Movements –** Compare the independence movements and formation of new nations in the Indian Subcontinent, Africa, Eastern Europe, and Southeast Asia during and after the Cold War. *(National Geography Standards 13 and 17, pp. 210 and 219)*

8.2.3 **Middle East –** Analyze the interregional causes and consequences of conflicts in the Middle East, including the development of the state of Israel, Arab-Israeli disputes, Palestine, the Suez crisis, and the nature of the continuing conflict. *(National Geography Standards 13 and 17, pp. 210 and 219)*

CONTEMPORARY GLOBAL ISSUES

Evaluate the events, trends and forces that are increasing global interdependence and expanding global networks and evaluate the events, trends and forces that are attempting to maintain or expand autonomy of regional or local networks.

CG1 Population

Explain the causes and consequences of population changes over the past 50 years by analyzing the

- population change (including birth rate, death rate, life expectancy, growth rate, doubling time, aging population, changes in science and technology)
- distributions of population (including relative changes in urban-rural population, gender, age, patterns of migrations, and population density)
- relationship of the population changes to global interactions, and their impact on three regions of the world

(National Geography Standards 9 and 17, pp. 201 and 219)

CG2 Resources

Explain the changes over the past 50 years in the use, distribution, and importance of natural resources (including land, water, energy, food, renewable, non-renewable, and flow resources) on human life, settlement, and interactions by describing and evaluating

- change in spatial distribution and use of natural resources
- the differences in ways societies have been using and distributing natural resources
- social, political, economic, and environmental consequences of the development, distribution, and use of natural resources
- major changes in networks for the production, distribution, and consumption of natural resources including growth of multinational corporations, and governmental and non-governmental organizations (e.g., OPEC, NAFTA, EU, NATO, World Trade Organization, Red Cross, Red Crescent)
- the impact of humans on the global environment

(National Geography Standard 16, p. 216)

CG3 Patterns of Global Interactions

Define the process of globalization and evaluate the merit of this concept to describe the contemporary world by analyzing

- economic interdependence of the world's countries and world trade patterns
- the exchanges of scientific, technological, and medical innovations
- cultural diffusion and the different ways cultures/societies respond to "new" cultural ideas and patterns
- comparative economic advantages and disadvantages of regions, regarding cost of labor, natural resources, location, and tradition
- distribution of wealth and resources and efforts to narrow the inequitable distribution of resources

(National Geography Standards 6 and 11, pp. 195 and 206)

CG4 Conflict, Cooperation, and Security

Analyze the causes and challenges of continuing and new conflicts by describing

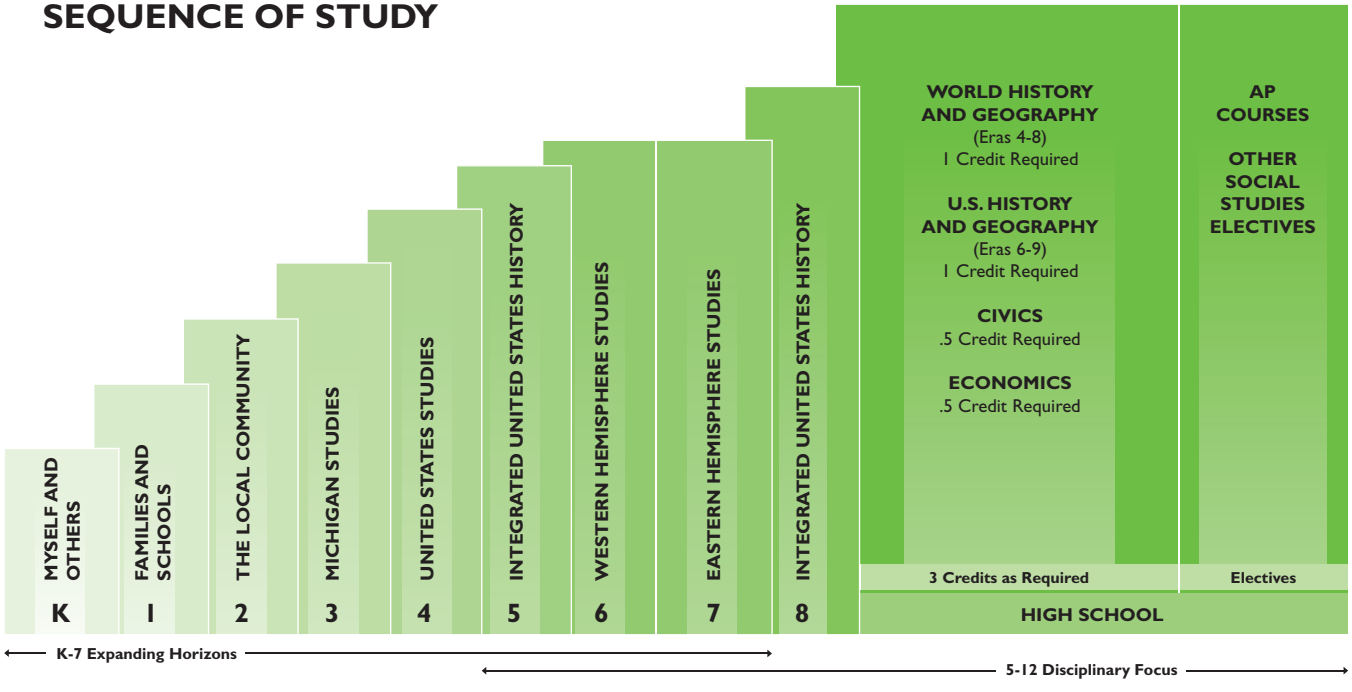
- tensions resulting from ethnic, territorial, religious, and/or nationalist differences (e.g., Israel/Palestine, Kashmir, Ukraine, Northern Ireland, al Qaeda, Shining Path)
- causes of and responses to ethnic cleansing/genocide/mass extermination (e.g., Darfur, Rwanda, Cambodia, Bosnia)
- local and global attempts at peacekeeping, security, democratization, and administering international justice and human rights
- the type of warfare used in these conflicts, including terrorism, private militias, and new technologies

(National Geography Standards10 and 13, pp. 203 and 210)

Michigan High School Social Studies

U.S. HISTORY AND GEOGRAPHY

SEQUENCE OF STUDY



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MICHIGAN Department of Education

UNITED STATES HISTORY AND GEOGRAPHY

The disciplined study of history and geography is vital and essential for citizens in a democratic society such as the United States. History and geography help us understand the origins, development, growth and challenges of our institutions and our culture. These disciplines help to locate ourselves in both time and space and thus help us think about who we are and about our possible futures. The study of history and geography of the United States prepares us to take up the challenges of life in contemporary society by helping us see the common and diverse strands that formed and continue to shape our present life while developing the habits of mind essential for democratic citizenship.

Since the content expectations use both geography and history, it is vital that Michigan teachers understand the major features of geography and history to understand the design of these expectations.

Geography: an Integrative, Disciplined Study

Geography is an integrative discipline that brings together the physical and human dimensions of the world in the study of people, places, and environments. The content of geography is Earth's surface and the processes that result in natural environments, the relationships between people and environments, and the ways that people use and view places both near and far. Geography is important because the world facing students in the 21st century is more crowded, the maintenance of a sustainable physical environment more challenging, and the global economy more competitive and interconnected. Comprehending issues and making decisions about local places, regions, the world, and the diverse environments and the economies require competencies with geography from the local to global scale.

The purpose for studying geography is to foster the development of citizens who will actively seek and systematically use a spatial perspective in viewing the world. The spatial perspective is the ability to view the patterns and dynamic processes on Earth. Those patterns and processes occur as webs of relationships within and between the natural world and the activities of human societies. A spatial perspective enables an individual to visualize, comprehend, and ask questions about why the human and physical systems occur in particular patterns and combinations, where they are on Earth's surface, why they are there, and what are the consequences for people and the environment? For example, large amounts of the world's petroleum resources are located near the Persian Gulf. They are at that location due to Earth's physical processes in the past. The consequences are that availability and cost of petroleum are affected by the political, economic, territorial, and military events that occur in and near the Persian Gulf Region.

The study of geography as a discipline is approached two ways. One is as a regional study in which Earth is examined by areas that share a similar criterion or continuity. For example, a regional criterion may be geopolitical. Examples include Michigan as a state and Canada as a country, each with its particular geopolitical boundaries and legal jurisdictions. The second approach is systematic geography. Earth is examined by topics that share common attributes, but may occur in different regions. Examples include urbanization and the spatial structure and function of cities. Most cities have a central business district, satellite business centers in the suburbs and social, economic, and ethnic residential patterns that spread across urban space. At times regional and systematic geographic studies merge, such as the study of migration to urban centers in Mexico, Central, and South America. A similar study of migration could be completed for Africa or Asia. Among the systematic topics are human/cultural, economic, historical, physical, and political geography. Geographic studies may be based on continents, groups of countries, an individual country, or a region within a country. The criteria for a region may include religion, language, and ethnicity. The spatial pattern of topics may cross political boundaries and connect continents such as Islam within Africa, Europe, and Asia.

Geography bridges the social and physical sciences by asking questions and seeking answers to those questions through inquiry. In doing so, students apply skills and develop habits of mind that they will be able to use in the diverse societies and workplaces of the community, nation, and the world. Maps, satellite images of Earth, Geographic Information Systems (GIS), Geographic Positioning Systems (GPS), and other resources on the World Wide Web provide valuable information about the spatial patterns on Earth. The tools of modern geography are based on modern technology. The technology is the means to explore the world and inquire about the spatial patterns and dynamic processes that shape the world in which we live.

History: an Integrative, Disciplined Study

History is an integrative discipline that studies change over time in people, places, and environments. The content of history consists of human beings and how, at different times and in different places, people and their cultures and societies have changed and developed. Historians study the past to understand the present, drawing upon a vast storehouse of information about human behavior, relationships between people and environments, and the ways that people developed solutions to meet their perceived problems. History is important for students in the 21st century, because of the role the past plays in shaping the present. As a philosopher once remarked, "We live our lives forward, but we understand them backward."

Like geography, history also seeks to foster citizens who actively and systematically investigate the world and its relationships. The disciplined study of history requires students to develop important questions, conduct inquiry, and evaluate and develop historical arguments. Like all disciplines, historical study begins with problems, questions and curiosities. Historians wonder about how things came to be the way they are, or how interpretations of the past influence action in the present. History, however, requires the ability to engage in investigations using different types of evidence and data, including those generated by other disciplines such as economics and geography. The study of history requires students to analyze and use a wide range of sources – such as public and private documents, numerical data and maps – to develop the most accurate picture of the past possible. Studying history also requires students to analyze and evaluate conflicting interpretations and assess past examples of change over time. History thus provides frequent opportunities to engage in reasoned debate, to assess the merits of competing claims about the present and the past, and to consider the world from different perspectives. It helps students understand the complexity involved in most changes while attending to the continuities often obscured by dramatic change. Students studying history also learn to make reasoned arguments, supported by facts and evidence, and informed by competing perspectives.

History thus not only helps us use facts to understand the context and background of our institutions, cultures and societies, it also helps increase our ability to analyze change, evaluate others' interpretations, and develop and improve our own. It draws on a wide range of information and approaches to investigate the dynamic historical processes and interpretations that shape the world in which we live.

Michigan's Content Expectations

The high school expectations begin with a short set of foundational expectations, include ERAs 4- 8 and conclude with a set of contemporary global issues.

- Foundational Issues in U.S. History and Geography:
- The Development of an Industrial, Urban and Global United States, 1870-1930
- The Great Depression and World War II, 1920-1945
- Postwar United States, 1945 -1989
- America in a New Global Age, 1989 to the present

Conclusion:
As Michigan students study United States History and Geography, they will learn about the American experience over time and space. They will encounter powerful and sometimes conflicting ideas while learning about people and events in different places and times. They will investigate our diverse and common traditions, and work to understand the complex interactions among various environmental, human, and social forces that have influenced and continues to influence America and Americans. Studying United States History and Geography connects us to people and events across time and space, illuminating the range and depth of human experience on grand as well as local scales. It involves an analytical study of the nation's political ideals, or times and places where people or events challenged, violated, or expanded those ideas.

This offers Michigan teachers and students both rewards and challenges. We should harbor no illusions about the challenges awaiting teachers and students engaged in such study. Historical and geographic literacy demands that students learn to read critically, analyze and evaluate arguments, decide which positions, given the evidence, are more or less plausible, better or worse. While learning about the facts, events and significant developments, historical and geographic study asks students to consider what they know, how they know it, and how confidently or tentatively they are "entitled" to hold their views.

It is equally important to remember the pleasures that such historical study can provide both teachers and students. A disciplined study of history and geography helps us to locate ourselves and our society among other peoples and societies in the world. It prepares us to take up the challenges of life in the 21st century by enabling us to understand the world that we encounter daily and developing the habits of mind essential for democratic citizenship. Using history and geography, teachers can fill the class with enduring human dramas and dilemma, grand successes and equally grand tragedies, fascinating mysteries, and an amazing cast of characters involved in events that exemplify the best and worst of human experience. In what other field of study can students experience such a range of possibilities and get to know so many people and places?

The study of history and geography is well worth our efforts because it is so vital. Learning about our nation and its place in the world is essential for every individual. Understanding the world's peoples, cultures, and societies and the story of our past is no longer a luxury but a necessity for Americans in the 21st century. As citizens, our students need the best understanding of the world and its past we can give them. A disciplined study of world history and geography promotes exactly the type of reasoned thought our students deserve and democratic societies so desperately need.

Using the United States History and Geography HSCE: Things to Remember

There are a number of important considerations for teachers to keep in mind as they use these United States History and Geography expectations to plan instruction. It is important to remember that this document:

Integrates Geography and History – In meeting these expectations, students will use the content and habits of mind of both history and geography to study America's past and present. This document uses a temporal organizational scheme to present the content expectations. To make geography more visible as a tool for studying the past, National Geographic Standards are referenced after expectations where appropriate.

Uses historical and geographic thinking – All of the expectations require students to think – analyze, synthesize, evaluate, compare, contrast, argue – using history's and geography's habits of mind. In meeting the expectations, students will use historical and geographic thinking to analyze and interpret information in developing their understanding. Students will gather, analyze and use information and evidence in their thinking. In identifying specific events and patterns, these expectations do not intend to stress memory over meaning, or coverage over understanding. While knowledge of specific names, places, dates, and facts is essential for historical and geographical study, high quality teaching and learning demands a great deal more than just the mastery of discrete collections of facts.

Requires active, disciplined inquiry – In using history and geography's habits of mind, students should engage in active, disciplined inquiry, analysis, and argumentation. Learning history and geography involves purposeful investigations within a community that has established goals, standards, criteria, and procedures for study.[6] It entails learning how to read, write, and use history and geography to understand and participate in the world around us. This calls upon students to frame important historical and geographic problems and questions concerning cause and effect, continuity and change, place and time; to locate and analyze appropriate evidence and data; and to determine significance in building reasoned and evidenced-based interpretations, arguments, or decisions. In short, historical and geographic inquiry provides Michigan students with the kind of reasoned and informed decision making that should characterize each citizen's participation in American society.

Represents Content Expectations and not Pedagogical Organization – This document lists content expectations for students. It does not establish a suggested organization for teaching or learning this content. For example, this document does not present expectations in a suggested instructional sequence. Further, individual expectations do not represent single lessons, a day's worth of instruction, or even a unit. Michigan teachers and curriculum coordinators should combine expectations to structure meaningful learning experiences for their students. For example, a teacher could use a compelling historical or geographic issue or problem to organize weeks of study, while coherently employing many content expectations.

Differentiates between required and suggested content – The expectations specify teachable content in two different ways. On numerous occasions, the expectations will offer *examples* for teachers to help clarify teachable content. Typically, these examples or suggestions appear in parentheses. The document always identifies such optional content with an "e.g." or "for example." These are simply suggestions and teachable options. Teachers may use other examples to meet the expectations. In short, these examples are not required content. In other places, the expectations identify specific content that students should study. This content is never preceded by "e.g." or "for example." Unlike the optional examples, a statewide assessment might assess the required content.

[6]Linda S. Levstik and Keith C. Barton, Doing History: Investigating with Children in Elementary and Middle Schools (Mahwah, NJ: Lawrence Erlbaum, 2000):13.

U.S. History and Geography Content Expectations

History Themes

1 Change and Continuity in American Society

2 The Gathering and Interactions of Peoples, Cultures, and Ideas

3 Economic and Technological Changes and Their Relationship to Society Cultures, and Ideas, and the Environment

4 The Changing Role of America in the World

Geography Themes

1 Space and Place

2 Environment and Society

3 Spatial Dynamics and Connections

4 U.S./Global Issues and Events

Era 1 (Grade 5) Beginnings to 1620
- American Indian Life in the Americas
- American Fundamental Values and Principles
- Three World Interactions

Era 2 (Grade 5) Colonization and Settlement (1585 – 1763)
- European Struggle for Control of North America
- Atlantic Slave Trade and Origins of Black America
- Comparative Life in North America

Era 3 (Grades 5 & 8) Revolution and the New Nation (1754 – 1800)
- Causes of the American Revolution
- The American Revolution and Its Consequences
- Creating New Government(s) and a New Constitution

Era 4 (Grade 8) Expansion and Reform (1792 – 1861)
- Political, Economic, and Regional Growth
- Regional and Economic Growth
- Reform Movements

Era 5 (Grade 8) Civil War and Reconstruction (1850 – 1877)
- Abolition and Anti-Slavery
- Civil War
- Reconstruction

Era 6 (Grade 8 and HS) Development of Industrial, Urban, and Global United States (1870 – 1930)
- Growth of an Industrial and Urban America (introduced in Grade 8; begins SS. HSCE)
- Becoming a World Power
- Progressivism and Reform

Era 7 (HS) Great Depression and World War II (1920 – 1945)
- Growing Crisis of Industrial Capitalism and Responses
- World War II

Era 8 (HS) Post-World War II United States (1945 – 1989)
- Cold War and the United States
- Domestic Policies
- Civil Rights in the Post WWII Era

Era 9 (HS) America in a New Global Age
- Impact of Globalization on the United States
- Changes in America's Role in the World
- Policy Debates

U.S. History and Geography Content Expectations

Disciplinary Knowledge *(See page 39)*

Historical and Geographical Knowledge and Perspective

Historical and Geographical Analysis and Interpretation

Thematic Analysis of U.S. History Eras 6 - 9

GENERAL SOCIAL SCIENCE KNOWLEDGE, PROCESSES, AND SKILLS

(listed on page 39)

- K1 General Knowledge
- P1 Reading and Communication
- P2 Inquiry, Research, and Analysis
- P3 Public Discourse and Decision Making
- P4 Citizen Involvement

UNITED STATES HISTORY AND GEOGRAPHY ERAS 6 – 9 ADDRESSED IN USHG HSCE

Foundational Issues in USHG – ERAS 1 – 5 *(Review of content taught in Grades 5 and 8)*

- F1 Political and Intellectual Transformations of America to 1877
- F2 Geographic, Economic, Social, and Demographic Trends in America (to 1898)

USHG ERA 6 – THE DEVELOPMENT OF AN INDUSTRIAL, URBAN, AND GLOBAL UNITED STATES (1870 -1930)

- 6.1 Growth of an Industrial and Urban America *(Included in Grade 8; begins SS. HSCE)*
- 6.2 Becoming a World Power
- 6.3 Progressivism and Reform

USHG ERA 7– THE GREAT DEPRESSION AND WORLD WAR II (1920 -1945)

- 7.1 Growing Crisis of Industrial Capitalism and Responses
- 7.2 World War II

USHG ERA 8 – POST-WORLD WAR 11 UNITED STATES (1945-1989)

- 8.1 Cold War and the United States
- 8.2 Domestic Changes and Policies
- 8.3 Civil Rights in the Post WWII Era

USHG ERA 9 – AMERICA IN A NEW GLOBAL AGE

- 9.1 Impact of Globalization on the United States
- 9.2 Changes in America's Role in the World
- 9.3 Policy Debates

National Geography Standards *(as referenced after expectations where appropriate)*

The World in Spatial Terms: Geographical Habits of Mind

1. Tools, Technology, and Information Processing
2. Mental Maps
3. Spatial Organization on Earth's Surface

Places and Regions

4. Physical and Human Characteristics of Place
5. Creating Regions
6. Perceptions of Places and Regions

Physical Systems

7. Physical Processes
8. Ecosystems

Human Systems

9. Distribution and Migration of People
10. Cultural Mosaic
11. Economic Interdependence
12. Patterns of Human Settlement
13. Forces of Cooperation and Conflict

Environment and Society

14. Human Modification of the Environment
15. How Physical Systems Affect Human Systems
16. Resource Use and Distribution

Uses of Geography

17. Using Geography to Interpret the Past
18. Using Geography to Interpret the Present and Plan for the Future

General Social Studies Knowledge, Processes, and Skills

K1 General Knowledge– embedded in USHG standards and expectations

K1.1 Know the defining characteristics of the disciplines of history and geography.
K1.2 Know that each discipline is subject to criticisms and limitations; be aware of the primary criticisms of history and geography.
K1.3 Understand and analyze temporal and spatial relationships and patterns.
K1.4 Understand historical and geographical perspectives.
K1.5 Understand the diversity of human beings and human cultures.
K1.6 Analyze events and circumstances from the vantage point of others.
K1.7 Understand social problems, social structures, institutions, class, groups, and interaction.
K1.8 Apply social studies concepts to better understand major current local, national, and world events, issues, and problems.
K1.9 Integrate concepts from at least two different social studies disciplines.
K1.10 Understand significant concepts, generalizations, principles, and theories of history and geography as disciplines.

Social Studies Procedures and Skills – embedded in USHG standards and expectations

P1 Reading and Communication – read and communicate effectively.

P1.1 Use close and critical reading strategies to read and analyze complex texts pertaining to social science; attend to nuance, make connections to prior knowledge, draw inferences, and determine main idea and supporting details.
P1.2 Analyze point of view, context, and bias to interpret primary and secondary source documents.
P1.3 Understand that diversity of interpretation arises from frame of reference.
P1.4 Communicate clearly and coherently in writing, speaking, and visually expressing ideas pertaining to social science topics, acknowledging audience and purpose.
P1.5 Present a coherent thesis when making an argument, support with evidence, articulate and answer possible objections, and present a concise, clear closing.

P2 Inquiry, Research, and Analysis – critically examine evidence, thoughtfully consider conflicting claims, and carefully weigh facts and hypotheses.

P2.1 Understand the scientific method of inquiry to investigate social scientific and historical problems.
P2.2 Read and interpret data in tables and graphs.
P2.3 Know how to find and organize information from a variety of sources; analyze, interpret, support interpretations with evidence, critically evaluate, and present the information orally and in writing; report investigation results effectively.
P2.4 Use multiple perspectives and resources to identify and analyze issues appropriate to the social studies discipline being studied.
P2.5 Use deductive and inductive problem-solving skills as appropriate to the problem being studied.

P3 Public Discourse and Decision Making – engage in reasoned and informed decision making that should characterize each citizen's participation in American society.

P3.1 Clearly state an issue as a question of public policy, trace the origins of an issue, analyze various perspectives, and generate and evaluate possible alternative resolutions.
P3.2 Deeply examine policy issues in group discussions and debates (clarify issues, consider opposing views, apply democratic values or constitutional principles, anticipate consequences) to make reasoned and informed decisions.
P3.3 Write persuasive/argumentative essays expressing and justifying decisions on public policy issues.

P4 Citizen Involvement

P4.1 Act out of respect for the rule of law and hold others accountable to the same standard.
P4.2 Demonstrate knowledge of how, when, and where individuals would plan and conduct activities intended to advance views on matters of public policy, report the results, and evaluate effectiveness.
P4.3 Plan and conduct activities intended to advance views on matters of public policy, report the results, and evaluate effectiveness.

Disciplinary Knowledge – embedded in USHG standards and expectations

Historical and Geographical Knowledge and Perspective

Know significant periods and events in world history; social, religious, and political movements; and major historical figures who influenced such movements.

Identify and define specific factual information, themes, movements, and general principles operating in United States history and geography to deduce meaning and comprehend patterns.

Historical and Geographical Analysis and Interpretation

Distinguish value judgments in historical and geographical information, weigh evidence, synthesize information, apply knowledge, make judgments, formulate generalizations, and draw conclusions.

Thematic Analysis of United States History Eras 6-9

U.S. HISTORY AND GEOGRAPHY

FOUNDATIONS IN U.S. HISTORY AND GEOGRAPHY: ERAS 1-5

These foundational expectations are included to help students draw upon their previous study of American history and connect high school United States history with the history studied in 5th and 8th grades.

Note: These might be reviewed as a separate opening unit or woven into Content Expectations 6.1, 6.2, and 6.3.

F1 Political and Intellectual Transformations of America to 1877

F1.1 Identify the core ideals of American society as reflected in the documents below and analyze the ways that American society moved toward and/or away from its core ideals

- Declaration of Independence
- the U.S. Constitution (including the Preamble)
- Bill of Rights
- the Gettysburg Address
- 13th, 14th, and 15th Amendments

F1.2 Using the American Revolution, the creation and adoption of the Constitution, and the Civil War as touchstones, develop an argument/narrative about the changing character of American political society and the roles of key individuals across cultures in prompting/supporting the change by discussing

- the birth of republican government, including the rule of law, inalienable rights, equality, and limited government
- the development of governmental roles in American life
- and competing views of the responsibilities of governments (federal, state, and local)
- changes in suffrage qualifications
- the development of political parties
- America's political and economic role in the world *(National Geography Standard 13, p. 210)*

F2 Geographic, Economic, Social, and Demographic Trends in America to 1877

Note to teacher: This foundational expectation might be taught in stand-alone lessons or integrated with Standard 6.1.

F2.1 Describe the major trends and transformations in American life prior to 1877 including

- changing political boundaries of the United States *(National Geography Standard 13, p. 210)*
- regional economic differences and similarities, including goods produced and the nature of the labor force *(National Geography Standard 11, p. 206)*
- changes in the size, location, and composition of the population *(National Geography Standard 9, p. 201)*
- patterns of immigration and migration *(National Geography Standard 9, p. 201)*
- development of cities *(National Geography Standard 12, p. 208)*
- changes in commerce, transportation, and communication *(National Geography Standard 11, p. 206)*
- major changes in Foreign Affairs marked by such events as the War of 1812, the Mexican-American War, and foreign relations during the Civil War

USHG ERA 6 – THE DEVELOPMENT OF AN INDUSTRIAL, URBAN, AND GLOBAL UNITED STATES (1870-1930)

6.1 Growth of an Industrial and Urban America

Explain the causes and consequences – both positive and negative – of the Industrial Revolution and America's growth from a predominantly agricultural, commercial, and rural nation to a more industrial and urban nation between 1870 and 1930.

6.1.1 **Factors in the American Industrial Revolution** – Analyze the factors that enabled the United States to become a major industrial power, including

- gains from trade *(National Geography Standard 11, p. 206)*
- organizational "revolution" (e.g., development of corporations and labor organizations)
- advantages of physical geography *(National Geography Standards 4, 7, and 15; pp. 190, 197, and 214)*
- increase in labor through immigration and migration *(National Geography Standard 9, p. 201)*
- economic polices of government and industrial leaders (including Andrew Carnegie and John D. Rockefeller)
- technological advances

6.1.2 **Labor's Response to Industrial Growth** – Evaluate the different responses of labor to industrial change including

- development of organized labor, including the Knights of Labor, American Federation of Labor, and the United Mine Workers
- southern and western farmers' reactions, including the growth of populism and the populist movement (e.g., Farmers Alliance, Grange, Platform of the Populist Party, Bryan's "Cross of Gold" speech) *(National Geography Standard 6, p. 195)*

6.1.3 **Urbanization** – Analyze the changing urban and rural landscape by examining

- the location and expansion of major urban centers *(National Geography Standard 12, p. 208)*
- the growth of cities linked by industry and trade *(National Geography Standard 11, p. 206)*
- the development of cities divided by race, ethnicity, and class *(National Geography Standard 10, p. 203)*
- resulting tensions among and within groups *(National Geography Standard 13, p. 210)*
- different perspectives about immigrant experiences in the urban setting *(National Geography Standards 9 and 12, pp. 201 and 208)*

6.1.4 **Population Changes** – Use census data from 1790-1940 to describe changes in the composition, distribution, and density of the American population and analyze their causes, including immigration, the Great Migration, and urbanization. *(National Geography Standard 9 and 12, pp. 201 and 208)*

6.1.5 **A Case Study of American Industrialism** – Using the automobile industry as a case study, analyze the causes and consequences of this major industrial transformation by explaining

- the impact of resource availability *(National Geography Standard 16, p. 216)*
- entrepreneurial decision making by Henry Ford and others
- domestic and international migrations *(National Geography Standard 9, p. 201)*
- the development of an industrial work force
- the impact on Michigan
- the impact on American society

6.2 Becoming a World Power

Describe and analyze the major changes – both positive and negative – in the role the United States played in world affairs after the Civil War, and explain the causes and consequences of this changing role.

6.2.1 **Growth of U.S. Global Power** – Locate on a map the territories (Cuba, Puerto Rico, Philippines, Hawaii, Panama Canal Zone) acquired by the United States during its emergence as an imperial power between 1890 and 1914, and analyze the role the Spanish American War, the Philippine Revolution, the Panama Canal, the Open Door Policy, and the Roosevelt Corollary played in expanding America's global influence and redefining its foreign policy. *(National Geography Standards 1 and 3; p.184 and 188)*

6.2.2 **WWI** – Explain the causes of World War I, the reasons for American neutrality and eventual entry into the war, and America's role in shaping the course of the war.

6.2.3 **Domestic Impact of WWI** – Analyze the domestic impact of WWI on the growth of the government (e.g., War Industries Board), the expansion of the economy, the restrictions on civil liberties (e.g., Sedition Act, Red Scare, Palmer Raids), and the expansion of women's suffrage.

6.2.4 **Wilson and His Opponents** – Explain how Wilson's "Fourteen Points" differed from proposals by others, including French and British leaders and domestic opponents, in the debate over the Versailles Treaty, United States participation in the League of Nations, the redrawing of European political boundaries, and the resulting geopolitical tensions that continued to affect Europe. *(National Geography Standards 3 and 13; p. 188 and 210)*

6.3 Progressivism and Reform

Select and evaluate major public and social issues emerging from the changes in industrial, urban, and global America during this period; analyze the solutions or resolutions developed by Americans, and their consequences (positive/negative – anticipated/unanticipated) including, but not limited to, the following:

6.3.1 **Social Issues** – Describe at least three significant problems or issues created by America's industrial and urban transformation between 1895 and 1930 (e.g., urban and rural poverty and blight, child labor, immigration, political corruption, public health, poor working conditions, and monopolies).

6.3.2 **Causes and Consequences of Progressive Reform** – Analyze the causes, consequences, and limitations of Progressive reform in the following areas

- major changes in the Constitution, including 16th, 17th, 18th, and 19th Amendments
- new regulatory legislation (e.g., Pure Food and Drug Act, Sherman and Clayton Anti-Trust Acts)
- the Supreme Court's role in supporting or slowing reform
- role of reform organizations, movements and individuals in promoting change (e.g., Women's Christian Temperance Union, settlement house movement, conservation movement, and the National Association for the Advancement of Colored People, Jane Addams, Carrie Chapman Catt, Eugene Debs, W.E.B. DuBois, Upton Sinclair, Ida Tarbell) *(National Geography Standard 14, p. 212)*
- efforts to expand and restrict the practices of democracy as reflected in post-Civil War struggles of African Americans and immigrants *(National Geography Standards 9 and 10; pp. 201 and 203)*

6.3.3 **Women's Suffrage** – Analyze the successes and failures of efforts to expand women's rights, including the work of important leaders (e.g., Susan B. Anthony, Elizabeth Cady Stanton) and the eventual ratification of the 19th Amendment.

U.S. HISTORY AND GEOGRAPHY

USHG ERA 7 – THE GREAT DEPRESSION AND WORLD WAR II (1920-1945)

7.1 Growing Crisis of Industrial Capitalism and Responses

Evaluate the key events and decisions surrounding the causes and consequences of the global depression of the 1930s and World War II.

7.1.1 **The Twenties** – Identify and explain the significance of the cultural changes and tensions in the "Roaring Twenties" including

- cultural movements, such as the Harlem Renaissance and the "lost generation"
- the struggle between "traditional" and "modern" America (e.g., Scopes Trial, immigration restrictions, Prohibition, role of women, mass consumption) *(National Geography Standard 10, p. 203)*

7.1.2 **Causes and Consequences of the Great Depression** – Explain and evaluate the multiple causes and consequences of the Great Depression by analyzing

- the political, economic, environmental, and social causes of the Great Depression including fiscal policy, overproduction, under consumption, and speculation, the 1929 crash, and the Dust Bowl *(National Geography Standards 14 and 15; p. 212 and 214)*
- the economic and social toll of the Great Depression, including unemployment and environmental conditions that affected farmers, industrial workers and families *(National Geography Standard 15, p. 214)*
- Hoover's policies and their impact (e.g., Reconstruction Finance Corporation)

7.1.3 **The New Deal** – Explain and evaluate Roosevelt's New Deal Policies including

- expanding the federal government's responsibilities to protect the environment (e.g., Dust Bowl and the Tennessee Valley), meet challenges of unemployment, address the needs of workers, farmers, poor, and elderly *(National Geography Standard 14, p. 212)*
- opposition to the New Deal and the impact of the Supreme Court in striking down and then accepting New Deal laws
- consequences of New Deal policies (e.g., promoting workers' rights, development of Social Security program, and banking and financial regulation conservation practices, crop subsidies) *(National Geography Standard 16, p. 216)*

7.2 World War II

Examine the causes and course of World War II, and the effects of the war on United States society and culture, including the consequences for United States involvement in world affairs.

7.2.1 **Causes of W WII** – Analyze the factors contributing to World War II in Europe and in the Pacific region, and America's entry into war including

- the political and economic disputes over territory (e.g., failure of Versailles Treaty, League of Nations, Munich Agreement)*(National Geography Standard 13, p. 210)*
- the differences in the civic and political values of the United States and those of Nazi Germany and Imperial Japan
- United States neutrality
- the bombing of Pearl Harbor *(National Geography Standard 13, p. 210)*

7.2.2 **U.S. and the Course of W WII** – Evaluate the role of the U.S. in fighting the war militarily, diplomatically and technologically across the world (e.g., Germany First strategy, Big Three Alliance and the development of atomic weapons).

7.2.3 **Impact of W WII on American Life** – Analyze the changes in American life brought about by U.S. participation in World War II including

- mobilization of economic, military, and social resources
- role of women and minorities in the war effort
- role of the home front in supporting the war effort (e.g., rationing, work hours, taxes)
- internment of Japanese-Americans *(National Geography Standard 10, p. 203)*

7.2.4 **Responses to Genocide** – Investigate development and enactment of Hitler's "final solution" policy, and the responses to genocide by the Allies, the U.S. government, international organizations, and individuals (e.g., liberation of concentration camps, Nuremberg war crimes tribunals, establishment of state of Israel). *(National Geography Standard 13, p. 210)*

USHG ERA 8 – POST-WORLD WAR 11 UNITED STATES (1945 -1989)

8.1 Cold War and the United States

Identify, analyze, and explain the causes, conditions, and impact of the Cold War Era on the United States.

8.1.1 **Origins and Beginnings of Cold War** – Analyze the factors that contributed to the Cold War including

- differences in the civic, ideological and political values, and the economic and governmental institutions of the U.S. and U.S.S.R.
- diplomatic decisions made at the Yalta and Potsdam Conferences (1945)
- actions by both countries in the last years of and years following World War II (e.g., the use of the atomic bomb, the Marshall Plan, the Truman Doctrine, North American Treaty Alliance (NATO), and Warsaw Pact) (*National Geography Standard 13, p. 210)*

8.1.2 **Foreign Policy during the Cold War** – Evaluate the origins, setbacks, and successes of the American policy of "containing" the Soviet Union, including

- the development of a U.S. national security establishment, composed of the Department of Defense, the Department of State, and the intelligence community *(National Geography Standard 13, p. 210)*
- the armed struggle with Communism, including the Korean conflict *(National Geography Standard 13, p. 210)*
- direct conflicts within specific world regions including Germany and Cuba *(National Geography Standards 5 and 13; pp. 192 and 210)*
- U.S. involvement in Vietnam, and the foreign and domestic consequences of the war (e.g., relationship/conflicts with U.S.S.R. and China, U.S. military policy and practices, responses of citizens and mass media) *(National Geography Standard 13, p. 210)*
- indirect (or proxy) confrontations within specific world regions (e.g., Chile, Angola, Iran, Guatemala) *(National Geography Standards 5 and 13; pp. 192 and 210)*
- the arms race *(National Geography Standards 13, p. 210)*

8.1.3 **End of the Cold War** – Evaluate the factors that led to the end of the cold war including détente, policies of the U.S. and U.S.S.R. and their leaders (President Reagan and Premier Gorbachev), the political breakup of the Soviet Union, and the Warsaw Pact.

8.2 Domestic Policies

Examine, analyze, and explain demographic changes, domestic policies, conflicts, and tensions in Post-WWII America.

8.2.1 **Demographic Changes** – Use population data to produce and analyze maps that show the major changes in population distribution, spatial patterns and density, including the Baby Boom, new immigration, suburbanization, reverse migration of African Americans to the South, and the flow of population to the "Sunbelt." *(National Geography Standards 1,3, 5, 9, 10; p. 184, 188, 192, 201, 203)*

8.2.2 **Policy Concerning Domestic Issues** – Analyze major domestic issues in the Post-World War II era and the policies designed to meet the challenges by

- describing issues challenging Americans such as domestic anticommunism (McCarthyism), labor, poverty, health care, infrastructure, immigration, and the environment *(National Geography Standards 9 and 14; pp. 201 and 212)*
- evaluating policy decisions and legislative actions to meet these challenges (e.g., G.I. Bill of Rights (1944), Taft-Hartley Act (1947), Twenty-Second Amendment to the U.S. Constitution (1951), Federal Highways Act (1956), National Defense Act (1957), E.P.A. (1970) *(National Geography Standards 12 and 14; pp. 208 and 212)*

8.2.3 **Comparing Domestic Policies** – Focusing on causes, programs, and impacts, compare and contrast Roosevelt's New Deal initiatives, Johnson's Great Society programs, and Reagan's market-based domestic policies. *(National Geography Standard 14, p. 212)*

8.2.4 **Domestic Conflicts and Tensions** – Using core democratic values, analyze and evaluate the competing perspectives and controversies among Americans generated by U.S. Supreme Court decisions (e.g., Roe v Wade, Gideon, Miranda, Tinker, Hazelwood), the Vietnam War (anti-war and counter-cultural movements), environmental movement, women's rights movement, and the constitutional crisis generated by the Watergate scandal. *(National Geography Standard 16, p. 216)*

8.3 Civil Rights in the Post-WWII Era

Examine and analyze the Civil Rights Movement using key events, people, and organizations.

8.3.1 **Civil Rights Movement** – Analyze the key events, ideals, documents, and organizations in the struggle for civil rights by African Americans including

- the impact of WWII and the Cold War (e.g., racial and gender integration of the military)
- Supreme Court decisions and governmental actions (e.g., *Brown* v. *Board* (1954), Civil Rights Act (1957), Little Rock schools desegregation, Civil Rights Act (1964), Voting Rights Act (1965))
- protest movements, organizations, and civil actions (e.g., integration of baseball, Montgomery Bus Boycott (1955–1956), March on Washington (1963), freedom rides, National Association for the Advancement of Colored People (NAACP), Southern Christian Leadership Conference (SCLC), Student Non-violent Coordinating Committee (SNCC), Nation of Islam, Black Panthers)
- resistance to Civil Rights *(National Geography Standard 6, p. 195)*

(National Geography Standard 10, p. 203)

8.3.2 **Ideals of the Civil Rights Movement** – Compare and contrast the ideas in Martin Luther King's March on Washington speech to the ideas expressed in the Declaration of Independence, the Seneca Falls Resolution, and the Gettysburg Address.

8.3.3 **Women's Rights** – Analyze the causes and course of the women's rights movement in the 1960s and 1970s (including role of population shifts, birth control, increasing number of women in the work force, National Organization for Women (NOW), and the Equal Rights Amendment (ERA)).
(National Geography Standard 10, p. 203)

8.3.4 **Civil Rights Expanded** – Evaluate the major accomplishments and setbacks in civil rights and liberties for American minorities over the 20th century including American Indians, Latinos/Latinas, new immigrants, people with disabilities, and gays and lesbians. *(National Geography Standard 10, p. 203)*

8.3.5 **Tensions and Reactions to Poverty and Civil Rights** – Analyze the causes and consequences of the civil unrest that occurred in American cities by comparing the civil unrest in Detroit with at least one other American city (e.g., Los Angeles, Cleveland, Chicago, Atlanta, Newark).
(National Geography Standard 12, p. 208)

USHG ERA 9 – AMERICA IN A NEW GLOBAL AGE

9.1 The Impact of Globalization on the United States

Explain the impact of globalization on the United States' economy, politics, society and role in the world.

9.1.1 **Economic Changes** – Using the changing nature of the American automobile industry as a case study, evaluate the changes in the American economy created by new markets, natural resources, technologies, corporate structures, international competition, new sources and methods of production, energy issues, and mass communication. *(National Geography Standard 11, p. 206)*

9.1.2 **Transformation of American Politics** – Analyze the transformation of American politics in the late 20th and early 21st centuries including

- growth of the conservative movement in national politics, including the role of Ronald Reagan
- role of evangelical religion in national politics *(National Geography Standards 3 and 6; pp.188 and 195)*
- intensification of partisanship
- partisan conflict over the role of government in American life
- role of regional differences in national politics *(National Geography Standard 6, p. 195)*

9.2 Changes in America's Role in the World

Examine the shifting role of United States on the world stage during the period from 1980 to the present.

9.2.1 **U.S. in the Post-Cold War World** – Explain the role of the United States as a super-power in the post-Cold War world, including advantages, disadvantages, and new challenges (e.g., military missions in Lebanon, Somalia, Haiti, Bosnia, Kosovo, and the Gulf War). (*National Geography Standard 13, p. 210)*

9.2.2 **9/11 and Responses to Terrorism** – Analyze how the attacks on 9/11 and the response to terrorism have altered American domestic and international policies (including e.g., the Office of Homeland Security, Patriot Act, wars in Afghanistan and Iraq, role of the United States in the United Nations, NATO). (*National Geography Standard 13, p. 210)*

9.3 Policy Debates

9.3.1 Compose a persuasive essay on a public policy issue, and justify the position with a reasoned argument based upon historical antecedents and precedents, and core democratic values or constitutional principles.

