Michigan Merit Curriculum

Course/Credit Requirements

ALGEBRA I

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1 Credit

MICHIGAN Department of Education

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Welcome

This guide was developed to assist teachers in successfully implementing the Michigan Merit Curriculum. The identified content expectations and guidelines provide a successful framework for designing curriculum, assessments, and relevant learning experiences for students. Through the collaborative efforts of Governor Jennifer M. Granholm, the State Board of Education, and the State Legislature, these landmark state graduation requirements are being implemented to give Michigan students the knowledge and skills to succeed in the 21st Century and drive Michigan's economic success in the global economy. Working together, teachers can explore varied pathways to help students demonstrate proficiency in meeting the content expectations and guidelines.

Curriculum Unit Design

One of the ultimate goals of teaching is for students to acquire transferable knowledge. To accomplish this, learning needs to result in a deep understanding of content and mastery level of skills. As educational designers, teachers must use both the art and the science of teaching. In planning coherent, rigorous instructional units of study, it is best to begin with the end in mind.

Engaging and effective units include:

- appropriate content expectations
- students setting goals and monitoring own progress
- a focus on big ideas that have great transfer value
- focus and essential questions that stimulate inquiry and connections
- identified valid and relevant skills and processes
- purposeful real-world applications
- relevant and worthy learning experiences
- varied flexible instruction for diverse learners
- research-based instructional strategies
- explicit and systematic instruction
- adequate teacher modeling and guided practice
- substantial time to review or apply new knowledge
- opportunities for revision of work based on feedback
- student evaluation of the unit
- culminating celebrations

Relevance

Instruction that is clearly relevant to today's rapidly changing world is at the forefront of unit design. Content knowledge cannot by itself lead all students to academic achievement. Classes and projects that spark student interest and provide a rationale for why the content is worth learning enable students to make connections between what they read and learn in school, their lives, and their futures. An engaging and effective curriculum provides opportunities for exploration and exposure to new ideas. Real-world learning experiences provide students with opportunities to transfer and apply knowledge in new, diverse situations.

Student Assessment

The assessment process can be a powerful tool for learning when students are actively involved in the process. Both assessment of learning and assessment for learning are essential. Reliable formative and summative assessments provide teachers with information they need to make informed instructional decisions that are more responsive to students' needs. Engagement empowers students to take ownership of their learning and builds confidence over time.

Sound assessments:

- align with learning goals
- vary in type and format
- use authentic performance tasks
- use criteria scoring tools such as rubrics or exemplars
- allow teachers and students to track growth over time
- validate the acquisition of transferable knowledge
- give insight into students' thinking processes
- cause students to use higher level thinking skills
- address guiding questions and identified skills and processes
- provide informative feedback for teachers and students
- ask students to reflect on their learning

High School Content Expectation Codes

To allow for ease in referencing expectations, each mathematics expectation has been coded by strand, standard, topic, and expectation. For example:

A1.2.3

- **A:** Algebra and Functions Strand
- **A1:** Standard 1 of the Algebra and Functions Strand
- **A1.2:** Topic 2 in Standard A1
- **A.1.2.3:** 3rd expectation in the 2nd topic of Standard A1

Organizational Structure

STRAND 1 Quantitative Literacy and Logic (L)	**STRAND 2** Algebra and Functions (A)
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)

STRAND 3 Geometry and Trigonometry (G)	**STRAND 4** Statistics and Probability (S)
STANDARDS (and number of core expectations in each standard)	
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)

Organization of this Document

In the Mathematics credit requirement documents, the expectations are organized by strand and standard underneath topic headings. The organization in no way implies an instructional sequence. Curriculum personnel or teachers are encouraged to organize these topics and expectations in a manner that encourages connections between strands and among topics with a strand.

Changes to Algebra I Course/Credit Descriptions

In summary the following changes were made:

- Moving four expectations to Algebra II. These are expectations that deal with more complex calculations that detract from the conceptual focus we want in Algebra I. They connect better with some of the expectations already in Algebra II.
- Deleting one expectation based on the advice of the original writers. It was hard to clarify because it was too ambiguous and the writers agreed that the underlying concept is already addressed with several other expectations.
- Addition of one expectation that currently is in Algebra II but should appear in both courses.
- Minor changes in wording to improve understanding. Also examples were removed from the expectations. More extensive examples can be found in the clarification companion documents.
- Moving Standard A3-Mathematical Modeling to A2.4. All the topics dealing with individual function families are now in A3.

Introduction to Algebra I

Algebra is not only a theoretical tool for analyzing and describing mathematical relationships, it is also a powerful tool for the mathematical modeling and solving of real-world problems. These problems can be found all around us: the workplace, the sciences, technology, engineering, and mathematics.

Algebra I Goal Statement

It is expected that students entering Algebra I are able to recognize and solve mathematical and real-world problems involving linear relationships and to make sense of and move fluently among the graphic, numeric, symbolic, and verbal representations of these patterns. Algebra I builds on this increasingly generalized approach to the study of functions and representations by broadening the study of linear relationships to include; systems of equations with three unknowns, formalized function notation, and the development of bivariate data analysis topics such as linear regression and correlation. In addition, their knowledge of exponential and quadratic function families is extended and deepened with the inclusion of topics such as, rules of exponentiation (including rational exponents), and use of standard and vertex forms for quadratic equations. Students will also develop their knowledge of power (including roots, cubics, and quartics) and polynomial patterns of change and the applications they model.

In addition to deepening and extending the student's knowledge of the algebra strand, Algebra I also draws upon and connects to topics related to number and geometry by including the formalized study of the real number system and its properties, and by introducing elementary number theory.

