TITLE PAGE

Michigan Merit Curriculum

Course/Credit Requirements

Algebra 1

1 credit

(INCLUDE COMMON CORE LOGO AND MDE LOGO)

STAMP, STATE SCHOOL BOARD, AND LOGO PAGE

Welcome

In June 2010, the Michigan State Board of Education adopted the Common Core State Standards (CCSS) as the state standards for mathematics and English Language Arts. Michigan will transition to a testing framework based on the CCSS in 2014-2015. It is important to note that there are varied pathways to help students successfully demonstrate proficiency in meeting the content defined by the CCSS. Working together, teachers can explore a variety of pathways that meet the rigorous requirements of the Michigan Merit Curriculum.

This document was developed to assist teachers in implementing the Michigan Merit Curriculum and defines the content for Algebra I as well as assists with the transition to instruction and assessment based on the CCSS. The identified standards and guidelines provide a framework for designing curriculum, assessments, and relevant learning experiences for students. Through the collaborative efforts of former Governor Jennifer M. Granholm, the State Board of Education, and the State Legislature, the CCSS are being implemented to give Michigan students the knowledge and skills to succeed in the 21st Century and to drive Michigan's economic success in the global economy.

Organization of this Document

The first portion of this document includes the CCSS Standards for Mathematical Practices as well as an explanation of the organization and coding of the CCSS. The second section provides the specific CCSS Mathematics statements that define the Algebra I Course/Credit requirement. The standards are organized in a fashion similar to the complete CCSS document which utilizes conceptual categories, domains, and clusters. The organization in no way implies an instructional sequence. Curriculum personnel or teachers are encouraged to organize these standards in a manner that supports connections between conceptual categories. Consideration should be given to the Standards for Mathematical Practices and the conceptual category of modeling when completing this work.

The final section provides appendices that are intended to assist in the transition from the High School Content Expectations to the CCSS. This includes strategies to implement the CCSS, a description of what content has changed from the 11/07 version of Algebra I Course/Credit Requirements, and an expected transition timeline. Please note that this document often includes exact wording from the CCSS mathematics document.

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, have a firm grasp of the concept of function, 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, formalized function notation, and the development of bivariate data analysis topics such as linear regression and correlation. Students will revisit linear equations, inequalities, and functions by applying them in more complex and applied situations, as well as extending their previous introductory work with quadratic and exponential functions and equations as they fully explore and analyze them. 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), use of standard and vertex forms for quadratic equations, and an introduction of complex numbers. Students will also develop their knowledge of root, absolute value functions, inverse and direct variations, and piecewise-defined functions, including step functions. Students will be introduced to polynomial patterns of change and the applications they model. Polynomial functions will be more rigorously analyzed and fully applied in Algebra II.

In addition to deepening and extending the student's knowledge of algebra, 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 communicate mathematical ideas and relationships to others, using a vocabulary of 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.

COMMON CORE STATE STANDARDS FOR MATHEMATICS

Standards for Mathematical Practice

The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important "processes and proficiencies" with longstanding importance in mathematics education. The first of these are the NCTM process standards of problem solving, reasoning and proof, communication, representation, and connections. The second are the strands of mathematical proficiency specified
in the National Research Council's report *Adding It Up*: adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently and appropriately), and productive disposition

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning.

1 Make sense of problems and persevere in solving them.
Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

2 Reason abstractly and quantitatively.
Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to *decontextualize*—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to *contextualize*, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

3 Construct viable arguments and critique the reasoning of others.
Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the

context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

4 Model with mathematics.

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

5 Use appropriate tools strategically.

Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

6 Attend to precision.

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

7 Look for and make use of structure.

Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see 7×8 equals the well-remembered $7 \times 5 + 7 \times 3$, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2×7 and the 9 as $2 + 7$. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems.

They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 - 3(x - y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y.

8 Look for and express regularity in repeated reasoning.
Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation $(y – 2)/(x – 1) = 3$. Noticing the regularity in the way terms cancel when expanding $(x – 1)(x + 1)$, $(x – 1)(x^2 + x + 1)$, and $(x – 1)(x^3 + x^2 + x + 1)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.