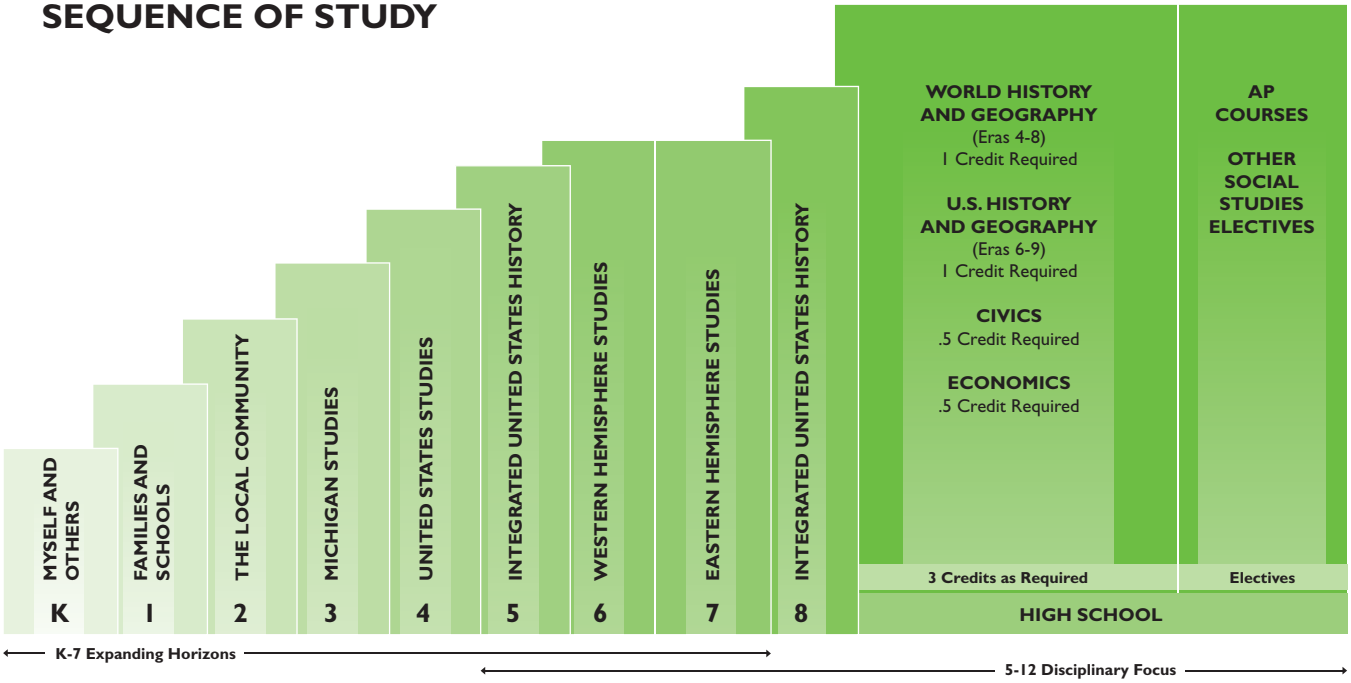
- role of the United States in the world
- national economic policy
- welfare policy
- energy policy
- health care
- education
- civil rights

(National Geography Standard 17, p. 216)

Michigan High School Social Studies

CIVICS

SEQUENCE OF STUDY



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MICHIGAN Department of Education

CIVICS

Citizenship, as the National Assessment of Educational Progress explains, is the "engine of constitutional democracy and a free society" and knowing our rights and responsibilities as citizens "fuels that engine." Democratic societies do not function without the participation of informed and responsible citizens. Civic education, therefore, is one of public education's central missions. The education of the next generation of citizens is essential to the well-being of American constitutional democracy. And, effective civic education also is important to civil society—that historically essential sector of society composed of non-governmental, voluntary, community, fraternal organizations, clubs, and religious institutions.

To participate effectively, American citizens need intellectual and participatory skills, as well as knowledge about their government and society. Acquisition of civic knowledge and skills makes possible a reasoned commitment to those fundamental values and principles essential to the preservation and improvement of American constitutional democracy. Sustained and systematic attention to civics, government, and civil society in the K–12 curriculum enables students to build on the knowledge they acquire in each successive grade. Therefore, students' understanding of civic life, politics, and government should increase both in scope and depth as they progress through the elementary, middle, and high school years. In addition, their command of essential intellectual and participatory skills should continue to develop as they move toward the assumption of the full rights and responsibilities of citizenship.

The Michigan Content Expectations in Civics, aligned with National Civics Standards and NAEP have three interrelated components: knowledge, intellectual and participatory skills, and civic dispositions.

The knowledge component is embodied in the form of five significant and enduring questions. These are questions that have continued to engage not only political philosophers and politicians; they are questions that do – or should – engage every thoughtful citizen. The five questions are:

- What are civic life, politics and government?
- What are the origins and foundations of the American political system?
- How does the government established by the Constitution function to embody the purposes, values and principles of American constitutional democracy?
- What is the relationship of the United States to other nations and its role in world affairs?
- What are the roles of citizens in American society?

Knowledge, while essential, is not sufficient for effective citizenship. Citizenship requires the use of knowledge to think and act in a reasoned manner. The **intellectual and participatory skills component** of civic education enables students to learn how, when, and where to apply civic knowledge in the many and varied roles of citizens. These skills help citizens identify, describe, explain, and analyze information and arguments as well as evaluate, take, and defend positions on public policies. Participatory skills enable citizens to monitor and influence public and civic life by working with others, clearly articulating ideas and interests, building coalitions, seeking consensus, negotiating compromise, and managing conflict.

A central feature of civic life is what the NAEP framework, quoting de Tocqueville, refers to as the "habits of the heart," or the civic principles or values. Beyond mere knowledge or participation skills, these reflect the core democratic values and include becoming an independent member of society; respecting individual worth and human dignity; assuming the personal, political, and economic responsibilities of a citizen; abiding by the "rules of the game," such as accepting the legitimate decisions of the majority while protecting the rights of the minority; participating in civic affairs in an informed, thoughtful, and effective manner; and promoting the healthy and lawful functioning of American constitutional democracy.

The acquisition of knowledge and skills and the development of civic values take place within a variety of contexts. Those of home, school, community, state, nation, and the world are especially important in civic education. They constitute the primary arenas in which citizens acquire knowledge and skills as well as put their knowledge and skills into practice.

Using the Civics HSCE: Things to Remember

There are a number of important considerations for teachers to keep in mind as they use these Civics expectations to plan instruction. It is important to remember that this document:

Uses Civics thinking – All of the expectations require students to think – analyze, synthesize, evaluate, compare, contrast, argue – using political and civics habits of mind. In meeting the expectations, students will use such thinking to analyze and interpret information in developing their understanding. These expectations do not intend to stress memory over meaning, coverage over understanding. While knowledge of names, definitions, and facts is essential, high quality teaching and learning demands a great deal more than just the mastery of discrete collections of facts or terms.

Requires active inquiry and participation – Civic education requires students to be active – actively engaged in investigations, analysis, argumentation, and in the civic activities of their school and communities. Learning involves purposeful action, public deliberation and investigation. Civics study should entail learning how to read, write, and know how, when, and where to use civics concepts and knowledge to understand and participate in the world around us. This calls upon students to frame important questions; locate and analyze appropriate evidence and data; consider differing points of view, apply concepts and principles to build reasoned and evidence-based interpretations, arguments, or decisions; and participate in democratic deliberations around public policy issues. In short, Civics should help Michigan students make reasoned and informed decisions and understand how citizens can and should participate fully in American society.

Represents Content Expectations and not Pedagogical Organization – This document lists content expectations for students. It does not establish suggested organization for teaching or learning this content. For example, this document is not presenting expectations in a suggested instructional sequence. The expectations do not represent single lessons, a day's worth of instruction or even a unit. Michigan teachers and curriculum coordinators can combine expectations to structure meaningful learning experiences for their students. For example, a teacher could use a compelling public policy issue or problem to organize weeks of study, while coherently employing many content expectations.

Differentiates between required and suggested (e.g.) content – The expectations specify teachable content in two different ways. On numerous occasions, the expectations will offer examples for teachers to help clarify teachable content. Typically, these examples or suggestions appear in parentheses. The document always identifies such optional content with an "e.g." or "for example." These are simply suggestions and teachable options. Teachers may use other examples to meet the expectations. In short, these examples are not required content.

In other places, the expectations identify specific content that students should study. This content is never preceded by "e.g." or "for example." Unlike the optional examples, a statewide assessment might assess the required content.

Civics Content Expectations

Components of Civics Proficiency

Civics Knowledge

1 What are civic life, politics, and government?

2 What are the foundations of the American political system?

3 How does the government established by the Constitution embody the purposes, values, and principles of American democracy?

4 What is the relationship of the United States to other nations and to world affairs?

5 What are the roles of citizens in American democracy?

Intellectual Skills

- identifying and describing
- explaining and analyzing
- evaluating, taking, and defending positions

Participatory Skills

- interacting
- monitoring
- influencing

Civic Dispositions

- self-governance
- moral responsibility
- self-discipline
- respect for individual worth
- respect for human dignity
- participating in civic affairs
- promoting democracy

adapted from Civics Framework for the 2006 NAEP

C1 - Conceptual Foundations of Civics and Political Life

- Nature of Civic Life, Politics, and Government
- Alternative Forms of Government

C2 - Origins and Foundations of Government of the United States of America

- Origins of American Constitutional Government
- Foundational Values and Constitutional Principles of American Government

C3 - Structure and Function of Government in the United States of America

- Structure, Functions, and Enumerated Powers of National Government
- Powers and Limits on Powers
- Structure and Functions of State and Local Governments
- System of Law and Laws
- Other Actors in the Policy Process

C4 - The United States of America and World Affairs

- Formation and Implementation of U.S. Foreign Policy
- U.S. Role in International Institutions and Affairs

C5 - Citizenship in the United States of America

- The Meaning of Citizenship in the United States of America
- Becoming a Citizen
- Rights of Citizenship
- Responsibilities of Citizenship
- Dispositions of Citizenship

C6 - Citizenship in Action

- Civic Inquiry and Public Discourse
- Participating in Civic Life

GENERAL SOCIAL SCIENCE KNOWLEDGE, PROCESSES, AND SKILLS *(listed on page 47)*

- K1 General Knowledge
- P1 Reading and Communication
- P2 Inquiry, Research, and Analysis
- P3 Public Discourse and Decision Making
- P4 Citizen Involvement

Civics Content Statement Outline

C1 – CONCEPTUAL FOUNDATIONS OF CIVIC AND POLITICAL LIFE

- 1.1 Nature Of Civic Life, Politics, and Government
- 1.2 Alternative Forms of Government

C2 – ORIGINS AND FOUNDATIONS OF GOVERNMENT OF THE UNITED STATES OF AMERICA

- 2.1 Origins of American Constitutional Government
- 2.2 Foundational Values and Constitutional Principles of American Government

C3 – STRUCTURE AND FUNCTION OF GOVERNMENT IN THE UNITED STATES OF AMERICA

- 3.1 Structure, Functions, and Enumerated Powers of National Government
- 3.2 Powers and Limits on Powers
- 3.3 Structure and Functions of State and Local Governments
- 3.4 System of Law and Laws
- 3.5 Other Actors in the Policy Process

C4 – THE UNITED STATES OF AMERICA AND WORLD AFFAIRS

- 4.1 Formation and Implementation of U.S. Foreign Policy
- 4.2 U.S. Role in International Institutions and Affairs

C5 – CITIZENSHIP IN THE UNITED STATES OF AMERICA

- 5.1 The Meaning of Citizenship in the United States of America
- 5.2 Becoming a Citizen
- 5.3 Rights of Citizenship
- 5.4 Responsibilities of Citizenship
- 5.5 Dispositions of Citizenship

C6 – CITIZENSHIP IN ACTION

- 6.1 Civic Inquiry and Public Discourse
- 6.2 Participating in Civic Life

General Social Studies Knowledge, Processes, and Skills

General Social Science Knowledge – embedded in civics standards and expectations

K1.1 Know the defining characteristics of the discipline of civics.
K1.2 Know that each discipline is subject to criticisms and limitations; be aware of the primary criticisms and limitations of civics.
K1.3 Understand and analyze social relationships and patterns.
K1.4 Understand social and political perspectives.
K1.5 Understand the diversity of human beings and human cultures.
K1.6 Analyze events and circumstances from the vantage point of others.
K1.7 Understand social problems, social structures, institutions, class, groups, and interaction.
K1.8 Apply social studies concepts to better understand major current local, national, and world events, issues, and problems.
K1.9 Integrate concepts from at least two different social studies disciplines.
K1.10 Understand significant concepts, generalizations, principles, and theories of civics as a discipline.

Social Studies Procedures and Skills – embedded in civics standards and expectations

P1 Reading and Communication – read and communicate effectively.

P1.1 Use close and critical reading strategies to read and analyze complex texts pertaining to social science; attend to nuance, make connections to prior knowledge, draw inferences, and determine main idea and supporting details.
P1.2 Analyze point of view, context, and bias to interpret primary and secondary source documents.
P1.3 Understand that diversity of interpretation arises from frame of reference.
P1.4 Communicate clearly and coherently in writing, speaking, and visually expressing ideas pertaining to social science topics, acknowledging audience and purpose.
P1.5 Present a coherent thesis when making an argument, support with evidence, articulate and answer possible objections, and present a concise, clear closing.

P2 Inquiry, Research, and Analysis – critically examine evidence, thoughtfully consider conflicting claims, and carefully weigh facts and hypotheses.

P2.1 Understand the scientific method of inquiry to investigate social scientific and historical problems.
P2.2 Read and interpret data in tables and graphs.
P2.3 Know how to find and organize information from a variety of sources, analyze, interpret, support interpretations with evidence, critically evaluate, and present the information orally and in writing; report investigation results effectively.
P2.4 Use multiple perspectives and resources to identify and analyze issues appropriate to the social studies discipline being studied.
P2.5 Use deductive and inductive problem-solving skills as appropriate to the problem being studied.

P3 Public Discourse and Decision Making – engage in reasoned and informed decision making that should characterize each citizen's participation in American society.

P3.1 Clearly state an issue as a question of public policy, trace the origins of an issue, analyze various perspectives, and generate and evaluate possible alternative resolutions.
P3.2 Deeply examine policy issues in group discussions and debates (clarify issues, consider opposing views, apply democratic values or constitutional principles, anticipate consequences) to make reasoned and informed decisions.
P3.3 Write persuasive/argumentative essays expressing and justifying decisions on public policy issues.

P4 Citizen Involvement

P4.1 Act out of respect for the rule of law and hold others accountable to the same standard.
P4.2 Demonstrate knowledge of how, when, and where individuals would plan and conduct activities intended to advance views on matters of public policy, report the results, and evaluate effectiveness.
P4.3 Plan and conduct activities intended to advance views on matters of public policy, report the results, and evaluate effectiveness.

CIVICS

C1 CONCEPTUAL FOUNDATIONS OF CIVIC AND POLITICAL LIFE

1.1 Nature of Civic Life, Politics, and Government

Explain the meaning of civic life, politics, and government through the investigation of such questions as: What is civic life? What are politics? What is government? What are the purposes of politics and government?

1.1.1 Identify roles citizens play in civic and private life, with emphasis on leadership.

1.1.2 Explain and provide examples of the concepts "power," "legitimacy," "authority," and "sovereignty."

1.1.3 Identify and explain competing arguments about the necessity and purposes of government (such as to protect inalienable rights, promote the general welfare, resolve conflicts, promote equality, and establish justice for all). (See USHG F1.1; F1.2; 8.3.2)

1.1.4 Explain the purposes of politics, why people engage in the political process, and what the political process can achieve (e.g., promote the greater good, promote self-interest, advance solutions to public issues and problems, achieve a just society). (See USHG F1.1; F1.2; 6.3.2; 8.3.1)

1.2 Alternative Forms of Government

Describe constitutional government and contrast it with other forms of government through the investigation of such questions as: What are essential characteristics of limited and unlimited government? What is constitutional government? What forms can a constitutional government take?

1.2.1 Identify, distinguish among, and provide examples of different forms of governmental structures including anarchy, monarchy, military junta, aristocracy, democracy, authoritarian, constitutional republic, fascist, communist, socialist, and theocratic states.

1.2.2 Explain the purposes and uses of constitutions in defining and limiting government, distinguishing between historical and contemporary examples of constitutional governments that failed to limit power (e.g., Nazi Germany and Stalinist Soviet Union) and successful constitutional governments (e.g., contemporary Germany and United Kingdom). (See USHG 7.2.1; WHG 7.3)

1.2.3 Compare and contrast parliamentary, federal, confederal, and unitary systems of government by analyzing similarities and differences in sovereignty, diffusion of power, and institutional structure. (See USHG F1.1; F1.2)

1.2.4 Compare and contrast direct and representative democracy. (See USHG F1.1; F1.2)

C2 ORIGINS AND FOUNDATIONS OF GOVERNMENT OF THE UNITED STATES OF AMERICA

2.1 Origins of American Constitutional Government (Note: Much of this content should have been an essential feature of students' 5th and 8th grade coursework. High School U.S. History and Geography teachers, however, revisit this in USHG Foundational Expectations 1.1, 1.2, and 2.1.)

Explain the fundamental ideas and principles of American constitutional government and their philosophical and historical origins through investigation of such questions as: What are the philosophical and historical roots of the foundational values of American constitutional government? What are the fundamental principles of American constitutional government?

2.1.1 Explain the historical and philosophical origins of American constitutional government and evaluate the influence of ideas found in the Magna Carta, English Bill of Rights, Mayflower Compact, Iroquois Confederation, Northwest Ordinance, Virginia Statute for Religious Freedom, Declaration of Independence, Articles of Confederation, and selected Federalist Papers (the 10th, 14th, 51st), John Locke's Second Treatise, Montesquieu's Spirit of Laws, Paine's Common Sense.

2.1.2 Explain the significance of the major debates and compromises underlying the formation and ratification of American constitutional government including the Virginia and New Jersey plans, the Great Compromise, debates between Federalists and Anti-Federalists, debates over slavery, and the promise for a bill of rights after ratification.

2.1.3 Explain how the Declaration of Independence, Constitution and Bill of Rights reflected political principles of popular sovereignty, rule of law, checks and balances, separation of powers, social compact, natural rights, individual rights, separation of church and state, republicanism and federalism.

2.1.4 Explain challenges and modifications to American constitutional government as a result of significant historical events such as the American Revolution, the Civil War, expansion of suffrage, the Great Depression, and the civil rights movement.

2.2 Foundational Values and Constitutional Principles of American Government

Explain how the American idea of constitutional government has shaped a distinctive American society through the investigation of such questions as: How have the fundamental values and principles of American constitutional government shaped American society?

2.2.1 Identify and explain the fundamental values of America's constitutional republic (e.g., life, liberty, property, the pursuit of happiness, the common good, justice, equality, diversity, authority, participation, and patriotism) and their reflection in the principles of the United States Constitution (e.g., popular sovereignty, republicanism, rule of law, checks and balances, separation of powers, and federalism).

2.2.2 Explain and evaluate how Americans, either through individual or collective actions, use constitutional principles and fundamental values to narrow gaps between American ideals and reality with respect to minorities, women, and the disadvantaged. (See USHG 6.1.2; 6.3.2; 7.1.3; 8.3)

2.2.3 Use past and present policies to analyze conflicts that arise in society due to competing constitutional principles or fundamental values (e.g., liberty and authority, justice and equality, individual rights, and the common good). (See USHG 6.3.2; 8.2.4; 8.3.1; 9.2.2)

2.2.4 Analyze and explain ideas about fundamental values like liberty, justice, and equality found in a range of documents (e.g., Martin Luther King's "I Have a Dream" speech and "Letter from Birmingham City Jail," the Universal Declaration of Human Rights, the Declaration of Sentiments, the Equal Rights Amendment, and the Patriot Act). (See USHG F1.1; 8.3.2; 9.2.2)

2.2.5 Use examples to investigate why people may agree on constitutional principles and fundamental values in the abstract, yet disagree over their meaning when they are applied to specific situations. (See USHG 8.2.4)

C3 STRUCTURE AND FUNCTIONS OF GOVERNMENT IN THE UNITED STATES OF AMERICA

3.1 Structure, Functions, and Enumerated Powers of National Government

Describe how the national government is organized and what it does through the investigation of such questions as: What is the structure of the national government? What are the functions of the national government? What are its enumerated powers?

3.1.1 Analyze the purposes, organization, functions, and processes of the legislative branch as enumerated in Article I of the Constitution.

3.1.2 Analyze the purposes, organization, functions, and processes of the executive branch as enumerated in Article II of the Constitution.

3.1.3 Analyze the purposes, organization, functions, and processes of the judicial branch as enumerated in Article III of the Constitution.

3.1.4 Identify the role of independent regulatory agencies in the federal bureaucracy (e.g., Federal Reserve Board, Food and Drug Administration, Federal Communications Commission). (See USHG 6.3.2)

3.1.5 Use case studies or examples to examine tensions between the three branches of government (e.g., powers of the purse and impeachment, advise and consent, veto power, and judicial review).

3.1.6 Evaluate major sources of revenue for the national government, including the constitutional provisions for taxing its citizens.

3.1.7 Explain why the federal government is one of enumerated powers while state governments are those of reserved powers.

3.2 Powers and Limits on Powers

Identify how power and responsibility are distributed, shared, and limited in American constitutional government through the investigation of such questions as: How are power and responsibility distributed, shared, and limited in the government established by the United States Constitution?

3.2.1 Explain how the principles of enumerated powers, federalism, separation of powers, bicameralism, checks and balances, republicanism, rule of law, individual rights, inalienable rights, separation of church and state, and popular sovereignty serve to limit the power of government.

3.2.2 Use court cases to explain how the Constitution is maintained as the supreme law of the land (e.g., *Marbury v. Madison, Gibbons* v. *Ogden, McCulloch v. Maryland*).

3.2.3 Identify specific provisions in the Constitution that limit the power of the federal government.

3.2.4 Explain the role of the Bill of Rights and each of its amendments in restraining the power of government over individuals. (See USHG F1.1)

3.2.5 Analyze the role of subsequent amendments to the Constitution in extending or limiting the power of government, including the Civil War/Reconstruction Amendments and those expanding suffrage. (See USHG F1.1)

3.3 Structure and Functions of State and Local Governments

Describe how state and local governments are organized and what they do through the investigation of such questions as: What are the structures and functions of state and local government?

3.3.1 Describe limits the U.S. Constitution places on powers of the states (e.g., prohibitions against coining money, impairing interstate commerce, making treaties with foreign governments) and on the federal government's power over the states (e.g., federal government cannot abolish a state, Tenth Amendment reserves powers to the states).

3.3.2 Identify and define states' reserved and concurrent powers.

3.3.3 Explain the tension among federal, state, and local governmental power using the necessary and proper clause, the commerce clause, and the Tenth Amendment.

3.3.4 Describe how state and local governments are organized, their major responsibilities, and how they affect the lives of citizens.

3.3.5 Describe the mechanisms by which citizens monitor and influence state and local governments (e.g., referendum, initiative, recall).

3.3.6 Evaluate the major sources of revenue for state and local governments.

3.3.7 Explain the role of state constitutions in state governments.

3.4 System of Law and Laws

Explain why the rule of law has a central place in American society through the investigation of such questions as: What is the role of law in the American political system? What is the importance of law in the American political system?

3.4.1 Explain why the rule of law has a central place in American society (e.g., Supreme Court cases like *Marbury* v. *Madison* and *U.S.* v. *Nixon*; practices such as submitting bills to legal counsel to ensure congressional compliance with the law). (See USHG F1.1, 8.2.4)

3.4.2 Describe what can happen in the absence or breakdown of the rule of law (e.g., Ku Klux Klan attacks, police corruption, organized crime, interfering with the right to vote, and perjury). (See USHG 8.3.5)

3.4.3 Explain the meaning and importance of equal protection of the law (e.g., the 14th Amendment, Americans with Disabilities Act, equal opportunity legislation).

3.4.4 Describe considerations and criteria that have been used to deny, limit, or extend protection of individual rights (e.g., clear and present danger, time, place and manner restrictions on speech, compelling government interest, security, libel or slander, public safety, and equal opportunity).

3.4.5 Analyze the various levels and responsibilities of courts in the federal and state judicial system and explain the relationships among them.

3.5 Other Actors in the Policy Process

Describe the roles of political parties, interest groups, the media, and individuals in determining and shaping public policy through the investigation of such questions as: What roles do political parties, interest groups, the media, and individuals play in the development of public policy?

3.5.1 Explain how political parties, interest groups, the media, and individuals can influence and determine the public agenda.

3.5.2 Describe the origin and the evolution of political parties and their influence. (See Grade 5 SS; USHG 9.1.2)

3.5.3 Identify and explain the roles of various associations and groups in American politics (e.g., political organizations, political action committees, interest groups, voluntary and civic associations, professional organizations, unions, and religious groups).

3.5.4 Explain the concept of public opinion, factors that shape it, and contrasting views on the role it should play in public policy.

3.5.5 Evaluate the actual influence of public opinion on public policy.

3.5.6 Explain the significance of campaigns and elections in American politics, current criticisms of campaigns, and proposals for their reform.

3.5.7 Explain the role of television, radio, the press, and the internet in political communication.

3.5.8 Evaluate, take, and defend positions about the formation and implementation of a current public policy issue, and examine ways to participate in the decision making process about the issue.

3.5.9 In making a decision on a public issue, analyze various forms of political communication (e.g., political cartoons, campaign advertisements, political speeches, and blogs) using criteria like logical validity, factual accuracy and/or omission, emotional appeal, distorted evidence, and appeals to bias or prejudice.

C4 THE UNITED STATES OF AMERICA AND WORLD AFFAIRS

4.1 Formation and Implementation of U.S. Foreign Policy

Describe the formation and implementation of U.S. foreign policy through such questions as: How is foreign policy formed and implemented in American constitutional government?

4.1.1 Identify and evaluate major foreign policy positions that have characterized the United States' relations with the world (e.g., isolated nation, imperial power, world leader) in light of foundational values and principles, provide examples of how they were implemented and their consequences (e.g., Spanish-American War, Cold War containment) (See USHG 6.2; 7.2; 8.1.2; 9.2.1).

4.1.2 Describe the process by which United States foreign policy is made, including the powers the Constitution gives to the president; Congress and the judiciary; and the roles federal agencies, domestic interest groups, the public, and the media play in foreign policy.

4.1.3 Evaluate the means used to implement U.S. foreign policy with respect to current or past international issues (e.g., diplomacy, economic, military and humanitarian aid, treaties, sanctions, military intervention, and covert action).

4.1.4 Using at least two historical examples, explain reasons for, and consequences of, conflicts that arise when international disputes cannot be resolved peacefully. (See USHG 6.2.2; 7.2; 8.1.2; 9.2.2; WHG 7.2.1; 7.2.3; 8.1.2)

4.2 U.S. Role in International Institutions and Affairs

Identify the roles of the United States of America in international institutions and affairs through the investigation of such questions as: What is the role of the United States in international institutions and affairs?

4.2.1 Describe how different political systems interact in world affairs with respect to international issues. (See USHG 6.2.4)

4.2.2 Analyze the impact of American political, economic, technological, and cultural developments on other parts of the world (e.g., immigration policies, economic, military and humanitarian aid, computer technology research, popular fashion, and film). (See USHG 6.1.4; 8.2.1)

4.2.3 Analyze the impact of political, economic, technological, and cultural developments around the world on the United States (e.g., terrorism, emergence of regional organizations like the European Union, multinational corporations, and interdependent world economy). (See USHG 6.1.1; 9.1.1; 9.2.1)

4.2.4 Identify the purposes and functions of governmental and non-governmental international organizations, and the role of the United States in each (e.g., the United Nations, NATO, World Court, Organization of American States, International Red Cross, Amnesty International).

4.2.5 Evaluate the role of the United States in important bilateral and multilateral agreements (e.g., NAFTA, Helsinki Accords, Antarctic Treaty, Most Favored Nation Agreements, and the Kyoto Protocol).

4.2.6 Evaluate the impact of American political ideas and values on other parts of the world (e.g., American Revolution, fundamental values and principles expressed in the Declaration of Independence and the Constitution).

C5 CITIZENSHIP IN THE UNITED STATES OF AMERICA

5.1 The Meaning of Citizenship in the United States of America

Describe the meaning of citizenship in the United States through the investigation of such questions as: What is the meaning of citizenship in the United States? What are the rights, responsibilities, and characteristics of citizenship in the United States?

5.1.1 Using examples, explain the idea and meaning of citizenship in the United States of America, and the rights and responsibilities of American citizens (e.g., people participate in public life, know about the laws that govern society, respect and obey those laws, participate in political life, stay informed and attentive about public issues, and voting).

5.1.2 Compare the rights of citizenship Americans have as a member of a state and the nation.

5.2 Becoming a Citizen

Describe how one becomes a citizen in the United States through birth or naturalization by investigating the question: How does one become a citizen in the United States?

5.2.1 Explain the distinction between citizens by birth, naturalized citizens, and non-citizens.

5.2.2 Describe the distinction between legal and illegal immigration and the process by which legal immigrants can become citizens.

5.2.3 Evaluate the criteria used for admission to citizenship in the United States and how Americans expanded citizenship over the centuries (e.g., removing limitations of suffrage).

5.3 Rights of Citizenship

Identify the rights of citizenship by investigating the question: What are the personal, political, and economic rights of citizens in the United States?

5.3.1 Identify and explain personal rights (e.g., freedom of thought, conscience, expression, association, movement and residence, the right to privacy, personal autonomy, due process of law, free exercise of religion, and equal protection of the law).

5.3.2 Identify and explain political rights (e.g., freedom of speech, press, assembly, and petition; and the right to vote and run for public office).

5.3.3 Identify and explain economic rights (e.g., the right to acquire, use, transfer, and dispose of property, choose one's work and change employment, join labor unions and professional associations, establish and operate a business, copyright protection, enter into lawful contracts, and just compensation for the taking of private property for public use).

5.3.4 Describe the relationship between personal, political, and economic rights and how they can sometimes conflict.

5.3.5 Explain considerations and criteria commonly used in determining what limits should be placed on specific rights.

5.3.6 Describe the rights protected by the First Amendment, and using case studies and examples, explore the limit and scope of First Amendment rights.

5.3.7 Using the Fourth, Fifth, Sixth, Seventh and Eighth Amendments, describe the rights of the accused; and using case studies and examples, explore the limit and scope of these rights.

5.3.8 Explain and give examples of the role of the Fourteenth Amendment in extending the protection of individual rights against state action.

5.3.9 Use examples to explain why rights are not unlimited and absolute.

5.4 Responsibilities of Citizenship

Identify the responsibilities associated with citizenship in the United States and the importance of those responsibilities in a democratic society through the investigation of questions such as: What are the responsibilities associated with citizenship in the United States? Why are those experiences considered important to the preservation of American constitutional government?

5.4.1 Distinguish between personal and civic responsibilities and describe how they can sometimes conflict with each other.

5.4.2 Describe the importance of citizens' civic responsibilities including obeying the law, being informed and attentive to public issues, monitoring political leaders and governmental agencies, assuming leadership when appropriate, paying taxes, registering to vote and voting knowledgeably on candidates and issues, serving as a juror, serving in the armed forces, performing public service.

5.4.3 Explain why meeting personal and civic responsibilities is important to the preservation and improvement of American constitutional democracy.

5.5 Dispositions of Citizenship

Explain why particular dispositions in citizens are considered important to the preservation of American constitutional government by investigating the question: What dispositions or character traits are considered important to the preservation of American constitutional government?

5.5.1 Describe dispositions people think lead citizens to become independent members of society (e.g., self-discipline, self-governance, and a sense of individual responsibility) and thought to foster respect for individual worth and human dignity (e.g., respect for individual rights and choice, and concern for the well-being of others).

5.5.2 Describe the dispositions thought to encourage citizen involvement in public affairs (e.g., "civic virtue" or attentiveness to and concern for public affairs; patriotism or loyalty to values and principles underlying American constitutional democracy) and to facilitate thoughtful and effective participation in public affairs (e.g., civility, respect for the rights of other individuals, respect for law, honesty, open-mindedness, negotiation and compromise; persistence, civic mindedness, compassion, patriotism, courage, and tolerance for ambiguity).

5.5.3 Explain why the development of citizens as independent members of society who are respectful of individual worth and human dignity, inclined to participate in public affairs, and are thoughtful and effective in their participation, is important to the preservation and improvement of American constitutional democracy.

C6 CITIZENSHIP IN ACTION

6.1 Civic Inquiry and Public Discourse

Use forms of inquiry and construct reasoned arguments to engage in public discourse around policy and public issues by investigating the question: How can citizens acquire information, solve problems, make decisions, and defend positions about public policy issues?

6.1.1 Identify and research various viewpoints on significant public policy issues.

6.1.2 Locate, analyze, and use various forms of evidence, information, and sources about a significant public policy issue, including primary and secondary sources, legal documents (e.g., Constitutions, court decisions, state law), non-text based information (e.g., maps, charts, tables, graphs, and cartoons), and other forms of political communication (e.g., oral political cartoons, campaign advertisements, political speeches, and blogs).

6.1.3 Develop and use criteria (e.g., logical validity, factual accuracy and/or omission, emotional appeal, credibility, unstated assumptions, logical fallacies, inconsistencies, distortions, and appeals to bias or prejudice, overall strength of argument) in analyzing evidence and position statements.

6.1.4 Address a public issue by suggesting alternative solutions or courses of action, evaluating the consequences of each, and proposing an action to address the issue or resolve the problem.

6.1.5 Make a persuasive, reasoned argument on a public issue and support using evidence (e.g., historical and contemporary examples), constitutional principles, and fundamental values of American constitutional democracy; explain the stance or position.

6.2 Participating in Civic Life

Describe multiple opportunities for citizens to participate in civic life by investigating the question: How can citizens participate in civic life?

6.2.1 Describe the relationship between politics and the attainment of individual and public goals (e.g., how individual interests are fulfilled by working to achieve collective goals).

6.2.2 Distinguish between and evaluate the importance of political participation and social participation.

6.2.3 Describe how, when, and where individuals can participate in the political process at the local, state, and national levels (including, but not limited to voting, attending political and governmental meetings, contacting public officials, working in campaigns, community organizing, demonstrating or picketing, boycotting, joining interest groups or political action committees); evaluate the effectiveness of these methods of participation.

6.2.4 Participate in a real or simulated election, and evaluate the results, including the impact of voter turnout and demographics.

6.2.5 Describe how citizen movements seek to realize fundamental values and principles of American constitutional democracy.

6.2.6 Analyze different ways people have used civil disobedience, the different forms civil disobedience might take (e.g., violent and non-violent) and their impact.

6.2.7 Participate in a service-learning project, reflect upon experiences, and evaluate the value of the experience to the American ideal of participation.[1]

6.2.8 Describe various forms and functions of political leadership and evaluate the characteristics of an effective leader.

6.2.9 Evaluate the claim that constitutional democracy requires the participation of an attentive, knowledgeable, and competent citizenry.

6.2.10 Participate in a real or simulated public hearing or debate and evaluate the role of deliberative public discussions in civic life.

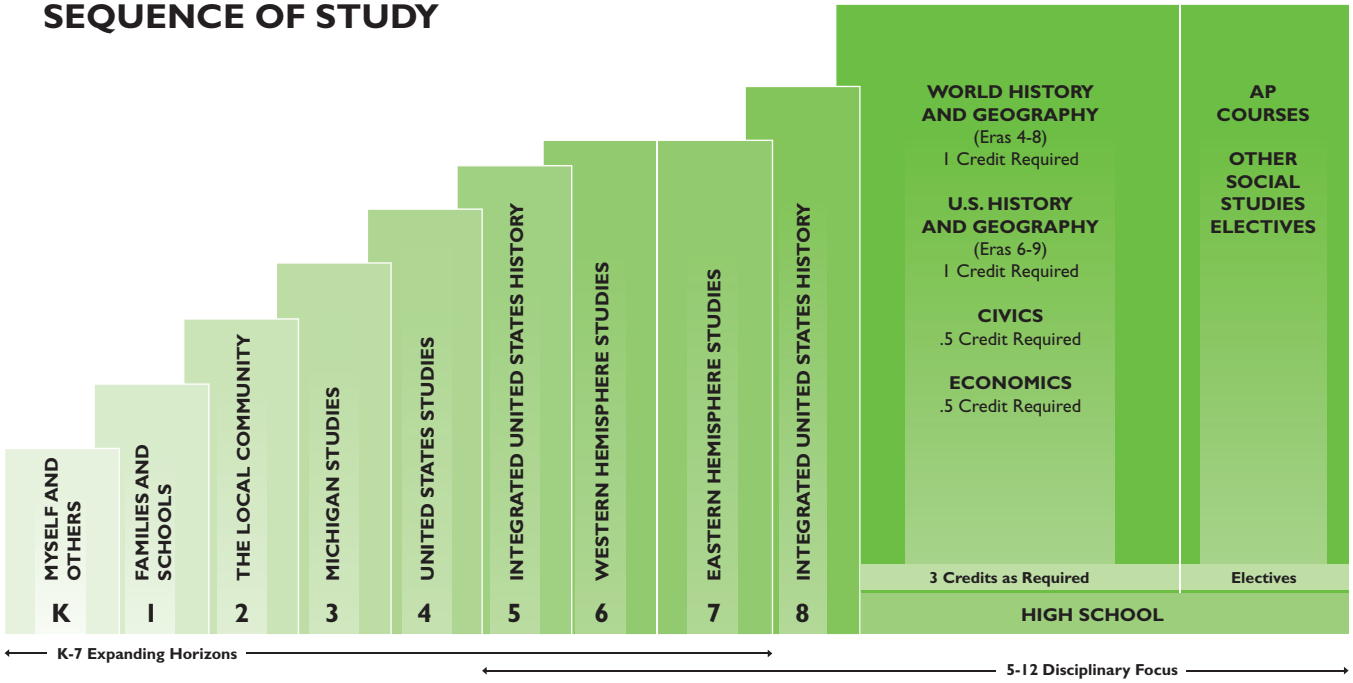
6.2.11 Identify typical issues, needs, or concerns of citizens (e.g., seeking variance, zoning changes, information about property taxes), and actively demonstrate ways citizens might use local governments to resolve issues or concerns.

[1]Note: Service learning projects need not be folded into a semester course in Civics, but could also be part of a larger or year-long/semester-long project outside the traditional course in Civics.

Michigan High School Social Studies

ECONOMICS

SEQUENCE OF STUDY



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MICHIGAN Department of Education

ECONOMICS

Understanding economics – what some people call "economic literacy" – is becoming essential for citizens in our national and increasingly interconnected world economy. Increasingly, productive members of society must be able to identify, analyze, and evaluate the causes and consequences of individual economic decisions and public policy including issues raised by constraints imposed by scarcity, how economies and markets work, and the benefits and costs of economic interaction and interdependence. Such literacy includes analysis, reasoning, problem solving, and decision making that helps people function as consumers, producers, savers, investors, and responsible citizens.

Students who meet the expectations will understand how economies function and how to apply the concepts and principles of economics to their lives as individuals and as citizens. Understanding and applying these concepts and principles should help students make sense of daily events and enable them to analyze, investigate and develop reasoned thinking about economic challenges and public policies. To cite the "Goals 2000: Educate America Act" of 1994, the study of economics (among other subjects) should ensure that students learn to "use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our Nation's modern economy."

The economics content is necessary for the understanding and the analysis of a wide variety of applications, including those involving individual and household choices, personal finance issues, business and entrepreneurial decisions, and public policy. Students analyze and study economic concepts and principles in three contextual areas: individual and household context, a business context, and a government or public context and focused around four content areas: The Market Economy; The National Economy; the International Economy; and Personal Finance.

Content in The Market Economy includes much of what is traditionally described as microeconomics. The core content focuses on the importance of scarcity and limited resources, the roles of economic institutions, such as legal systems, corporations and labor unions in the market economy; the influence on prices and supplies of the interaction of buyers and sellers; and trade-offs and incentives in people's behavior.

Content in the National Economy includes much of what is traditionally described as macroeconomics. The National Economy content area includes the concepts, terminology, and data used to identify and describe inflation, unemployment, output, and growth; the factors that cause changes in those conditions; the role of money and interest rates in an economy; and the mechanics and the appropriate uses of Federal Reserve monetary policies and federal government fiscal policies.

Content in International Economy includes the reasons for individuals and businesses to specialize and trade; the rationale for specialization and trade across international borders; and the comparison of the benefits and costs of that specialization and resulting trade for consumers, producers, and governments.

Content in Personal Finance includes the role of economic concepts in understanding personal finance issues and in creating personal finance strategies.

Using the Economics HSCE: Things to Remember

There are a number of important considerations for teachers to keep in mind as they use these Economics expectations to plan instruction. It is important to remember that this document:

Uses economics thinking – All of the expectations require students to think – analyze, synthesize, evaluate, compare, contrast, argue – using economics habits of mind. In meeting the expectations, students will use such thinking to analyze and interpret information in developing their understanding. These expectations do not intend to stress memory over meaning, coverage over understanding. While knowledge of names and definitions is essential for economics study, high quality teaching and learning demands a great deal more than just the mastery of discrete collections of facts or terms.

Requires active, economic inquiry – In using economics concepts and habits of mind, students should engage in active, disciplined inquiry, analysis and argumentation. Learning involves purposeful investigations within a community that has established goals, standards, criteria, and procedures for study. It entails learning how to read, write, and use economics to understand and participate in the world around us. This calls upon students to frame important economic problems and questions; to locate and analyze appropriate evidence and data; and to apply economic concepts and principles to build reasoned and evidenced-based interpretations, arguments, or decisions. In short, economics should provide Michigan students with the kind of reason and informed decision making that will enable them to function effectively both in their personal lives and as citizens and participants in an increasingly connected world economy.

Represents Content Expectations and not Pedagogical Organization – This document lists content expectations for students. It does not establish suggested organization for teaching or learning this content. For example, this document is not presenting expectations in a suggested instructional sequence. The expectations do not represent single lessons, a day's worth of instruction or even a unit. Michigan teachers and curriculum coordinators can combine expectations to structure meaningful learning experiences for their students. For example, a teacher could use a compelling economic issue or problem to organize weeks of study, while coherently employing many content expectations.

Differentiates between required and suggested (e.g.) content – The expectations specify teachable content in two different ways. On numerous occasions, the expectations will offer examples for teachers to help clarify teachable content. Typically, these examples or suggestions appear in parentheses. The document always identifies such optional content with an "e.g." or "for example." These are simply suggestions and teachable options. Teachers may use other examples to meet the expectations. In short, these examples are not required content.

In other places, the expectations identify specific content that students should study. This content is never preceded by "e.g." or "for example." Unlike the optional examples, a statewide assessment might assess the required content.

Economics Content Expectations

The Market Economy
- relevance of limited resources
- how individuals and institutions make and evaluate decisions
- the role of incentives
- how buyers and sellers interact to create markets
- how these markets allocate resources
- the economic role of government in a market economy
- evaluation of short-run and long-run decisions
- the comparison of benefits and costs when making a decision
- concepts – scarcity, choice, opportunity costs, supply and demand, profit, competition, incentives, individual incomes

The National Economy
- the data that describe the overall conditions in the U.S. economy
- the factors that cause changes in those conditions
- the role of money and interest rates in an economy
- the appropriate policy alternatives
- mechanics and appropriate use of Federal Reserve monetary and federal government fiscal policies
- how economies use different systems of allocating goods and services and can compare the benefits and the costs of different methods
- the economic role of government as a provider of goods and services in the national economy
- concepts – unemployment, inflation, output, economic growth, money, and gross domestic product (GDP), interest rates

International Economy
- reasons for individuals and businesses to specialize and trade, and the rationale for specialization and trade across international borders
- an ability to compare the benefits and costs of that specialization and resulting trade for consumers, producers, and governments
- an understanding that this trade brings additional complications
- benefit and cost comparison of policies that alter trade barriers between nations
- the processes and consequences of exchange rate determination
- concepts – voluntary exchange, specialization, interdependence, imports and exports, and barriers to trade (tariffs, quotas)

**adapted from Economics Framework for the 2006 NAEP*

E1 - The Market Economy
- Individual, Business, and Government Choices
- Competitive Markets
- Prices, Supply, and Demand
- Role of Government

E2 - The National Economy
- Understanding National Markets
- Role of Government in the United States Economy

E3 - International Economy
- Economic Systems
- Economic Interdependence - Trade

E4 - Personal Finance
- Decision Making

Economics Knowledge
- Understand the fundamental constraints imposed by limited resources, the resulting choices people have to make, and the trade-offs they face
- Understand how economies and markets work and how people function within them
- Understand the benefits and costs of economic interaction and interdependence among people and nations.