Throughout Algebra I and II, students will experience mathematics generally, and algebra in particular, not only as the theoretical study of mathematical patterns and relationships, but also as a language that allows us to make sense of mathematical symbols. Finally, students will develop an understanding that algebraic thinking is an accessible and powerful tool that can be used to model and solve real-world problems.

Algebra I Content Expectations Outline

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

- L1.1 Number Systems and Number Sense
- L1.2 Representations and Relationships

STANDARD L2: CALCULATION, ALGORITHMS, AND ESTIMATION

- L2.1 Calculation Using Real and Complex Numbers

STANDARD A1: EXPRESSIONS, EQUATIONS, AND INEQUALITIES

- A1.1 Construction, Interpretation, and Manipulation of Expressions
- A1.2 Solutions of Equations and Inequalities

STANDARD A2: FUNCTIONS

- A2.1 Definitions, Representations, and Attributes of Functions
- A2.2 Operations and Tansformations with Functions
- A2.3 Representations of Functions
- A2.4 Models of Real-World Situations Using Families of Functions

STANDARD A3: FAMILIES OF FUNCTIONS

- A3.1 Lines and Linear Functions
- A3.2 Exponential and Logarithmic Functions
- A3.3 Quadratic Functions
- A3.4 Power Functions (including roots, cubics, quartics, etc.)
- A3.5 Polynomial Functions

STANDARD S2: BIVARIATE DATA-EXAMINING RELATIONSHIPS

- S2.1 Scatterplots and Correlation
- S2.2 Linear Regression

CONTENT EXPECTATIONS FOR ALGEBRA I

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

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.

L1.2 Representations and Relationships

L1.2.2 Interpret representations that reflect absolute value relationships.

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.

STANDARD L2: CALCULATION, ALGORITHMS, AND ESTIMATION

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.

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

STANDARD A1: EXPRESSIONS, EQUATIONS, AND INEQUALITIES

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 properties of exponents and roots and apply them in algebraic expressions.

A1.1.3 Factor algebraic expressions using, for example, greatest common factor, grouping, and the special product identities.

A1.2 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.

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

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

STANDARD A2: FUNCTIONS

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(s).

A2.2 Operations and Transformations with Functions

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

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

A2.2.3 Determine 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 a 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 specifications 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

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.

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

A3.2.5 Relate exponential 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 directly and inversely proportional 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 zeroes of a polynomial function and understand the relationship between the *x*-intercepts of the graph and the factored form of the function.

STANDARD S2: BIVARIATE DATA-EXAMINING RELATIONSHIPS

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.

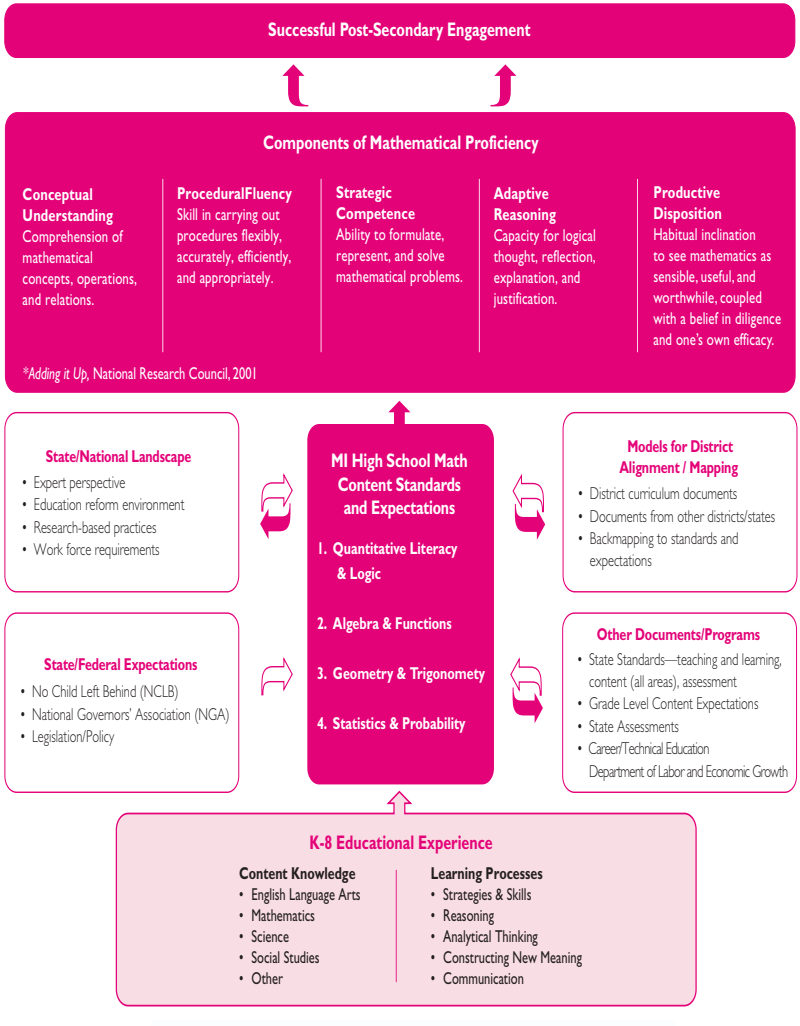
S2.2 Linear Regression

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.

Preparing Students for Successful Post-Secondary Engagement

As educators use these standards and expectations to develop rigorous and relevant units of instruction, 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; and to make connections between what they read and hear in class, and the world around them. 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.



This chart includes talking points for the professional development model.

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