Intellectual Skills
- economic reasoning
- problem solving
- decision making
- analyzing real-life situations

Components of Economics Literacy
- The ability to identify, analyze, and evaluate the consequences of individual decisions and public policy.

GENERAL SOCIAL SCIENCE KNOWLEDGE, PROCESSES, AND SKILLS
(listed on page 67)

K1 General Knowledge
- P1 Reading and Communication
- P2 Inquiry, Research, and Analysis
- P3 Public Discourse and Decision Making
- P4 Citizen Involvement

Economics Secondary Content Statement Outline

E1 – THE MARKET ECONOMY
- 1.1 Individual, Business, and Government Choices
- 1.2 Competitive Markets
- 1.3 Prices, Supply, and Demand
- 1.4 Role of Government

E2 – THE NATIONAL ECONOMY
- 2.1 Understanding National Markets
- 2.2 Role of Government in the United States Economy

E3 – INTERNATIONAL ECONOMY
- 3.1 Economic Systems
- 3.2 Economic Interdependence – Trade

E4 – PERSONAL FINANCE
- 4.1 Decision Making

Alignment of National Economics Concepts to the HSCE

E1 The Market Economy

1.1 Individual, Business, and Government Choices
- NS 1 Choices and Costs
- NS 2 Effective Decision Making
- NS 14 Entrepreneurs
- NS 17 Government Decision Making

1.2 Competitive Markets
- NS 4 Incentives
- NS 7 Markets
- NS 9 Competition

1.3 Prices, Supply, and Demand
- NS 8 Prices
- NS 14 Entrepreneurs

1.4 Role of Government
- NS 10 Role of Economic Institutions
- NS 15 Investment, Productivity, and Growth
- NS 16 Economic Role for Government
- NS 17 Government Decision Making

E2 The National Economy

2.1 Understanding National Markets
- NS 3 Resource Allocation
- NS 12 Interest Rates
- NS 13 Income
- NS 15 Investment, Productivity, and Growth
- NS 19 Unemployment and Inflation

2.2 Role of Government in the United States Economy
- NS 11 Money
- NS 16 Economic Role for Government
- NS 17 Government Decision Making
- NS 18 Gross Domestic Product
- NS 20 Fiscal and Monetary Policies

E3 International Economy

3.1 Economic Systems
- NS 16 Economic Role for Government
- NS 17 Government Decision Making

3.2 Economic Interdependence – Trade
- NS 5 Voluntary Exchange
- NS 6 Benefits of Trade
- NS 7 Markets
- NS 15 Investment, Productivity, and Growth

General Social Studies Knowledge, Processes, and Skills

General Social Science Knowledge – embedded in economics standards and expectations

K1.1 Know the defining characteristics of the discipline of economics.
K1.2 Know that each discipline is subject to criticisms and limitations; be aware of the primary criticisms and limitations of economics.
K1.3 Understand and analyze economic relationships, patterns, and trends.
K1.4 Understand economic perspectives.
K1.5 Understand the diversity of human beings and human cultures.
K1.6 Analyze events and circumstances from the vantage point of others.
K1.7 Understand social problems, social structures, institutions, class, groups, and interaction.
K1.8 Apply social studies concepts to better understand major current local, national, and world events, issues, and problems.
K1.9 Integrate concepts from at least two different social studies disciplines.
K1.10 Understand significant concepts, generalizations, principles, and theories of economics.

Social Studies Procedures and Skills – embedded in economics standards and expectations

P1 Reading and Communication – *read and communicate effectively.*

P1.1 Use close and critical reading strategies to read and analyze complex texts pertaining to social science; attend to nuance, make connections to prior knowledge, draw inferences, and determine main idea and supporting details.
P1.2 Analyze point of view, context, and bias to interpret primary and secondary source documents.
P1.3 Understand that diversity of interpretation arises from frame of reference.
P1.4 Communicate clearly and coherently in writing, speaking, and visually expressing ideas pertaining to social science topics, acknowledging audience and purpose.
P1.5 Present a coherent thesis when making an argument, support with evidence, articulate and answer possible objections, and present a concise, clear closing.

P2 Inquiry, Research, and Analysis – *critically examine evidence, thoughtfully consider conflicting claims, and carefully weigh facts and hypotheses.*

P2.1 Understand the scientific method of inquiry to investigate social scientific and historical problems.
P2.2 Read and interpret data in tables and graphs.
P2.3 Know how to find and organize information from a variety of sources; analyze, interpret, support interpretations with evidence critically evaluate, and present the information orally and in writing; report investigation results effectively.
P2.4 Use multiple perspectives and resources to identify and analyze issues appropriate to the social studies discipline being studied.
P2.5 Use deductive and inductive problem-solving skills as appropriate to the problem being studied.

P3 Public Discourse and Decision Making *– engage in reasoned and informed decision making that should characterize each citizen's participation in American society.*

P3.1 Clearly state an issue as a question of public policy, trace the origins of an issue, analyze various perspectives, and generate and evaluate possible alternative resolutions.
P3.2 Deeply examine policy issues in group discussions and debates (clarify issues, consider opposing views, apply democratic values or constitutional principles, anticipate consequences) to make reasoned and informed decisions.
P3.3 Write persuasive/argumentative essays expressing and justifying decisions on public policy issues.

P4 Citizen Involvement

P4.1 Act out of respect for the rule of law and hold others accountable to the same standard.
P4.2 Demonstrate knowledge of how, when, and where individuals would plan and conduct activities intended to advance views on matters of public policy, report the results, and evaluate effectiveness.
P4.3 Plan and conduct activities intended to advance views on matters of public policy, report the results, and evaluate effectiveness.

ECONOMICS

E1 THE MARKET ECONOMY

1.1 Individual, Business, and Government Choices

Explain and demonstrate how economic organizations confront scarcity and market forces when organizing, producing, using, and allocating resources to supply the marketplace.

1.1.1 **Scarcity, Choice, Opportunity Costs, and Comparative Advantage** – Using examples, explain how scarcity, choice, opportunity costs affect decisions that households, businesses, and governments make in the market place and explain how comparative advantage creates gains from trade.

1.1.2 **Entrepreneurship** – Identify the risks, returns and other characteristics of entrepreneurship that bear on its attractiveness as a career.

1.2 Competitive Markets

Analyze how the functions and constraints of business structures, the role of price in the market, and relationships of investment to productivity and growth, impact competitive markets.

1.2.1 **Business Structures** – Compare and contrast the functions and constraints facing economic institutions including small and large businesses, labor unions, banks, and households.

1.2.2 **Price in the Market** – Analyze how prices send signals and provide incentives to buyers and sellers in a competitive market.

1.2.3 **Investment, Productivity and Growth** – Analyze the role investments in physical (e.g., technology) and human capital (e.g., education) play in increasing productivity and how these influence the market.

1.3 Prices, Supply, and Demand

Compare how supply, demand, price, equilibrium, elasticity, and incentives affect the workings of a market.

1.3.1 **Law of Supply** – Explain the law of supply and analyze the likely change in supply when there are changes in prices of the productive resources (e.g., labor, land, capital including technology), or the profit opportunities available to producers by selling other goods or services, or the number of sellers in a market.

1.3.2 **Law of Demand** – Explain the law of demand and analyze the likely change in demand when there are changes in prices of the goods or services, availability of alternative (substitute or complementary) goods or services, or changes in the number of buyers in a market created by such things as change in income or availability of credit.

1.3.3 **Price, Equilibrium, Elasticity, and Incentives** – Analyze how prices change through the interaction of buyers and sellers in a market including the role of supply, demand, equilibrium, elasticity, and explain how incentives (monetary and non-monetary) affect choices of households and economic organizations.

1.4 Role of Government in the Market

Describe the varied ways government can impact the market through policy decisions, protection of consumers, and as a producer and consumer of goods and services, and explain how economic incentives affect government decisions.

1.4.1 **Public Policy and the Market** – Analyze the impact of a change in public policy (such as an increase in the minimum wage, a new tax policy, or a change in interest rates) on consumers, producers, workers, savers, and investors.

1.4.2 **Government and Consumers** – Analyze the role of government in protecting consumers and enforcing contracts, (including property rights), and explain how this role influences the incentives (or disincentives) for people to produce and exchange goods and services.

1.4.3 **Government Revenue and Services** – Analyze the ways in which local and state governments generate revenue (e.g., income, sales, and property taxes) and use that revenue for public services (e.g., parks and highways).

1.4.4 **Functions of Government** – Explain the various functions of government in a market economy including the provision of public goods and services, the creation of currency, the establishment of property rights, the enforcement of contracts, correcting for externalities and market failures, the redistribution of income and wealth, regulation of labor (e.g., minimum wage, child labor, working conditions), and the promotion of economic growth and security.

1.4.5 **Economic Incentives and Government** – Identify and explain how monetary and non-monetary incentives affect government officials and voters and explain how government policies affect the behavior of various people including consumers, savers, investors, workers, and producers.

E2 THE NATIONAL ECONOMY OF THE UNITES STATES OF AMERICA

2.1 Understanding National Markets

Describe inflation, unemployment, output, and growth, and the factors that cause changes in those conditions, and describe the role of money and interest rates in national markets.

2.1.1 **Income** – Describe how individuals and businesses earn income by selling productive resources.

2.1.2 **Circular Flow and the National Economy** – Using the concept of circular flow, analyze the roles of and the relationships between households, business firms, financial institutions, and government and non-government agencies in the economy of the United States.

2.1.3 **Financial Institutions and Money Supply** – Analyze how decisions by the Federal Reserve and actions by financial institutions (e.g., commercial banks, credit unions) regarding deposits and loans, impact the expansion and contraction of the money supply.

2.1.4 **Money Supply, Inflation, and Recession** – Explain the relationships between money supply, inflation, and recessions.

2.1.5 **Gross Domestic Product (GDP) and Economic Growth** – Use GDP data to measure the rate of economic growth in the United States and identify factors that have contributed to this economic growth

2.1.6 **Unemployment** – Analyze the character of different types of unemployment including frictional, structural, and cyclical.

2.1.7 **Economic Indicators** – Using a number of indicators, such as GDP, per capita GDP, unemployment rates, and Consumer Price Index, analyze the characteristics of business cycles, including the characteristics of peaks, recessions, and expansions.

2.1.8 **Relationship Between Expenditures and Revenue (Circular Flow)** – Using the circular flow model, explain how spending on consumption, investment, government and net exports determines national income; explain how a decrease in total expenditures affects the value of a nation's output of final goods and services.

2.1.9 **American Economy in the World –** Analyze the changing relationship between the American economy and the global economy including, but not limited to, the increasing complexity of American economic activity (e.g., outsourcing, off-shoring, and supply-chaining) generated by the expansion of the global economy. *(National Geography Standard 11, p. 206)*

2.2 Role of Government in the United States Economy

Analyze the role of government in the United States economy by identifying macroeconomic goals; comparing perspectives on government roles; analyzing fiscal and monetary policy; and describing the role of government as a producer and consumer of public goods and services. Analyze how governmental decisions on taxation, spending, protections, and regulation impact macroeconomic goals.

2.2.1 **Federal Government and Macroeconomic Goals** – Identify the three macroeconomic goals of an economic system (stable prices, low unemployment, and economic growth).

2.2.2. **Macroeconomic Policy Alternatives** – Compare and contrast differing policy recommendations for the role of the Federal government in achieving the macroeconomic goals of stable prices, low unemployment, and economic growth.

2.2.3 **Fiscal Policy and its Consequences** – Analyze the consequences – intended and unintended – of using various tax and spending policies to achieve macroeconomic goals of stable prices, low unemployment, and economic growth.

2.2.4 **Federal Reserve and Monetary Policy** – Explain the roles and responsibilities of the Federal Reserve System and compare and contrast the consequences – intended and unintended – of different monetary policy actions of the Federal Reserve Board as a means to achieve macroeconomic goals of stable prices, low unemployment, and economic growth.

2.2.5 **Government Revenue and Services** – Analyze the ways in which governments generate revenue on consumption, income and wealth and use that revenue for public services (e.g., parks and highways) and social welfare (e.g., social security, Medicaid, Medicare).

E3 THE INTERNATIONAL ECONOMY

3.1 Economic Systems

Explain how different economic systems, including free market, command, and mixed systems, coordinate and facilitate the exchange, production, distribution, and consumption of goods and services.

3.1.1 **Major Economic Systems** – Give examples of and analyze the strengths and weaknesses of major economic systems (command, market and mixed), including their philosophical and historical foundations (e.g., Marx and the Communist Manifesto, Adam Smith and the Wealth of Nations). *(National Geography Standard 11, p. 206)*

3.1.2 **Developing Nations** – Assess how factors such as availability of natural resources, investments in human and physical capital, technical assistance, public attitudes and beliefs, property rights and free trade can affect economic growth in developing nations. *(National Geography Standards 1 and 4, pp. 184 and 190)*

3.1.3 **International Organizations and the World Economy** – Evaluate the diverse impact of trade policies of the World Trade Organization, World Bank, or International Monetary Fund on developing economies of Africa, Central America, or Asia, and the developed economies of the United States and Western Europe. *(National Geography Standard 11, p. 206)*

3.1.4 **GDP and Standard of Living** – Using current and historical data on real per capita GDP for the United States, and at least three other countries (e.g., Japan, Somalia, and South Korea) construct a relationship between real GDP and standard of living. *(National Geography Standard 11, p. 206)*

3.1.5 **Comparing Economic Systems** – Using the three basic economic questions (e.g., what to produce, how to produce, and for whom to produce), compare and contrast a socialist (command) economy (such as North Korea or Cuba) with the Capitalist as a mixed, free market system of the United States. *(National Geography Standard 11, p. 206)*

3.1.6 **Impact of Transitional Economies** – Analyze the impact of transitional economies, such as in China and India, on the global economy in general and the American economy in particular. *(National Geography Standard 11, p. 206)*

3.2 Economic Interdependence – Trade

Describe how trade generates economic development and interdependence and analyze the resulting challenges and benefits for individuals, producers, and government.

3.2.1 **Absolute and Comparative Advantage** – Use the concepts of absolute and comparative advantage to explain why goods and services are produced in one nation or locale versus another. *(National Geography Standard 11, p. 206)*

3.2.2 **Domestic Activity and World Trade** – Assess the impact of trade policies (i.e. tariffs, quotas, export subsidies, product standards and other barriers), monetary policy, exchange rates, and interest rates on domestic activity and world trade. *(National Geography Standard 11, p. 206)*

3.2.3 **Exchange Rates and the World Trade** – Describe how interest rates in the United States impact the value of the dollar against other currencies (such as the Euro), and explain how exchange rates affect the value of goods and services of the United States in other markets. *(National Geography Standard 11, p. 206)*

3.2.4 **Monetary Policy and International Trade** – Analyze how the decisions made by a country's central bank (or the Federal Reserve) impact a nation's international trade. *(National Geography Standard 13, p. 210)*

3.2.5 **The Global Economy and the Marketplace** – Analyze and describe how the global economy has changed the interaction of buyers and sellers, such as in the automobile industry. *(National Geography Standard 13, p. 210)*

E4 PERSONAL FINANCE[1]

4.1 Decision Making

Describe and demonstrate how the economic forces of scarcity and opportunity costs impact individual and household choices.

4.1.1 **Scarcity and Opportunity Costs** – Apply concepts of scarcity and opportunity costs to personal financial decision making.

4.1.2 **Marginal Benefit and Cost** – Use examples and case studies to explain and evaluate the impact of marginal benefit and marginal cost of an activity on choices and decisions.

4.1.3 **Personal Finance Strategy** – Develop a personal finance strategy for earning, spending, saving and investing resources.

4.1.4 **Key Components of Personal Finance** – Evaluate key components of personal finance including, money management, saving and investment, spending and credit, income, mortgages, retirement, investing (e.g., 401K, IRAs), and insurance.

4.1.5 **Personal Decisions** – Use a decision-making model (e.g., stating a problem, listing alternatives, establishing criteria, weighing options, making the decision, and evaluating the result) to evaluate the different aspects of personal finance including careers, savings and investing tools, and different forms of income generation.

4.1.6 **Risk Management Plan** – Develop a risk management plan that uses a combination of avoidance, reduction, retention, and transfer (insurance).

[1]The Personal Finance expectations should be included in high school Economics and other elementary, middle, and high school courses.

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High School Content Expectations

SCIENCE

- Earth Science
- **Biology**
- Physics
- Chemistry

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Welcome to Michigan's High School Science Content Standards and Expectations

Why Develop Content Standards and Expectations for High School?

To prepare Michigan's students with the knowledge and skills to succeed in the 21st Century, the State of Michigan has enacted a rigorous new set of statewide graduation requirements that are among the best in the nation. These requirements, called the Michigan Merit Curriculum, are the result of a collaborative effort between Governor Jennifer M. Granholm, the State Board of Education, and the State Legislature.

In preparation for the implementation of the new high school graduation requirements, the Michigan Department of Education's Office of School Improvement is leading the development of high school content expectations. An Academic Work Group of science experts chaired by nationally known scholars was commissioned to conduct a scholarly review and identify content standards and expectations. The Michigan Department of Education conducted an extensive field review of the expectations by high school, university, and business and industry representatives.

The Michigan High School Science Content Expectations (Science HSCE) establish what every student is expected to know and be able to do by the end of high school and define the expectations for high school science credit in Earth Science, Biology, Physics, and Chemistry.

An Overview

In developing these expectations, the Academic Work Group depended heavily on the *Science Framework for the 2009 National Assessment of Educational Progress* (National Assessment Governing Board, 2006). In particular, the group adapted the structure of the NAEP framework, including Content Statements and Performance Expectations. These expectations align closely with the NAEP framework, which is based on *Benchmarks for Science Literacy* (AAAS Project 2061, 1993) and the *National Science Education Standards* (National Research Council, 1996).

The Academic Work Group carefully analyzed other documents, including the Michigan Curriculum Framework Science Benchmarks (2000 revision), the Standards for Success report *Understanding University Success*, ACT's *College Readiness Standards*, College Board's *AP Biology, AP Physics, AP Chemistry,* and *AP Environmental Science Course Descriptions*, ACT's *On Course for Success*, South Regional Education Board's *Getting Ready for College-Preparatory/Honors Science: What Middle Grades Students Need to Know and Be Able to Do,* and standards documents from other states.

Earth Science	Biology	Physics	Chemistry
STANDARDS *(and number of content statements in each standard)*			
E1 Inquiry, Reflection, and Social Implications (2) E2 Earth Systems (4) E3 The Solid Earth (4) E4 The Fluid Earth (3) E5 Earth in Space and Time (4)	B1 Inquiry, Reflection, and Social Implications (2) B2 Organization and Development of Living Systems (6) B3 Interdependence of Living Systems and the Environment (5) B4 Genetics (4) B5 Evolution and Biodiversity (3)	P1 Inquiry, Reflection, and Social Implications (2) P2 Motion of Objects (3) P3 Forces and Motion (8) P4 Forms of Energy and Energy Transformations (12)	C1 Inquiry, Reflection, and Social Implications (2) C2 Forms of Energy (5) C3 Energy Transfer and Conservation (5) C4 Properties of Matter (10) C5 Changes in Matter (7)

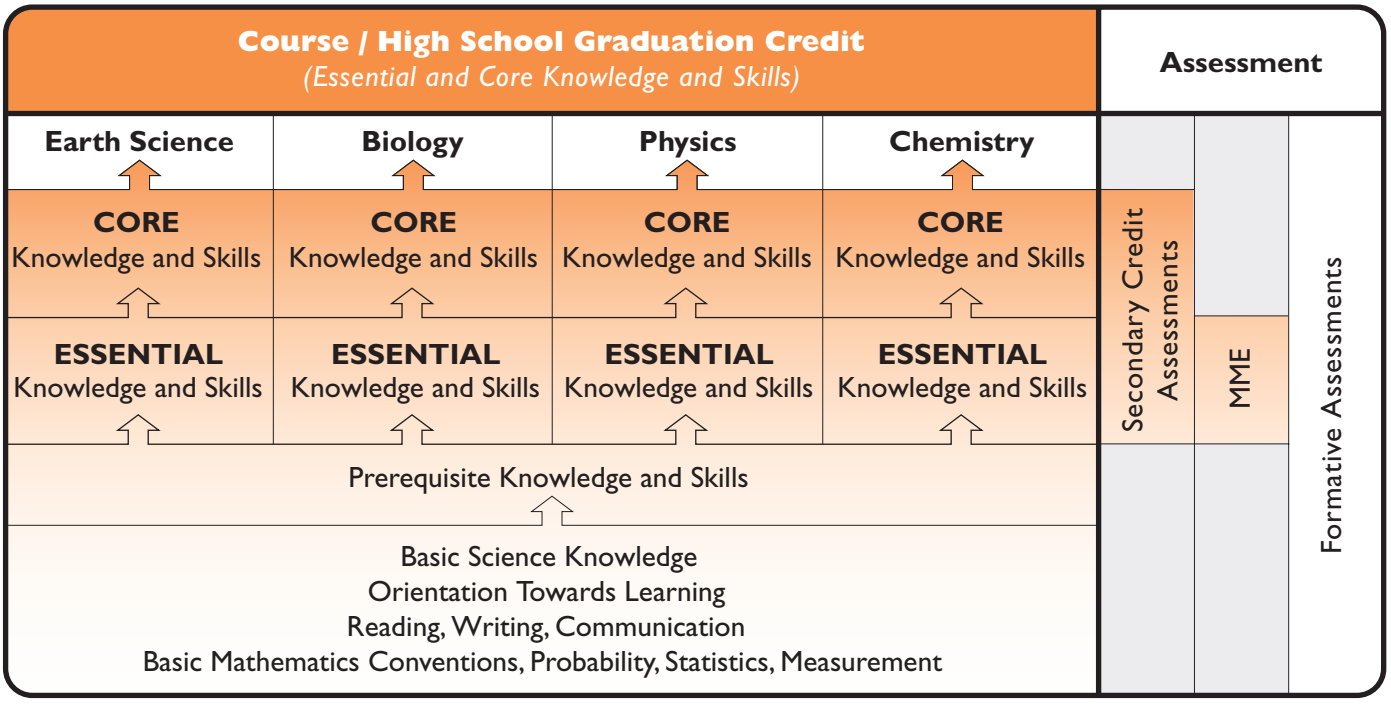
Useful and Connected Knowledge for All Students

This document defines expectations for Michigan High School graduates, organized by discipline: Earth Science, Biology, Physics, and Chemistry. It defines ***useful*** and ***connected knowledge*** at four levels:

- **Prerequisite knowledge**
  Useful and connected knowledge that all students should bring as a prerequisite to high school science classes. Prerequisite expectation codes include a "**p**" and an upper case letter (e.g., **E3.p1A**). Prerequisite content could be assessed through formative and/or large scale assessments.
- **Essential knowledge**
  Useful and connected knowledge for all high school graduates, regardless of what courses they take in high school. Essential expectation codes include an upper case letter (e.g., **E2.1A**). Essential content knowledge and performance expectations are required for graduation and are assessable on the Michigan Merit Exam (MME) and on future secondary assessments. Essential knowledge can also be assessed with formative assessments.
- **Core knowledge**
  Useful and connected knowledge for all high school graduates who have completed a discipline-specific course. In general core knowledge includes content and expectations that students need to be prepared for more advanced study in that discipline. Core content statement codes include an "x" and core expectation codes include a lower case letter (e.g., **B2.2x** Proteins; **B2.2f**) to indicate that they are NOT assessable on existing large-scale assessments (MME, NAEP), but will be assessed on future secondary credit assessments. Core knowledge can also be assessed with formative assessments.
- **Recommended knowledge**
  Useful and connected knowledge that is desirable as preparation for more advanced study in the discipline, but not required for graduation credit. Content and expectations labeled as recommended represent extensions of the core. Recommended content statement codes include an "**r**" and an "**x**"; recommended expectations include an "**r**" and a lower case letter (e.g., **P4.r9x Nature of Light**; **P4.r9a**). They will not be assessed on either the MME or secondary credit assessments.

Useful and connected knowledge is contrasted with ***procedural display***—learning to manipulate words and symbols without fully understanding their meaning. When expectations are excessive, procedural display is the kind of learning that takes place. Teachers and students "cover the content" instead of "uncovering" useful and connected knowledge.

Credit for high school Earth Science, Biology, Physics, and Chemistry will be defined as meeting both essential and core subject area content expectations. Credit requirements are outlined in separate Michigan Merit Curriculum Course/Credit Requirement documents.



Preparing Students for Successful Post-Secondary Engagement

Students who have useful and connected knowledge should be able to apply knowledge in new situations; to solve problems by generating new ideas; to make connections among what they read and hear in class, the world around them, and the future; and through their work, to develop leadership qualities while still in high school. In particular, high school graduates with useful and connected knowledge are able to engage in four key practices of science literacy.

Successful Post-Secondary Engagement

Practices of Science Literacy

Communicate accurately and effectively...

Identifying Science Principles

- Describe, measure, or classify observations.
- State or recognize correct science principles.
- Demonstrate relationships among closely related science principles.
- Demonstrate relationships among different representations of principles.

Using Science Principles

- Explain observations of phenomena.
- Predict observations of phenomena.
- Suggest examples of observations that illustrate a science principle.
- Propose, analyze, and evaluate alternative explanations or predictions.

Scientific Inquiry

- Generate new questions that can be investigated in the laboratory or field.
- Critique aspects of scientific investigations.
- Conduct scientific investigations using appropriate tools and techniques.
- Identify patterns in data: relate patterns to theoretical models.
- Describe a reason for a given conclusion using evidence from an investigation.
- Explain how scientific evidence supports or refutes claims or explanations of phenomena.
- Design and conduct a scientific investigation with a hypothesis, several controlled variables, and one manipulated variable. Gather data and organized the results in graphs, tables, and/or charts.

Reflection and Social Implications

- Critique whether questions can be answered through scientific investigations.
- Identify and critique arguments based on scientific evidence.
- Use appropriate scientific knowledge in social arguments, recognizing their limitations.
- Gather, synthesize, and evaluate information from multiple sources.
- Discuss scientific topics in groups, make presentations summarize what others have said, ask for clarification, take alternative perspectives, and defend a position.
- Evaluate the future career and occupational prospects of science fields.
- Explain why a claim or a conclusion is flawed.
- Critique solutions to problems, given criteria and scientific constraints.
- Identify scientific tradeoffs in design decisions and choose among alternative solutions.
- Apply science principles or scientific data to anticipate effects of technological design decisions.

State / National Landscape

- Expert perspective
- Education reform environment
- Research-based practices
- Work force requirements

State / Federal Expectations

- No Child Left Behind (NCLB)
- National Governors' Association (NGA)
- Legislation/Policy

Michigan High School Science Content Standards and Expectations

Earth Science

Biology

Physics

Chemistry

Models for District Alignment / Mapping

- District curriculum documents
- Documents from other districts/states
- Backmapping to standards and expectations

Other MI Documents / Programs

- State Standards – teaching and learning, content (all areas), assessment
- Grade Level Content Expectations
- State Assessments
- Career/Technical Education Department of Labor and Economic Growth

K-8 Educational Experience

Content Knowledge

- English Language Arts
- Mathematics
- Science
- Social Studies
- Other

Learning Processes

- Strategies & Skills
- Reasoning
- Analytical Thinking
- Constructing New Meaning
- Communication

This chart includes talking points for professional development.

Practices of Science Literacy

- **Identifying**
  Identifying performances generally have to do with stating models, theories, and patterns inside the triangle in Figure 1.
- **Using**
  Using performances generally have to do with the downward arrow in Figure 1—using scientific models and patterns to explain or describe specific observations.
- **Inquiry**
  Inquiry performances generally have to do with the upward arrow in Figure 1—finding and explaining patterns in data.
- **Reflection and Social Implications**
  Reflecting and Social Implications performances generally have to do with the figure as a whole (reflecting) or the downward arrow (technology as the application of models and theories to practical problems).

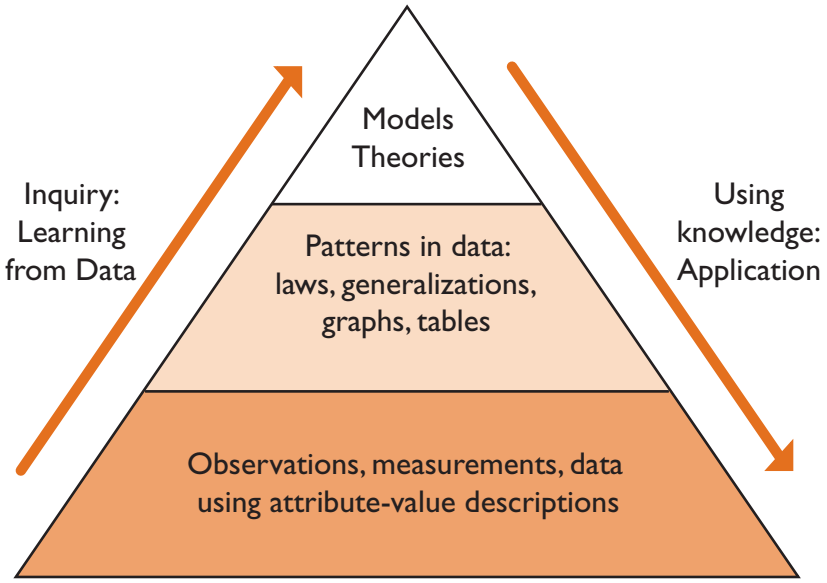


Figure 1: Knowledge and practices of model-based reasoning

Identifying Science Principles

This category focuses on students' abilities to recall, define, relate, and represent basic science principles. The content statements themselves are often closely related to one another conceptually. Moreover, the science principles included in the content statements can be represented in a variety of forms, such as words, pictures, graphs, tables, formulas, and diagrams (AAAS, 1993; NRC, 1996). Identifying practices include describing, measuring, or classifying observations; stating or recognizing principles included in the content statements; connecting closely related content statements; and relating different representations of science knowledge.

Identifying Science Principles comprises the following general types of practices:

- Describe, measure, or classify observations (e.g., describe the position and motion of objects, measure temperature, classify relationships between organisms as being predator/prey, parasite/host, producer/consumer).
- State or recognize correct science principles (e.g., mass is conserved when substances undergo changes of state; all organisms are composed of cells; the atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor).
- Demonstrate relationships among closely related science principles (e.g., statements of Newton's three laws of motion, energy transfer and the water cycle).
- Demonstrate relationships among different representations of principles (e.g., verbal, symbolic, diagrammatic) and data patterns (e.g., tables, equations, graphs).

Identifying Science Principles is integral to all of the other science practices.

Using Science Principles

Scientific knowledge is useful for making sense of the natural world. Both scientists and informed citizens can use patterns in observations and theoretical models to predict and explain observations that they make now or that they will make in the future.

Using Science Principles comprises the following general types of performance expectations:

- Explain observations of phenomena (using science principles from the content statements).
- Predict observations of phenomena (using science principles from the content statements, including quantitative predictions based on science principles that specify quantitative relationships among variables).
- Suggest examples of observations that illustrate a science principle (e.g., identify examples where the net force on an object is zero; provide examples of observations explained by the movement of tectonic plates; given partial DNA sequences of organisms, identify likely sequences of close relatives).
- Propose, analyze, and evaluate alternative explanations or predictions.

The first two categories—***Identifying Science Principles*** and ***Using Science Principles***—both require students to correctly state or recognize the science principles contained in the content statements. A difference between the categories is that Using Science Principles focuses on what makes science knowledge valuable—that is, its usefulness in making accurate predictions about phenomena and in explaining observations of the natural world in coherent ways (i.e., "knowing why"). Distinguishing between these two categories draws attention to differences in depth and richness of individuals' knowledge of the content statements. Assuming a continuum from "just knowing the facts" to "using science principles," there is considerable overlap at the boundaries. The line between the Identifying and Using categories is not distinct.

Scientific Inquiry

Scientifically literate graduates make observations about the natural world, identify patterns in data, and propose explanations to account for the patterns. Scientific inquiry involves the collection of relevant data, the use of logical reasoning, and the application of imagination in devising hypotheses to explain patterns in data. Scientific inquiry is a complex and time-intensive process that is iterative rather than linear. Habits of mind—curiosity, openness to new ideas, informed skepticism—are part of scientific inquiry. This includes the ability to read or listen critically to assertions in the media, deciding what evidence to pay attention to and what to dismiss, and distinguishing careful arguments from shoddy ones. Thus, Scientific Inquiry depends on the practices described above—Identifying Science Principles and Using Science Principles.

Scientific Inquiry comprises the following general types of performance expectations:

- Generate new questions that can be investigated in the laboratory or field.
- Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.
- Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).
- Identify patterns in data and relate them to theoretical models.
- Describe a reason for a given conclusion using evidence from an investigation.
- Predict what would happen if the variables, methods, or timing of an investigation were changed.
- Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation.
- Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.
- Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.

Scientific inquiry is more complex than simply making, summarizing, and explaining observations, and it is more flexible than the rigid set of steps often referred to as the "scientific method." The *National Standards* makes it clear that inquiry goes beyond "science as a process" to include an understanding of the nature of science (p. 105).

It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists. Evaluation includes reviewing the experimental procedures, examining the evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations (p. 171).

When students engage in Scientific Inquiry, they are drawing on their understanding about the nature of science, including the following ideas (see Benchmarks for Science Literacy):

- Arguments are flawed when fact and opinion are intermingled or the conclusions do not follow logically from the evidence given.
- A single example can never support the inference that something is always true, but sometimes a single example can support the inference that something is not always true.
- If more than one variable changes at the same time in an experiment, the outcome of the experiment may not be clearly attributable to any one of the variables.
- The way in which a sample is drawn affects how well it represents the population of interest. The larger the sample, the smaller the error in inference to the population. But, large samples do not necessarily guarantee representation, especially in the absence of random sampling.

Students can demonstrate their abilities to engage in Scientific Inquiry in two ways: students can *do* the practices specified above, and students can *critique examples* of scientific inquiry. In *doing*, practices can include analyzing data tables and deciding which conclusions are consistent with the data. Other practices involve hands-on performance and/or interactive computer tasks—for example, where students collect data and present their results or where students specify experimental conditions on computer simulations and observe the outcomes. As to *critiquing*, students can identify flaws in a poorly designed investigation or suggest changes in the design in order to produce more reliable data. Students should also be able to critique print or electronic media—for example, items may ask students to suggest alternative interpretations of data described in a newspaper article.

Scientific Reflection and Social Implications

Scientifically literate people recognize the strengths and limitations of scientific knowledge, which will provide the perspective they need to use the information to solve real-world problems. Students must learn to decide who and what sources of information they can trust. They need to learn to critique and justify their own ideas and the ideas of others. Since knowledge comes from many sources, students need to appreciate the historical origins of modern science and the multitude of connections between science and other disciplines. Students need to understand how science and technology support one another and the political, economic, and environmental consequences of scientific and technological progress. Finally, it is important that the ideas and contributions of men and women from all cultures be recognized as having played a significant role in scientific communities.

Scientific Reflection and Social Implications include the following general types of practices, all of which entail students using science knowledge to:

- Critique whether or not specific questions can be answered through scientific investigations.
- Identify and critique arguments about personal or societal issues based on scientific evidence.
- Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.
- Evaluate scientific explanations in a peer review process or discussion format.
- Evaluate the future career and occupational prospects of science fields.
- Critique solutions to problems, given criteria and scientific constraints.
- Identify scientific tradeoffs in design decisions and choose among alternative solutions.
- Describe the distinctions between scientific theories, laws, hypotheses, and observations.
- Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.
- Apply science principles or scientific data to anticipate effects of technological design decisions.
- Analyze how science and society interact from a historical, political, economic, or social perspective.

Organization of the Expectations

The Science Expectations are organized into Disciplines, Standards, Content Statements, and specific Performance Expectations.

Disciplines

Earth Science, Biology, Physics, and Chemistry

Organization of Each Standard

Each standard includes three parts:

- A standard statement that describes what students who have mastered that standard will be able to do.
- Content statements that describe Prerequisite, Essential, Core, and Recommended science content understanding for that standard.
- Performance expectations that describe Prerequisite, Essential, Core, and Recommended performances for that standard.

NOTE: Boundary statements that clarify the standards and set limits for expected performances, technical vocabulary, and additional discipline-specific inquiry and reflection expectations will be included in a companion document.

Standard Statement

The Standard Statement describes how students who meet that standard will engage in Identifying, Using, Inquiry, or Reflection for that topic.

Content Statements

Content statements describe the Prerequisite, Essential, Core, and Recommended *knowledge* associated with the standard.

1. ***Prerequisite science content*** that all students should bring as a prerequisite to high school science classes. Prerequisite content statement codes include a "**p**" and are organized by topic [e.g., **E3.p1 Landforms and Soils *(prerequisite)***].
2. ***Essential science content*** that all high school graduates should master. Essential content and expectations are organized by topic (e.g., **E2.1 Earth Systems Overview**).
3. ***Core science content*** that high school graduates need for more advanced study in the discipline and for some kinds of work. Core content and expectations are organized by topic (e.g., **B2.2x Proteins)**; "**x**" designates a core topic).
4. ***Recommended science content*** that is desirable as preparation for more advanced study in the discipline, but is not required for credit. Content and expectations labeled as recommended represent extensions of the core. Recommended content statement codes include an "**r**" and an "**x**"; expectations include an "**r**" and a lower case letter (e.g., **P4.r9x Nature of Light**; **P4.r9a**).

NOTE: Basic mathematics and English language arts skills necessary for meeting the high school science content expectations will be included in a companion document.

Performance Expectations

Performance expectations are derived from the intersection of content statements and practices—if the content statements from the Earth Sciences, Biology, Physics, and Chemistry are the columns of a table and the practices (Identifying Science Principles, Using Science Principles, Using Scientific Inquiry, Reflection and Social Implications) are the rows, the cells of the table are inhabited by performance expectations.

Performance expectations are written with particular verbs indicating the desired performance expected of the student. The action verbs associated with each practice are contextualized to generate performance expectations. For example, when the "conduct scientific investigations" is crossed with a states-of-matter content statement, this can generate a performance expectation that employs a different action verb, "heats as a way to evaporate liquids."

Michigan High School Science

BIOLOGY

Prerequisite, Essential, Core, and Recommended Content Statements and Expectations

CE • **RIGOR** • RELEVANCE • RELATIONSHIPS • RIGOR • RE
IPS • RELATIONSHIPS • RIGOR • **RELEVANCE** • RELAT
CE • RIGOR • RELEVANCE • RELATIONSHIPS • RIGOR • RE
IPS • **RELATIONSHIPS** • RIGOR • RELEVANCE • RELAT

MICHIGAN Department of Education
10/06

BIOLOGY (B)

The life sciences are changing in ways that have important implications for high school biology. Many of these changes concern our understanding of the largest and the smallest living systems. Molecular biology continues to produce new insights into how living systems work and how they are connected with one another, as well as new technologies, such as recombinant DNA, that have profound implications for our health, our lifestyles, and our political and economic systems. Equally important are changes in ecology, a traditional biological discipline which plays a key role in the emerging interdisciplinary field of environmental science. Ecologists are working together with oceanographers, atmospheric scientists, and social scientists to study the coupled human and natural systems that support all life on earth, and to understand how those systems are changing in response to growing human populations and our technologies. Our students will need to understand these changing fields in order to be healthy and responsible citizens and productive workers.

An understanding of biology begins with appreciation of the diversity and the structures of living systems. The structure of living systems directly influences how they carry out their life functions. Reasoning about living systems often involves relating different levels of organization, from the molecule to the biosphere, and understanding how living systems are structured at each level. Life processes in a cell are based on molecular interactions which keep the internal environment relatively constant. Cells are composed of highly organized structures called organelles. Cells are the smallest unit of life that can assimilate energy, reproduce, and react to the environment. A collection of cells with a common function forms a tissue and several kinds of tissues form an organ. Together many organs form an organ system such as the digestive system. A multicellular organism is the composite of cells, tissues, and organs. All organisms are interconnected in populations, communities, and ecosystems.

All living systems function in ways that are consistent with basic physical laws, including conservation of matter and energy. Transformations of matter and energy are crucial to the functions of every living system, from the molecular to the global level. The food-making process of photosynthesis generates the energy source, in the form of organic compounds, for all living things. Organic compounds transfer matter and energy through ecosystems via food chains and webs. The energy found in organic chemical bonds is changed to usable cellular energy through the process of cellular respiration. Photosynthesis and cellular respiration are key processes through which living systems exchange matter and energy with the non-living environment, participating in biogeochemical cycles that are being altered in unprecedented ways by human populations and human technologies.

In addition to transforming matter and energy, living systems have a unique ability to maintain their complex organization over time. The information that enables them to do this is stored in the genomes of every living cell. Genetic information is passed from parent to offspring in the form of gametes. Fertilization unites the genetic information from both parents creating a unique individual. Organisms within a species are generally similar because they posses very similar genetic material. However, genetic mixing and occasional mutation result in differences among individuals. Over time, changes in genetic information can affect the size, diversity, and genetic composition of populations, a process called biological evolution.

It is widely accepted that Earth's present day life forms have evolved from common ancestors by processes that include natural selection. In the scientific community, evolution has been a unifying principle that provides a framework for organizing most of biological knowledge into a coherent picture. It has been accepted by the scientific community that evidence for evolution is found in the fossil record and is indicated by anatomical and chemical similarities evident within the diversity of existing organisms.

Biology Content Statement Outline

STANDARD B1 Inquiry, Reflection, and Social Implications

- B1.1 Scientific Inquiry
- B1.2 Scientific Reflection and Social Implications

STANDARD B2 Organization and Development of Living Systems

- L2.p1 Cells *(prerequisite)*
- L2.p2 Cell Function *(prerequisite)*
- L2.p3 Plants as Producers *(prerequisite)*
- L2.p4 Animals as Consumers *(prerequisite)*
- L2.p5 Common Elements *(prerequisite)*
- B2.1 Transformation of Matter and Energy in Cells
- B2.1x Cell Differentiation
- B2.2 Organic Molecules
- B2.2x Proteins
- B2.3 Maintaining Environmental Stability
- B2.3x Homeostasis
- B2.4 Cell Specialization
- B2.5 Living Organism Composition
- B2.5x Energy Transfer
- B2.6x Internal/External Cell Regulation

STANDARD B3 Interdependence of Living Systems and the Environment

- L3.p1 Populations, Communities, and Ecosystems *(prerequisite)*
- L3.p2 Relationships Among Organisms *(prerequisite)*
- L3.p3 Factors Influencing Ecosystems *(prerequisite)*
- L3.p4 Human Impact on Ecosystems *(prerequisite)*
- B3.1 Photosynthesis and Respiration
- B3.2 Ecosystems
- B3.3 Element Recombination
- B3.4 Changes in Ecosystems
- B3.4x Human Impact
- B3.5 Populations
- B3.5x Environmental Factors

STANDARD B4 Genetics

- L4.p1 Reproduction *(prerequisite)*
- L4.p2 Heredity and Environment *(prerequisite)*
- B4.1 Genetics and Inherited Traits
- B4.2 DNA
- B4.2x DNA, RNA, and Protein Synthesis
- B4.3 Cell Division – Mitosis and Meiosis
- B4.4x Genetic Variation
- B4.r5x Recombinant DNA *(recommended)*

STANDARD B5 Evolution and Biodiversity

- L5.p1 Survival and Extinction *(prerequisite)*
- L5.p2 Classification *(prerequisite)*
- B5.1 Theory of Evolution
- B5.2 Molecular Evidence
- B5.3 Natural Selection

STANDARD B1: INQUIRY, REFLECTION, AND SOCIAL IMPLICATIONS

Students will understand the nature of science and demonstrate an ability to practice scientific reasoning by applying it to the design, execution, and evaluation of scientific investigations. Students will demonstrate their understanding that scientific knowledge is gathered through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation. They will be able to distinguish between types of scientific knowledge (e.g., hypotheses, laws, theories) and become aware of areas of active research in contrast to conclusions that are part of established scientific consensus. They will use their scientific knowledge to assess the costs, risks, and benefits of technological systems as they make personal choices and participate in public policy decisions. These insights will help them analyze the role science plays in society, technology, and potential career opportunities.

B1.1 Scientific Inquiry

Science is a way of understanding nature. Scientific research may begin by generating new scientific questions that can be answered through replicable scientific investigations that are logically developed and conducted systematically. Scientific conclusions and explanations result from careful analysis of empirical evidence and the use of logical reasoning. Some questions in science are addressed through indirect rather than direct observation, evaluating the consistency of new evidence with results predicted by models of natural processes. Results from investigations are communicated in reports that are scrutinized through a peer review process.

B1.1A Generate new questions that can be investigated in the laboratory or field.

B1.1B Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.

B1.1C Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).

B1.1D Identify patterns in data and relate them to theoretical models.

B1.1E Describe a reason for a given conclusion using evidence from an investigation.

B1.1f Predict what would happen if the variables, methods, or timing of an investigation were changed.

B1.1g Use empirical evidence to explain and critique the reasoning used to draw a scientific conclusion or explanation.

B1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.

B1.1i Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.

B1.2 Scientific Reflection and Social Implications

The integrity of the scientific process depends on scientists and citizens understanding and respecting the "nature of science." Openness to new ideas, skepticism, and honesty are attributes required for good scientific practice. Scientists must use logical reasoning during investigation design, analysis, conclusion, and communication. Science can produce critical insights on societal problems from a personal and local scale to a global scale. Science both aids in the development of technology and provides tools for assessing the costs, risks, and benefits of technological systems. Scientific conclusions and arguments play a role in personal choice and public policy decisions. New technology and scientific discoveries have had a major influence in shaping human history. Science and technology continue to offer diverse and significant career opportunities.

B1.2A Critique whether or not specific questions can be answered through scientific investigations.

B1.2B Identify and critique arguments about personal or societal issues based on scientific evidence.

B1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.

B1.2D Evaluate scientific explanations in a peer review process or discussion format.

B1.2E Evaluate the future career and occupational prospects of science fields.

B1.2f Critique solutions to problems, given criteria and scientific constraints.

B1.2g Identify scientific tradeoffs in design decisions and choose among alternative solutions.

B1.2h Describe the distinctions between scientific theories, laws, hypotheses, and observations.

B1.2i Explain the progression of ideas and explanations that leads to science theories that are part of the current scientific consensus or core knowledge.

B1.2j Apply science principles or scientific data to anticipate effects of technological design decisions.

B1.2k Analyze how science and society interact from a historical, political, economic, or social perspective.

STANDARD B2: ORGANIZATION AND DEVELOPMENT OF LIVING SYSTEMS

Students describe the general structure and function of cells. They can explain that all living systems are composed of cells and that organisms may be unicellular or multicellular. They understand that cells are composed of biological macromolecules and that the complex processes of the cell allow it to maintain a stable internal environment necessary to maintain life. They make predictions based on these understandings.

L2.p1 Cells *(prerequisite)*

All organisms are composed of cells, from just one cell to many cells. Water accounts for more than two-thirds of the weight of a cell, which gives cells many of their properties. In multicellular organisms, specialized cells perform specialized functions. Organs and organ systems are composed of cells and function to serve the needs of organisms for food, air, and waste removal. The way in which cells function is similar in all living organisms. *(prerequisite)*

L2.p1A Distinguish between living and nonliving systems. *(prerequisite)*

L2.p1B Explain the importance of both water and the element carbon to cells. *(prerequisite)*

L2.p1C Describe growth and development in terms of increase in cell number, cell size, and/or cell products. *(prerequisite)*

L2.p1D Explain how the systems in a multicellular organism work together to support the organism. *(prerequisite)*

L2.p1E Compare and contrast how different organisms accomplish similar functions (e.g., obtain oxygen for respiration, and excrete waste). *(prerequisite)*

L2.p2 Cell Function *(prerequisite)*

Cells carry out the many functions needed to sustain life. They grow and divide, thereby producing more cells. Food is used to provide energy for the work that cells do and is a source of the molecular building blocks from which needed materials are assembled. *(prerequisite)*

L2.p2A Describe how organisms sustain life by obtaining, transporting, transforming, releasing, and eliminating matter and energy. *(prerequisite)*

L2.p2B Describe the effect of limiting food to developing cells. *(prerequisite)*

L2.p3 Plants as Producers *(prerequisite)*

Plants are producers; they use the energy from light to make sugar molecules from the atoms of carbon dioxide and water. Plants use these sugars, along with minerals from the soil, to form fats, proteins, and carbohydrates. This food can be used immediately, incorporated into the cells of a plant as the plant grows, or stored for later use. *(prerequisite)*

L2.p3A Explain the significance of carbon in organic molecules. *(prerequisite)*

L2.p3B Explain the origins of plant mass. *(prerequisite)*

L2.p3C Predict what would happen to plants growing in low carbon dioxide atmospheres. *(prerequisite)*

L2.p3D Explain how the roots of specific plants grow. *(prerequisite)*

L2.p4 Animals as Consumers *(prerequisite)*

All animals, including humans, are consumers; they obtain food by eating other organisms or their products. Consumers break down the structures of the organisms they eat to obtain the materials they need to grow and function. Decomposers, including bacteria and fungi, use dead organisms or their products for food. *(prerequisite)*

L2.p4A Classify different organisms based on how they obtain energy for growth and development. *(prerequisite)*

L2.p4B Explain how an organism obtains energy from the food it consumes. *(prerequisite)*

L2.p5 Common Elements *(prerequisite)*

Living systems are made of complex molecules that consist mostly of a few elements, especially carbon, hydrogen, oxygen, nitrogen, and phosphorous. *(prerequisite)*

L2.p5A Recognize the six most common elements in organic molecules (C, H, N, O, P, S). *(prerequisite)*

L2.p5B Identify the most common complex molecules that make up living organisms. *(prerequisite)*

L2.p5C Predict what would happen if essential elements were withheld from developing cells. *(prerequisite)*

B2.1 Transformation of Matter and Energy in Cells

In multicellular organisms, cells are specialized to carry out specific functions such as transport, reproduction, or energy transformation.

B2.1A Explain how cells transform energy (ultimately obtained from the sun) from one form to another through the processes of photosynthesis and respiration. Identify the reactants and products in the general reaction of photosynthesis.

B2.1B Compare and contrast the transformation of matter and energy during photosynthesis and respiration.

B2.1C Explain cell division, growth, and development as a consequence of an increase in cell number, cell size, and/or cell products.

B2.1x Cell Differentiation

Following fertilization, cell division produces a small cluster of cells that then differentiate by appearance and function to form the basic tissues of an embryo.

B2.1d Describe how, through cell division, cells can become specialized for specific function.

B2.1e Predict what would happen if the cells from one part of a developing embryo were transplanted to another part of the embryo.

B2.2 Organic Molecules

There are four major categories of organic molecules that make up living systems: carbohydrates, fats, proteins, and nucleic acids.

B2.2A Explain how carbon can join to other carbon atoms in chains and rings to form large and complex molecules.

B2.2B Recognize the six most common elements in organic molecules (C, H, N, O, P, S).

B2.2C Describe the composition of the four major categories of organic molecules (carbohydrates, lipids, proteins, and nucleic acids).

B2.2D Explain the general structure and primary functions of the major complex organic molecules that compose living organisms.

B2.2E Describe how dehydration and hydrolysis relate to organic molecules.

B2.2x Proteins

Protein molecules are long, usually folded chains composed mostly of amino acids and are made of C, H, O, and N. Protein molecules assemble fats and carbohydrates; they function as enzymes, structural components, and hormones. The function of each protein molecule depends on its specific sequence of amino acids and the shape of the molecule.

B2.2f Explain the role of enzymes and other proteins in biochemical functions (e.g., the protein hemoglobin carries oxygen in some organisms, digestive enzymes, and hormones).

B2.2g Propose how moving an organism to a new environment may influence its ability to survive and predict the possible impact of this type of transfer.

B2.3 Maintaining Environmental Stability

The internal environment of living things must remain relatively constant. Many systems work together to maintain stability. Stability is challenged by changing physical, chemical, and environmental conditions as well as the presence of disease agents.

B2.3A Describe how cells function in a narrow range of physical conditions, such as temperature and pH (acidity), to perform life functions.

B2.3B Describe how the maintenance of a relatively stable internal environment is required for the continuation of life.

B2.3C Explain how stability is challenged by changing physical, chemical, and environmental conditions as well as the presence of disease agents.

B2.3x Homeostasis

The internal environment of living things must remain relatively constant. Many systems work together to maintain homeostasis. When homeostasis is lost, death occurs.

B2.3d Identify the general functions of the major systems of the human body (digestion, respiration, reproduction, circulation, excretion, protection from disease, and movement, control, and coordination) and describe ways that these systems interact with each other.

B2.3e Describe how human body systems maintain relatively constant internal conditions (temperature, acidity, and blood sugar).

B2.3f Explain how human organ systems help maintain human health.

B2.3g Compare the structure and function of a human body system or subsystem to a nonliving system (e.g., human joints to hinges, enzyme and substrate to interlocking puzzle pieces).

B2.4 Cell Specialization

In multicellular organisms, specialized cells perform specialized functions. Organs and organ systems are composed of cells and function to serve the needs of cells for food, air, and waste removal. The way in which cells function is similar in all living organisms.

B2.4A Explain that living things can be classified based on structural, embryological, and molecular (relatedness of DNA sequence) evidence.

B2.4B Describe how various organisms have developed different specializations to accomplish a particular function and yet the end result is the same (e.g., excreting nitrogenous wastes in animals, obtaining oxygen for respiration).

B2.4C Explain how different organisms accomplish the same result using different structural specializations (gills vs. lungs vs. membranes).

B2.4d Analyze the relationships among organisms based on their shared physical, biochemical, genetic, and cellular characteristics and functional processes.

B2.4e Explain how cellular respiration is important for the production of ATP (build on aerobic vs. anaerobic).

B2.4f Recognize and describe that both living and nonliving things are composed of compounds, which are themselves made up of elements joined by energy-containing bonds, such as those in ATP.

B2.4g Explain that some structures in the modern eukaryotic cell developed from early prokaryotes, such as mitochondria, and in plants, chloroplasts.

B2.4h Describe the structures of viruses and bacteria.

B2.4i Recognize that while viruses lack cellular structure, they have the genetic material to invade living cells.

B2.5 Living Organism Composition

All living or once-living organisms are composed of carbohydrates, lipids, proteins, and nucleic acids. Carbohydrates and lipids contain many carbon-hydrogen bonds that also store energy.

B2.5A Recognize and explain that macromolecules such as lipids contain high energy bonds.

B2.5B Explain how major systems and processes work together in animals and plants, including relationships between organelles, cells, tissues, organs, organ systems, and organisms. Relate these to molecular functions.

B2.5C Describe how energy is transferred and transformed from the Sun to energy-rich molecules during photosynthesis.

B2.5D Describe how individual cells break down energy-rich molecules to provide energy for cell functions.

B2.5x Energy Transfer

All living or once living organisms are composed of carbohydrates, lipids, proteins, and nucleic acids. Carbohydrates and lipids contain many carbon-hydrogen bonds that also store energy. However, that energy must be transferred to ATP (adenosine triphosphate) to be usable by the cell.

B2.5e Explain the interrelated nature of photosynthesis and cellular respiration in terms of ATP synthesis and degradation.

B2.5f Relate plant structures and functions to the process of photosynthesis and respiration.

B2.5g Compare and contrast plant and animal cells.

B2.5h Explain the role of cell membranes as a highly selective barrier (diffusion, osmosis, and active transport).

B2.5i Relate cell parts/organelles to their function.

B2.6x Internal/External Cell Regulation

Cellular processes are regulated both internally and externally by environments in which cells exist, including local environments that lead to cell differentiation during the development of multicellular organisms. During the development of complex multicellular organisms, cell differentiation is regulated through the expression of different genes.

B2.6a Explain that the regulatory and behavioral responses of an organism to external stimuli occur in order to maintain both short- and long-term equilibrium.

B2.r6b Explain that complex interactions among the different kinds of molecules in the cell cause distinct cycles of activities, such as growth and division. Note that cell behavior can also be affected by molecules from other parts of the organism, such as hormones. *(recommended)*

B2.r6c Recognize and explain that communication and/or interaction are required between cells to coordinate their diverse activities. *(recommended)*

B2.r6d Explain how higher levels of organization result from specific complex interactions of smaller units and that their maintenance requires a constant input of energy as well as new material. *(recommended)*

B2.r6e Analyze the body's response to medical interventions such as organ transplants, medicines, and inoculations. *(recommended)*

STANDARD B3: INTERDEPENDENCE OF LIVING SYSTEMS AND THE ENVIRONMENT

Students describe the processes of photosynthesis and cellular respiration and how energy is transferred through food webs. They recognize and analyze the consequences of the dependence of organisms on environmental resources and the interdependence of organisms in ecosystems.

L3.p1 Populations, Communities, and Ecosystems *(prerequisite)*

Organisms of one species form a population. Populations of different organisms interact and form communities. Living communities and the nonliving factors that interact with them form ecosystems. *(prerequisite)*

L3.p1A Provide examples of a population, community, and ecosystem. *(prerequisite)*

L3.p2 Relationships Among Organisms *(prerequisite)*

Two types of organisms may interact with one another in several ways; they may be in a producer/consumer, predator/prey, or parasite/host relationship. Or one organism may scavenge or decompose another. Relationships may be competitive or mutually beneficial. Some species have become so adapted to each other that neither could survive without the other. *(prerequisite)*

L3.p2A Describe common relationships among organisms and provide examples of producer/consumer, predator/prey, or parasite/host relationship. *(prerequisite)*

L3.p2B Describe common ecological relationships between and among species and their environments (competition, territory, carrying capacity, natural balance, population, dependence, survival, and other biotic and abiotic factors). *(prerequisite)*

L3.p2C Describe the role of decomposers in the transfer of energy in an ecosystem. *(prerequisite)*

L3.p2D Explain how two organisms can be mutually beneficial and how that can lead to interdependency. *(prerequisite)*

L3.p3 Factors Influencing Ecosystems *(prerequisite)*

The number of organisms and populations an ecosystem can support depends on the biotic resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition. *(prerequisite)*

L3.p3A Identify the factors in an ecosystem that influence fluctuations in population size. *(prerequisite)*

L3.p3B Distinguish between the living (biotic) and nonliving (abiotic) components of an ecosystem. *(prerequisite)*

L3.p3C Explain how biotic and abiotic factors cycle in an ecosystem (water, carbon, oxygen, and nitrogen). *(prerequisite)*

L3.p3D Predict how changes in one population might affect other populations based upon their relationships in a food web. *(prerequisite)*

L3.p4 Human Impact on Ecosystems *(prerequisite)*

All organisms cause changes in their environments. Some of these changes are detrimental, whereas others are beneficial. *(prerequisite)*

L3.p4A Recognize that, and describe how, human beings are part of Earth's ecosystems. Note that human activities can deliberately or inadvertently alter the equilibrium in ecosystems. *(prerequisite)*

B3.1 Photosynthesis and Respiration

Organisms acquire their energy directly or indirectly from sunlight. Plants capture the Sun's energy and use it to convert carbon dioxide and water to sugar and oxygen through the process of photosynthesis. Through the process of cellular respiration, animals are able to release the energy stored in the molecules produced by plants and use it for cellular processes, producing carbon dioxide and water.

B3.1A Describe how organisms acquire energy directly or indirectly from sunlight.

B3.1B Illustrate and describe the energy conversions that occur during photosynthesis and respiration.

B3.1C Recognize the equations for photosynthesis and respiration and identify the reactants and products for both.

B3.1D Explain how living organisms gain and use mass through the processes of photosynthesis and respiration.

B3.1e Write the chemical equation for photosynthesis and cellular respiration and explain in words what they mean.

B3.1f Summarize the process of photosynthesis.

B3.2 Ecosystems

The chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways. At each link in an ecosystem, some energy is stored in newly made structures, but much is dissipated into the environment as heat. Continual input of energy from sunlight keeps the process going.

B3.2A Identify how energy is stored in an ecosystem.

B3.2B Describe energy transfer through an ecosystem, accounting for energy lost to the environment as heat.

B3.2C Draw the flow of energy through an ecosystem. Predict changes in the food web when one or more organisms are removed.

B3.3 Element Recombination

As matter cycles and energy flows through different levels of organization of living systems—cells, organs, organisms, and communities—and between living systems and the physical environment, chemical elements are recombined in different ways. Each recombination results in storage and dissipation of energy into the environment as heat. Matter and energy are conserved in each change.

B3.3A Use a food web to identify and distinguish producers, consumers, and decomposers and explain the transfer of energy through trophic levels.

B3.3b Describe environmental processes (e.g., the carbon and nitrogen cycles) and their role in processing matter crucial for sustaining life.

B3.4 Changes in Ecosystems

Although the interrelationships and interdependence of organisms may generate biological communities in ecosystems that are stable for hundreds or thousands of years, ecosystems always change when climate changes or when one or more new species appear as a result of migration or local evolution. The impact of the human species has major consequences for other species.

B3.4A Describe ecosystem stability. Understand that if a disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in stages of succession that eventually result in a system similar to the original one.

B3.4B Recognize and describe that a great diversity of species increases the chance that at least some living organisms will survive in the face of cataclysmic changes in the environment.

B3.4C Examine the negative impact of human activities.

B3.4x Human Impact

Humans can have tremendous impact on the environment. Sometimes their impact is beneficial, and sometimes it is detrimental.

B3.4d Describe the greenhouse effect and list possible causes.

B3.4e List the possible causes and consequences of global warming.

B3.5 Populations

Populations of living things increase and decrease in size as they interact with other populations and with the environment. The rate of change is dependent upon relative birth and death rates.

B3.5A Graph changes in population growth, given a data table.

B3.5B Explain the influences that affect population growth.

B3.5C Predict the consequences of an invading organism on the survival of other organisms.

B3.5x Environmental Factors

The shape of population growth curves vary with the type of organism and environmental conditions, such as availability of nutrients and space. As the population increases and resources become more scarce, the population usually stabilizes at the carrying capacity of that environment.

B3.5d Describe different reproductive strategies employed by various organisms and explain their advantages and disadvantages.

B3.5e Recognize that and describe how the physical or chemical environment may influence the rate, extent, and nature of population dynamics within ecosystems.

B3.5f Graph an example of exponential growth. Then show the population leveling off at the carrying capacity of the environment.

B3.r5g Diagram and describe the stages of the life cycle for a human disease-causing organism. *(recommended)*

STANDARD B4: GENETICS

Students recognize that the specific genetic instructions for any organism are contained within genes composed of DNA molecules located in chromosomes. They explain the mechanism for the direct production of specific proteins based on inherited DNA. Students diagram how occasional modifications in genes and the random distribution of genes from each parent provide genetic variation and become the raw material for evolution. Content Statements, Performances, and Boundaries

L4.p1 Reproduction *(prerequisite)*

Reproduction is a characteristic of all living systems; because no individual organism lives forever, reproduction is essential to the continuation of every species. Some organisms reproduce asexually. Other organisms reproduce sexually. *(prerequisite)*

L4.p1A Compare and contrast the differences between sexual and asexual reproduction. *(prerequisite)*

L4.p1B Discuss the advantages and disadvantages of sexual vs. asexual reproduction. *(prerequisite)*

L4.p2 Heredity and Environment *(prerequisite)*

The characteristics of organisms are influenced by heredity and environment. For some characteristics, inheritance is more important. For other characteristics, interactions with the environment are more important. *(prerequisite)*

L4.p2A Explain that the traits of an individual are influenced by both the environment and the genetics of the individual. Acquired traits are not inherited; only genetic traits are inherited. *(prerequisite)*

B4.1 Genetics and Inherited Traits

Hereditary information is contained in genes, located in the chromosomes of each cell. Cells contain many thousands of different genes. One or many genes can determine an inherited trait of an individual, and a single gene can influence more than one trait. Before a cell divides, this genetic information must be copied and apportioned evenly into the daughter cells.

B4.1A Draw and label a homologous chromosome pair with heterozygous alleles highlighting a particular gene location.

B4.1B Explain that the information passed from parents to offspring is transmitted by means of genes that are coded in DNA molecules. These genes contain the information for the production of proteins.

B4.1c Differentiate between dominant, recessive, codominant, polygenic, and sex-linked traits.

B4.1d Explain the genetic basis for Mendel's laws of segregation and independent assortment.

B4.1e Determine the genotype and phenotype of monohybrid crosses using a Punnett Square.

B4.2 DNA

The genetic information encoded in DNA molecules provides instructions for assembling protein molecules. Genes are segments of DNA molecules. Inserting, deleting, or substituting DNA segments can alter genes. An altered gene may be passed on to every cell that develops from it. The resulting features may help, harm, or have little or no effect on the offspring's success in its environment.

B4.2A Show that when mutations occur in sex cells, they can be passed on to offspring (inherited mutations), but if they occur in other cells, they can be passed on to descendant cells only (noninherited mutations).

B4.2B Recognize that every species has its own characteristic DNA sequence.

B4.2C Describe the structure and function of DNA.

B4.2D Predict the consequences that changes in the DNA composition of particular genes may have on an organism (e.g., sickle cell anemia, other).

B4.2E Propose possible effects (on the genes) of exposing an organism to radiation and toxic chemicals.

B4.2x DNA, RNA, and Protein Synthesis

Protein synthesis begins with the information in a sequence of DNA bases being copied onto messenger RNA. This molecule moves from the nucleus to the ribosome in the cytoplasm where it is "read." Transfer RNA brings amino acids to the ribosome, where they are connected in the correct sequence to form a specific protein.

B4.2f Demonstrate how the genetic information in DNA molecules provides instructions for assembling protein molecules and that this is virtually the same mechanism for all life forms.

B4.2g Describe the processes of replication, transcription, and translation and how they relate to each other in molecular biology.

B4.2h Recognize that genetic engineering techniques provide great potential and responsibilities.

B4.r2i Explain how recombinant DNA technology allows scientists to analyze the structure and function of genes. *(recommended)*

B4.3 Cell Division — Mitosis and Meiosis

Sorting and recombination of genes in sexual reproduction results in a great variety of possible gene combinations from the offspring of any two parents.

B4.3A Compare and contrast the processes of cell division (mitosis and meiosis), particularly as those processes relate to production of new cells and to passing on genetic information between generations.

B4.3B Explain why only mutations occurring in gametes (sex cells) can be passed on to offspring.

B4.3C Explain how it might be possible to identify genetic defects from just a karyotype of a few cells.

B4.3d Explain that the sorting and recombination of genes in sexual reproduction result in a great variety of possible gene combinations from the offspring of two parents.

B4.3e Recognize that genetic variation can occur from such processes as crossing over, jumping genes, and deletion and duplication of genes.

B4.3f Predict how mutations may be transferred to progeny.

B4.3g Explain that cellular differentiation results from gene expression and/or environmental influence (e.g., metamorphosis, nutrition).

B4.4x Genetic Variation

Genetic variation is essential to biodiversity and the stability of a population. Genetic variation is ensured by the formation of gametes and their combination to form a zygote. Opportunities for genetic variation also occur during cell division when chromosomes exchange genetic material causing permanent changes in the DNA sequences of the chromosomes. Random mutations in DNA structure caused by the environment are another source of genetic variation.

B4.4a Describe how inserting, deleting, or substituting DNA segments can alter a gene. Recognize that an altered gene may be passed on to every cell that develops from it and that the resulting features may help, harm, or have little or no effect on the offspring's success in its environment.

B4.4b Explain that gene mutation in a cell can result in uncontrolled cell division called cancer. Also know that exposure of cells to certain chemicals and radiation increases mutations and thus increases the chance of cancer.

B4.4c Explain how mutations in the DNA sequence of a gene may be silent or result in phenotypic change in an organism and in its offspring.

B4.r5x Recombinant DNA

Recombinant DNA technology allows scientists in the laboratory to combine the genes from different sources, sometimes different species, into a single DNA molecule. This manipulation of genes using bacterial plasmids has been used for many practical purposes including the mass production of chemicals and drugs. *(recommended)*

B4.r5a Explain how recombinant DNA technology allows scientists to analyze the structure and function of genes. *(recommended)*

B4.r5b Evaluate the advantages and disadvantages of human manipulation of DNA. *(recommended)*

STANDARD B5: EVOLUTION AND BIODIVERSITY

Students recognize that evolution is the result of genetic changes that occur in constantly changing environments. They can explain that modern evolution includes both the concepts of common descent and natural selection. They illustrate how the consequences of natural selection and differential reproduction have led to the great biodiversity on Earth.

L5.p1 Survival and Extinction *(prerequisite)*

Individual organisms with certain traits in particular environments are more likely than others to survive and have offspring. When an environment changes, the advantage or disadvantage of characteristics can change. Extinction of a species occurs when the environment changes and the characteristics of a species are insufficient to allow survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the Earth no longer exist. *(prerequisite)*

L5.p1A Define a species and give examples. *(prerequisite)*

L5.p1B Define a population and identify local populations. *(prerequisite)*

L5.p1C Explain how extinction removes genes from the gene pool. *(prerequisite)*

L5.p1D Explain the importance of the fossil record. *(prerequisite)*

L5.p2 Classification *(prerequisite)*

Similarities among organisms are found in anatomical features, which can be used to infer the degree of relatedness among organisms. In classifying organisms, biologists consider details of internal and external structures to be more important than behavior or general appearance. *(prerequisite)*

L5.p2A Explain, with examples, that ecology studies the varieties and interactions of living things across space while evolution studies the varieties and interactions of living things across time. *(prerequisite)*

B5.1 Theory of Evolution

The theory of evolution provides a scientific explanation for the history of life on Earth as depicted in the fossil record and in the similarities evident within the diversity of existing organisms.

B5.1A Summarize the major concepts of natural selection (differential survival and reproduction of chance inherited variants, depending on environmental conditions).

B5.1B Describe how natural selection provides a mechanism for evolution.

B5.1c Summarize the relationships between present-day organisms and those that inhabited the Earth in the past (e.g., use fossil record, embryonic stages, homologous structures, chemical basis).

B5.1d Explain how a new species or variety originates through the evolutionary process of natural selection.

B5.1e Explain how natural selection leads to organisms that are well suited for the environment (differential survival and reproduction of chance inherited variants, depending upon environmental conditions).

B5.1f Explain, using examples, how the fossil record, comparative anatomy, and other evidence supports the theory of evolution.

B5.1g Illustrate how genetic variation is preserved or eliminated from a population through natural selection (evolution) resulting in biodiversity.

B5.2x Molecular Evidence

Molecular evidence substantiates the anatomical evidence for evolution and provides additional detail about the sequence in which various lines of descents branched.

B5.2a Describe species as reproductively distinct groups of organisms that can be classified based on morphological, behavioral, and molecular similarities.

B5.2b Explain that the degree of kinship between organisms or species can be estimated from the similarity of their DNA and protein sequences.

B5.2c Trace the relationship between environmental changes and changes in the gene pool, such as genetic drift and isolation of subpopulations.

B5.r2d Interpret a cladogram or phylogenetic tree showing evolutionary relationships among organisms. *(recommended)*

B5.3 Natural Selection

Evolution is the consequence of natural selection, the interactions of (1) the potential for a population to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection from environmental pressure of those organisms better able to survive and leave offspring.

B5.3A Explain how natural selection acts on individuals, but it is populations that evolve. Relate genetic mutations and genetic variety produced by sexual reproduction to diversity within a given population.

B5.3B Describe the role of geographic isolation in speciation.

B4.3C Give examples of ways in which genetic variation and environmental factors are causes of evolution and the diversity of organisms.

B5.3d Explain how evolution through natural selection can result in changes in biodiversity.

B5.3e Explain how changes at the gene level are the foundation for changes in populations and eventually the formation of new species.

B5.3f Demonstrate and explain how biotechnology can improve a population and species.

NOTES

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High School Content Expectations




SCIENCE

- Earth Science
- Biology
- Physics
- **Chemistry**

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Welcome to Michigan's High School Science Content Standards and Expectations

Why Develop Content Standards and Expectations for High School?

To prepare Michigan's students with the knowledge and skills to succeed in the 21st Century, the State of Michigan has enacted a rigorous new set of statewide graduation requirements that are among the best in the nation. These requirements, called the Michigan Merit Curriculum, are the result of a collaborative effort between Governor Jennifer M. Granholm, the State Board of Education, and the State Legislature.

In preparation for the implementation of the new high school graduation requirements, the Michigan Department of Education's Office of School Improvement is leading the development of high school content expectations. An Academic Work Group of science experts chaired by nationally known scholars was commissioned to conduct a scholarly review and identify content standards and expectations. The Michigan Department of Education conducted an extensive field review of the expectations by high school, university, and business and industry representatives.

The Michigan High School Science Content Expectations (Science HSCE) establish what every student is expected to know and be able to do by the end of high school and define the expectations for high school science credit in Earth Science, Biology, Physics, and Chemistry.

An Overview

In developing these expectations, the Academic Work Group depended heavily on the *Science Framework for the 2009 National Assessment of Educational Progress* (National Assessment Governing Board, 2006). In particular, the group adapted the structure of the NAEP framework, including Content Statements and Performance Expectations. These expectations align closely with the NAEP framework, which is based on *Benchmarks for Science Literacy* (AAAS Project 2061, 1993) and the *National Science Education Standards* (National Research Council, 1996).

The Academic Work Group carefully analyzed other documents, including the Michigan Curriculum Framework Science Benchmarks (2000 revision), the Standards for Success report *Understanding University Success*, ACT's *College Readiness Standards*, College Board's *AP Biology, AP Physics, AP Chemistry,* and *AP Environmental Science Course Descriptions*, ACT's *On Course for Success*, South Regional Education Board's *Getting Ready for College-Preparatory/Honors Science: What Middle Grades Students Need to Know and Be Able to Do,* and standards documents from other states.

Earth Science	Biology	Physics	Chemistry
STANDARDS *(and number of content statements in each standard)*			
E1 Inquiry, Reflection, and Social Implications (2) E2 Earth Systems (4) E3 The Solid Earth (4) E4 The Fluid Earth (3) E5 Earth in Space and Time (4)	B1 Inquiry, Reflection, and Social Implications (2) B2 Organization and Development of Living Systems (6) B3 Interdependence of Living Systems and the Environment (5) B4 Genetics (4) B5 Evolution and Biodiversity (3)	P1 Inquiry, Reflection, and Social Implications (2) P2 Motion of Objects (3) P3 Forces and Motion (8) P4 Forms of Energy and Energy Transformations (12)	C1 Inquiry, Reflection, and Social Implications (2) C2 Forms of Energy (5) C3 Energy Transfer and Conservation (5) C4 Properties of Matter (10) C5 Changes in Matter (7)

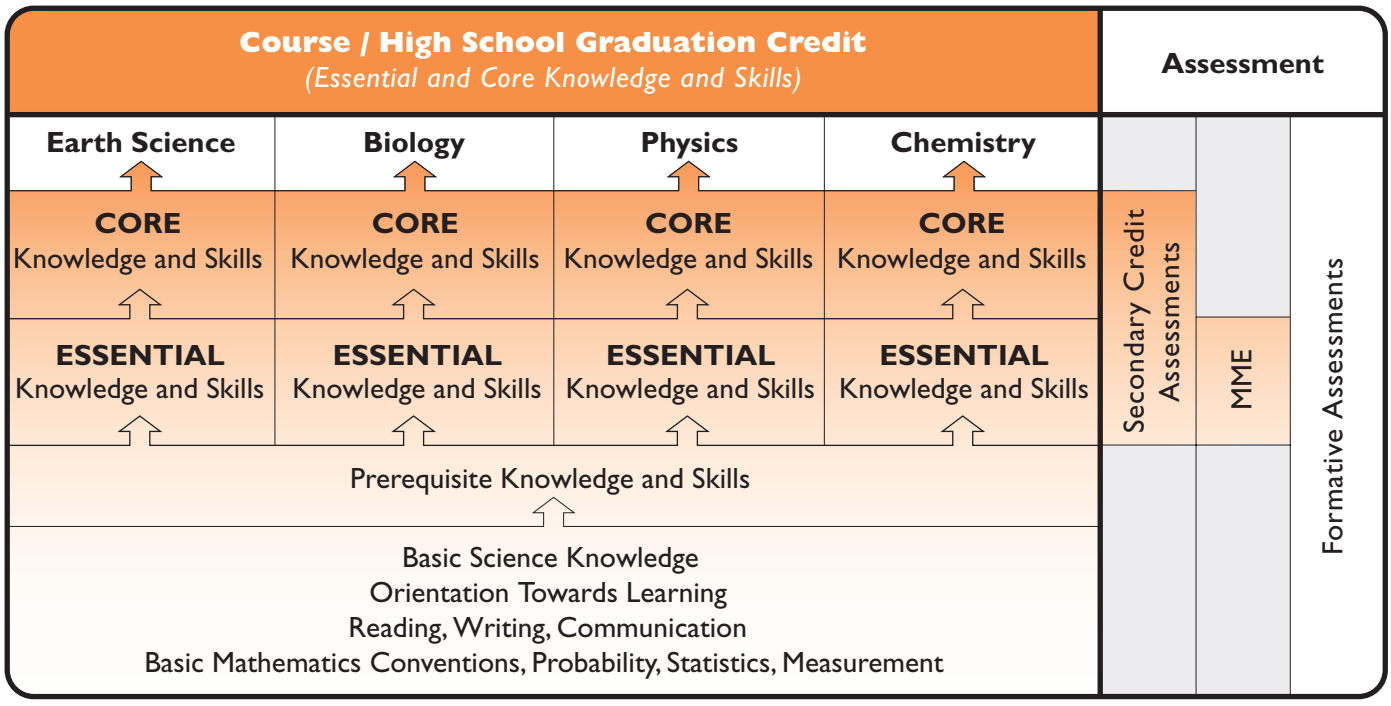
Useful and Connected Knowledge for All Students

This document defines expectations for Michigan High School graduates, organized by discipline: Earth Science, Biology, Physics, and Chemistry. It defines ***useful*** and ***connected knowledge*** at four levels:

- **Prerequisite knowledge**
  Useful and connected knowledge that all students should bring as a prerequisite to high school science classes. Prerequisite expectation codes include a "**p**" and an upper case letter (e.g., **E3.p1A**). Prerequisite content could be assessed through formative and/or large scale assessments.
- **Essential knowledge**
  Useful and connected knowledge for all high school graduates, regardless of what courses they take in high school. Essential expectation codes include an upper case letter (e.g., **E2.1A**). Essential content knowledge and performance expectations are required for graduation and are assessable on the Michigan Merit Exam (MME) and on future secondary assessments. Essential knowledge can also be assessed with formative assessments.
- **Core knowledge**
  Useful and connected knowledge for all high school graduates who have completed a discipline-specific course. In general core knowledge includes content and expectations that students need to be prepared for more advanced study in that discipline. Core content statement codes include an "x" and core expectation codes include a lower case letter (e.g., **B2.2x** Proteins; **B2.2f**) to indicate that they are NOT assessable on existing large-scale assessments (MME, NAEP), but will be assessed on future secondary credit assessments. Core knowledge can also be assessed with formative assessments.
- **Recommended knowledge**
  Useful and connected knowledge that is desirable as preparation for more advanced study in the discipline, but not required for graduation credit. Content and expectations labeled as recommended represent extensions of the core. Recommended content statement codes include an "**r**" and an "**x**"; recommended expectations include an "**r**" and a lower case letter (e.g., **P4.r9x Nature of Light**; **P4.r9a**). They will not be assessed on either the MME or secondary credit assessments.

Useful and connected knowledge is contrasted with ***procedural display***—learning to manipulate words and symbols without fully understanding their meaning. When expectations are excessive, procedural display is the kind of learning that takes place. Teachers and students "cover the content" instead of "uncovering" useful and connected knowledge.

Credit for high school Earth Science, Biology, Physics, and Chemistry will be defined as meeting both essential and core subject area content expectations. Credit requirements are outlined in separate Michigan Merit Curriculum Course/Credit Requirement documents.



Preparing Students for Successful Post-Secondary Engagement

Students who have useful and connected knowledge should be able to apply knowledge in new situations; to solve problems by generating new ideas; to make connections among what they read and hear in class, the world around them, and the future; and through their work, to develop leadership qualities while still in high school. In particular, high school graduates with useful and connected knowledge are able to engage in four key practices of science literacy.

Successful Post-Secondary Engagement

Practices of Science Literacy

Communicate accurately and effectively...

Identifying Science Principles

- Describe, measure, or classify observations.
- State or recognize correct science principles.
- Demonstrate relationships among closely related science principles.
- Demonstrate relationships among different representations of principles.

Using Science Principles

- Explain observations of phenomena.
- Predict observations of phenomena.
- Suggest examples of observations that illustrate a science principle.
- Propose, analyze, and evaluate alternative explanations or predictions.

Scientific Inquiry

- Generate new questions that can be investigated in the laboratory or field.
- Critique aspects of scientific investigations.
- Conduct scientific investigations using appropriate tools and techniques.
- Identify patterns in data: relate patterns to theoretical models.
- Describe a reason for a given conclusion using evidence from an investigation.
- Explain how scientific evidence supports or refutes claims or explanations of phenomena.
- Design and conduct a scientific investigation with a hypothesis, several controlled variables, and one manipulated variable. Gather data and organized the results in graphs, tables, and/or charts.

Reflection and Social Implications

- Critique whether questions can be answered through scientific investigations.
- Identify and critique arguments based on scientific evidence.
- Use appropriate scientific knowledge in social arguments, recognizing their limitations.
- Gather, synthesize, and evaluate information from multiple sources.
- Discuss scientific topics in groups, make presentations summarize what others have said, ask for clarification, take alternative perspectives, and defend a position.
- Evaluate the future career and occupational prospects of science fields.
- Explain why a claim or a conclusion is flawed.
- Critique solutions to problems, given criteria and scientific constraints.
- Identify scientific tradeoffs in design decisions and choose among alternative solutions.
- Apply science principles or scientific data to anticipate effects of technological design decisions.

State / National Landscape

- Expert perspective
- Education reform environment
- Research-based practices
- Work force requirements

State / Federal Expectations

- No Child Left Behind (NCLB)
- National Governors' Association (NGA)
- Legislation/Policy

Michigan High School Science Content Standards and Expectations

Earth Science

Biology

Physics

Chemistry

Models for District Alignment / Mapping

- District curriculum documents
- Documents from other districts/states
- Backmapping to standards and expectations

Other MI Documents / Programs

- State Standards – teaching and learning, content (all areas), assessment
- Grade Level Content Expectations
- State Assessments
- Career/Technical Education Department of Labor and Economic Growth

K-8 Educational Experience

Content Knowledge

- English Language Arts
- Mathematics
- Science
- Social Studies
- Other

Learning Processes

- Strategies & Skills
- Reasoning
- Analytical Thinking
- Constructing New Meaning
- Communication

This chart includes talking points for professional development.

Practices of Science Literacy

- **Identifying**
  Identifying performances generally have to do with stating models, theories, and patterns inside the triangle in Figure 1.
- **Using**
  Using performances generally have to do with the downward arrow in Figure 1—using scientific models and patterns to explain or describe specific observations.
- **Inquiry**
  Inquiry performances generally have to do with the upward arrow in Figure 1—finding and explaining patterns in data.
- **Reflection and Social Implications**
  Reflecting and Social Implications performances generally have to do with the figure as a whole (reflecting) or the downward arrow (technology as the application of models and theories to practical problems).

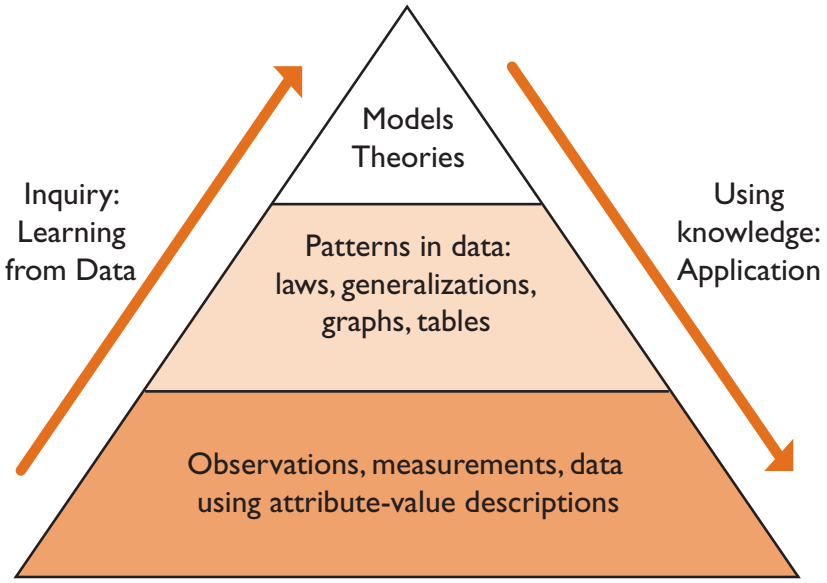


Figure 1: Knowledge and practices of model-based reasoning

Identifying Science Principles

This category focuses on students' abilities to recall, define, relate, and represent basic science principles. The content statements themselves are often closely related to one another conceptually. Moreover, the science principles included in the content statements can be represented in a variety of forms, such as words, pictures, graphs, tables, formulas, and diagrams (AAAS, 1993; NRC, 1996). Identifying practices include describing, measuring, or classifying observations; stating or recognizing principles included in the content statements; connecting closely related content statements; and relating different representations of science knowledge.

Identifying Science Principles comprises the following general types of practices:

- Describe, measure, or classify observations (e.g., describe the position and motion of objects, measure temperature, classify relationships between organisms as being predator/prey, parasite/host, producer/consumer).
- State or recognize correct science principles (e.g., mass is conserved when substances undergo changes of state; all organisms are composed of cells; the atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor).
- Demonstrate relationships among closely related science principles (e.g., statements of Newton's three laws of motion, energy transfer and the water cycle).
- Demonstrate relationships among different representations of principles (e.g., verbal, symbolic, diagrammatic) and data patterns (e.g., tables, equations, graphs).

Identifying Science Principles is integral to all of the other science practices.

Using Science Principles

Scientific knowledge is useful for making sense of the natural world. Both scientists and informed citizens can use patterns in observations and theoretical models to predict and explain observations that they make now or that they will make in the future.

Using Science Principles comprises the following general types of performance expectations:

- Explain observations of phenomena (using science principles from the content statements).
- Predict observations of phenomena (using science principles from the content statements, including quantitative predictions based on science principles that specify quantitative relationships among variables).
- Suggest examples of observations that illustrate a science principle (e.g., identify examples where the net force on an object is zero; provide examples of observations explained by the movement of tectonic plates; given partial DNA sequences of organisms, identify likely sequences of close relatives).
- Propose, analyze, and evaluate alternative explanations or predictions.

The first two categories—***Identifying Science Principles*** and ***Using Science Principles***—both require students to correctly state or recognize the science principles contained in the content statements. A difference between the categories is that Using Science Principles focuses on what makes science knowledge valuable—that is, its usefulness in making accurate predictions about phenomena and in explaining observations of the natural world in coherent ways (i.e., "knowing why"). Distinguishing between these two categories draws attention to differences in depth and richness of individuals' knowledge of the content statements. Assuming a continuum from "just knowing the facts" to "using science principles," there is considerable overlap at the boundaries. The line between the Identifying and Using categories is not distinct.

Scientific Inquiry

Scientifically literate graduates make observations about the natural world, identify patterns in data, and propose explanations to account for the patterns. Scientific inquiry involves the collection of relevant data, the use of logical reasoning, and the application of imagination in devising hypotheses to explain patterns in data. Scientific inquiry is a complex and time-intensive process that is iterative rather than linear. Habits of mind—curiosity, openness to new ideas, informed skepticism—are part of scientific inquiry. This includes the ability to read or listen critically to assertions in the media, deciding what evidence to pay attention to and what to dismiss, and distinguishing careful arguments from shoddy ones. Thus, Scientific Inquiry depends on the practices described above—Identifying Science Principles and Using Science Principles.

Scientific Inquiry comprises the following general types of performance expectations:

- Generate new questions that can be investigated in the laboratory or field.
- Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.
- Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).
- Identify patterns in data and relate them to theoretical models.
- Describe a reason for a given conclusion using evidence from an investigation.
- Predict what would happen if the variables, methods, or timing of an investigation were changed.
- Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation.
- Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.
- Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.

Scientific inquiry is more complex than simply making, summarizing, and explaining observations, and it is more flexible than the rigid set of steps often referred to as the "scientific method." The *National Standards* makes it clear that inquiry goes beyond "science as a process" to include an understanding of the nature of science (p. 105).

It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists. Evaluation includes reviewing the experimental procedures, examining the evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations (p. 171).

When students engage in Scientific Inquiry, they are drawing on their understanding about the nature of science, including the following ideas (see Benchmarks for Science Literacy):

- Arguments are flawed when fact and opinion are intermingled or the conclusions do not follow logically from the evidence given.
- A single example can never support the inference that something is always true, but sometimes a single example can support the inference that something is not always true.
- If more than one variable changes at the same time in an experiment, the outcome of the experiment may not be clearly attributable to any one of the variables.
- The way in which a sample is drawn affects how well it represents the population of interest. The larger the sample, the smaller the error in inference to the population. But, large samples do not necessarily guarantee representation, especially in the absence of random sampling.

Students can demonstrate their abilities to engage in Scientific Inquiry in two ways: students can *do* the practices specified above, and students can *critique examples* of scientific inquiry. In *doing*, practices can include analyzing data tables and deciding which conclusions are consistent with the data. Other practices involve hands-on performance and/or interactive computer tasks—for example, where students collect data and present their results or where students specify experimental conditions on computer simulations and observe the outcomes. As to *critiquing*, students can identify flaws in a poorly designed investigation or suggest changes in the design in order to produce more reliable data. Students should also be able to critique print or electronic media—for example, items may ask students to suggest alternative interpretations of data described in a newspaper article.

Scientific Reflection and Social Implications

Scientifically literate people recognize the strengths and limitations of scientific knowledge, which will provide the perspective they need to use the information to solve real-world problems. Students must learn to decide who and what sources of information they can trust. They need to learn to critique and justify their own ideas and the ideas of others. Since knowledge comes from many sources, students need to appreciate the historical origins of modern science and the multitude of connections between science and other disciplines. Students need to understand how science and technology support one another and the political, economic, and environmental consequences of scientific and technological progress. Finally, it is important that the ideas and contributions of men and women from all cultures be recognized as having played a significant role in scientific communities.

Scientific Reflection and Social Implications include the following general types of practices, all of which entail students using science knowledge to:

- Critique whether or not specific questions can be answered through scientific investigations.
- Identify and critique arguments about personal or societal issues based on scientific evidence.
- Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.
- Evaluate scientific explanations in a peer review process or discussion format.
- Evaluate the future career and occupational prospects of science fields.
- Critique solutions to problems, given criteria and scientific constraints.
- Identify scientific tradeoffs in design decisions and choose among alternative solutions.
- Describe the distinctions between scientific theories, laws, hypotheses, and observations.
- Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.
- Apply science principles or scientific data to anticipate effects of technological design decisions.
- Analyze how science and society interact from a historical, political, economic, or social perspective.

Organization of the Expectations

The Science Expectations are organized into Disciplines, Standards, Content Statements, and specific Performance Expectations.

Disciplines

Earth Science, Biology, Physics, and Chemistry

Organization of Each Standard

Each standard includes three parts:

- A standard statement that describes what students who have mastered that standard will be able to do.
- Content statements that describe Prerequisite, Essential, Core, and Recommended science content understanding for that standard.
- Performance expectations that describe Prerequisite, Essential, Core, and Recommended performances for that standard.

NOTE: Boundary statements that clarify the standards and set limits for expected performances, technical vocabulary, and additional discipline-specific inquiry and reflection expectations will be included in a companion document.

Standard Statement

The Standard Statement describes how students who meet that standard will engage in Identifying, Using, Inquiry, or Reflection for that topic.

Content Statements

Content statements describe the Prerequisite, Essential, Core, and Recommended *knowledge* associated with the standard.

1. ***Prerequisite science content*** that all students should bring as a prerequisite to high school science classes. Prerequisite content statement codes include a "**p**" and are organized by topic [e.g., **E3.p1 Landforms and Soils *(prerequisite)***].
2. ***Essential science content*** that all high school graduates should master. Essential content and expectations are organized by topic (e.g., **E2.1 Earth Systems Overview**).
3. ***Core science content*** that high school graduates need for more advanced study in the discipline and for some kinds of work. Core content and expectations are organized by topic (e.g., **B2.2x Proteins)**; "**x**" designates a core topic).
4. ***Recommended science content*** that is desirable as preparation for more advanced study in the discipline, but is not required for credit. Content and expectations labeled as recommended represent extensions of the core. Recommended content statement codes include an "**r**" and an "**x**"; expectations include an "**r**" and a lower case letter (e.g., **P4.r9x Nature of Light**; **P4.r9a**).

NOTE: Basic mathematics and English language arts skills necessary for meeting the high school science content expectations will be included in a companion document.

Performance Expectations

Performance expectations are derived from the intersection of content statements and practices—if the content statements from the Earth Sciences, Biology, Physics, and Chemistry are the columns of a table and the practices (Identifying Science Principles, Using Science Principles, Using Scientific Inquiry, Reflection and Social Implications) are the rows, the cells of the table are inhabited by performance expectations.

Performance expectations are written with particular verbs indicating the desired performance expected of the student. The action verbs associated with each practice are contextualized to generate performance expectations. For example, when the "conduct scientific investigations" is crossed with a states-of-matter content statement, this can generate a performance expectation that employs a different action verb, "heats as a way to evaporate liquids."

Michigan High School Science

CHEMISTRY

Prerequisite, Essential, Core, and Recommended Content Statements and Expectations

CE • **RIGOR** • RELEVANCE • RELATIONSHIPS • RIGOR • RE
IPS • RELATIONSHIPS • RIGOR • **RELEVANCE** • RELAT
CE • RIGOR • RELEVANCE • RELATIONSHIPS • RIGOR • RE
IPS • **RELATIONSHIPS** • RIGOR • RELEVANCE • RELAT

MICHIGAN Department of Education
10/06

CHEMISTRY (C)

Properties of matter

All objects and substances in the natural world are composed of matter. All matter has two fundamental properties: matter takes up space, and matter has intertia – it changes motion only when under the influence of a non-zero net force. Matter can be characterized in terms of its physical and chemical properties. These properties can be explained through the particulate model of matter, which describes the particles as atoms or molecules that are continuously in motion. The extent of the motion can be used to explain the physical properties associated with the common states of matter, solid, liquid and gas, as well as the changes of state. Whether or not a particular substance will exist as a solid, liquid or a gas will depend on the force due to particle motion in comparison to the force of attraction between particles. The attractive forces between particles are explained by the detailed structure of molecules and the atoms that compose them.

The structure of an atom in terms of its component protons, neutrons and electrons provides the basis for a systematic description of the building blocks of matter and their organization in the Periodic Table of the Elements. The Periodic Table demonstrates the relationship between the number of protons in an element, which is the defining characteristic of each element, and the chemical and physical properties of the elements. The Periodic Table also provides a structure for inquiry into the characteristics of the elements, since the electronic structure of atoms is reflected in the arrangement of elements in the Periodic Table. It is the electronic structure of atoms, especially the outermost electrons, that explains the chemical properties of elements and the breaking and making of bonds between atoms in a chemical reaction. An understanding of the bonding between elements leads to the concept of molecules as particles with specific combinations of atoms. When a substance consists of only one type of molecule it is referred to as a compound, with each compound having unique chemical and physical pr operties due to the detailed structure of its component molecules.

Changes in matter

As a general principle, a great deal of understanding chemistry is in differentiating what Nobelist Roald Hoffmann deftly labeled as "the same and not the same." Chemistry is filled with comparisons that fall under this rubric. Isomerism, for instance, is built on this idea. Molecules have the same molecular formula, but have completely different properties (ethyl acetate and butyric acid). In photo- or thermal isomerization reactions, what constitutes the starting material and the product different on the basis of some observable property because here, too, the molecular formulas are the same. We create false dichotomies for the convenience of categorization (physical properties versus chemical properties, ionic versus covalent bonding), yet when you dissolve blue cobalt chloride in water, and the solution turns pick, it is hard to argue "dissolving is a simple act of physical change."

Are polymorphous crystalline forms that different? There are real property differences that we would traditionally include as "chemical" changes (spectroscopic differences, for instance). Is dissolving sodium chloride in water and then evaporating the water to get it back that different? Not really. Ionic networks or lattices are complex structures with billions and billions of degenerate isomeric forms. Add a sample of radio-labeled sodium chloride to a differently-labeled sample; crystallization accomplishes a cross-over experiment no matter how you look at it.

Changes in matter then, are not simple binary classifications, but derived from defining what is changing and the criteria by which those changes are judged, particularly those properties that are used to make the decision about what sort of change has taken place. A useful concept that helps sort through these relationships is "material kind," a term that us used when a substance is made up of a homogenous aggregate of atomic or molecular species (macroscopic "liquid water" is a "material kind," and differentiates it from the matter – molecular water: "HOH" – that comprises it). Solid water and liquid water are different material kinds, while the matter that makes them up is the same.

Forms of energy

From the chemical perspective it is critical that the student understand the role of energy in the breaking and formation of chemical bonds, since bond breaking/making is the fundamental process in a chemical reaction. Potential energy is stored energy resulting from the attraction between two objects. Students commonly only understand gravitational potential energy. Just as the force of gravity results in potential energy changes as objects are moved relative to the earth, there are changes

in potential energy when any particles held by a force (gravitational, electrical, magnetic, strong) are moved relative to each other. Chemical bonds are the result of a decrease in potential energy from the increased electrostatic attractions between atoms. Chemical bonds will not form unless there is a decrease in potential energy compared to the unbonded state. The strength of a chemical bond is directly proportional to the energy released when the bond forms from the separated gaseous atoms (ions). Breaking a chemical bond always requires energy to overcome the attractive forces holding the particle (ions, atoms, molecules) together. At grade 8 the student should be able to describe physical changes (changes of state, dissolving) in terms of rearranging the atoms, molecules or ions). At grade 12 the student should be able to describe chemical changes in terms of bond making and bond breaking to demonstrate a deeper understanding of the term "chemical potential energy".

Energy transformations

The transfer of energy and the conservation of energy are of great explanatory and predictive value. Left on their own all systems will naturally move to a state of minimum energy and maximum randomness. Application of these two driving forces coupled with the conservation of matter and energy will allow students to explain and predict most chemical phenomena. Students will understand the tremendous energy released in nuclear reactions is a result of small amounts of matter being converted to energy.

Chemistry Content Statement Outline

STANDARD C1 Inquiry, Reflection, and Social Implications

- C1.1 Scientific Inquiry
- C1.2 Scientific Reflection and Social Implications

STANDARD C2 Forms of Energy

- P2.p1 Potential Energy *(prerequisite)*
- C2.1x Chemical Potential Energy
- C2.2 Molecules in Motion
- C2.2x Molecular Entropy
- C2.3x Breaking Chemical Bonds
- C2.4x Electron Movement
- C2.5x Nuclear Stability

STANDARD C3 Energy Transfer and Conservation

- P3.p1 Conservation of Energy *(prerequisite)*
- C3.1x Hess's Law
- P3.p2 Energy Transfer *(prerequisite)*
- C3.2x Enthalpy
- C3.3 Heating Impacts
- C3.3x Bond Energy
- C3.4 Endothermic and Exothermic Reactions
- C3.4x Enthalpy and Entropy
- C3.5x Mass Defect

STANDARD C4 Properties of Matter

- P4.p1 Kinetic Molecular Theory *(prerequisite)*
- P4.p2 Elements, Compounds, and Mixtures *(prerequisite)*

STANDARD C4 Properties of Matter (cont.)

- C4.1x Molecular and Empirical Formulae
- C4.2 Nomenclature
- C4.3 Properties of Substances
- C4.3x Solids
- C4.4x Molecular Polarity
- C4.5x Ideal Gas Law
- C4.6x Moles
- C4.7x Solutions
- C4.8 Atomic Structure
- C4.8x Electron Configuration
- C4.9 Periodic Table
- C4.9x Electron Energy Levels
- C4.10 Neutral Atoms, Ions, and Isotopes
- C4.10x Average Atomic Mass

STANDARD C5 Changes in Matter

- P5.p1 Conservation of Matter *(prerequisite)*
- C5.r1x Rates of Reactions *(recommended)*
- C5.2 Chemical Changes
- C5.2x Balancing Equations
- C5.3x Equilibrium
- C5.4 Phase Change/Diagrams
- C5.4x Changes of State
- C5.5 Chemical Bonds — Trends
- C5.5x Chemical Bonds
- C5.6x Reduction/Oxidation Reactions
- C5.7 Acids and Bases
- C5.7x Brønsted-Lowry
- C5.8 Carbon Chemistry

STANDARD C1: INQUIRY, REFLECTION, AND SOCIAL IMPLICATIONS

Students will understand the nature of science and demonstrate an ability to practice scientific reasoning by applying it to the design, execution, and evaluation of scientific investigations. Students will demonstrate their understanding that scientific knowledge is gathered through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation. They will be able to distinguish between types of scientific knowledge (e.g., hypotheses, laws, theories) and become aware of areas of active research in contrast to conclusions that are part of established scientific consensus. They will use their scientific knowledge to assess the costs, risks, and benefits of technological systems as they make personal choices and participate in public policy decisions. These insights will help them analyze the role science plays in society, technology, and potential career opportunities.

C1.1 Scientific Inquiry

Science is a way of understanding nature. Scientific research may begin by generating new scientific questions that can be answered through replicable scientific investigations that are logically developed and conducted systematically. Scientific conclusions and explanations result from careful analysis of empirical evidence and the use of logical reasoning. Some questions in science are addressed through indirect rather than direct observation, evaluating the consistency of new evidence with results predicted by models of natural processes. Results from investigations are communicated in reports that are scrutinized through a peer review process.

C1.1A Generate new questions that can be investigated in the laboratory or field.

C1.1B Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.

C1.1C Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).

C1.1D Identify patterns in data and relate them to theoretical models.

C1.1E Describe a reason for a given conclusion using evidence from an investigation.

C1.1f Predict what would happen if the variables, methods, or timing of an investigation were changed.

C1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation

C1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.

C1.1i Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.

C1.2 Scientific Reflection and Social Implications

The integrity of the scientific process depends on scientists and citizens understanding and respecting the "Nature of Science." Openness to new ideas, skepticism, and honesty are attributes required for good scientific practice. Scientists must use logical reasoning during investigation design, analysis, conclusion, and communication. Science can produce critical insights on societal problems from a personal and local scale to a global scale. Science both aids in the development of technology and provides tools for assessing the costs, risks, and benefits of technological systems. Scientific conclusions and arguments play a role in personal choice and public policy decisions. New technology and scientific discoveries have had a major influence in shaping human history. Science and technology continue to offer diverse and significant career opportunities.

C1.2A Critique whether or not specific questions can be answered through scientific investigations.

C1.2B Identify and critique arguments about personal or societal issues based on scientific evidence.

C1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.

C1.2D Evaluate scientific explanations in a peer review process or discussion format.

C1.2E Evaluate the future career and occupational prospects of science fields.

C1.2f Critique solutions to problems, given criteria and scientific constraints.

C1.2g Identify scientific tradeoffs in design decisions and choose among alternative solutions.

C1.2h Describe the distinctions between scientific theories, laws, hypotheses, and observations.

C1.2i Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.

C1.2j Apply science principles or scientific data to anticipate effects of technological design decisions.

C1.2k Analyze how science and society interact from a historical, political, economic, or social perspective.

STANDARD C2: FORMS OF ENERGY

Students recognize the many forms of energy and understand that energy is central to predicting and explaining how and why chemical reactions occur. The chemical topics of bonding, gas behavior, kinetics, enthalpy, entropy, free energy, and nuclear stability are addressed in this standard.

Chemistry students relate temperature to the average kinetic energy of the molecules and use the kinetic molecular theory to describe and explain the behavior of gases and the rates of chemical reactions. They understand nuclear stability in terms of reaching a state of minimum potential energy.

P2.p1 Potential Energy *(prerequisite)*

Three forms of potential energy are gravitational, elastic, and chemical. Objects can have elastic potential energy due to their compression or chemical potential energy due to the arrangement of the atoms. *(prerequisite)*

P2.p1A Describe energy changes associated with changes of state in terms of the arrangement and order of the atoms (molecules) in each state. *(prerequisite)*

P2.p1B Use the positions and arrangements of atoms and molecules in solid, liquid, and gas state to explain the need for an input of energy for melting and boiling and a release of energy in condensation and freezing. *(prerequisite)*

C2.1x Chemical Potential Energy

Potential energy is stored whenever work must be done to change the distance between two objects. The attraction between the two objects may be gravitational, electrostatic, magnetic, or strong force. Chemical potential energy is the result of electrostatic attractions between atoms.

C2.1a Explain the changes in potential energy (due to electrostatic interactions) as a chemical bond forms and use this to explain why bond breaking always requires energy.

C2.1b Describe energy changes associated with chemical reactions in terms of bonds broken and formed (including intermolecular forces).

C2.1c Compare qualitatively the energy changes associated with melting various types of solids in terms of the types of forces between the particles in the solid.

C2.2 Molecules in Motion

Molecules that compose matter are in constant motion (translational, rotational, vibrational). Energy may be transferred from one object to another during collisions between molecules.

C2.2A Describe conduction in terms of molecules bumping into each other to transfer energy. Explain why there is better conduction in solids and liquids than gases.

C2.2B Describe the various states of matter in terms of the motion and arrangement of the molecules (atoms) making up the substance.

C2.2x Molecular Entropy

As temperature increases, the average kinetic energy and the entropy of the molecules in a sample increases.

C2.2c Explain changes in pressure, volume, and temperature for gases using the kinetic molecular model.

C2.2d Explain convection and the difference in transfer of thermal energy for solids, liquids, and gases using evidence that molecules are in constant motion.

C2.2e Compare the entropy of solids, liquids, and gases.

C2.2f Compare the average kinetic energy of the molecules in a metal object and a wood object at room temperature.

C2.3x Breaking Chemical Bonds

For molecules to react, they must collide with enough energy (activation energy) to break old chemical bonds before their atoms can be rearranged to form new substances.

C2.3a Explain how the rate of a given chemical reaction is dependent on the temperature and the activation energy.

C2.3b Draw and analyze a diagram to show the activation energy for an exothermic reaction that is very slow at room temperature.

C2.4x Electron Movement

For each element, the arrangement of electrons surrounding the nucleus is unique. These electrons are found in different energy levels and can only move from a lower energy level (closer to nucleus) to a higher energy level (farther from nucleus) by absorbing energy in discrete packets. The energy content of the packets is directly proportional to the frequency of the radiation. These electron transitions will produce unique absorption spectra for each element. When the electron returns from an excited (high energy state) to a lower energy state, energy is emitted in only certain wavelengths of light, producing an emission spectra.

C2.4a Describe energy changes in flame tests of common elements in terms of the (characteristic) electron transitions.

C2.4b Contrast the mechanism of energy changes and the appearance of absorption and emission spectra.

C2.4c Explain why an atom can absorb only certain wavelengths of light.

C2.4d Compare various wavelengths of light (visible and nonvisible) in terms of frequency and relative energy.

C2.5x Nuclear Stability

Nuclear stability is related to a decrease in potential energy when the nucleus forms from protons and neutrons. If the neutron/proton ratio is unstable, the element will undergo radioactive decay. The rate of decay is characteristic of each isotope; the time for half the parent nuclei to decay is called the half-life. Comparison of the parent/daughter nuclei can be used to determine the age of a sample. Heavier elements are formed from the fusion of lighter elements in the stars.

C2.5a Determine the age of materials using the ratio of stable and unstable isotopes of a particular type.

C2.r5b Illustrate how elements can change in nuclear reactions using balanced equations. *(recommended)*

C2.r5c Describe the potential energy changes as two protons approach each other. *(recommended)*

C2.r5d Describe how and where all the elements on earth were formed. *(recommended)*

STANDARD C3: ENERGY TRANSFER AND CONSERVATION

Students apply the First and Second Laws of Thermodynamics to explain and predict most chemical phenomena.

Chemistry students use the term enthalpy to describe the transfer of energy between reactants and products in simple calorimetry experiments performed in class and will recognize Hess's Law as an application of the conservation of energy.

Students understand the tremendous energy released in nuclear reactions is a result of small amounts of matter being converted to energy.

P3.p1 Conservation of Energy *(prerequisite)*

When energy is transferred from one system to another, the quantity of energy before transfer equals the quantity of energy after transfer. *(prerequisite)*

P3.p1A Explain that the amount of energy necessary to heat a substance will be the same as the amount of energy released when the substance is cooled to the original temperature. *(prerequisite)*

C3.1x Hess's Law

For chemical reactions where the state and amounts of reactants and products are known, the amount of energy transferred will be the same regardless of the chemical pathway. This relationship is called Hess's law.

C3.1a Calculate the ΔH for a given reaction using Hess's Law.

C3.1b Draw enthalpy diagrams for exothermic and endothermic reactions.

C3.1c Calculate the ΔH for a chemical reaction using simple coffee cup calorimetry.

C3.1d Calculate the amount of heat produced for a given mass of reactant from a balanced chemical equation.

P3.p2 Energy Transfer *(prerequisite)*

Nuclear reactions take place in the sun. In plants, light from the sun is transferred to oxygen and carbon compounds, which, in combination, have chemical potential energy (photosynthesis). *(prerequisite)*

P3.p2A Trace (or diagram) energy transfers involving various types of energy including nuclear, chemical, electrical, sound, and light. *(prerequisite)*

C3.2x Enthalpy

Chemical reactions involve breaking bonds in reactants (endothermic) and forming new bonds in the products (exothermic). The enthalpy change for a chemical reaction will depend on the relative strengths of the bonds in the reactants and products.

C3.2a Describe the energy changes in photosynthesis and in the combustion of sugar in terms of bond breaking and bond making.

C3.2b Describe the relative strength of single, double, and triple covalent bonds between nitrogen atoms.

C3.3 Heating Impacts

Heating increases the kinetic (translational, rotational, and vibrational) energy of the atoms composing elements and the molecules or ions composing compounds. As the kinetic (translational) energy of the atoms, molecules, or ions increases, the temperature of the matter increases. Heating a sample of a crystalline solid increases the kinetic (vibrational) energy of the atoms, molecules, or ions. When the kinetic (vibrational) energy becomes great enough, the crystalline structure breaks down, and the solid melts.

C3.3A Describe how heat is conducted in a solid.

C3.3B Describe melting on a molecular level.

C3.3x Bond Energy

Chemical bonds possess potential (vibrational and rotational) energy.

C3.3c Explain why it is necessary for a molecule to absorb energy in order to break a chemical bond.

C3.4 Endothermic and Exothermic Reactions

Chemical interactions either release energy to the environment (exothermic) or absorb energy from the environment (endothermic).

C3.4A Use the terms endothermic and exothermic correctly to describe chemical reactions in the laboratory.

C3.4B Explain why chemical reactions will either release or absorb energy.

C3.4x Enthalpy and Entropy

All chemical reactions involve rearrangement of the atoms. In an exothermic reaction, the products have less energy than the reactants. There are two natural driving forces: (1) toward minimum energy (enthalpy) and (2) toward maximum disorder (entropy).

C3.4c Write chemical equations including the heat term as a part of equation or using ΔH notation.

C3.4d Draw enthalpy diagrams for reactants and products in endothermic and exothermic reactions.

C3.4e Predict if a chemical reaction is spontaneous given the enthalpy (ΔH) and entropy (ΔS) changes for the reaction using Gibb's Free Energy, $\Delta G = \Delta H - T\Delta S$ (Note: mathematical computation of ΔG is not required.)

C3.4f Explain why some endothermic reactions are spontaneous at room temperature.

C3.4g Explain why gases are less soluble in warm water than cold water.

C3.5x Mass Defect

Nuclear reactions involve energy changes many times the magnitude of chemical changes. In chemical reactions matter is conserved, but in nuclear reactions a small loss in mass (mass defect) will account for the tremendous release of energy. The energy released in nuclear reactions can be calculated from the mass defect using $E = mc^2$.

C3.5a Explain why matter is not conserved in nuclear reactions.

STANDARD C4: PROPERTIES OF MATTER

Compounds, elements, and mixtures are categories used to organize matter. Students organize materials into these categories based on their chemical and physical behavior. Students understand the structure of the atom to make predictions about the physical and chemical properties of various elements and the types of compounds those elements will form. An understanding of the organization the Periodic Table in terms of the outer electron configuration is one of the most important tools for the chemist and student to use in prediction and explanation of the structure and behavior of atoms.

P4.p1 Kinetic Molecular Theory *(prerequisite)*

Properties of solids, liquids, and gases are explained by a model of matter that is composed of tiny particles in motion. *(prerequisite)*

P4.p1A For a substance that can exist in all three phases, describe the relative motion of the particles in each of the phases. *(prerequisite)*

P4.p1B For a substance that can exist in all three phases, make a drawing that shows the arrangement and relative spacing of the particles in each of the phases. *(prerequisite)*

P4.p1C For a simple compound, present a drawing that shows the number of particles in the system does not change as a result of a phase change. *(prerequisite)*

P4.p2 Elements, Compounds, and Mixtures *(prerequisite)*

Elements are a class of substances composed of a single kind of atom. Compounds are composed of two or more different elements chemically combined. Mixtures are composed of two or more different elements and/or compounds physically combined. Each element and compound has physical and chemical properties, such as boiling point, density, color, and conductivity, which are independent of the amount of the sample. *(prerequisite)*

P4.p2A Distinguish between an element, compound, or mixture based on drawings or formulae. *(prerequisite)*

P4.p2B Identify a pure substance (element or compound) based on unique chemical and physical properties. *(prerequisite)*

P4.p2C Separate mixtures based on the differences in physical properties of the individual components. *(prerequisite)*

P4.p2D Recognize that the properties of a compound differ from those of its individual elements. *(prerequisite)*

C4.1x Molecular and Empirical Formulae

Compounds have a fixed percent elemental composition. For a compound, the empirical formula can be calculated from the percent composition or the mass of each element. To determine the molecular formula from the empirical formula, the molar mass of the substance must also be known.

C4.1a Calculate the percent by weight of each element in a compound based on the compound formula.

C4.1b Calculate the empirical formula of a compound based on the percent by weight of each element in the compound.

C4.1c Use the empirical formula and molecular weight of a compound to determine the molecular formula.

C4.2 Nomenclature

All compounds have unique names that are determined systematically.

C4.2A Name simple binary compounds using their formulae.

C4.2B Given the name, write the formula of simple binary compounds.

C4.2x Nomenclature

All molecular and ionic compounds have unique names that are determined systematically.

C4.2c Given a formula, name the compound.

C4.2d Given the name, write the formula of ionic and molecular compounds.

C4.2e Given the formula for a simple hydrocarbon, draw and name the isomers.

C4.3 Properties of Substances

Differences in the physical and chemical properties of substances are explained by the arrangement of the atoms, ions, or molecules of the substances and by the strength of the forces of attraction between the atoms, ions, or molecules.

C4.3A Recognize that substances that are solid at room temperature have stronger attractive forces than liquids at room temperature, which have stronger attractive forces than gases at room temperature.

C4.3B Recognize that solids have a more ordered, regular arrangement of their particles than liquids and that liquids are more ordered than gases.

C4.3x Solids

Solids can be classified as metallic, ionic, covalent, or network covalent. These different types of solids have different properties that depend on the particles and forces found in the solid.

C4.3c Compare the relative strengths of forces between molecules based on the melting point and boiling point of the substances.

C4.3d Compare the strength of the forces of attraction between molecules of different elements. (For example, at room temperature, chlorine is a gas and iodine is a solid.)

C4.3e Predict whether the forces of attraction in a solid are primarily metallic, covalent, network covalent, or ionic based upon the elements' location on the periodic table.

C4.3f Identify the elements necessary for hydrogen bonding (N, O, F).

C4.3g Given the structural formula of a compound, indicate all the intermolecular forces present (dispersion, dipolar, hydrogen bonding).

C4.3h Explain properties of various solids such as malleability, conductivity, and melting point in terms of the solid's structure and bonding.

C4.3i Explain why ionic solids have higher melting points than covalent solids. (For example, NaF has a melting point of 995°C, while water has a melting point of 0° C.)

C4.4x Molecular Polarity

The forces between molecules depend on the net polarity of the molecule as determined by shape of the molecule and the polarity of the bonds.

C4.4a Explain why at room temperature different compounds can exist in different phases.

C4.4b Identify if a molecule is polar or nonpolar given a structural formula for the compound.

C4.5x Ideal Gas Law

The forces in gases are explained by the ideal gas law.

C4.5a Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the pressure-volume relationship in gases.

C4.5b Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the pressure-temperature relationship in gases.

C4.5c Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the temperature-volume relationship in gases.

C4.6x Moles

The mole is the standard unit for counting atomic and molecular particles in terms of common mass units.

C4.6a Calculate the number of moles of any compound or element given the mass of the substance.

C4.6b Calculate the number of particles of any compound or element given the mass of the substance.

C4.7x Solutions

The physical properties of a solution are determined by the concentration of solute.

C4.7a Investigate the difference in the boiling point or freezing point of pure water and a salt solution.

C4.7b Compare the density of pure water to that of a sugar solution.

C4.8 Atomic Structure

Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons.

C4.8A Identify the location, relative mass, and charge for electrons, protons, and neutrons.

C4.8B Describe the atom as mostly empty space with an extremely small, dense nucleus consisting of the protons and neutrons and an electron cloud surrounding the nucleus.

C4.8C Recognize that protons repel each other and that a strong force needs to be present to keep the nucleus intact.

C4.8D Give the number of electrons and protons present if the fluoride ion has a -1 charge.

C4.8x Electron Configuration

Electrons are arranged in main energy levels with sublevels that specify particular shapes and geometry. Orbitals represent a region of space in which an electron may be found with a high level of probability. Each defined orbital can hold two electrons, each with a specific spin orientation. The specific assignment of an electron to an orbital is determined by a set of 4 quantum numbers. Each element and, therefore, each position in the periodic table is defined by a unique set of quantum numbers.

C4.8e Write the complete electron configuration of elements in the first four rows of the periodic table.

C4.8f Write kernel structures for main group elements.

C4.8g Predict oxidation states and bonding capacity for main group elements using their electron structure.

C4.8h Describe the shape and orientation of s and p orbitals.

C4.8i Describe the fact that the electron location cannot be exactly determined at any given time.

C4.9 Periodic Table

In the periodic table, elements are arranged in order of increasing number of protons (called the atomic number). Vertical groups in the periodic table (families) have similar physical and chemical properties due to the same outer electron structures.

C4.9A Identify elements with similar chemical and physical properties using the periodic table.

C4.9x Electron Energy Levels

The rows in the periodic table represent the main electron energy levels of the atom. Within each main energy level are sublevels that represent an orbital shape and orientation.

C4.9b Identify metals, non-metals, and metalloids using the periodic table.

C4.9c Predict general trends in atomic radius, first ionization energy, and electonegativity of the elements using the periodic table.

C4.10 Neutral Atoms, Ions, and Isotopes

A neutral atom of any element will contain the same number of protons and electrons. Ions are charged particles with an unequal number of protons and electrons. Isotopes are atoms of the same element with different numbers of neutrons and essentially the same chemical and physical properties.

C4.10A List the number of protons, neutrons, and electrons for any given ion or isotope.

C4.10B Recognize that an element always contains the same number of protons.

C4.10x Average Atomic Mass

The atomic mass listed on the periodic table is an average mass for all the different isotopes that exist, taking into account the percent and mass of each different isotope.

C4.10c Calculate the average atomic mass of an element given the percent abundance and mass of the individual isotopes.

C4.10d Predict which isotope will have the greatest abundance given the possible isotopes for an element and the average atomic mass in the periodic table.

C4.10e Write the symbol for an isotope, ${}^{A}_{Z}X$, where Z is the atomic number, A is the mass number, and X is the symbol for the element.

STANDARD C5: CHANGES IN MATTER

Students will analyze a chemical change phenomenon from the point of view of what is the same and what is not the same.

P5.p1 Conservation of Matter *(prerequisite)*

Changes of state are explained by a model of matter composed of tiny particles that are in motion. When substances undergo changes of state, neither atoms nor molecules themselves are changed in structure. Mass is conserved when substances undergo changes of state. *(prerequisite)*

P5.p1A Draw a picture of the particles of an element or compound as a solid, liquid, and gas. *(prerequisite)*

C5.r1x Rates of Reactions *(recommended)*

The rate of a chemical reaction will depend upon (1) concentration of reacting species, (2) temperature of reaction, (3) pressure if reactants are gases, and (4) nature of the reactants. A model of matter composed of tiny particles that are in constant motion is used to explain rates of chemical reactions. *(recommended)*

C5.r1a Predict how the rate of a chemical reaction will be influenced by changes in concentration, and temperature, pressure. *(recommended)*

C5.r1b Explain how the rate of a reaction will depend on concentration, temperature, pressure, and nature of reactant. *(recommended)*

C5.2 Chemical Changes

Chemical changes can occur when two substances, elements, or compounds interact and produce one or more different substances whose physical and chemical properties are different from the interacting substances. When substances undergo chemical change, the number of atoms in the reactants is the same as the number of atoms in the products. This can be shown through simple balancing of chemical equations. Mass is conserved when substances undergo chemical change. The total mass of the interacting substances (reactants) is the same as the total mass of the substances produced (products).

C5.2A Balance simple chemical equations applying the conservation of matter.

C5.2B Distinguish between chemical and physical changes in terms of the properties of the reactants and products.

C5.2C Draw pictures to distinguish the relationships between atoms in physical and chemical changes.

C5.2x Balancing Equations

A balanced chemical equation will allow one to predict the amount of product formed.

C5.2d Calculate the mass of a particular compound formed from the masses of starting materials.

C5.2e Identify the limiting reagent when given the masses of more than one reactant.

C5.2f Predict volumes of product gases using initial volumes of gases at the same temperature and pressure.

C5.2g Calculate the number of atoms present in a given mass of element.

C5.3x Equilibrium

Most chemical reactions reach a state of dynamic equilibrium where the rates of the forward and reverse reactions are equal.

C5.3a Describe equilibrium shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).

C5.3b Predict shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).

C5.3c Predict the extent reactants are converted to products using the value of the equilibrium constant.

C5.4 Phase Change/Diagrams

Changes of state require a transfer of energy. Water has unusually high-energy changes associated with its changes of state.

C5.4A Compare the energy required to raise the temperature of one gram of aluminum and one gram of water the same number of degrees.

C5.4B Measure, plot, and interpret the graph of the temperature versus time of an ice-water mixture, under slow heating, through melting and boiling.

C5.4x Changes of State

All changes of state require energy. Changes in state that require energy involve breaking forces holding the particles together. The amount of energy will depend on the type of forces.

C5.4c Explain why both the melting point and boiling points for water are significantly higher than other small molecules of comparable mass (e.g., ammonia and methane).

C5.4d Explain why freezing is an exothermic change of state.

C5.4e Compare the melting point of covalent compounds based on the strength of IMFs (intermolecular forces).

C5.5 Chemical Bonds — Trends

An atom's electron configuration, particularly of the outermost electrons, determines how the atom can interact with other atoms. The interactions between atoms that hold them together in molecules or between oppositely charged ions are called chemical bonds.

C5.5A Predict if the bonding between two atoms of different elements will be primarily ionic or covalent.

C5.4B Predict the formula for binary compounds of main group elements.

C5.5x Chemical Bonds

Chemical bonds can be classified as ionic, covalent, and metallic. The properties of a compound depend on the types of bonds holding the atoms together.

C5.5c Draw Lewis structures for simple compounds.

C5.5d Compare the relative melting point, electrical and thermal conductivity and hardness for ionic, metallic, and covalent compounds.

C5.5e Relate the melting point, hardness, and electrical and thermal conductivity of a substance to its structure.

C5.6x Reduction/Oxidation Reactions

Chemical reactions are classified according to the fundamental molecular or submolecular changes that occur. Reactions that involve electron transfer are known as oxidation/reduction (or "redox").

C5.6a Balance half-reactions and describe them as oxidations or reductions.

C5.6b Predict single replacement reactions.

C5.6c Explain oxidation occurring when two different metals are in contact.

C5.6d Calculate the voltage for spontaneous redox reactions from the standard reduction potentials.

C5.6e Identify the reactions occurring at the anode and cathode in an electrochemical cell.

C5.7 Acids and Bases

Acids and bases are important classes of chemicals that are recognized by easily observed properties in the laboratory. Acids and bases will neutralize each other. Acid formulas usually begin with hydrogen, and base formulas are a metal with a hydroxide ion. As the pH decreases, a solution becomes more acidic. A difference of one pH unit is a factor of 10 in hydrogen ion concentration.

C5.7A Recognize formulas for common inorganic acids, carboxylic acids, and bases formed from families I and II.

C5.7B Predict products of an acid-base neutralization.

C5.7C Describe tests that can be used to distinguish an acid from a base.

C5.7D Classify various solutions as acidic or basic, given their pH.

C5.7E Explain why lakes with limestone or calcium carbonate experience less adverse effects from acid rain than lakes with granite beds.

C5.7x Brønsted-Lowry

Chemical reactions are classified according to the fundamental molecular or submolecular changes that occur. Reactions that involve proton transfer are known as acid/base reactions.

C5.7f Write balanced chemical equations for reactions between acids and bases and perform calculations with balanced equations.

C5.7g Calculate the pH from the hydronium ion or hydroxide ion concentration.

C5.7h Explain why sulfur oxides and nitrogen oxides contribute to acid rain.

C5.r7i Identify the Brønsted-Lowry conjugate acid-base pairs in an equation. *(recommended)*

C5.8 Carbon Chemistry

The chemistry of carbon is important. Carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures, including synthetic polymers, oils, and the large molecules essential to life.

C5.8A Draw structural formulas for up to ten carbon chains of simple hydrocarbons.

C5.8B Draw isomers for simple hydrocarbons.

C5.8C Recognize that proteins, starches, and other large biological molecules are polymers.

NOTES

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High School Content Expectations




SCIENCE

- **Earth Science**
- Biology
- Physics
- Chemistry

NCE • **RIGOR** • RELEVANCE • RELATIONSHIPS • RIGOR • RELEVA
HIPS • RELATIONSHIPS • RIGOR • **RELEVANCE** • RELATIONS
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Welcome to Michigan's High School Science Content Standards and Expectations

Why Develop Content Standards and Expectations for High School?

To prepare Michigan's students with the knowledge and skills to succeed in the 21st Century, the State of Michigan has enacted a rigorous new set of statewide graduation requirements that are among the best in the nation. These requirements, called the Michigan Merit Curriculum, are the result of a collaborative effort between Governor Jennifer M. Granholm, the State Board of Education, and the State Legislature.

In preparation for the implementation of the new high school graduation requirements, the Michigan Department of Education's Office of School Improvement is leading the development of high school content expectations. An Academic Work Group of science experts chaired by nationally known scholars was commissioned to conduct a scholarly review and identify content standards and expectations. The Michigan Department of Education conducted an extensive field review of the expectations by high school, university, and business and industry representatives.

The Michigan High School Science Content Expectations (Science HSCE) establish what every student is expected to know and be able to do by the end of high school and define the expectations for high school science credit in Earth Science, Biology, Physics, and Chemistry.

An Overview

In developing these expectations, the Academic Work Group depended heavily on the *Science Framework for the 2009 National Assessment of Educational Progress* (National Assessment Governing Board, 2006). In particular, the group adapted the structure of the NAEP framework, including Content Statements and Performance Expectations. These expectations align closely with the NAEP framework, which is based on *Benchmarks for Science Literacy* (AAAS Project 2061, 1993) and the *National Science Education Standards* (National Research Council, 1996).

The Academic Work Group carefully analyzed other documents, including the Michigan Curriculum Framework Science Benchmarks (2000 revision), the Standards for Success report *Understanding University Success*, ACT's *College Readiness Standards*, College Board's *AP Biology, AP Physics, AP Chemistry,* and *AP Environmental Science Course Descriptions*, ACT's *On Course for Success*, South Regional Education Board's *Getting Ready for College-Preparatory/Honors Science: What Middle Grades Students Need to Know and Be Able to Do,* and standards documents from other states.

Earth Science	Biology	Physics	Chemistry
STANDARDS *(and number of content statements in each standard)*			
E1 Inquiry, Reflection, and Social Implications (2) E2 Earth Systems (4) E3 The Solid Earth (4) E4 The Fluid Earth (3) E5 Earth in Space and Time (4)	B1 Inquiry, Reflection, and Social Implications (2) B2 Organization and Development of Living Systems (6) B3 Interdependence of Living Systems and the Environment (5) B4 Genetics (4) B5 Evolution and Biodiversity (3)	P1 Inquiry, Reflection, and Social Implications (2) P2 Motion of Objects (3) P3 Forces and Motion (8) P4 Forms of Energy and Energy Transformations (12)	C1 Inquiry, Reflection, and Social Implications (2) C2 Forms of Energy (5) C3 Energy Transfer and Conservation (5) C4 Properties of Matter (10) C5 Changes in Matter (7)

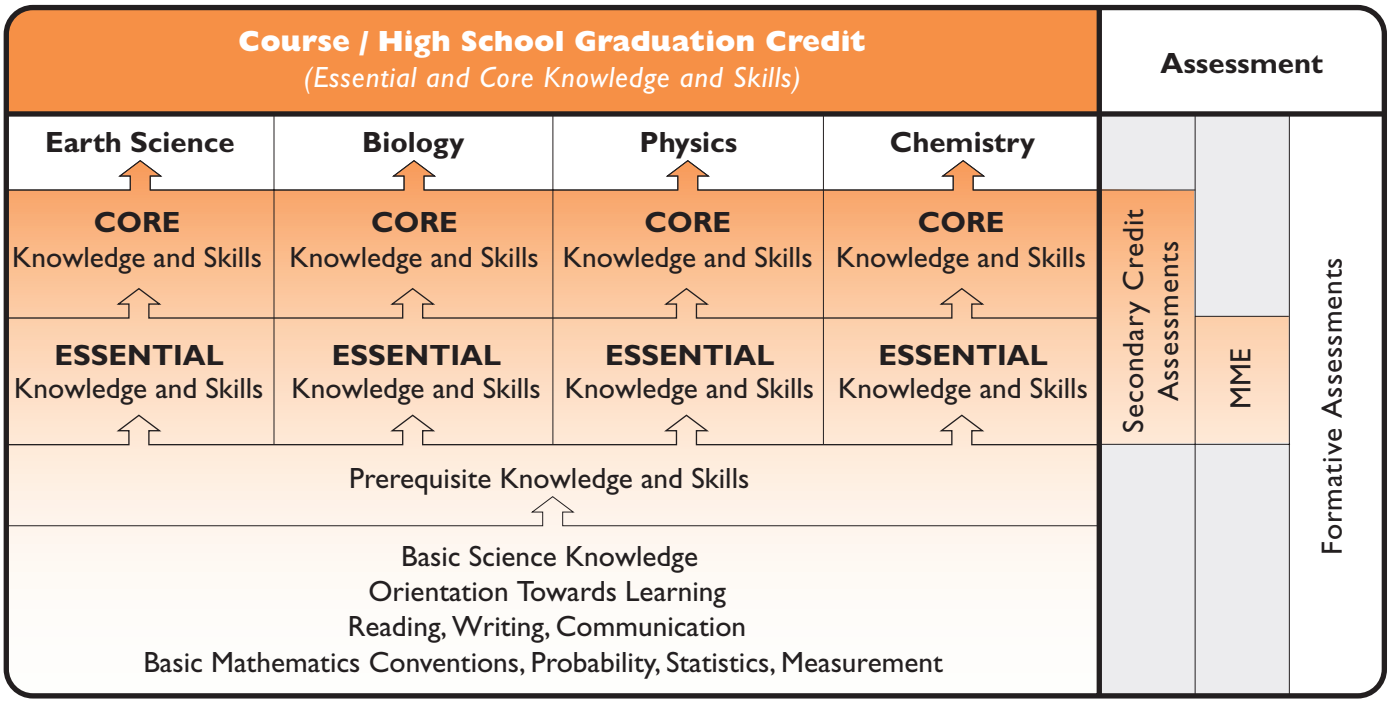
Useful and Connected Knowledge for All Students

This document defines expectations for Michigan High School graduates, organized by discipline: Earth Science, Biology, Physics, and Chemistry. It defines ***useful*** and ***connected knowledge*** at four levels:

- **Prerequisite knowledge**
  Useful and connected knowledge that all students should bring as a prerequisite to high school science classes. Prerequisite expectation codes include a "**p**" and an upper case letter (e.g., **E3.p1A**). Prerequisite content could be assessed through formative and/or large scale assessments.
- **Essential knowledge**
  Useful and connected knowledge for all high school graduates, regardless of what courses they take in high school. Essential expectation codes include an upper case letter (e.g., **E2.1A**). Essential content knowledge and performance expectations are required for graduation and are assessable on the Michigan Merit Exam (MME) and on future secondary assessments. Essential knowledge can also be assessed with formative assessments.
- **Core knowledge**
  Useful and connected knowledge for all high school graduates who have completed a discipline-specific course. In general core knowledge includes content and expectations that students need to be prepared for more advanced study in that discipline. Core content statement codes include an "x" and core expectation codes include a lower case letter (e.g., **B2.2x** Proteins; **B2.2f**) to indicate that they are NOT assessable on existing large-scale assessments (MME, NAEP), but will be assessed on future secondary credit assessments. Core knowledge can also be assessed with formative assessments.
- **Recommended knowledge**
  Useful and connected knowledge that is desirable as preparation for more advanced study in the discipline, but not required for graduation credit. Content and expectations labeled as recommended represent extensions of the core. Recommended content statement codes include an "**r**" and an "**x**"; recommended expectations include an "**r**" and a lower case letter (e.g., **P4.r9x Nature of Light**; **P4.r9a**). They will not be assessed on either the MME or secondary credit assessments.

Useful and connected knowledge is contrasted with ***procedural display***—learning to manipulate words and symbols without fully understanding their meaning. When expectations are excessive, procedural display is the kind of learning that takes place. Teachers and students "cover the content" instead of "uncovering" useful and connected knowledge.

Credit for high school Earth Science, Biology, Physics, and Chemistry will be defined as meeting both essential and core subject area content expectations. Credit requirements are outlined in separate Michigan Merit Curriculum Course/Credit Requirement documents.



Preparing Students for Successful Post-Secondary Engagement

Students who have useful and connected knowledge should be able to apply knowledge in new situations; to solve problems by generating new ideas; to make connections among what they read and hear in class, the world around them, and the future; and through their work, to develop leadership qualities while still in high school. In particular, high school graduates with useful and connected knowledge are able to engage in four key practices of science literacy.

Successful Post-Secondary Engagement

Practices of Science Literacy

Communicate accurately and effectively...

Identifying Science Principles

- Describe, measure, or classify observations.
- State or recognize correct science principles.
- Demonstrate relationships among closely related science principles.
- Demonstrate relationships among different representations of principles.

Using Science Principles

- Explain observations of phenomena.
- Predict observations of phenomena.
- Suggest examples of observations that illustrate a science principle.
- Propose, analyze, and evaluate alternative explanations or predictions.

Scientific Inquiry

- Generate new questions that can be investigated in the laboratory or field.
- Critique aspects of scientific investigations.
- Conduct scientific investigations using appropriate tools and techniques.
- Identify patterns in data: relate patterns to theoretical models.
- Describe a reason for a given conclusion using evidence from an investigation.
- Explain how scientific evidence supports or refutes claims or explanations of phenomena.
- Design and conduct a scientific investigation with a hypothesis, several controlled variables, and one manipulated variable. Gather data and organized the results in graphs, tables, and/or charts.

Reflection and Social Implications

- Critique whether questions can be answered through scientific investigations.
- Identify and critique arguments based on scientific evidence.
- Use appropriate scientific knowledge in social arguments, recognizing their limitations.
- Gather, synthesize, and evaluate information from multiple sources.
- Discuss scientific topics in groups, make presentations summarize what others have said, ask for clarification, take alternative perspectives, and defend a position.
- Evaluate the future career and occupational prospects of science fields.
- Explain why a claim or a conclusion is flawed.
- Critique solutions to problems, given criteria and scientific constraints.
- Identify scientific tradeoffs in design decisions and choose among alternative solutions.
- Apply science principles or scientific data to anticipate effects of technological design decisions.

State / National Landscape

- Expert perspective
- Education reform environment
- Research-based practices
- Work force requirements

State / Federal Expectations

- No Child Left Behind (NCLB)
- National Governors' Association (NGA)
- Legislation/Policy

Michigan High School Science Content Standards and Expectations

Earth Science

Biology

Physics

Chemistry

Models for District Alignment / Mapping

- District curriculum documents
- Documents from other districts/states
- Backmapping to standards and expectations

Other MI Documents / Programs

- State Standards – teaching and learning, content (all areas), assessment
- Grade Level Content Expectations
- State Assessments
- Career/Technical Education Department of Labor and Economic Growth

K-8 Educational Experience

Content Knowledge

- English Language Arts
- Mathematics
- Science
- Social Studies
- Other

Learning Processes

- Strategies & Skills
- Reasoning
- Analytical Thinking
- Constructing New Meaning
- Communication

This chart includes talking points for professional development.

Practices of Science Literacy

- **Identifying**
  Identifying performances generally have to do with stating models, theories, and patterns inside the triangle in Figure 1.
- **Using**
  Using performances generally have to do with the downward arrow in Figure 1—using scientific models and patterns to explain or describe specific observations.
- **Inquiry**
  Inquiry performances generally have to do with the upward arrow in Figure 1—finding and explaining patterns in data.
- **Reflection and Social Implications**
  Reflecting and Social Implications performances generally have to do with the figure as a whole (reflecting) or the downward arrow (technology as the application of models and theories to practical problems).

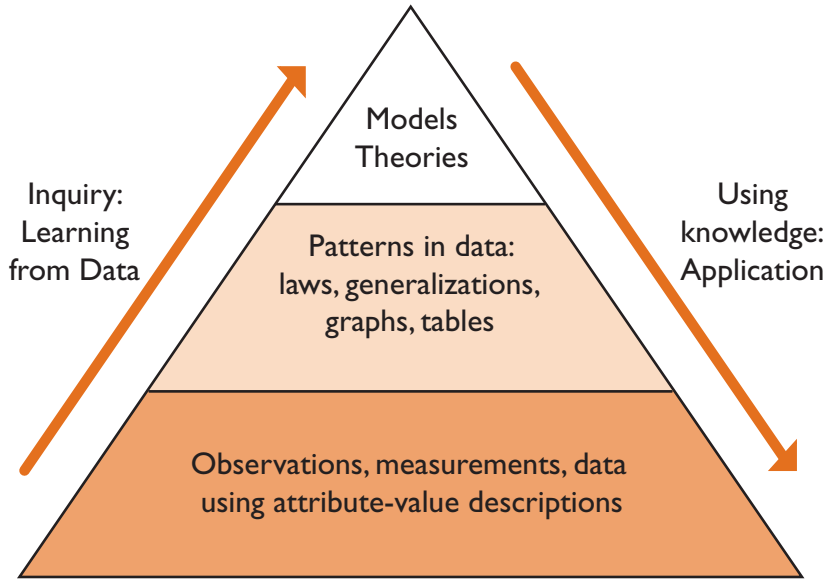


Figure 1: Knowledge and practices of model-based reasoning

Identifying Science Principles

This category focuses on students' abilities to recall, define, relate, and represent basic science principles. The content statements themselves are often closely related to one another conceptually. Moreover, the science principles included in the content statements can be represented in a variety of forms, such as words, pictures, graphs, tables, formulas, and diagrams (AAAS, 1993; NRC, 1996). Identifying practices include describing, measuring, or classifying observations; stating or recognizing principles included in the content statements; connecting closely related content statements; and relating different representations of science knowledge.

Identifying Science Principles comprises the following general types of practices:

- Describe, measure, or classify observations (e.g., describe the position and motion of objects, measure temperature, classify relationships between organisms as being predator/prey, parasite/host, producer/consumer).
- State or recognize correct science principles (e.g., mass is conserved when substances undergo changes of state; all organisms are composed of cells; the atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor).
- Demonstrate relationships among closely related science principles (e.g., statements of Newton's three laws of motion, energy transfer and the water cycle).
- Demonstrate relationships among different representations of principles (e.g., verbal, symbolic, diagrammatic) and data patterns (e.g., tables, equations, graphs).

Identifying Science Principles is integral to all of the other science practices.

Using Science Principles

Scientific knowledge is useful for making sense of the natural world. Both scientists and informed citizens can use patterns in observations and theoretical models to predict and explain observations that they make now or that they will make in the future.

Using Science Principles comprises the following general types of performance expectations:

- Explain observations of phenomena (using science principles from the content statements).
- Predict observations of phenomena (using science principles from the content statements, including quantitative predictions based on science principles that specify quantitative relationships among variables).
- Suggest examples of observations that illustrate a science principle (e.g., identify examples where the net force on an object is zero; provide examples of observations explained by the movement of tectonic plates; given partial DNA sequences of organisms, identify likely sequences of close relatives).
- Propose, analyze, and evaluate alternative explanations or predictions.

The first two categories—***Identifying Science Principles*** and ***Using Science Principles***—both require students to correctly state or recognize the science principles contained in the content statements. A difference between the categories is that Using Science Principles focuses on what makes science knowledge valuable—that is, its usefulness in making accurate predictions about phenomena and in explaining observations of the natural world in coherent ways (i.e., "knowing why"). Distinguishing between these two categories draws attention to differences in depth and richness of individuals' knowledge of the content statements. Assuming a continuum from "just knowing the facts" to "using science principles," there is considerable overlap at the boundaries. The line between the Identifying and Using categories is not distinct.

Scientific Inquiry

Scientifically literate graduates make observations about the natural world, identify patterns in data, and propose explanations to account for the patterns. Scientific inquiry involves the collection of relevant data, the use of logical reasoning, and the application of imagination in devising hypotheses to explain patterns in data. Scientific inquiry is a complex and time-intensive process that is iterative rather than linear. Habits of mind—curiosity, openness to new ideas, informed skepticism—are part of scientific inquiry. This includes the ability to read or listen critically to assertions in the media, deciding what evidence to pay attention to and what to dismiss, and distinguishing careful arguments from shoddy ones. Thus, Scientific Inquiry depends on the practices described above—Identifying Science Principles and Using Science Principles.

Scientific Inquiry comprises the following general types of performance expectations:

- Generate new questions that can be investigated in the laboratory or field.
- Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.
- Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).
- Identify patterns in data and relate them to theoretical models.
- Describe a reason for a given conclusion using evidence from an investigation.
- Predict what would happen if the variables, methods, or timing of an investigation were changed.
- Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation.
- Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.
- Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.

Scientific inquiry is more complex than simply making, summarizing, and explaining observations, and it is more flexible than the rigid set of steps often referred to as the "scientific method." The *National Standards* makes it clear that inquiry goes beyond "science as a process" to include an understanding of the nature of science (p. 105).

It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists. Evaluation includes reviewing the experimental procedures, examining the evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations (p. 171).

When students engage in Scientific Inquiry, they are drawing on their understanding about the nature of science, including the following ideas (see Benchmarks for Science Literacy):

- Arguments are flawed when fact and opinion are intermingled or the conclusions do not follow logically from the evidence given.
- A single example can never support the inference that something is always true, but sometimes a single example can support the inference that something is not always true.
- If more than one variable changes at the same time in an experiment, the outcome of the experiment may not be clearly attributable to any one of the variables.
- The way in which a sample is drawn affects how well it represents the population of interest. The larger the sample, the smaller the error in inference to the population. But, large samples do not necessarily guarantee representation, especially in the absence of random sampling.

Students can demonstrate their abilities to engage in Scientific Inquiry in two ways: students can *do* the practices specified above, and students can *critique examples* of scientific inquiry. In *doing*, practices can include analyzing data tables and deciding which conclusions are consistent with the data. Other practices involve hands-on performance and/or interactive computer tasks—for example, where students collect data and present their results or where students specify experimental conditions on computer simulations and observe the outcomes. As to *critiquing*, students can identify flaws in a poorly designed investigation or suggest changes in the design in order to produce more reliable data. Students should also be able to critique print or electronic media—for example, items may ask students to suggest alternative interpretations of data described in a newspaper article.

Scientific Reflection and Social Implications

Scientifically literate people recognize the strengths and limitations of scientific knowledge, which will provide the perspective they need to use the information to solve real-world problems. Students must learn to decide who and what sources of information they can trust. They need to learn to critique and justify their own ideas and the ideas of others. Since knowledge comes from many sources, students need to appreciate the historical origins of modern science and the multitude of connections between science and other disciplines. Students need to understand how science and technology support one another and the political, economic, and environmental consequences of scientific and technological progress. Finally, it is important that the ideas and contributions of men and women from all cultures be recognized as having played a significant role in scientific communities.

Scientific Reflection and Social Implications include the following general types of practices, all of which entail students using science knowledge to:

- Critique whether or not specific questions can be answered through scientific investigations.
- Identify and critique arguments about personal or societal issues based on scientific evidence.
- Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.
- Evaluate scientific explanations in a peer review process or discussion format.
- Evaluate the future career and occupational prospects of science fields.
- Critique solutions to problems, given criteria and scientific constraints.
- Identify scientific tradeoffs in design decisions and choose among alternative solutions.
- Describe the distinctions between scientific theories, laws, hypotheses, and observations.
- Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.
- Apply science principles or scientific data to anticipate effects of technological design decisions.
- Analyze how science and society interact from a historical, political, economic, or social perspective.

Organization of the Expectations

The Science Expectations are organized into Disciplines, Standards, Content Statements, and specific Performance Expectations.

Disciplines

Earth Science, Biology, Physics, and Chemistry

Organization of Each Standard

Each standard includes three parts:

- A standard statement that describes what students who have mastered that standard will be able to do.
- Content statements that describe Prerequisite, Essential, Core, and Recommended science content understanding for that standard.
- Performance expectations that describe Prerequisite, Essential, Core, and Recommended performances for that standard.

NOTE: Boundary statements that clarify the standards and set limits for expected performances, technical vocabulary, and additional discipline-specific inquiry and reflection expectations will be included in a companion document.

Standard Statement

The Standard Statement describes how students who meet that standard will engage in Identifying, Using, Inquiry, or Reflection for that topic.

Content Statements

Content statements describe the Prerequisite, Essential, Core, and Recommended *knowledge* associated with the standard.

1. ***Prerequisite science content*** that all students should bring as a prerequisite to high school science classes. Prerequisite content statement codes include a "**p**" and are organized by topic [e.g., **E3.p1 Landforms and Soils *(prerequisite)***].
2. ***Essential science content*** that all high school graduates should master. Essential content and expectations are organized by topic (e.g., **E2.1 Earth Systems Overview**).
3. ***Core science content*** that high school graduates need for more advanced study in the discipline and for some kinds of work. Core content and expectations are organized by topic (e.g., **B2.2x Proteins)**; "**x**" designates a core topic).
4. ***Recommended science content*** that is desirable as preparation for more advanced study in the discipline, but is not required for credit. Content and expectations labeled as recommended represent extensions of the core. Recommended content statement codes include an "**r**" and an "**x**"; expectations include an "**r**" and a lower case letter (e.g., **P4.r9x Nature of Light**; **P4.r9a**).

NOTE: Basic mathematics and English language arts skills necessary for meeting the high school science content expectations will be included in a companion document.

Performance Expectations

Performance expectations are derived from the intersection of content statements and practices—if the content statements from the Earth Sciences, Biology, Physics, and Chemistry are the columns of a table and the practices (Identifying Science Principles, Using Science Principles, Using Scientific Inquiry, Reflection and Social Implications) are the rows, the cells of the table are inhabited by performance expectations.

Performance expectations are written with particular verbs indicating the desired performance expected of the student. The action verbs associated with each practice are contextualized to generate performance expectations. For example, when the "conduct scientific investigations" is crossed with a states-of-matter content statement, this can generate a performance expectation that employs a different action verb, "heats as a way to evaporate liquids."

Michigan High School Science

EARTH SCIENCE

Prerequisite, Essential, Core, and Recommended Content Statements and Expectations

CE • **RIGOR** • RELEVANCE • RELATIONSHIPS • RIGOR • RE
IPS • RELATIONSHIPS • RIGOR • **RELEVANCE** • RELAT
CE • RIGOR • RELEVANCE • RELATIONSHIPS • RIGOR • RE
IPS • **RELATIONSHIPS** • RIGOR • RELEVANCE • RELAT

MICHIGAN Department of Education
10/06

EARTH SCIENCE (E)

In recent years, the study of Earth has undergone profound changes. It has expanded from surface geology and the recovery of economic resources toward global change and Earth systems. Concurrently, research methods have changed from solely using human observations and mapping, to using remote sensing and computer modeling. The advent of technology has made it possible to conduct more integrated and interdisciplinary research to view the Earth as a single dynamic entity composed of four interacting systems.

The Earth system is usually subdivided into the geosphere (solid Earth), the hydrosphere (the liquid part of the planet), the atmosphere (the gaseous part of the planet), and the biosphere (the living part of the planet). These four parts do not exist in isolation, but are interconnected by complex cycles. Alterations to one part of the Earth system result in effects on another part of the system. The study of the individual components and their interactions are necessary to completely understand the complex dynamics of our planet.

There has also been a shift in goals, as advances in theory have made it possible to more accurately predict changes (especially in weather and climate), to provide life-saving warnings of floods, hurricanes, and volcanic eruptions, and to understand how human activities influence air and water quality, ecosystems, and climate across the globe. We are also better prepared to understand the processes that occur within and between each of the Earth systems.

Recent research in the Earth sciences has focused on:

1. climate variability and change
2. impact of elements and compounds on ecosystems
3. water and energy cycles
4. atmospheric processes
5. earth surface and internal processes.

National education standards have moved to mirror these foci, requiring that students explore the methods and tools for studying Earth systems. In addition, public awareness and education is critical in mitigating the effects of natural hazards as economic and population growth expand in areas most susceptible to the effects of nature (e.g., Florida, Texas, California). Events such as hurricanes and tsunamis demonstrate the significant impacts of the Earth on society. Some of the decisions students will need to consider include, where to live, where to store waste, and where to develop.

Many topics and questions of Earth science lend themselves well to the possibility of offering direct and authentic empirical experience to K-12 students. For example, all students live in a watershed, experience severe weather, and observe landforms, all of which can be observed and researched by students.

However, unlike many other disciplines, direct experimentation and observation are difficult in many aspects of the Earth sciences. Scientists often must depend on the formulation of models both to describe and to determine the implications of various factors. Many aspects of the Earth sciences occur over very long time frames ("deep time"), as well as deep in the Earth or far off in space, that need to be studied more like a murder mystery with inferences from indirect data; such concepts are often difficult for students to comprehend.

The tools available to both scientists and students for learning about Earth and space have changed as well. Communication and visualization tools, such as the internet and data bases, have made it possible for Earth science students to have direct access to the raw data and models used by scientists and to pursue real world questions and inquiry. Other web-based programs allow students to view and process satellite images of Earth, to direct a camera on board the Space Shuttle, and to access professional telescopes around the world to carry out science projects.

The Earth system, however, is generally too complex for students to view as whole, thus it is best to study each of the components separately. It is imperative, however, that students inquire about and understand the interconnections between Earth systems and distinguish between systems at "micro" and "macro" levels. In light of this, many content statements in this document cross standard boundaries and are interconnected.

The Earth science standards focus on:

1. the nature and practice of scientific inquiry
2. the Earth system and the movement of elements, compounds, and energy through it
3. the solid Earth and its hazards
4. the fluid Earth, and its hazards
5. the history of the Earth and the universe

The standards begin with a section on the nature and practice of science. This is followed by an overview of Earth systems and cycles and the movement of elements, compounds, and energy within and between the four component systems. This is followed by an examination of the major components of the Earth system that are covered in Earth Science courses, focusing on the solid Earth (geosphere) and fluid Earth (hydrology, oceans, climate, and weather). The final standard covers the position of the Earth in the universe and its evolution over time.

The interdisciplinary nature of the Earth sciences makes it difficult to rigidly separate and sequence subject matter. Many topics can fit equally well in many different places. This document represents one possible organizational structure.

Earth Science Content Statement Outline

STANDARD E1 Inquiry, Reflection, and Social Implications

- E1.1 Scientific Inquiry
- E1.2 Scientific Reflection and Social Implications

STANDARD E2 Earth Systems

- E2.1 Earth Systems Overview
- E2.2 Energy in Earth Systems
- E2.3 Biogeochemical Cycles
- E2.4 Resources and Human Impacts on Earth Systems

STANDARD E3 Solid Earth

- E3.p1 Landforms and Soils *(prerequisite)*
- E3.p2 Rocks and Minerals *(prerequisite)*
- E3.p3 Basic Plate Tectonics *(prerequisite)*
- E3.1 Advanced Rock Cycle
- E3.2 Interior of the Earth
- E3.3 Plate Tectonics Theory
- E3.4 Earthquakes and Volcanoes

STANDARD E4 Fluid Earth

- E4.p1 Water Cycle *(prerequisite)*
- E4.p2 Weather and the Atmosphere *(prerequisite)*
- E4.p3 Glaciers *(prerequisite)*
- E4.1 Hydrogeology
- E4.2 Oceans and Climate
- E4.3 Severe Weather

STANDARD E5 The Earth in Space and Time

- E5.p1 Sky Observations *(prerequisite)*
- E5.1 The Earth in Space
- E5.2 The Sun
- E5.2x Stellar Evolution
- E5.3 Earth History and Geologic Time
- E5.3x Geologic Dating
- E5.4 Climate Change

STANDARD E1: INQUIRY, REFLECTION, AND SOCIAL IMPLICATIONS

Students will understand the nature of science and demonstrate an ability to practice scientific reasoning by applying it to the design, execution, and evaluation of scientific investigations. Students will demonstrate their understanding that scientific knowledge is gathered through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation. They will be able to distinguish between types of scientific knowledge (e.g., hypotheses, laws, theories) and become aware of areas of active research in contrast to conclusions that are part of established scientific consensus. They will use their scientific knowledge to assess the costs, risks, and benefits of technological systems as they make personal choices and participate in public policy decisions. These insights will help them analyze the role science plays in society, technology, and potential career opportunities.

E1.1 Scientific Inquiry

Science is a way of understanding nature. Scientific research may begin by generating new scientific questions that can be answered through replicable scientific investigations that are logically developed and conducted systematically. Scientific conclusions and explanations result from careful analysis of empirical evidence and the use of logical reasoning. Some questions in science are addressed through indirect rather than direct observation, evaluating the consistency of new evidence with results predicted by models of natural processes. Results from investigations are communicated in reports that are scrutinized through a peer review process.

E1.1A Generate new questions that can be investigated in the laboratory or field.

E1.1B Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.

E1.1C Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).

E1.1D Identify patterns in data and relate them to theoretical models.

E1.1E Describe a reason for a given conclusion using evidence from an investigation.

E1.1f Predict what would happen if the variables, methods, or timing of an investigation were changed.

E1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation.

E1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.

E1.1i Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.

E1.2 Scientific Reflection and Social Implications

The integrity of the scientific process depends on scientists and citizens understanding and respecting the "Nature of Science." Openness to new ideas, skepticism, and honesty are attributes required for good scientific practice. Scientists must use logical reasoning during investigation design, analysis, conclusion, and communication. Science can produce critical insights on societal problems from a personal and local scale to a global scale. Science both aids in the development of technology and provides tools for assessing the costs, risks, and benefits of technological systems. Scientific conclusions and arguments play a role in personal choice and public policy decisions. New technology and scientific discoveries have had a major influence in shaping human history. Science and technology continue to offer diverse and significant career opportunities.

E1.2A Critique whether or not specific questions can be answered through scientific investigations.

E1.2B Identify and critique arguments about personal or societal issues based on scientific evidence.

E1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.

E1.2D Evaluate scientific explanations in a peer review process or discussion format.

E1.2E Evaluate the future career and occupational prospects of science fields.

E1.2f Critique solutions to problems, given criteria and scientific constraints.

E1.2g Identify scientific tradeoffs in design decisions and choose among alternative solutions.

E1.2h Describe the distinctions between scientific theories, laws, hypotheses, and observations.

E1.2i Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.

E1.2j Apply science principles or scientific data to anticipate effects of technological design decisions.

E1.2k Analyze how science and society interact from a historical, political, economic, or social perspective.

STANDARD E2: EARTH SYSTEMS

Students describe the interactions within and between Earth systems. Students will explain how both fluids (water cycle) and solids (rock cycle) move within Earth systems and how these movements form and change their environment. They will describe the relationship between physical process and human activities and use this understanding to demonstrate an ability to make wise decisions about land use.

E2.1 Earth Systems Overview

The Earth is a system consisting of four major interacting components: geosphere (crust, mantle, and core), atmosphere (air), hydrosphere (water), and biosphere (the living part of Earth). Physical, chemical, and biological processes act within and among the four components on a wide range of time scales to continuously change Earth's crust, oceans, atmosphere, and living organisms. Earth elements move within and between the lithosphere, atmosphere, hydrosphere, and biosphere as part of geochemical cycles.

E2.1A Explain why the Earth is essentially a closed system in terms of matter.

E2.1B Analyze the interactions between the major systems (geosphere, atmosphere, hydrosphere, biosphere) that make up the Earth.

E2.1C Explain, using specific examples, how a change in one system affects other Earth systems.

E2.2 Energy in Earth Systems

Energy in Earth systems can exist in a number of forms (e.g., thermal energy as heat in the Earth, chemical energy stored as fossil fuels, mechanical energy as delivered by tides) and can be transformed from one state to another and move from one reservoir to another. Movement of matter and its component elements, through and between Earth's systems, is driven by Earth's internal (radioactive decay and gravity) and external (Sun as primary) sources of energy. Thermal energy is transferred by radiation, convection, and conduction. Fossil fuels are derived from plants and animals of the past, are nonrenewable, and, therefore, are limited in availability. All sources of energy for human consumption (e.g., solar, wind, nuclear, ethanol, hydrogen, geothermal, hydroelectric) have advantages and disadvantages.

E2.2A Describe the Earth's principal sources of internal and external energy (e.g., radioactive decay, gravity, solar energy).

E2.2B Identify differences in the origin and use of renewable (e.g., solar, wind, water, biomass) and nonrenewable (e.g., fossil fuels, nuclear [U-235]) sources of energy.

E2.2C Describe natural processes in which heat transfer in the Earth occurs by conduction, convection, and radiation.

E2.2D Identify the main sources of energy to the climate system.

E2.2e Explain how energy changes form through Earth systems.

E2.2f Explain how elements exist in different compounds and states as they move from one reservoir to another.

E2.3 Biogeochemical Cycles

The Earth is a system containing essentially a fixed amount of each stable chemical atom or element. Most elements can exist in several different states and chemical forms; they move within and between the geosphere, atmosphere, hydrosphere, and biosphere as part of the Earth system. The movements can be slow or rapid. Elements and compounds have significant impacts on the biosphere and have important impacts on human health.

E2.3A Explain how carbon exists in different forms such as limestone (rock), carbon dioxide (gas), carbonic acid (water), and animals (life) within Earth systems and how those forms can be beneficial or harmful to humans.

E2.3b Explain why small amounts of some chemical forms may be beneficial for life but are poisonous in large quantities (e.g., dead zone in the Gulf of Mexico, Lake Nyos in Africa, fluoride in drinking water).

E2.3c Explain how the nitrogen cycle is part of the Earth system.

E2.3d Explain how carbon moves through the Earth system (including the geosphere) and how it may benefit (e.g., improve soils for agriculture) or harm (e.g., act as a pollutant) society.

E2.4 Resources and Human Impacts on Earth Systems

The Earth provides resources (including minerals) that are used to sustain human affairs. The supply of nonrenewable natural resources is limited and their extraction and use can release elements and compounds into Earth systems. They affect air and water quality, ecosystems, landscapes, and may have effects on long-term climate. Plans for land use and long-term development must include an understanding of the interactions between Earth systems and human activities.

E2.4A Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their effects on the environment, and include overall costs and benefits.

E2.4B Explain how the impact of human activities on the environment (e.g., deforestation, air pollution, coral reef destruction) can be understood through the analysis of interactions between the four Earth systems.

E2.4c Explain ozone depletion in the stratosphere and methods to slow human activities to reduce ozone depletion.

E2.4d Describe the life cycle of a product, including the resources, production, packaging, transportation, disposal, and pollution.

STANDARD E3: THE SOLID EARTH

Students explain how scientists study and model the interior of the Earth and its dynamic nature. They use the theory of plate tectonics, the unifying theory of geology, to explain a wide variety of Earth features and processes and how hazards resulting from these processes impact society.

E3.p1 Landforms and Soils *(prerequisite)*

Landforms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruptions, and deposition of sediments transported in rivers, streams, and lakes through watersheds. Destructive forces include weathering and erosion. The weathering of rocks and decomposed organic matter result in the formation of soils. *(prerequisite)*

E3.p1A Explain the origin of Michigan landforms. Describe and identify surface features using maps and satellite images. *(prerequisite)*

E3.p1B Explain how physical and chemical weathering leads to erosion and the formation of soils and sediments. *(prerequisite)*

E3.p1C Describe how coastal features are formed by wave erosion and deposition. *(prerequisite)*

E3.p2 Rocks and Minerals *(prerequisite)*

Igneous, metamorphic, and sedimentary rocks are constantly forming and changing through various processes. As they do so, elements move through the geosphere. In addition to other geologic features, rocks and minerals are indicators of geologic and environmental conditions that existed in the past. *(prerequisite)*

E3.p2A Identify common rock-forming minerals (quartz, feldspar, biotite, calcite, hornblende). *(prerequisite)*

E3.p2B Identify common igneous (granite, basalt, andesite, obsidian, pumice), metamorphic (schist, gneiss, marble, slate, quartzite), and sedimentary (sandstone, limestone, shale, conglomerate) rocks and describe the processes that change one kind of rock to another. *(prerequisite)*

E3.p3 Basic Plate Tectonics *(prerequisite)*

Early evidence for the movement of continents was based on the similarities of coastlines, geology, faunal distributions, and paleoclimatelogical data across the Atlantic and Indian Oceans. In the 1960s, additional evidence from marine geophysical surveys, seismology, volcanology, and paleomagnetism resulted in the development of the theory of plate tectonics. *(prerequisite)*

E3.p3A Describe geologic, paleontologic, and paleoclimatalogic evidence that indicates Africa and South America were once part of a single continent.

E3.p3B Describe the three types of plate boundaries (divergent, convergent, and transform) and geographic features associated with them (e.g., continental rifts and mid-ocean ridges, volcanic and island arcs, deep-sea trenches, transform faults).

E3.p3C Describe the three major types of volcanoes (shield volcano, stratovolcano, and cinder cones) and their relationship to the Ring of Fire.

E3.1 Advanced Rock Cycle

Igneous, metamorphic, and sedimentary rocks are indicators of geologic and environmental conditions and processes that existed in the past. These include cooling and crystallization, weathering and erosion, sedimentation and lithification, and metamorphism. In some way, all of these processes are influenced by plate tectonics, and some are influenced by climate.

E3.1A Discriminate between igneous, metamorphic, and sedimentary rocks and describe the processes that change one kind of rock into another.

E3.1B Explain the relationship between the rock cycle and plate tectonics theory in regard to the origins of igneous, sedimentary, and metamorphic rocks.

E3.1c Explain how the size and shape of grains in a sedimentary rock indicate the environment of formation (including climate) and deposition.

E3.1d Explain how the crystal sizes of igneous rocks indicate the rate of cooling and whether the rock is extrusive or intrusive.

E3.1e Explain how the texture (foliated, nonfoliated) of metamorphic rock can indicate whether it has experienced regional or contact metamorphism.

E3.2 Interior of the Earth

The Earth can also be subdivided into concentric layers based on their physical characteristics: (lithosphere, asthenosphere, lower mantle, outer core, and inner core). The crust and upper mantle compose the rigid lithosphere (plates) that moves over a "softer" asthenosphere (part of the upper mantle). The magnetic field of the Earth is generated in the outer core. The interior of the Earth cannot be directly sampled and must be modeled using data from seismology.

E3.2A Describe the interior of the Earth (in terms of crust, mantle, and inner and outer cores) and where the magnetic field of the Earth is generated.

E3.2B Explain how scientists infer that the Earth has interior layers with discernable properties using patterns of primary (P) and secondary (S) seismic wave arrivals.

E3.2C Describe the differences between oceanic and continental crust (including density, age, composition).

E3.2d Explain the uncertainties associated with models of the interior of the Earth and how these models are validated.

E3.3 Plate Tectonics Theory

The Earth's crust and upper mantle make up the lithosphere, which is broken into large mobile pieces called tectonic plates. The plates move at velocities in units of centimeters per year as measured using the global positioning system (GPS). Motion histories are determined with calculations that relate rate, time, and distance of offset geologic features. Oceanic plates are created at mid-ocean ridges by magmatic activity and cooled until they sink back into the Earth at subduction zones. At some localities, plates slide by each other. Mountain belts are formed both by continental collision and as a result of subduction. The outward flow of heat from Earth's interior provides the driving energy for plate tectonics.

E3.3A Explain how plate tectonics accounts for the features and processes (sea floor spreading, mid-ocean ridges, subduction zones, earthquakes and volcanoes, mountain ranges) that occur on or near the Earth's surface.

E3.3B Explain why tectonic plates move using the concept of heat flowing through mantle convection, coupled with the cooling and sinking of aging ocean plates that result from their increased density.

E3.3C Describe the motion history of geologic features (e.g., plates, Hawaii) using equations relating rate, time, and distance.

E3.3d Distinguish plate boundaries by the pattern of depth and magnitude of earthquakes.

E3.r3e Predict the temperature distribution in the lithosphere as a function of distance from the mid-ocean ridge and how it relates to ocean depth. *(recommended)*

E3.r3f Describe how the direction and rate of movement for the North American plate has affected the local climate over the last 600 million years. *(recommended)*

E3.4 Earthquakes and Volcanoes

Plate motions result in potentially catastrophic events (earthquakes, volcanoes, tsunamis, mass wasting) that affect humanity. The intensity of volcanic eruptions is controlled by the chemistry and properties of the magma. Earthquakes are the result of abrupt movements of the Earth. They generate energy in the form of body and surface waves.

E3.4A Use the distribution of earthquakes and volcanoes to locate and determine the types of plate boundaries.

E3.4B Describe how the sizes of earthquakes and volcanoes are measured or characterized.

E3.4C Describe the effects of earthquakes and volcanic eruptions on humans.

E3.4d Explain how the chemical composition of magmas relates to plate tectonics and affects the geometry, structure, and explosivity of volcanoes.

E3.4e Explain how volcanoes change the atmosphere, hydrosphere, and other Earth systems.

E3.4f Explain why fences are offset after an earthquake, using the elastic rebound theory.

STANDARD E4: THE FLUID EARTH

Students explain how the ocean and atmosphere move and transfer energy around the planet. They also explain how these movements affect climate and weather and how severe weather impacts society. Students explain how long term climatic changes (glaciers) have shaped the Michigan landscape. They also explain features and processes related to surface and groundwater and describe the sustainability of systems in terms of water quality and quantity.

E4.p1 Water Cycle *(prerequisite)*

Water circulates through the crust and atmosphere and in oceans, rivers, glaciers, and ice caps and connects all of the Earth systems. Groundwater is a significant reservoir and source of freshwater on Earth. The recharge and movement of groundwater depends on porosity, permeability, and the shape of the water table. The movement of groundwater occurs over a long period time. Groundwater and surface water are often interconnected. *(prerequisite)*

E4.p1A Describe that the water cycle includes evaporation, transpiration, condensation, precipitation, infiltration, surface runoff, groundwater, and absorption. *(prerequisite)*

E4.p1B Analyze the flow of water between the elements of a watershed, including surface features (lakes, streams, rivers, wetlands) and groundwater. *(prerequisite)*

E4.p1C Describe the river and stream types, features, and process including cycles of flooding, erosion, and deposition as they occur naturally and as they are impacted by land use decisions. *(prerequisite)*

E4.p1D Explain the types, process, and beneficial functions of wetlands.

E4.p2 Weather and the Atmosphere *(prerequisite)*

The atmosphere is divided into layers defined by temperature. Clouds are indicators of weather. *(prerequisite)*

E4.p2A Describe the composition and layers of the atmosphere. *(prerequisite)*

E4.p2B Describe the difference between weather and climate. *(prerequisite)*

E4.p2C Explain the differences between fog and dew formation and cloud formation. *(prerequisite)*

E4.p2D Describe relative humidity in terms of the moisture content of the air and the moisture capacity of the air and how these depend on the temperature. *(prerequisite)*

E4.p2E Describe conditions associated with frontal boundaries (cold, warm, stationary, and occluded). *(prerequisite)*

E4.p2F Describe the characteristics and movement across North America of the major air masses and the jet stream. *(prerequisite)*

E4.p2G Interpret a weather map and describe present weather conditions and predict changes in weather over 24 hours. *(prerequisite)*

E4.p2H Explain the primary causes of seasons. *(prerequisite)*

E4.p2I Identify major global wind belts (trade winds, prevailing westerlies, and polar easterlies) and that their vertical components control the global distribution of rainforests and deserts. *(prerequisite)*

E4.p3 Glaciers *(prerequisite)*

Glaciers are large bodies of ice that move under the influence of gravity. They form part of both the rock and water cycles. Glaciers and ice sheets have shaped the landscape of the Great Lakes region. Areas that have been occupied by ice sheets are depressed. When the ice sheet is removed, the region rebounds (see also climate change). *(prerequisite)*

E4.p3A Describe how glaciers have affected the Michigan landscape and how the resulting landforms impact our state economy. *(prerequisite)*

E4.p3B Explain what happens to the lithosphere when an ice sheet is removed. *(prerequisite)*

E4.p3C Explain the formation of the Great Lakes. *(prerequisite)*

E4.1 Hydrogeology

Fresh water moves over time between the atmosphere, hydrosphere (surface water, wetlands, rivers, and glaciers), and geosphere (groundwater). Water resources are both critical to and greatly impacted by humans. Changes in water systems will impact quality, quantity, and movement of water. Natural surface water processes shape the landscape everywhere and are affected by human land use decisions.

E4.1A Compare and contrast surface water systems (lakes, rivers, streams, wetlands) and groundwater in regard to their relative sizes as Earth's freshwater reservoirs and the dynamics of water movement (inputs and outputs, residence times, sustainability).

E4.1B Explain the features and processes of groundwater systems and how the sustainability of North American aquifers has changed in recent history (e.g., the past 100 years) qualitatively using the concepts of recharge, residence time, inputs, and outputs.

E4.1C Explain how water quality in both groundwater and surface systems is impacted by land use decisions.

E4.2 Oceans and Climate

Energy from the sun and the rotation of the Earth control global atmospheric circulation. Oceans redistribute matter and energy around the Earth through currents, waves, and interaction with other Earth systems. Ocean currents are controlled by prevailing winds, changes in water density, ocean topography, and the shape and location of landmasses. Oceans and large lakes (e.g., Great Lakes) have a major effect on climate and weather because they are a source of moisture and a large reservoir of heat. Interactions between oceanic circulation and the atmosphere can affect regional climates throughout the world.

E4.2A Describe the major causes for the ocean's surface and deep water currents, including the prevailing winds, the Coriolis effect, unequal heating of the earth, changes in water temperature and salinity in high latitudes, and basin shape.

E4.2B Explain how interactions between the oceans and the atmosphere influence global and regional climate. Include the major concepts of heat transfer by ocean currents, thermohaline circulation, boundary currents, evaporation, precipitation, climatic zones, and the ocean as a major CO_2 reservoir.

E4.2c Explain the dynamics (including ocean-atmosphere interactions) of the El Niño-Southern Oscillation (ENSO) and its effect on continental climates.

E4.2d Identify factors affecting seawater density and salinity and describe how density affects oceanic layering and currents.

E4.2e Explain the differences between maritime and continental climates with regard to oceanic currents.

E4.2f Explain how the Coriolis effect controls oceanic circulation.

E4.r2g Explain how El Niño affects economies (e.g., in South America). *(recommended)*

E4.3 Severe Weather

Tornadoes, hurricanes, blizzards, and thunderstorms are severe weather phenomena that impact society and ecosystems. Hazards include downbursts (wind shear), strong winds, hail, lightning, heavy rain, and flooding. The movement of air in the atmosphere is due to differences in air density resulting from variations in temperature. Many weather conditions can be explained by fronts that occur when air masses meet.

E4.3A Describe the various conditions of formation associated with severe weather (thunderstorms, tornadoes, hurricanes, floods, waves, and drought).

E4.3B Describe the damage resulting from, and the social impact of thunderstorms, tornadoes, hurricanes, and floods.

E4.3C Describe severe weather and flood safety and mitigation.

E4.3D Describe the seasonal variations in severe weather.

E4.3E Describe conditions associated with frontal boundaries that result in severe weather (thunderstorms, tornadoes, and hurricanes).

E4.3F Describe how mountains, frontal wedging (including dry lines), convection, and convergence form clouds and precipitation.

E4.3g Explain the process of adiabatic cooling and adiabatic temperature changes to the formation of clouds.

STANDARD E5: THE EARTH IN SPACE AND TIME

Students explain theories about how the Earth and universe formed and evolved over a long period of time. Students predict how human activities may influence the climate of the future.

E5.p1 Sky Observations *(prerequisite)*

Common sky observations (such as lunar phases) can be explained by the motion of solar system objects in regular and predictable patterns. Our galaxy, observable as the Milky Way, is composed of billions of stars, some of which have planetary systems. Seasons are a result of the tilt of the rotation axis of the Earth. The motions of the moon and sun affect the phases of the moon and ocean tides. *(prerequisite)*

E5.p1A Describe the motions of various celestial bodies and some effects of those motions. *(prerequisite)*

E5.p1B Explain the primary cause of seasons. *(prerequisite)*

E5.p1C Explain how a light year can be used as a distance unit. *(prerequisite)*

E5.p1D Describe the position and motion of our solar system in our galaxy. *(prerequisite)*

E5.1 The Earth in Space

Scientific evidence indicates the universe is orderly in structure, finite, and contains all matter and energy. Information from the entire light spectrum tells us about the composition and motion of objects in the universe. Early in the history of the universe, matter clumped together by gravitational attraction to form stars and galaxies. According to the Big Bang theory, the universe has been continually expanding at an increasing rate since its formation about 13.7 billion years ago.

E5.1A Describe the position and motion of our solar system in our galaxy and the overall scale, structure, and age of the universe.

E5.1b Describe how the Big Bang theory accounts for the formation of the universe.

E5.1c Explain how observations of the cosmic microwave background have helped determine the age of the universe.

E5.1d Differentiate between the cosmological and Doppler red shift.

E5.2 The Sun

Stars, including the Sun, transform matter into energy in nuclear reactions. When hydrogen nuclei fuse to form helium, a small amount of matter is converted to energy. Solar energy is responsible for life processes and weather as well as phenomena on Earth. These and other processes in stars have led to the formation of all the other chemical elements.

E5.2A Identify patterns in solar activities (sunspot cycle, solar flares, solar wind).

E5.2B Relate events on the Sun to phenomena such as auroras, disruption of radio and satellite communications, and power grid disturbances.

E5.2C Describe how nuclear fusion produces energy in the Sun.

E5.2D Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements.

E5.2x Stellar Evolution

Stars, including the Sun, transform matter into energy in nuclear reactions. When hydrogen nuclei fuse to form helium, a small amount of matter is converted to energy. These and other processes in stars have led to the formation of all the other chemical elements. There is a wide range of stellar objects of different sizes and temperatures. Stars have varying life histories based on these parameters.

E5.2e Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).

E5.2f Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.

E5.2g Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).

E5.2h Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.

E5.3 Earth History and Geologic Time

The solar system formed from a nebular cloud of dust and gas 4.6 Ga (billion years ago). The Earth has changed through time and has been affected by both catastrophic (e.g., earthquakes, meteorite impacts, volcanoes) and gradual geologic events (e.g., plate movements, mountain building) as well as the effects of biological evolution (formation of an oxygen atmosphere). Geologic time can be determined through both relative and absolute dating.

E5.3A Explain how the solar system formed from a nebula of dust and gas in a spiral arm of the Milky Way Galaxy about 4.6 Ga (billion years ago).

E5.3B Describe the process of radioactive decay and explain how radioactive elements are used to date the rocks that contain them.

E5.3C Relate major events in the history of the Earth to the geologic time scale, including formation of the Earth, formation of an oxygen atmosphere, rise of life, Cretaceous-Tertiary (K-T) and Permian extinctions, and Pleistocene ice age.

E5.3D Describe how index fossils can be used to determine time sequence.

E5.3x Geologic Dating

Early methods of determining geologic time, such as the use of index fossils and stratigraphic principles, allowed for the relative dating of geological events. However, absolute dating was impossible until the discovery that certain radioactive isotopes in rocks have known decay rates, making it possible to determine how many years ago a given mineral or rock formed. Different kinds of radiometric dating techniques exist. Technique selection depends on the composition of the material to be dated, the age of the material, and the type of geologic event that affected the material.

E5.3e Determine the approximate age of a sample, when given the half-life of a radioactive substance (in graph or tabular form) along with the ratio of daughter to parent substances present in the sample.

E5.3f Explain why C-14 can be used to date a 40,000 year old tree, but U-Pb cannot.

E5.3g Identify a sequence of geologic events using relative-age dating principles.

E5.4 Climate Change

Atmospheric gases trap solar energy that has been reradiated from the Earth's surface (the greenhouse effect). The Earth's climate has changed both gradually and catastrophically over geological and historical time frames due to complex interactions between many natural variables and events. The concentration of greenhouse gases (especially carbon dioxide) has increased due to human industrialization, which has contributed to a rise in average global atmospheric temperatures and changes in the biosphere, atmosphere, and hydrosphere. Climates of the past are researched, usually using indirect indicators, to better understand and predict climate change.

E5.4A Explain the natural mechanism of the greenhouse effect, including comparisons of the major greenhouse gases (water vapor, carbon dioxide, methane, nitrous oxide, and ozone).

E5.4B Describe natural mechanisms that could result in significant changes in climate (e.g., major volcanic eruptions, changes in sunlight received by the earth, and meteorite impacts).

E5.4C Analyze the empirical relationship between the emissions of carbon dioxide, atmospheric carbon dioxide levels, and the average global temperature over the past 150 years.

E5.4D Based on evidence of observable changes in recent history and climate change models, explain the consequences of warmer oceans (including the results of increased evaporation, shoreline and estuarine impacts, oceanic algae growth, and coral bleaching) and changing climatic zones (including the adaptive capacity of the biosphere).

E5.4e Based on evidence from historical climate research (e.g. fossils, varves, ice core data) and climate change models, explain how the current melting of polar ice caps can impact the climatic system .

E5.4f Describe geologic evidence that implies climates were significantly colder at times in the geologic record (e.g., geomorphology, striations, and fossils).

E5.4g Compare and contrast the heat-trapping mechanisms of the major greenhouse gases resulting from emissions (carbon dioxide, methane, nitrous oxide, fluorocarbons) as well as their abundance and heat-trapping capacity.

E5.r4h Use oxygen isotope data to estimate paleotemperature. *(recommended)*

E5.r4i Explain the causes of short-term climate changes such as catastrophic volcanic eruptions and impact of solar system objects. *(recommended)*

E5.r4j Predict the global temperature increase by 2100, given data on the annual trends of CO_2 concentration increase. *(recommended)*

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High School Content Expectations




SCIENCE

- Earth Science
- Biology
- **Physics**
- Chemistry

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Welcome to Michigan's High School Science Content Standards and Expectations

Why Develop Content Standards and Expectations for High School?

To prepare Michigan's students with the knowledge and skills to succeed in the 21st Century, the State of Michigan has enacted a rigorous new set of statewide graduation requirements that are among the best in the nation. These requirements, called the Michigan Merit Curriculum, are the result of a collaborative effort between Governor Jennifer M. Granholm, the State Board of Education, and the State Legislature.

In preparation for the implementation of the new high school graduation requirements, the Michigan Department of Education's Office of School Improvement is leading the development of high school content expectations. An Academic Work Group of science experts chaired by nationally known scholars was commissioned to conduct a scholarly review and identify content standards and expectations. The Michigan Department of Education conducted an extensive field review of the expectations by high school, university, and business and industry representatives.

The Michigan High School Science Content Expectations (Science HSCE) establish what every student is expected to know and be able to do by the end of high school and define the expectations for high school science credit in Earth Science, Biology, Physics, and Chemistry.

An Overview

In developing these expectations, the Academic Work Group depended heavily on the *Science Framework for the 2009 National Assessment of Educational Progress* (National Assessment Governing Board, 2006). In particular, the group adapted the structure of the NAEP framework, including Content Statements and Performance Expectations. These expectations align closely with the NAEP framework, which is based on *Benchmarks for Science Literacy* (AAAS Project 2061, 1993) and the *National Science Education Standards* (National Research Council, 1996).

The Academic Work Group carefully analyzed other documents, including the Michigan Curriculum Framework Science Benchmarks (2000 revision), the Standards for Success report *Understanding University Success*, ACT's *College Readiness Standards*, College Board's *AP Biology, AP Physics, AP Chemistry,* and *AP Environmental Science Course Descriptions*, ACT's *On Course for Success*, South Regional Education Board's *Getting Ready for College-Preparatory/Honors Science: What Middle Grades Students Need to Know and Be Able to Do,* and standards documents from other states.

Earth Science	Biology	Physics	Chemistry
STANDARDS *(and number of content statements in each standard)*			
E1 Inquiry, Reflection, and Social Implications (2) E2 Earth Systems (4) E3 The Solid Earth (4) E4 The Fluid Earth (3) E5 Earth in Space and Time (4)	B1 Inquiry, Reflection, and Social Implications (2) B2 Organization and Development of Living Systems (6) B3 Interdependence of Living Systems and the Environment (5) B4 Genetics (4) B5 Evolution and Biodiversity (3)	P1 Inquiry, Reflection, and Social Implications (2) P2 Motion of Objects (3) P3 Forces and Motion (8) P4 Forms of Energy and Energy Transformations (12)	C1 Inquiry, Reflection, and Social Implications (2) C2 Forms of Energy (5) C3 Energy Transfer and Conservation (5) C4 Properties of Matter (10) C5 Changes in Matter (7)

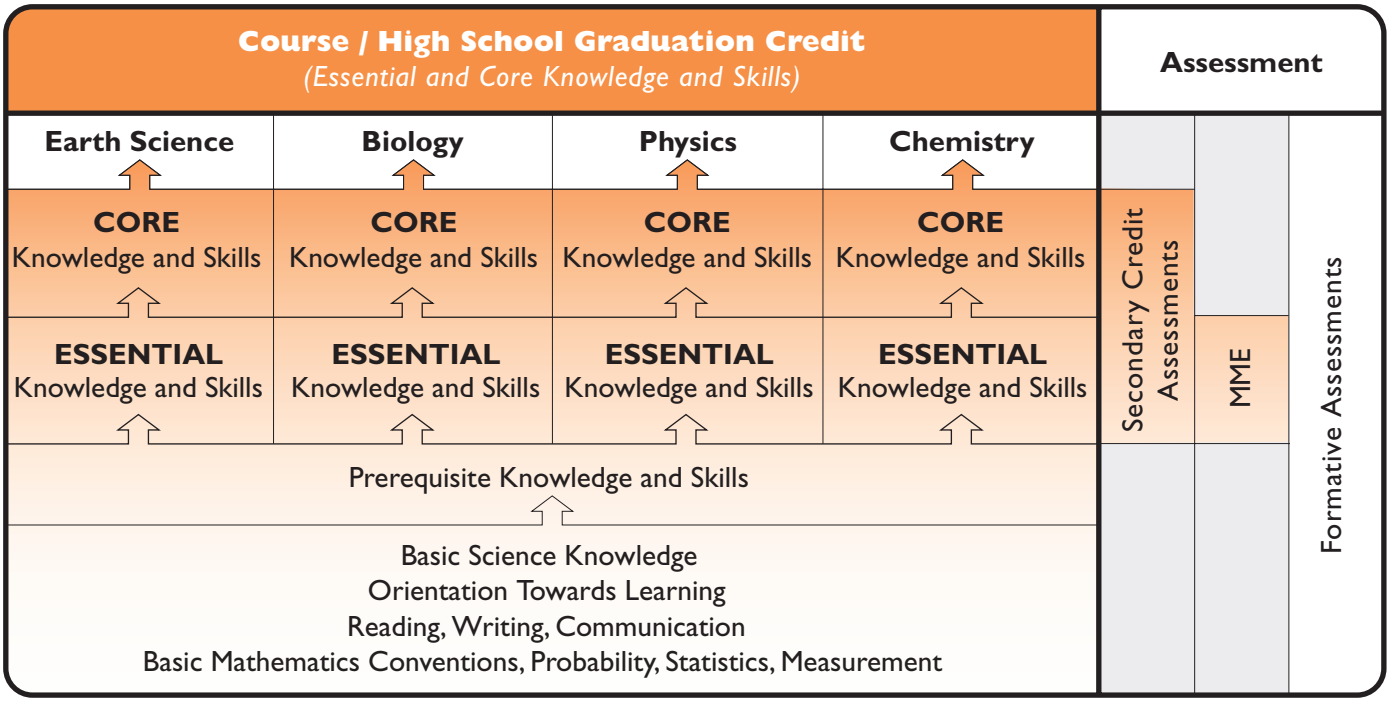
Useful and Connected Knowledge for All Students

This document defines expectations for Michigan High School graduates, organized by discipline: Earth Science, Biology, Physics, and Chemistry. It defines ***useful*** and ***connected knowledge*** at four levels:

- **Prerequisite knowledge**
  Useful and connected knowledge that all students should bring as a prerequisite to high school science classes. Prerequisite expectation codes include a "**p**" and an upper case letter (e.g., **E3.p1A**). Prerequisite content could be assessed through formative and/or large scale assessments.
- **Essential knowledge**
  Useful and connected knowledge for all high school graduates, regardless of what courses they take in high school. Essential expectation codes include an upper case letter (e.g., **E2.1A**). Essential content knowledge and performance expectations are required for graduation and are assessable on the Michigan Merit Exam (MME) and on future secondary assessments. Essential knowledge can also be assessed with formative assessments.
- **Core knowledge**
  Useful and connected knowledge for all high school graduates who have completed a discipline-specific course. In general core knowledge includes content and expectations that students need to be prepared for more advanced study in that discipline. Core content statement codes include an "x" and core expectation codes include a lower case letter (e.g., **B2.2x** Proteins; **B2.2f**) to indicate that they are NOT assessable on existing large-scale assessments (MME, NAEP), but will be assessed on future secondary credit assessments. Core knowledge can also be assessed with formative assessments.
- **Recommended knowledge**
  Useful and connected knowledge that is desirable as preparation for more advanced study in the discipline, but not required for graduation credit. Content and expectations labeled as recommended represent extensions of the core. Recommended content statement codes include an "**r**" and an "**x**"; recommended expectations include an "**r**" and a lower case letter (e.g., **P4.r9x Nature of Light**; **P4.r9a**). They will not be assessed on either the MME or secondary credit assessments.

Useful and connected knowledge is contrasted with ***procedural display***—learning to manipulate words and symbols without fully understanding their meaning. When expectations are excessive, procedural display is the kind of learning that takes place. Teachers and students "cover the content" instead of "uncovering" useful and connected knowledge.

Credit for high school Earth Science, Biology, Physics, and Chemistry will be defined as meeting both essential and core subject area content expectations. Credit requirements are outlined in separate Michigan Merit Curriculum Course/Credit Requirement documents.



Preparing Students for Successful Post-Secondary Engagement

Students who have useful and connected knowledge should be able to apply knowledge in new situations; to solve problems by generating new ideas; to make connections among what they read and hear in class, the world around them, and the future; and through their work, to develop leadership qualities while still in high school. In particular, high school graduates with useful and connected knowledge are able to engage in four key practices of science literacy.

Successful Post-Secondary Engagement

Practices of Science Literacy

Communicate accurately and effectively...

Identifying Science Principles

- Describe, measure, or classify observations.
- State or recognize correct science principles.
- Demonstrate relationships among closely related science principles.
- Demonstrate relationships among different representations of principles.

Using Science Principles

- Explain observations of phenomena.
- Predict observations of phenomena.
- Suggest examples of observations that illustrate a science principle.
- Propose, analyze, and evaluate alternative explanations or predictions.

Scientific Inquiry

- Generate new questions that can be investigated in the laboratory or field.
- Critique aspects of scientific investigations.
- Conduct scientific investigations using appropriate tools and techniques.
- Identify patterns in data: relate patterns to theoretical models.
- Describe a reason for a given conclusion using evidence from an investigation.
- Explain how scientific evidence supports or refutes claims or explanations of phenomena.
- Design and conduct a scientific investigation with a hypothesis, several controlled variables, and one manipulated variable. Gather data and organized the results in graphs, tables, and/or charts.

Reflection and Social Implications

- Critique whether questions can be answered through scientific investigations.
- Identify and critique arguments based on scientific evidence.
- Use appropriate scientific knowledge in social arguments, recognizing their limitations.
- Gather, synthesize, and evaluate information from multiple sources.
- Discuss scientific topics in groups, make presentations summarize what others have said, ask for clarification, take alternative perspectives, and defend a position.
- Evaluate the future career and occupational prospects of science fields.
- Explain why a claim or a conclusion is flawed.
- Critique solutions to problems, given criteria and scientific constraints.
- Identify scientific tradeoffs in design decisions and choose among alternative solutions.
- Apply science principles or scientific data to anticipate effects of technological design decisions.

State / National Landscape

- Expert perspective
- Education reform environment
- Research-based practices
- Work force requirements

State / Federal Expectations

- No Child Left Behind (NCLB)
- National Governors' Association (NGA)
- Legislation/Policy

Michigan High School Science Content Standards and Expectations

Earth Science

Biology

Physics

Chemistry

Models for District Alignment / Mapping

- District curriculum documents
- Documents from other districts/states
- Backmapping to standards and expectations

Other MI Documents / Programs

- State Standards – teaching and learning, content (all areas), assessment
- Grade Level Content Expectations
- State Assessments
- Career/Technical Education Department of Labor and Economic Growth

K-8 Educational Experience

Content Knowledge

- English Language Arts
- Mathematics
- Science
- Social Studies
- Other

Learning Processes

- Strategies & Skills
- Reasoning
- Analytical Thinking
- Constructing New Meaning
- Communication

This chart includes talking points for professional development.

Practices of Science Literacy

- **Identifying**
  Identifying performances generally have to do with stating models, theories, and patterns inside the triangle in Figure 1.
- **Using**
  Using performances generally have to do with the downward arrow in Figure 1—using scientific models and patterns to explain or describe specific observations.
- **Inquiry**
  Inquiry performances generally have to do with the upward arrow in Figure 1—finding and explaining patterns in data.
- **Reflection and Social Implications**
  Reflecting and Social Implications performances generally have to do with the figure as a whole (reflecting) or the downward arrow (technology as the application of models and theories to practical problems).

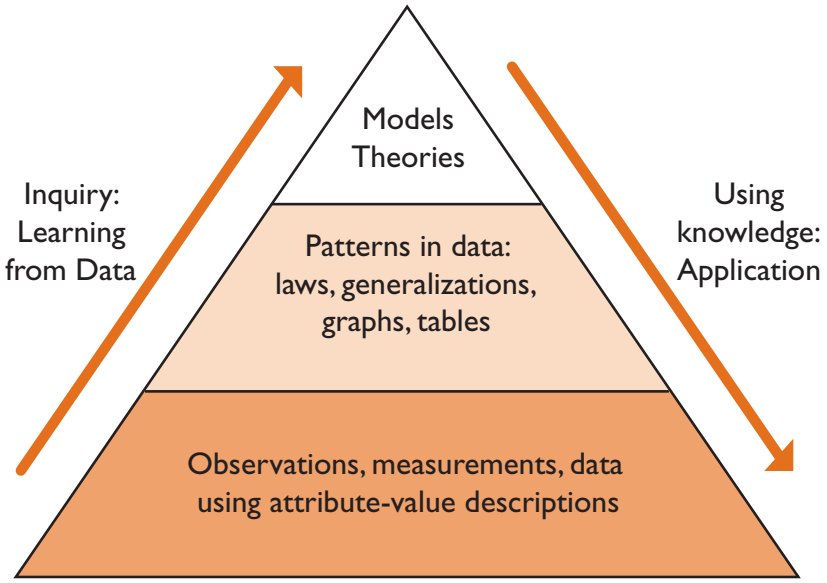


Figure 1: Knowledge and practices of model-based reasoning

Identifying Science Principles

This category focuses on students' abilities to recall, define, relate, and represent basic science principles. The content statements themselves are often closely related to one another conceptually. Moreover, the science principles included in the content statements can be represented in a variety of forms, such as words, pictures, graphs, tables, formulas, and diagrams (AAAS, 1993; NRC, 1996). Identifying practices include describing, measuring, or classifying observations; stating or recognizing principles included in the content statements; connecting closely related content statements; and relating different representations of science knowledge.

Identifying Science Principles comprises the following general types of practices:

- Describe, measure, or classify observations (e.g., describe the position and motion of objects, measure temperature, classify relationships between organisms as being predator/prey, parasite/host, producer/consumer).
- State or recognize correct science principles (e.g., mass is conserved when substances undergo changes of state; all organisms are composed of cells; the atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor).
- Demonstrate relationships among closely related science principles (e.g., statements of Newton's three laws of motion, energy transfer and the water cycle).
- Demonstrate relationships among different representations of principles (e.g., verbal, symbolic, diagrammatic) and data patterns (e.g., tables, equations, graphs).

Identifying Science Principles is integral to all of the other science practices.

Using Science Principles

Scientific knowledge is useful for making sense of the natural world. Both scientists and informed citizens can use patterns in observations and theoretical models to predict and explain observations that they make now or that they will make in the future.

Using Science Principles comprises the following general types of performance expectations:

- Explain observations of phenomena (using science principles from the content statements).
- Predict observations of phenomena (using science principles from the content statements, including quantitative predictions based on science principles that specify quantitative relationships among variables).
- Suggest examples of observations that illustrate a science principle (e.g., identify examples where the net force on an object is zero; provide examples of observations explained by the movement of tectonic plates; given partial DNA sequences of organisms, identify likely sequences of close relatives).
- Propose, analyze, and evaluate alternative explanations or predictions.

The first two categories—***Identifying Science Principles*** and ***Using Science Principles***—both require students to correctly state or recognize the science principles contained in the content statements. A difference between the categories is that Using Science Principles focuses on what makes science knowledge valuable—that is, its usefulness in making accurate predictions about phenomena and in explaining observations of the natural world in coherent ways (i.e., "knowing why"). Distinguishing between these two categories draws attention to differences in depth and richness of individuals' knowledge of the content statements. Assuming a continuum from "just knowing the facts" to "using science principles," there is considerable overlap at the boundaries. The line between the Identifying and Using categories is not distinct.

Scientific Inquiry

Scientifically literate graduates make observations about the natural world, identify patterns in data, and propose explanations to account for the patterns. Scientific inquiry involves the collection of relevant data, the use of logical reasoning, and the application of imagination in devising hypotheses to explain patterns in data. Scientific inquiry is a complex and time-intensive process that is iterative rather than linear. Habits of mind—curiosity, openness to new ideas, informed skepticism—are part of scientific inquiry. This includes the ability to read or listen critically to assertions in the media, deciding what evidence to pay attention to and what to dismiss, and distinguishing careful arguments from shoddy ones. Thus, Scientific Inquiry depends on the practices described above—Identifying Science Principles and Using Science Principles.

Scientific Inquiry comprises the following general types of performance expectations:

- Generate new questions that can be investigated in the laboratory or field.
- Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.
- Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).
- Identify patterns in data and relate them to theoretical models.
- Describe a reason for a given conclusion using evidence from an investigation.
- Predict what would happen if the variables, methods, or timing of an investigation were changed.
- Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation.
- Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.
- Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.

Scientific inquiry is more complex than simply making, summarizing, and explaining observations, and it is more flexible than the rigid set of steps often referred to as the "scientific method." The *National Standards* makes it clear that inquiry goes beyond "science as a process" to include an understanding of the nature of science (p. 105).

It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists. Evaluation includes reviewing the experimental procedures, examining the evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations (p. 171).

When students engage in Scientific Inquiry, they are drawing on their understanding about the nature of science, including the following ideas (see Benchmarks for Science Literacy):

- Arguments are flawed when fact and opinion are intermingled or the conclusions do not follow logically from the evidence given.
- A single example can never support the inference that something is always true, but sometimes a single example can support the inference that something is not always true.
- If more than one variable changes at the same time in an experiment, the outcome of the experiment may not be clearly attributable to any one of the variables.
- The way in which a sample is drawn affects how well it represents the population of interest. The larger the sample, the smaller the error in inference to the population. But, large samples do not necessarily guarantee representation, especially in the absence of random sampling.

Students can demonstrate their abilities to engage in Scientific Inquiry in two ways: students can *do* the practices specified above, and students can *critique examples* of scientific inquiry. In *doing*, practices can include analyzing data tables and deciding which conclusions are consistent with the data. Other practices involve hands-on performance and/or interactive computer tasks—for example, where students collect data and present their results or where students specify experimental conditions on computer simulations and observe the outcomes. As to *critiquing*, students can identify flaws in a poorly designed investigation or suggest changes in the design in order to produce more reliable data. Students should also be able to critique print or electronic media—for example, items may ask students to suggest alternative interpretations of data described in a newspaper article.

Scientific Reflection and Social Implications

Scientifically literate people recognize the strengths and limitations of scientific knowledge, which will provide the perspective they need to use the information to solve real-world problems. Students must learn to decide who and what sources of information they can trust. They need to learn to critique and justify their own ideas and the ideas of others. Since knowledge comes from many sources, students need to appreciate the historical origins of modern science and the multitude of connections between science and other disciplines. Students need to understand how science and technology support one another and the political, economic, and environmental consequences of scientific and technological progress. Finally, it is important that the ideas and contributions of men and women from all cultures be recognized as having played a significant role in scientific communities.

Scientific Reflection and Social Implications include the following general types of practices, all of which entail students using science knowledge to:

- Critique whether or not specific questions can be answered through scientific investigations.
- Identify and critique arguments about personal or societal issues based on scientific evidence.
- Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.
- Evaluate scientific explanations in a peer review process or discussion format.
- Evaluate the future career and occupational prospects of science fields.
- Critique solutions to problems, given criteria and scientific constraints.
- Identify scientific tradeoffs in design decisions and choose among alternative solutions.
- Describe the distinctions between scientific theories, laws, hypotheses, and observations.
- Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.
- Apply science principles or scientific data to anticipate effects of technological design decisions.
- Analyze how science and society interact from a historical, political, economic, or social perspective.

Organization of the Expectations

The Science Expectations are organized into Disciplines, Standards, Content Statements, and specific Performance Expectations.

Disciplines

Earth Science, Biology, Physics, and Chemistry

Organization of Each Standard

Each standard includes three parts:

- A standard statement that describes what students who have mastered that standard will be able to do.
- Content statements that describe Prerequisite, Essential, Core, and Recommended science content understanding for that standard.
- Performance expectations that describe Prerequisite, Essential, Core, and Recommended performances for that standard.

NOTE: Boundary statements that clarify the standards and set limits for expected performances, technical vocabulary, and additional discipline-specific inquiry and reflection expectations will be included in a companion document.

Standard Statement

The Standard Statement describes how students who meet that standard will engage in Identifying, Using, Inquiry, or Reflection for that topic.

Content Statements

Content statements describe the Prerequisite, Essential, Core, and Recommended *knowledge* associated with the standard.

1. ***Prerequisite science content*** that all students should bring as a prerequisite to high school science classes. Prerequisite content statement codes include a "**p**" and are organized by topic [e.g., **E3.p1 Landforms and Soils *(prerequisite)***].
2. ***Essential science content*** that all high school graduates should master. Essential content and expectations are organized by topic (e.g., **E2.1 Earth Systems Overview**).
3. ***Core science content*** that high school graduates need for more advanced study in the discipline and for some kinds of work. Core content and expectations are organized by topic (e.g., **B2.2x Proteins)**; "**x**" designates a core topic).
4. ***Recommended science content*** that is desirable as preparation for more advanced study in the discipline, but is not required for credit. Content and expectations labeled as recommended represent extensions of the core. Recommended content statement codes include an "**r**" and an "**x**"; expectations include an "**r**" and a lower case letter (e.g., **P4.r9x Nature of Light**; **P4.r9a**).

NOTE: Basic mathematics and English language arts skills necessary for meeting the high school science content expectations will be included in a companion document.

Performance Expectations

Performance expectations are derived from the intersection of content statements and practices—if the content statements from the Earth Sciences, Biology, Physics, and Chemistry are the columns of a table and the practices (Identifying Science Principles, Using Science Principles, Using Scientific Inquiry, Reflection and Social Implications) are the rows, the cells of the table are inhabited by performance expectations.

Performance expectations are written with particular verbs indicating the desired performance expected of the student. The action verbs associated with each practice are contextualized to generate performance expectations. For example, when the "conduct scientific investigations" is crossed with a states-of-matter content statement, this can generate a performance expectation that employs a different action verb, "heats as a way to evaporate liquids."

Michigan High School Science

PHYSICS

Prerequisite, Essential, Core, and Recommended Content Statements and Expectations

CE • **RIGOR** • RELEVANCE • RELATIONSHIPS • RIGOR • RE
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MICHIGAN Department of Education
10/06

PHYSICS (P)

Physics is a basic science. It is a human construct to attempt to explain observations on both the macro and micro levels. Knowledge of physical principles allows understanding in other sciences and everyday experiences, (e.g., heat exchanges in the atmosphere as they relate to weather; pressure and temperature differences causing different geological formations; radiation of electromagnetic energy and how it affects photosynthesis; the behavior of light and the eye; electricity, electromagnetic waves and your cell phone; nuclear fission and power plants; atomic structure and chemical reactions).

The universe is in a state of constant change. From small particles (electrons) to the large systems (galaxies) all things are in motion. Therefore, understanding the universe requires the ability to describe and represent various types of motion. Kinematics, the description of motion, always involves measurements of position and time. The relationships between these quantities can be represented by mathematical statements, graphs, and motion maps. These representations are powerful tools that can not only describe past motions but can also predict future events.

Objects can interact with each other by direct contact (e.g., pushes or pulls, friction) or at a distance (e.g., gravity, electromagnetism). Forces are used for describing interactions between objects. Non-zero net forces always cause changes in motion (Newton's first law). These changes can be changes in speed, direction, or both. Newton's second law summarizes relationships between net forces, masses, and changes in motion. Whenever one object exerts a force on another, a force equal in magnitude and opposite in direction is exerted back on it (Newton's third law).

Energy is a constant in an ever-changing world. Energy from the sun fuels electrical storms, hurricanes, tornados, and photosynthesis. In turn, the products of photosynthesis (carbohydrates and oxygen) react during respiration to fuel the life processes, such as growth and reproduction, of plants and animals. Energy is the conceptual system for explaining how the universe works and accounting for changes in matter. (NAEP) Energy is not a "thing". "Three energy-related ideas are important. One is energy transformation. All physical events involve transferring energy or changing one form of energy into another. … A second idea is the conservation of energy. … A third idea is that whenever there is a transformation of energy, some of it is likely to go into heat which is spread around and is therefore not available for use." (*Benchmarks for Science Literacy*, AAAS, 1993)

Physics Content Statement Outline

STANDARD P1 Inquiry, Reflection, and Social Implications

P1.1 Scientific Inquiry
P1.2 Scientific Reflection and Social Implications

STANDARD P2 Motion of Objects

P2.1 Position – Time
P2.2 Velocity – Time
P2.3x Frames of Reference

STANDARD P3 Forces and Motion

P3.1 Basic Forces in Nature
P3.1x Forces
P3.2 Net Forces
P3.3 Newton's Third Law
P3.4 Forces and Acceleration
P3.5x Momentum
P3.6 Gravitational Interactions
P3.7 Electric Charges
P3.7x Electric Charges – Interactions
P3.p8 Magnetic Force *(prerequisite)*
P3.8x Electromagnetic Force

STANDARD P4 Forms of Energy and Energy Transformations

P4.1 Energy Transfer
P4.1x Energy Transfer – Work
P4.2 Energy Transformation
P4.3 Kinetic and Potential Energy
P4.3x Kinetic and Potential Energy – Calculations
P4.4 Wave Characteristics
P4.4x Wave Characteristics – Calculations
P4.5 Mechanical Wave Propagation
P4.6 Electromagnetic Waves
P4.6x Electromagnetic Propagation
P4.r7x Quantum Theory of Waves *(recommended)*
P4.8 Wave Behavior – Reflection and Refraction
P4.8x Wave Behavior – Diffraction, Interference, and Refraction
P4.9 Nature of Light
P4.r9x Nature of Light – Wave-Particle Nature *(recommended)*
P4.10 Current Electricity – Circuits
P4.10x Current Electricity – Ohm's Law, Work, and Power
P4.11x Heat, Temperature, and Efficiency
P4.12 Nuclear Reactions
P4.12x Mass and Energy

STANDARD P1: INQUIRY, REFLECTION, AND SOCIAL IMPLICATIONS

Students will understand the nature of science and demonstrate an ability to practice scientific reasoning by applying it to the design, execution, and evaluation of scientific investigations. Students will demonstrate their understanding that scientific knowledge is gathered through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation. They will be able to distinguish between types of scientific knowledge (e.g., hypotheses, laws, theories) and become aware of areas of active research in contrast to conclusions that are part of established scientific consensus. They will use their scientific knowledge to assess the costs, risks, and benefits of technological systems as they make personal choices and participate in public policy decisions. These insights will help them analyze the role science plays in society, technology, and potential career opportunities.

P1.1 Scientific Inquiry

Science is a way of understanding nature. Scientific research may begin by generating new scientific questions that can be answered through replicable scientific investigations that are logically developed and conducted systematically. Scientific conclusions and explanations result from careful analysis of empirical evidence and the use of logical reasoning. Some questions in science are addressed through indirect rather than direct observation, evaluating the consistency of new evidence with results predicted by models of natural processes. Results from investigations are communicated in reports that are scrutinized through a peer review process.

P1.1A Generate new questions that can be investigated in the laboratory or field.

P1.1B Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.

P1.1C Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity–length, volume, weight, time interval, temperature–with the appropriate level of precision).

P1.1D Identify patterns in data and relate them to theoretical models.

P1.1E Describe a reason for a given conclusion using evidence from an investigation.

P1.1f Predict what would happen if the variables, methods, or timing of an investigation were changed.

P1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation.

P1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.

P1.1i Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.

P1.2 Scientific Reflection and Social Implications

The integrity of the scientific process depends on scientists and citizens understanding and respecting the "Nature of Science." Openness to new ideas, skepticism, and honesty are attributes required for good scientific practice. Scientists must use logical reasoning during investigation design, analysis, conclusion, and communication. Science can produce critical insights on societal problems from a personal and local scale to a global scale. Science both aids in the development of technology and provides tools for assessing the costs, risks, and benefits of technological systems. Scientific conclusions and arguments play a role in personal choice and public policy decisions. New technology and scientific discoveries have had a major influence in shaping human history. Science and technology continue to offer diverse and significant career opportunities.

P1.2A Critique whether or not specific questions can be answered through scientific investigations.

P1.2B Identify and critique arguments about personal or societal issues based on scientific evidence.

P1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.

P1.2D Evaluate scientific explanations in a peer review process or discussion format.

P1.2E Evaluate the future career and occupational prospects of science fields.

P1.2f Critique solutions to problems, given criteria and scientific constraints.

P1.2g Identify scientific tradeoffs in design decisions and choose among alternative solutions.

P1.2h Describe the distinctions between scientific theories, laws, hypotheses, and observations.

P1.2i Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.

P1.2j Apply science principles or scientific data to anticipate effects of technological design decisions.

P1.2k Analyze how science and society interact from a historical, political, economic, or social perspective.

STANDARD P2: MOTION OF OBJECTS

The universe is in a state of constant change. From small particles (electrons) to the large systems (galaxies) all things are in motion. Therefore, for students to understand the universe they must describe and represent various types of motion. Kinematics, the description of motion, always involves measurements of position and time. Students must describe the relationships between these quantities using mathematical statements, graphs, and motion maps. They use these representations as powerful tools to not only describe past motions but also predict future events.

P2.1 Position — Time

An object's position can be measured and graphed as a function of time. An object's speed can be calculated and graphed as a function of time.

P2.1A Calculate the average speed of an object using the change of position and elapsed time.

P2.1B Represent the velocities for linear and circular motion using motion diagrams (arrows on strobe pictures).

P2.1C Create line graphs using measured values of position and elapsed time.

P2.1D Describe and analyze the motion that a position-time graph represents, given the graph.

P2.1E Describe and classify various motions in a plane as one dimensional, two dimensional, circular, or periodic.

P2.1F Distinguish between rotation and revolution and describe and contrast the two speeds of an object like the Earth.

P2.1g Solve problems involving average speed and constant acceleration in one dimension.

P2.1h Identify the changes in speed and direction in everyday examples of circular (rotation and revolution), periodic, and projectile motions.

P2.2 Velocity — Time

The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time.

P2.2A Distinguish between the variables of distance, displacement, speed, velocity, and acceleration.

P2.2B Use the change of speed and elapsed time to calculate the average acceleration for linear motion.

P2.2C Describe and analyze the motion that a velocity-time graph represents, given the graph.

P2.2D State that uniform circular motion involves acceleration without a change in speed.

P2.2e Use the area under a velocity-time graph to calculate the distance traveled and the slope to calculate the acceleration.

P2.2f Describe the relationship between changes in position, velocity, and acceleration during periodic motion.

P2.2g Apply the independence of the vertical and horizontal initial velocities to solve projectile motion problems.

P2.3x Frames of Reference

All motion is relative to whatever frame of reference is chosen, for there is no motionless frame from which to judge all motion.

P2.3a Describe and compare the motion of an object using different reference frames.

STANDARD P3: FORCES AND MOTION

Students identify interactions between objects either as being by direct contact (e.g., pushes or pulls, friction) or at a distance (e.g., gravity, electromagnetism), and to use forces to describe interactions between objects. They recognize that non-zero net forces always cause changes in motion (Newton's first law). These changes can be changes in speed, direction, or both. Students use Newton's second law to summarize relationships among and solve problems involving net forces, masses, and changes in motion (using standard metric units). They explain that whenever one object exerts a force on another, a force equal in magnitude and opposite in direction is exerted back on it (Newton's third law).

P3.1 Basic Forces in Nature

Objects can interact with each other by "direct contact" (e.g., pushes or pulls, friction) or at a distance (e.g., gravity, electromagnetism, nuclear).

P3.1A Identify the force(s) acting between objects in "direct contact" or at a distance.

P3.1x Forces

There are four basic forces (gravitational, electromagnetic, strong, and weak nuclear) that differ greatly in magnitude and range. Between any two charged particles, electric force is vastly greater than the gravitational force. Most observable forces (e.g., those exerted by a coiled spring or friction) may be traced to electric forces acting between atoms and molecules.

P3.1b Explain why scientists can ignore the gravitational force when measuring the net force between two electrons.

P3.1c Provide examples that illustrate the importance of the electric force in everyday life.

P3.1d Identify the basic forces in everyday interactions.

P3.2 Net Forces

Forces have magnitude and direction. The net force on an object is the sum of all the forces acting on the object. Objects change their speed and/or direction only when a net force is applied. If the net force on an object is zero, there is no change in motion (Newton's First Law).

P3.2A Identify the magnitude and direction of everyday forces (e.g., wind, tension in ropes, pushes and pulls, weight).

P3.2B Compare work done in different situations.

P3.2C Calculate the net force acting on an object.

P3.2d Calculate all the forces on an object on an inclined plane and describe the object's motion based on the forces using free-body diagrams.

P3.3 Newton's Third Law

Whenever one object exerts a force on another object, a force equal in magnitude and opposite in direction is exerted back on the first object.

P3.3A Identify the action and reaction force from examples of forces in everyday situations (e.g., book on a table, walking across the floor, pushing open a door).

P3.3b Predict how the change in velocity of a small mass compares to the change in velocity of a large mass when the objects interact (e.g., collide).

P3.3c Explain the recoil of a projectile launcher in terms of forces and masses.

P3.3d Analyze why seat belts may be more important in autos than in buses.

P3.4 Forces and Acceleration

The change of speed and/or direction (acceleration) of an object is proportional to the net force and inversely proportional to the mass of the object. The acceleration and net force are always in the same direction.

P3.4A Predict the change in motion of an object acted on by several forces.

P3.4B Identify forces acting on objects moving with constant velocity (e.g., cars on a highway).

P3.4C Solve problems involving force, mass, and acceleration in linear motion (Newton's second law).

P3.4D Identify the force(s) acting on objects moving with uniform circular motion (e.g., a car on a circular track, satellites in orbit).

P3.4e Solve problems involving force, mass, and acceleration in two-dimensional projectile motion restricted to an initial horizontal velocity with no initial vertical velocity (e.g., ball rolling off a table).

P3.4f Calculate the changes in velocity of a thrown or hit object during and after the time it is acted on by the force.

P3.4g Explain how the time of impact can affect the net force (e.g., air bags in cars, catching a ball).

P3.5x Momentum

A moving object has a quantity of motion (momentum) that depends on its velocity and mass. In interactions between objects, the total momentum of the objects does not change.

P3.5a Apply conservation of momentum to solve simple collision problems.

P3.6 Gravitational Interactions

Gravitation is a universal attractive force that a mass exerts on every other mass. The strength of the gravitational force between two masses is proportional to the masses and inversely proportional to the square of the distance between them.

P3.6A Explain earth-moon interactions (orbital motion) in terms of forces.

P3.6B Predict how the gravitational force between objects changes when the distance between them changes.

P3.6C Explain how your weight on Earth could be different from your weight on another planet.

P3.6d Calculate force, masses, or distance, given any three of these quantities, by applying the Law of Universal Gravitation, given the value of G.

P3.6e Draw arrows (vectors) to represent how the direction and magnitude of a force changes on an object in an elliptical orbit.

P3.7 Electric Charges

Electric force exists between any two charged objects. Oppositely charged objects attract, while objects with like charge repel. The strength of the electric force between two charged objects is proportional to the magnitudes of the charges and inversely proportional to the square of the distance between them (Coulomb's Law).

P3.7A Predict how the electric force between charged objects varies when the distance between them and/or the magnitude of charges change.

P3.7B Explain why acquiring a large excess static charge (e.g., pulling off a wool cap, touching a Van de Graaff generator, combing) affects your hair.

P3.7x Electric Charges — Interactions

Charged objects can attract electrically neutral objects by induction.

P3.7c Draw the redistribution of electric charges on a neutral object when a charged object is brought near.

P3.7d Identify examples of induced static charges.

P3.7e Explain why an attractive force results from bringing a charged object near a neutral object.

P3.7f Determine the new electric force on charged objects after they touch and are then separated.

P3.7g Propose a mechanism based on electric forces to explain current flow in an electric circuit.

P3.p8 Magnetic Force (prerequisite)

Magnets exert forces on all objects made of ferromagnetic materials (e.g., iron, cobalt, and nickel) as well as other magnets. This force acts at a distance. Magnetic fields accompany magnets and are related to the strength and direction of the magnetic force. *(prerequisite)*

P3.p8A Create a representation of magnetic field lines around a bar magnet and qualitatively describe how the relative strength and direction of the magnetic force changes at various places in the field. *(prerequisite)*

P3.8x Electromagnetic Force

Magnetic and electric forces are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces and moving magnets produce electric forces (e.g., electric current in a conductor).

P3.8b Explain how the interaction of electric and magnetic forces is the basis for electric motors, generators, and the production of electromagnetic waves.

STANDARD P4: FORMS OF ENERGY AND ENERGY TRANSFORMATIONS

Energy is a useful conceptual system for explaining how the universe works and accounting for changes in matter. Energy is not a "thing." Students develop several energy-related ideas: First, they keep track of energy during transfers and transformations, and account for changes using energy conservation. Second, they identify places where energy is apparently lost during a transformation process, but is actually spread around to the environment as thermal energy and therefore not easily recoverable. Third, they identify the means of energy transfers: collisions between particles, or waves.

P4.1 Energy Transfer

Moving objects and waves transfer energy from one location to another. They also transfer energy to objects during interactions (e.g., sunlight transfers energy to the ground when it warms the ground; sunlight also transfers energy from the Sun to the Earth).

P4.1A Account for and represent energy into and out of systems using energy transfer diagrams.

P4.1B Explain instances of energy transfer by waves and objects in everyday activities (e.g., why the ground gets warm during the day, how you hear a distant sound, why it hurts when you are hit by a baseball).

P4.1x Energy Transfer — Work

Work is the amount of energy transferred during an interaction. In mechanical systems, work is the amount of energy transferred as an object is moved through a distance, $W = Fd$, where d is in the same direction as F. The total work done on an object depends on the net force acting on the object and the object's displacement.

P4.1c Explain why work has a more precise scientific meaning than the meaning of work in everyday language.

P4.1d Calculate the amount of work done on an object that is moved from one position to another.

P4.1e Using the formula for work, derive a formula for change in potential energy of an object lifted a distance h.

P4.2 Energy Transformation

Energy is often transformed from one form to another. The amount of energy before a transformation is equal to the amount of energy after the transformation. In most energy transformations, some energy is converted to thermal energy.

P4.2A Account for and represent energy transfer and transformation in complex processes (interactions).

P4.2B Name devices that transform specific types of energy into other types (e.g., a device that transforms electricity into motion).

P4.2C Explain how energy is conserved in common systems (e.g., light incident on a transparent material, light incident on a leaf, mechanical energy in a collision).

P4.2D Explain why all the stored energy in gasoline does not transform to mechanical energy of a vehicle.

P4.2e Explain the energy transformation as an object (e.g., skydiver) falls at a steady velocity.

P4.2f Identify and label the energy inputs, transformations, and outputs using qualitative or quantitative representations in simple technological systems (e.g., toaster, motor, hair dryer) to show energy conservation.

P4.3 Kinetic and Potential Energy

Moving objects have kinetic energy. Objects experiencing a force may have potential energy due to their relative positions (e.g., lifting an object or stretching a spring, energy stored in chemical bonds). Conversions between kinetic and gravitational potential energy are common in moving objects. In frictionless systems, the decrease in gravitational potential energy is equal to the increase in kinetic energy or vice versa.

P4.3A Identify the form of energy in given situations (e.g., moving objects, stretched springs, rocks on cliffs, energy in food).

P4.3B Describe the transformation between potential and kinetic energy in simple mechanical systems (e.g., pendulums, roller coasters, ski lifts).

P4.3C Explain why all mechanical systems require an external energy source to maintain their motion.

P4.3x Kinetic and Potential Energy — Calculations

The kinetic energy of an object is related to the mass of an object and its speed: $KE = {}^1/_2\ mv^2$.

P4.3d Rank the amount of kinetic energy from highest to lowest of everyday examples of moving objects.

P4.3e Calculate the changes in kinetic and potential energy in simple mechanical systems (e.g., pendulums, roller coasters, ski lifts) using the formulas for kinetic energy and potential energy.

P4.3f Calculate the impact speed (ignoring air resistance) of an object dropped from a specific height or the maximum height reached by an object (ignoring air resistance), given the initial vertical velocity.

P4.4 Wave Characteristics

Waves (mechanical and electromagnetic) are described by their wavelength, amplitude, frequency, and speed.

P4.4A Describe specific mechanical waves (e.g., on a demonstration spring, on the ocean) in terms of wavelength, amplitude, frequency, and speed.

P4.4B Identify everyday examples of transverse and compression (longitudinal) waves.

P4.4C Compare and contrast transverse and compression (longitudinal) waves in terms of wavelength, amplitude, and frequency.

P4.4x Wave Characteristics — Calculations

Wave velocity, wavelength, and frequency are related by $v = \lambda f$. The energy transferred by a wave is proportional to the square of the amplitude of vibration and its frequency.

P4.4d Demonstrate that frequency and wavelength of a wave are inversely proportional in a given medium.

P4.4e Calculate the amount of energy transferred by transverse or compression waves of different amplitudes and frequencies (e.g., seismic waves).

P4.5 Mechanical Wave Propagation

Vibrations in matter initiate mechanical waves (e.g., water waves, sound waves, seismic waves), which may propagate in all directions and decrease in intensity in proportion to the distance squared for a point source. Waves transfer energy from one place to another without transferring mass.

P4.5A Identify everyday examples of energy transfer by waves and their sources.

P4.5B Explain why an object (e.g., fishing bobber) does not move forward as a wave passes under it.

P4.5C Provide evidence to support the claim that sound is energy transferred by a wave, not energy transferred by particles.

P4.5D Explain how waves propagate from vibrating sources and why the intensity decreases with the square of the distance from a point source.

P4.5E Explain why everyone in a classroom can hear one person speaking, but why an amplification system is often used in the rear of a large concert auditorium.

P4.6 Electromagnetic Waves

Electromagnetic waves (e.g., radio, microwave, infrared, visible light, ultraviolet, x-ray) are produced by changing the motion (acceleration) of charges or by changing magnetic fields. Electromagnetic waves can travel through matter, but they do not require a material medium. (That is, they also travel through empty space.) All electromagnetic waves move in a vacuum at the speed of light. Types of electromagnetic radiation are distinguished from each other by their wavelength and energy.

P4.6A Identify the different regions on the electromagnetic spectrum and compare them in terms of wavelength, frequency, and energy.

P4.6B Explain why radio waves can travel through space, but sound waves cannot.

P4.6C Explain why there is a delay between the time we send a radio message to astronauts on the moon and when they receive it.

P4.6D Explain why we see a distant event before we hear it (e.g., lightning before thunder, exploding fireworks before the boom).

P4.6x Electromagnetic Propagation

Modulated electromagnetic waves can transfer information from one place to another (e.g., televisions, radios, telephones, computers and other information technology devices). Digital communication makes more efficient use of the limited electromagnetic spectrum, is more accurate than analog transmission, and can be encrypted to provide privacy and security.

P4.6e Explain why antennas are needed for radio, television, and cell phone transmission and reception.

P4.6f Explain how radio waves are modified to send information in radio and television programs, radio-control cars, cell phone conversations, and GPS systems.

P4.6g Explain how different electromagnetic signals (e.g., radio station broadcasts or cell phone conversations) can take place without interfering with each other.

P4.6h Explain the relationship between the frequency of an electromagnetic wave and its technological uses.

P4.r7x Quantum Theory of Waves *(recommended)*

Electromagnetic energy is transferred on the atomic scale in discrete amounts called quanta. The equation $E = hf$ quantifies the relationship between the energy transferred and the frequency, where h is Planck's constant. *(recommended)*

P4.r7a Calculate and compare the energy in various electromagnetic quanta (e.g., visible light, x-rays). *(recommended)*

P4.8 Wave Behavior — Reflection and Refraction

The laws of reflection and refraction describe the relationships between incident and reflected/refracted waves.

P4.8A Draw ray diagrams to indicate how light reflects off objects or refracts into transparent media.

P4.8B Predict the path of reflected light from flat, curved, or rough surfaces (e.g., flat and curved mirrors, painted walls, paper).

P4.8x Wave Behavior — Diffraction, Interference, and Refraction

Waves can bend around objects (diffraction). They also superimpose on each other and continue their propagation without a change in their original properties (interference). When refracted, light follows a defined path.

P4.8c Describe how two wave pulses propagated from opposite ends of a demonstration spring interact as they meet.

P4.8d List and analyze everyday examples that demonstrate the interference characteristics of waves (e.g., dead spots in an auditorium, whispering galleries, colors in a CD, beetle wings).

P4.8e Given an angle of incidence and indices of refraction of two materials, calculate the path of a light ray incident on the boundary (Snell's Law).

P4.8f Explain how Snell's Law is used to design lenses (e.g., eye glasses, microscopes, telescopes, binoculars).

P4.9 Nature of Light

Light interacts with matter by reflection, absorption, or transmission.

P4.9A Identify the principle involved when you see a transparent object (e.g., straw, piece of glass) in a clear liquid.

P4.9B Explain how various materials reflect, absorb, or transmit light in different ways.

P4.9C Explain why the image of the Sun appears reddish at sunrise and sunset.

P4.r9x Nature of Light — Wave-Particle Nature *(recommended)*

The dual wave-particle nature of matter and light is the foundation for modern physics. *(recommended)*

P4.r9d Describe evidence that supports the dual wave - particle nature of light. *(recommended)*

P4.10 Current Electricity — Circuits

Current electricity is described as movement of charges. It is a particularly useful form of energy because it can be easily transferred from place to place and readily transformed by various devices into other forms of energy (e.g., light, heat, sound, and motion). Electrical current (amperage) in a circuit is determined by the potential difference (voltage) of the power source and the resistance of the loads in the circuit.

P4.10A Describe the energy transformations when electrical energy is produced and transferred to homes and businesses.

P4.10B Identify common household devices that transform electrical energy to other forms of energy, and describe the type of energy transformation.

P4.10C Given diagrams of many different possible connections of electric circuit elements, identify complete circuits, open circuits, and short circuits and explain the reasons for the classification.

P4.10D Discriminate between voltage, resistance, and current as they apply to an electric circuit.

P4.10x Current Electricity — Ohm's Law, Work, and Power

In circuits, the relationship between electric current, I, electric potential difference, V, and resistance, R, is quantified by $V = I\,R$ (Ohm's Law). Work is the amount of energy transferred during an interaction. In electrical systems, work is done when charges are moved through the circuit. Electric power is the amount of work done by an electric current in a unit of time, which can be calculated using $P = I\,V$.

P4.10e Explain energy transfer in a circuit, using an electrical charge model.

P4.10f Calculate the amount of work done when a charge moves through a potential difference, V.

P4.10g Compare the currents, voltages, and power in parallel and series circuits.

P4.10h Explain how circuit breakers and fuses protect household appliances.

P4.10i Compare the energy used in one day by common household appliances (e.g., refrigerator, lamps, hair dryer, toaster, televisions, music players).

P4.10j Explain the difference between electric power and electric energy as used in bills from an electric company.

P4.11x Heat, Temperature, and Efficiency

Heat is often produced as a by-product during energy transformations. This energy is transferred into the surroundings and is not usually recoverable as a useful form of energy. The efficiency of systems is defined as the ratio of the useful energy output to the total energy input. The efficiency of natural and human-made systems varies due to the amount of heat that is not recovered as useful work.

P4.11a Calculate the energy lost to surroundings when water in a home water heater is heated from room temperature to the temperature necessary to use in a dishwasher, given the efficiency of the home hot water heater.

P4.11b Calculate the final temperature of two liquids (same or different materials) at the same or different temperatures and masses that are combined.

P4.12 Nuclear Reactions

Changes in atomic nuclei can occur through three processes: fission, fusion, and radioactive decay. Fission and fusion can convert small amounts of matter into large amounts of energy. Fission is the splitting of a large nucleus into smaller nuclei at extremely high temperature and pressure. Fusion is the combination of smaller nuclei into a large nucleus and is responsible for the energy of the Sun and other stars. Radioactive decay occurs naturally in the Earth's crust (rocks, minerals) and can be used in technological applications (e.g., medical diagnosis and treatment).

P4.12A Describe peaceful technological applications of nuclear fission and radioactive decay.

P4.12B Describe possible problems caused by exposure to prolonged radioactive decay.

P4.12C Explain how stars, including our Sun, produce huge amounts of energy (e.g., visible, infrared, ultraviolet light).

P4.12x Mass and Energy

In nuclear reactions, a small amount of mass is converted to a large amount of energy, $E = mc^2$, where c is the speed of light in a vacuum. The amount of energy before and after nuclear reactions must consider mass changes as part of the energy transformation.

P4.12d Identify the source of energy in fission and fusion nuclear reactions.

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High School Content Expectations

ENGLISH LANGUAGE ARTS

- Writing, Speaking, and Expressing
- Reading, Listening, and Viewing
- Literature and Culture
- Language

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Welcome to Michigan's High School English Language Arts Content Standards and Expectations

Why Develop Content Standards and Expectations for High School?

In 2004, the Michigan Department of Education embraced the challenge to initiate a "high school redesign" project. Since then, the national call to create more rigorous learning for high school students has become a major priority for state leaders across the country. The Cherry Commission Report highlighted several goals for Michigan including the development of high school content expectations that reflect both a rigorous and a relevant curricular focus. Dovetailing with this call to "curricular action" is Michigan's legislative change in high school assessment. The Michigan Merit Exam, based on rigorous high school learning standards, is to be fully implemented by 2007.

Given these two catalysts, the Michigan Department of Education's Office of School Improvement led the development of high school content expectations for English Language Arts and Mathematics. Content area work groups of academicians chaired by a nationally known scholar in the respective field, were commissioned to conduct a scholarly review and identify content standards and expectations. These content standards and expectations have gone through an extensive field and national review and are presented to educators in this document.

An Overview

The expectations contained in this document reflect best practices and current research in the teaching and learning of English language, the craft of writing, and literature. They not only build from the *Michigan English Language Arts Curriculum Framework Standards and Benchmarks* (1996), the *Career and Employability Skills Content Standards and Benchmarks* (2001), but extend the *Michigan K-8 English Language Arts Grade Level Content Expectations* (2004) as appropriate for grades 9-12. These standards and expectations represent a vision for a rigorous and relevant high school experience for all Michigan students, with special attention being paid to national research and support for the skills that prepare students for succcessful post-secondary engagement in the workplace. The standards and expectations are closely aligned with national standards as described in College Board's *Standards for College Success* (2005), ACT's *College Readiness Standards*, American Diploma Project's *Ready or Not: Creating a High School DiplomaThat Counts* (2004), NCTE/IRA Standards for the English Language Arts (1996), the National Communication Association Guiding Principles for Speaking and Listening (1996), and the National Assessment Governing Board's *Reading Framework for the 2009 National Assessment of Educational Progress* (NAEP, 2005).

The ELA Standards are built upon the expectation that students will engage in broad reading and writing experiences to encompass literary texts, nonfiction literary texts, and other informational texts. Within Michigan's continued commitment to the wide range of academic rigor and mastery needed by successful English Language Arts graduates, these expectations incorporate a new emphasis on informational text comprehension and workplace reading/writing skills.

Examples of Text:

- Literary: myth, folklore, epic, oral narrative, plays, allegory, satire, poetry, short stories, novels, popular and series fiction, music lyrics, film
- Creative/Literary Nonfiction: personal and literary essays, memoirs, auto-biographies, biographies, commentaries, nature writing, advertising
- Informational: cultural and historical documents, scholarly essays and writing, persuasive/argumentative essays, historical and literary analysis, research and technical reports, book reviews, textbooks and manuals, compare/contrast essays, speeches, newspapers, propaganda, legal documents, proposals, informational presentations, memos, and letters

Understanding the Organizational Structure

The expectations in this document are divided into four strands with multiple standards within each, as shown below. The skills and content addressed in these standards will, in practice, be woven together into a coherent, integrated English language arts curriculum. While the standards are comprehensive, they are not meant to be used as a proportional guide to curriculum development. For example, students and teachers are not expected to spend equal time on each strand or standard, and content should logically be divided among courses (e.g., not every class must address American, British, and world literature). Writing, reading, speaking, listening, viewing, and visually expressing are recursive and reinforcing processes; students learn by engaging in and reflecting on these processes at increasingly complex levels over time. Many of the skills addressed in Language Arts classes will also be re-inforced by teachers in other disciplines across the curriculum, while beyond the English language arts curriculum, students will use the English language arts processes to support their learning in all content areas.

STRAND 1 **Writing, Speaking, and Expressing**	**STRAND 2** **Reading, Listening, and Viewing**	**STRAND 3** **Literature and Culture**	**STRAND 4** **Language**
STANDARDS (and number of expectations in each standard)			
	Narrative and Informational (Literary and Expository) Text		
1.1: Writing Process (8) **1.2: Personal Growth** (4) **1.3: Purpose and Audience** (9) **1.4: Inquiry and Research** (7) **1.5: Finished Products** (5)	**2.1: Strategy Development** (12) **2.2: Meaning Beyond the Literal Level** (3) **2.3: Independent Reading** (8)	**3.1: Close Literary Reading** (10) **3.2: Reading and Response *(varied genres and time periods)*** (5) **3.3: Text Analysis** (6) **3.4: Mass Media** (4)	**4.1: Effective Use of the English Language** (5) **4.2: Language Variety** (5)

Beliefs

Standards for English language arts are developed with certain beliefs in mind:

- Listening, speaking, reading, writing, viewing, and expressing are critical for all students.
- With appropriate instruction, all students can be successful listeners, speakers, readers, and writers.
- Acquaintance with content, strategies, and skills does not equal mastery. The English language arts are highly recursive and must be continuously developed as students engage with more complex ideas, texts, and tasks.
- Students learn best by being actively involved in high quality, challenging experiences; they demonstrate their learning best in authentic contexts. Not all skills are easily testable, especially on standardized tests; therefore, the curriculum must not be limited to teaching skills that are so tested.
- High standards in the English language arts support the acquisition of skills and strategies for reading and writing in a variety of genres and for varying purposes: skills and strategies that students can transfer independently to writing beyond the classroom.
- Conventions for edited and finished texts are important and help to shape the way a message is received. Students need to understand and be able to use Standard English as appropriate for composing and speaking tasks.
- Classroom teachers have extensive content knowledge, an ability to make on-going, data-driven curriculum decisions, and the ability to adapt curriculum to student needs. Teacher passion and creativity is essential to learning.

Curriculum and Assessment

This document is intended to support conversations at the school and district levels that result in rigorous and relevant curriculum incorporating these content expectations. The expectations should be addressed recursively and with increasing complexity throughout the high school language arts curriculum.

As stakeholders (e.g., teachers, administrators, school board members, parents, community members, students, local legislative representatives) work with these standards, they should consider the following questions:

- How are these content standards and expectations reflected in our curriculum and instruction already?
- Where do we need to strengthen our curriculum and instruction to more fully realize the intent of these standards and expectations?
- What opportunities do these standards and expectations present to develop new and strengthen existing curriculum, leading to instructional excellence and college/workplace readiness?
- How do we implement these standards and expectations taking into account what we know about our students, school, and community?
- How will we assess the effectiveness with which our students and schools are meeting these standards and content expectations?
- How can we use school-based assessments (e.g., student portfolios, school-based writing assessments, teacher or classroom research, district-level assessments) to make data-driven decisions about teaching and learning?

Through conversations about questions such as these, and building upon the multitude of existing strengths in our current high schools, voices of all stakeholders will participate in the important and continuing process of shaping instructional excellence in Michigan schools and preparing Michigan students for college and the workplace.

English Language Arts*

The English language arts are the vehicles of communication by which we live, work, share, and build ideas and understandings of the present, reflect on the past, and imagine the future. Through the English language arts, we learn to appreciate, integrate, and apply what is learned for real purposes in our homes, schools, communities, and workplaces.

The English language arts encompass process and content – how people communicate as well as what they communicate. Process includes skills and strategies used in listening, speaking, reading, writing, viewing, and expressing. Content includes the ideas, themes, issues, problems, and conflicts found in classical and contemporary literature and other texts, such as technical manuals, periodicals, speeches, and videos. Ideas, experiences, and cultural perspectives we discover in texts help us shape our vision of the world. The insights we gain enable us to understand our cultural, linguistic, and literary heritages.

The ultimate goal for all English language arts learners is personal, social, occupational, and civic literacy. Literacy goes beyond the ability to read and write at basic levels. Literate individuals understand the different functions of English language arts for personal, social, and political purposes (e.g., for personal enjoyment and interest; for communicating with and understanding others; for accomplishing goals, understanding others' perspectives, shaping opinions and attitudes, and controlling behaviors).

As a contributing citizen, a literate individual:

- communicates skillfully and effectively through printed, visual, auditory, and technological media in the home, school, community and workplace;
- thinks analytically and creatively about important themes, concepts, and ideas;
- uses the English language arts to identify and solve problems;
- uses the English language arts to understand and appreciate the commonalities and differences within social, cultural, and linguistic communities;
- understands and appreciates the aesthetic elements of oral, visual, and written texts;
- uses the English language arts to develop insights about human experiences;
- uses the English language arts to develop the characteristics of lifelong learners and workers, such as curiosity, patience, flexibility, and reflection; and,
- connects all knowledge from all curriculum areas to enhance understanding of the world.

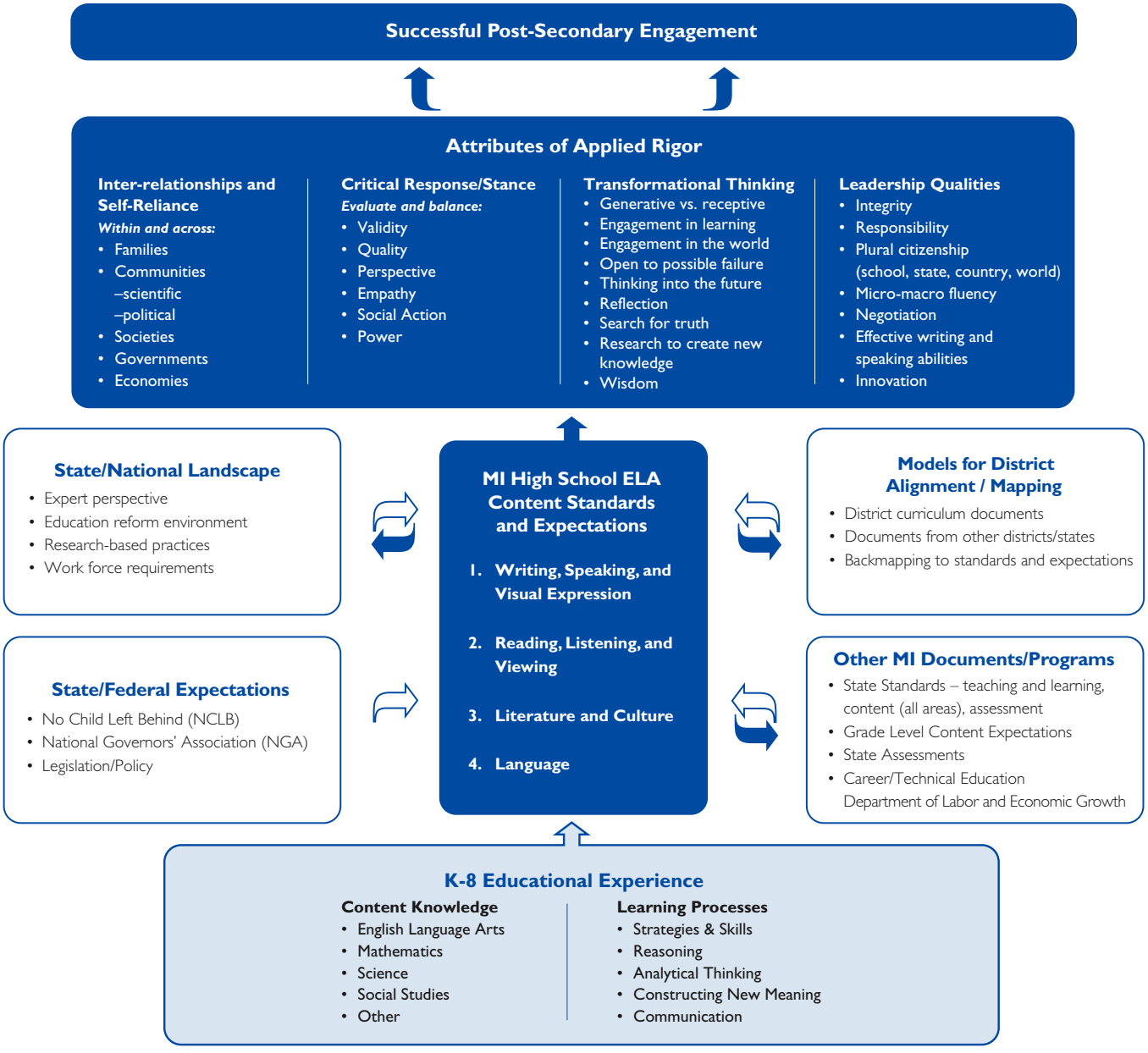
**Adapted from Michigan Curriculum Framework 1996*

Preparing Students for Successful Post-Secondary Engagement

As educators use these standards and expectations to develop rigorous and relevant units of instruction, powerful and engaging learning activities, and challenging high school curricula, it is critical to keep in mind that content knowledge alone will not provide adequate preparation for success in entry-level university courses or entry-level positions in today's workforce.

Successful post-secondary engagement requires that students must be able to apply knowledge in new situations; to solve problems by generating new ideas; to make connections between what they read and hear in class, the world around them, and the future; and through their work, develop leadership qualities while still in high school.

Therefore, educators must model for and develop in students the cognitive skills and habits of mind that will result in attributes of applied rigor as indentified in the chart below.



This chart includes talking points for the professional development model.

STRAND 1: WRITING, SPEAKING, AND VISUAL EXPRESSION

Writing and speaking involve a complex process of inquiry and the discovery of meaning. Through writing, speaking, and visually expressing, students understand themselves, communicate with others, advance personal and professional goals, and participate in a democratic society. Effective communication requires an understanding of purpose and audience, and reflects well-developed ideas using appropriate conventions of genre, content, form, style, voice, and mechanics.

STANDARD 1.1 *Understand and practice writing as a recursive process.*

CE 1.1.1 Demonstrate flexibility in using independent and collaborative strategies for planning, drafting, revising, and editing complex texts.

CE 1.1.2 Know and use a variety of prewriting strategies to generate, focus, and organize ideas (e.g., free writing, clustering/mapping, talking with others, brainstorming, outlining, developing graphic organizers, taking notes, summarizing, paraphrasing).

CE 1.1.3 Select and use language that is appropriate (e.g., formal, informal, literary, or technical) for the purpose, audience, and context of the text, speech, or visual representation (e.g., letter to editor, proposal, poem, or digital story).

CE 1.1.4 Compose drafts that convey an impression, express an opinion, raise a question, argue a position, explore a topic, tell a story, or serve another purpose, while simultaneously considering the constraints and possibilities (e.g., structure, language, use of conventions of grammar, usage, and mechanics) of the selected form or genre.

CE 1.1.5 Revise drafts to more fully and/or precisely convey meaning—drawing on response from others, self-reflection, and reading one's own work with the eye of a reader; then refine the text—deleting and/or reorganizing ideas, and addressing potential readers' questions.

CE 1.1.6 Reorganize sentence elements as needed and choose grammatical and stylistic options that provide sentence variety, fluency, and flow.

CE 1.1.7 Edit for style, tone, and word choice (specificity, variety, accuracy, appropriateness, conciseness) and for conventions of grammar, usage and mechanics that are appropriate for audience.

CE 1.1.8 Proofread to check spelling, layout, and font; and prepare selected pieces for a public audience.

STANDARD 1.2 *Use writing, speaking, and visual expression for personal understanding and growth.*

CE 1.2.1 Write, speak, and use images and graphs to understand and discover complex ideas.

CE 1.2.2 Write, speak, and visually represent to develop self-awareness and insight (e.g., diary, journal writing, portfolio self-assessment).

CE 1.2.3 Write, speak, and create artistic representations to express personal experience and perspective (e.g., personal narrative, poetry, imaginative writing, slam poetry, blogs, webpages).

CE 1.2.4 Assess strengths, weaknesses, and development as a writer by examining a collection of own writing.

STANDARD 1.3 ***Communicate in speech, writing, and multimedia using content, form, voice, and style appropriate to the audience and purpose (e.g., to reflect, persuade, inform, analyze, entertain, inspire).***

CE 1.3.1 Compose written, spoken, and/or multimedia compositions in a range of genres (e.g., personal narrative, biography, poem, fiction, drama, creative nonfiction, summary, literary analysis essay, research report, or work-related text): pieces that serve a variety of purposes (e.g., expressive, informative, creative, and persuasive) and that use a variety of organizational patterns (e.g., autobiography, free verse, dialogue, comparison/contrast, definition, or cause and effect).

CE 1.3.2 Compose written and spoken essays or work-related text that demonstrate logical thinking and the development of ideas for academic, creative, and personal purposes: essays that convey the author's message by using an engaging introduction (with a clear thesis as appropriate), well-constructed paragraphs, transition sentences, and a powerful conclusion.

CE 1.3.3 Compose essays with well-crafted and varied sentences demonstrating a precise, flexible, and creative use of language.

CE 1.3.4 Develop and extend a thesis, argument, or exploration of a topic by analyzing differing perspectives and employing a structure that effectively conveys the ideas in writing (e.g. resolve inconsistencies in logic; use a range of strategies to persuade, clarify, and defend a position with precise and relevant evidence; anticipate and address concerns and counterclaims; provide a clear and effective conclusion).

CE 1.3.5 From the outset, identify and assess audience expectations and needs; consider the rhetorical effects of style, form, and content based on that assessment; and adapt communication strategies appropriately and effectively.

CE 1.3.6 Use speaking, writing, and visual presentations to appeal to audiences of different social, economic, and cultural backgrounds and experiences (e.g., include explanations and definitions according to the audience's background, age, or knowledge of the topic; adjust formality of style; consider interests of potential readers).

CE 1.3.7 Participate collaboratively and productively in groups (e.g., response groups, work teams, discussion groups, and committees)—fulfilling roles and responsibilities, posing relevant questions, giving and following instructions, acknowledging and building on ideas and contributions of others to answer questions or to solve problems, and offering dissent courteously.

CE 1.3.8 Evaluate own and others' effectiveness in group discussions and formal presentations (e.g., considering accuracy, relevance, clarity, and delivery; types of arguments used; and relationships among purpose, audience, and content).

CE 1.3.9 Use the formal, stylistic, content, and mechanical conventions of a variety of genres in speaking, writing, and multimedia presentations.

STANDARD 1.4 *Develop and use the tools and practices of inquiry and research—generating, exploring, and refining important questions; creating a hypothesis or thesis; gathering and studying evidence; drawing conclusions; and composing a report.*

CE 1.4.1 Identify, explore, and refine topics and questions appropriate for research.

CE 1.4.2 Develop a system for gathering, organizing, paraphrasing, and summarizing information; select, evaluate, synthesize, and use multiple primary and secondary (print and electronic) resources.

CE 1.4.3 Develop and refine a position, claim, thesis, or hypothesis that will be explored and supported by analyzing different perspectives, resolving inconsistencies, and writing about those differences in a structure appropriate for the audience (e.g., argumentative essay that avoids inconsistencies in logic and develops a single thesis; exploratory essay that explains differences and similarities and raises additional questions).

CE 1.4.4 Interpret, synthesize, and evaluate information/findings in various print sources and media (e.g., fact and opinion, comprehensiveness of the evidence, bias, varied perspectives, motives and credibility of the author, date of publication) to draw conclusions and implications.

CE 1.4.5 Develop organizational structures appropriate to the purpose and message, and use transitions that produce a sequential or logical flow of ideas.

CE 1.4.6 Use appropriate conventions of textual citation in different contexts (e.g., different academic disciplines and workplace writing situations).

CE 1.4.7 Recognize the role of research, including student research, as a contribution to collective knowledge, selecting an appropriate method or genre through which research findings will be shared and evaluated, keeping in mind the needs of the prospective audience. (e.g., presentations, online sharing, written products such as a research report, a research brief, a multi-genre report, I-Search, literary analysis, news article).

STANDARD 1.5 *Produce a variety of written, spoken, multigenre, and multimedia works, making conscious choices about language, form, style, and/or visual representation for each work (e.g., poetry, fiction and creative nonfiction stories, academic and literary essays, proposals, memos, manifestos, business letters, advertisements, prepared speeches, group and dramatic performances, poetry slams, and digital stories).*

CE 1.5.1 Use writing, speaking, and visual expression to develop powerful, creative and critical messages.

CE 1.5.2 Prepare spoken and multimedia presentations that effectively address audiences by careful use of voice, pacing, gestures, eye contact, visual aids, audio and video technology.

CE 1.5.3 Select format and tone based on the desired effect and audience, using effective written and spoken language, sound, and/or visual representations (e.g., focus, transitions, facts, detail and evidence to support judgments, skillful use of rhetorical devices, and a coherent conclusion).

CE 1.5.4 Use technology tools (e.g, word processing, presentation and multimedia software) to produce polished written and multimedia work (e.g., literary and expository works, proposals, business presentations, advertisements).

CE 1.5.5 Respond to and use feedback to strengthen written and multimedia presentations (e.g., clarify and defend ideas, expand on a topic, use logical arguments, modify organization, evaluate effectiveness of images, set goals for future presentations).

STRAND 2: READING, LISTENING, AND VIEWING

In constructing meaning while reading, listening, or viewing, students draw upon prior knowledge and engage complex skills and strategies of comprehension and interpretation, and critical thinking. They develop skill, confidence, and independence in understanding narrative and expository texts, including aural, visual, and multimodal works. Students synthesize information through reading, listening, and viewing and also generate new thinking.

STANDARD 2.1 *Develop critical reading, listening, and viewing strategies.*

CE 2.1.1 Use a variety of pre-reading and previewing strategies (e.g., acknowledge own prior knowledge, make connections, generate questions, make predictions, scan a text for a particular purpose or audience, analyze text structure and features) to make conscious choices about how to approach the reading based on purpose, genre, level of difficulty, text demands and features.

CE 2.1.2 Make supported inferences and draw conclusions based on informational print and multimedia features (e.g., prefaces, appendices, marginal notes, illustrations, bibliographies, author's pages, footnotes, diagrams, tables, charts, maps, timelines, graphs, and other visual and special effects) and explain how authors and speakers use them to infer the organization of text and enhance understanding, convey meaning, and inspire or mislead audiences.

CE 2.1.3 Determine the meaning of unfamiliar words, specialized vocabulary, figurative language, idiomatic expressions, and technical meanings of terms through context clues, word roots and affixes, and the use of appropriate resource materials such as print and electronic dictionaries.

CE 2.1.4 Identify and evaluate the primary focus, logical argument, structure, and style of a text or speech and the ways in which these elements support or confound meaning or purpose.

CE 2.1.5 Analyze and evaluate the components of multiple organizational patterns (e.g., compare/contrast, cause/effect, problem/solution, fact/opinion, theory/evidence).

CE 2.1.6 Recognize the defining characteristics of informational texts, speeches, and multimedia presentations (e.g., documentaries and research presentations) and elements of expository texts (e.g., thesis, supporting ideas, and statistical evidence); critically examine the argumentation and conclusions of multiple informational texts.

CE 2.1.7 Demonstrate understanding of written, spoken, or visual information by restating, paraphrasing, summarizing, critiquing, or composing a personal response; distinguish between a summary and a critique.

CE 2.1.8 Recognize the conventions of visual and multimedia presentations (e.g., lighting, camera angle, special effects, color, and soundtrack) and how they carry or influence messages.

CE 2.1.9 Examine the intersections and distinctions between visual (media images, painting, film, and graphic arts) and verbal communication.

CE 2.1.10 Listen to and view speeches, presentations, and multimedia works to identify and respond thoughtfully to key ideas, significant details, logical organization, fact and opinion, and propaganda.

CE 2.1.11 Demonstrate appropriate social skills of audience, group discussion, or work team behavior by listening attentively and with civility to the ideas of others, gaining the floor in respectful ways, posing appropriate questions, and tolerating ambiguity and lack of consensus.

CE 2.1.12 Use a variety of strategies to enhance listening comprehension (e.g., monitor message for clarity and understanding, ask relevant questions, provide verbal and nonverbal feedback, notice cues such as change of pace or emphasis that indicate a new point is about to be made; and take notes to organize essential information).

STANDARD 2.2 ***Use a variety of reading, listening, and viewing strategies to construct meaning beyond the literal level (e.g., drawing inferences; confirming and correcting; making comparisons, connections, and generalizations; and drawing conclusions).***

CE 2.2.1 Recognize literary and persuasive strategies as ways by which authors convey ideas and readers make meaning (e.g., imagery, irony, satire, parody, propaganda, overstatement/understatement, omission, and multiple points of view).

CE 2.2.2 Examine the ways in which prior knowledge and personal experience affect the understanding of written, spoken, or multimedia text.

CE 2.2.3 Interpret the meaning of written, spoken, and visual texts by drawing on different cultural, theoretical, and critical perspectives.

STANDARD 2.3 ***Develop as a reader, listener, and viewer for personal, social, and political purposes, through independent and collaborative reading.***

CE 2.3.1 Read, listen to, and view diverse texts for multiple purposes such as learning complex procedures, making work-place decisions, or pursuing in-depth studies.

CE 2.3.2 Read, view, and/or listen independently to a variety of fiction, nonfiction, and multimedia genres based on student interest and curiosity.

CE 2.3.3 Critically read and interpret instructions for a variety of tasks (e.g., completing assignments, using software, writing college and job applications).

CE 2.3.4 Critically interpret primary and secondary research-related documents (e.g., historical and government documents, newspapers, critical and technical articles, and subject-specific books).

CE 2.3.5 Engage in self-assessment as a reader, listener, and viewer, while monitoring comprehension and using a variety of strategies to overcome difficulties when constructing and conveying meaning.

CE 2.3.6 Reflect on personal understanding of reading, listening, and viewing; set personal learning goals; and take responsibility for personal growth.

CE 2.3.7 Participate as an active member of a reading, listening, and viewing community, collaboratively selecting materials to read or events to view and enjoy (e.g., book talks, literature circles, film clubs).

CE 2.3.8 Develop and apply personal, shared, and academic criteria to evaluate own and others' oral, written, and visual texts.

STRAND 3: LITERATURE AND CULTURE

Students study and appreciate a rich and varied selection of classical and contemporary literary, cultural, and historical texts from American, British, and world traditions. They learn to make meaning from the experiences, ideas, and emotions of others across the ages, applying their understanding to contemporary circumstances.

STANDARD 3.1 *Develop the skills of close and contextual literary reading.*

CE 3.1.1 Interpret literary language (e.g., imagery, allusions, symbolism, metaphor) while reading literary and expository works.

CE 3.1.2 Demonstrate an understanding of literary characterization, character development, the function of major and minor characters, motives and causes for action, and moral dilemmas that characters encounter by describing their function in specific works.

CE 3.1.3 Recognize a variety of plot structures and elements (e.g., story within a story, rising action, foreshadowing, flash backs, cause-and-effect relationships, conflicts, resolutions) and describe their impact on the reader in specific literary works.

CE 3.1.4 Analyze characteristics of specific works and authors (e.g., voice, mood, time sequence, author vs. narrator, stated vs. implied author, intended audience and purpose, irony, parody, satire, propaganda, use of archetypes and symbols) and identify basic beliefs, perspectives, and philosophical assumptions underlying an author's work.

CE 3.1.5 Comparatively analyze two or more literary or expository texts, comparing how and why similar themes are treated differently, by different authors, in different types of text, in different historical periods, and/or from different cultural perspectives.

CE 3.1.6 Examine differing and diverse interpretations of literary and expository works and explain how and why interpretation may vary from reader to reader.

CE 3.1.7 Analyze and evaluate the portrayal of various groups, societies, and cultures in literature and other texts.

CE 3.1.8 Demonstrate an understanding of historical, political, cultural, and philosophical themes and questions raised by literary and expository works.

CE 3.1.9 Analyze how the tensions among characters, communities, themes, and issues in literature and other texts reflect human experience.

CE 3.1.10 Demonstrate an understanding of the connections between literary and expository works, themes, and historical and contemporary contexts.

STANDARD 3.2 *Read and respond to classic and contemporary fiction, literary nonfiction, and expository text, from a variety of literary genres representing many time periods and authors (e.g., myth, epic, folklore, drama, poetry, autobiography, novels, short stories, philosophical pieces, science fiction, fantasy, young adult literature, creative non-fiction, hypertext fiction).*

CE 3.2.1 Recognize a variety of literary genres and forms (e.g., poetry, drama, novels, short stories, autobiographies, biographies, multi-genre texts, satire, parody, allegory) and demonstrate an understanding of the way in which genre and form influence meaning.

CE 3.2.2 Identify different types of poetry (e.g., epic, lyric, sonnet, free verse) and explain how specific features (e.g., figurative language, imagery, rhythm, alliteration, etc.) influence meaning.

CE 3.2.3 Identify how elements of dramatic literature (e.g., dramatic irony, soliloquy, stage direction, and dialogue) illuminate the meaning of the text.

CE 3.2.4 Respond by participating actively and appropriately in small and large group discussions about literature (e.g., posing questions, listening to others, contributing ideas, reflecting on and revising initial responses).

CE 3.2.5 Respond to literature in a variety of ways (e.g., dramatic interpretation, reader's theatre, literature circles, illustration, writing in a character's voice, engaging in social action, writing an analytic essay) providing examples of how texts affect their lives, connect them with the contemporary world, and communicate across time.

STANDARD 3.3 *Use knowledge of literary history, traditions, and theory to respond to and analyze the meaning of texts.*

CE 3.3.1 Explore the relationships among individual works, authors, and literary movements in English and American literature (e.g., Romanticism, Puritanism, the Harlem Renaissance, Postcolonial), and consider the historical, cultural, and societal contexts in which works were produced.

CE 3.3.2 Read and analyze classic and contemporary works of literature (American, British, world) representing a variety of genres and traditions and consider their significance in their own time period as well as how they may be relevant to contemporary society.

CE 3.3.3 Draw on a variety of critical perspectives to respond to and analyze works of literature (e.g., religious, biographical, feminist, multicultural, political).

CE 3.3.4 Demonstrate knowledge of American minority literature and the contributions of minority writers.

CE 3.3.5 Demonstrate familiarity with world literature, including authors beyond American and British literary traditions.

CE 3.3.6 Critically examine standards of literary judgment (e.g., aesthetic value, quality of writing, literary merit, social significance) and questions regarding the inclusion and/or exclusion of literary works in the curriculum (e.g., canon formation, "classic" vs. "popular" texts, traditional vs. non-traditional literature, the place of literature by women and/or minority writers).

STANDARD 3.4 *Examine mass media, film, series fiction, and other texts from popular culture.*

CE 3.4.1 Use methods of close and contextualized reading and viewing to examine, interpret, and evaluate print and visual media and other works from popular culture.

CE 3.4.2 Understand that media and popular texts are produced within a social context and have economic, political, social, and aesthetic purposes.

CE 3.4.3 Understand the ways people use media in their personal and public lives.

CE 3.4.4 Understand how the commercial and political purposes of producers and publishers influence not only the nature of advertisements and the selection of media content, but the slant of news articles in newspapers, magazines, and the visual media.

STRAND 4: LANGUAGE

Language is an evolving tool with powerful personal, cultural, economic, and political implications. Knowledge of the structures of language (e.g., the history, meaning, and use of words; varying sentence structures and patterns of language; the conventions of standard English) is essential for the effective use of language for varying purposes (e.g., the development of a rich vocabulary, sentence structures for different rhetorical purposes, appropriate speech patterns for different social contexts). Understanding the political implications of language use is also critical for fostering a democratic society in which all voices are valued.

STANDARD 4.1 *Understand and use the English language effectively in a variety of contexts and settings.*

CE 4.1.1 Use sentence structures and vocabulary effectively within different modes (oral and written, formal and informal) and for various rhetorical purposes.

CE 4.1.2 Use resources to determine word meanings, pronunciations, and word etymologies (e.g., context, print and electronic dictionaries, thesauruses, glossaries, and others).

CE 4.1.3 Use a range of linguistic applications and styles for accomplishing different rhetorical purposes (e.g., persuading others to change opinions, conducting business transactions, speaking in a public forum, discussing issues informally with peers).

CE 4.1.4 Control standard English structures in a variety of contexts (e.g., formal speaking, academic prose, business, and public writing) using language carefully and precisely.

CE 4.1.5 Demonstrate use of conventions of grammar, usage, and mechanics in written texts, including parts of speech, sentence structure and variety, spelling, capitalization, and punctuation.

STANDARD 4.2 *Understand how language variety reflects and shapes experience.*

CE 4.2.1 Understand how languages and dialects are used to communicate effectively in different roles, under different circumstances, and among speakers of different speech communities (e.g., ethnic communities, social groups, professional organizations).

CE 4.2.2 Understand the implications and potential consequences of language use (e.g., appropriate professional speech; sexist, racist, homophobic language).

CE 4.2.3 Recognize and appreciate language variety, understand that all dialects are rule-governed, and respect the linguistic differences of other speech communities.

CE 4.2.4 Understand the appropriate uses and implications of casual or informal versus professional language; understand, as well, the implications of language designed to control others and the detrimental effects of its use on targeted individuals or groups (e.g., propaganda, homophobic language, and racial, ethnic, or gender epithets).

CE 4.2.5 Recognize language bias in one's community, school, textbooks, the public press, and in one's own use of language.

NOTES

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