Organization of the Common Core State Standards

The high school standards specify the mathematics that all students should study in order to be college and career ready. These high school standards are listed in conceptual categories:

- Number and Quantity
- Algebra
- Functions
- Modeling
- Geometry
- Statistics and Probability

Conceptual categories portray a coherent view of high school mathematics; a student's work with functions, for example, crosses a number of traditional course boundaries, potentially up through and including calculus. Modeling is best interpreted not as a collection of isolated topics but in relation to other standards. Making mathematical models is a Standard for Mathematical Practice, and specific modeling standards appear throughout the high school standards indicated by a star symbol (★). (See Appendix II for further information about mathematical modeling)

Coding for the Common Core State Standards for Mathematics

The high school Common Core State Standards themselves are organized into six *Conceptual Categories*, then into *Domains (*large groups that progress across grades) and then by *Clusters* (groups of related standards, similar to the *Topics in the High School Content Expectations*). In the example provided the *Conceptual Category* is "Number and Quantity" *(N)* and the *Domain* is "The Real Number System" (RN). The *Cluster* is defined by the statement "Extend the properties of exponents to rational exponents" and includes two standards.
To allow for ease in referencing standards, each mathematics standard has been coded by conceptual category, domain, and standard. For example:

N: Number and Quantity conceptual category
N.RN: The Real Number System domain of the Number and Quantity conceptual category
N.RN.2: Standard 2 in The Real Number System domain

The Real Number System	N-RN

Extend the properties of exponents to rational exponents.

Cluster

1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. *For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.*
2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Standards for Algebra I

NUMBER AND QUANTITY (N)

The Real Number System — N.RN

Extend the properties of exponents to rational exponents

N.RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define $5^{(1/3)}$ to be the cube root of 5 because we want $5^{(1/3)3} = 5^{(1/3)3}$ to hold, so $5^{(1/3)3}$ must equal 5.

N.RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Use properties of rational and irrational numbers.

N.RN.3 Explain why the sum or product of rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Quantities ★ — N.Q

Reason quantitatively and use units to solve problems.

N.Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.★

N.Q.2 Define appropriate quantities for the purpose of descriptive modeling.★

N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.★

ALGEBRA (A)

Seeing Structure in Expressions — A.SSE

Interpret the structure of expressions.

A.SSE.1 Interpret expressions that represent a quantity in terms of its context.★

a. Interpret parts of an expression, such as terms, factors, and coefficients.★

b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)^n$ as the product of P and a factor not depending on P.★

A.SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see $x^4 – y^4$ as $(x^2)^2 – (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 – y^2)(x^2 + y^2)$.

Write expressions in equivalent forms to solve problems.

A.SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.★

a. Factor a quadratic expression to reveal the zeros of the function it defines.★

b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.★

c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15^t can be rewritten as $(1.15^{1/12})^{12t} \approx 1.012^{12t}$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.★

Arithmetic with Polynomials and Rational Expressions — A.APR

Perform arithmetic operations on polynomials.

A.APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

Creating Equations ★ A.CED

Create equations that describe numbers or relationship.

A.CED.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.★

A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.★

A.CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.★

A.CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.★

Reasoning with Equations and Inequalities A.REI

Understand solving equations as a process of reasoning and explain the reasoning.

A.REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

Solve equations and inequalities in one variable.

A.REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

A.REI.4 Solve equations and inequalities in one variable. Solve quadratic equations in one variable.

a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.

b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b. (IN ALGEBRA I THE EXISTENCE OF THE COMPLEX NUMBER SYSTEM IS INTRODUCED; STUDENTS WILL SOLVE QUADRATICS WITH COMPLEX SOLUTIONS IN ALGEBRA II)

Solve systems of equations.

A.REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A.REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

A.REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line $y = –3x$ and the circle $x^2 + y^2 = 3$.

Represent and solve equations and inequalities graphically.

A.REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A.REI.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.★ (EMPHASIZE LINEAR, ABSOLUTE VALUE, AND EXPONENTIAL FUNCTIONS)

A.REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

FUNCTIONS (F)

Interpreting Functions F.IF

Understand the concept of a function and use function notation.

F.IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

F.IF.2 Understand the concept of a function and use function notation. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F.IF.3 Understand the concept of a function and use function notation. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1 (n is greater than or equal to 1).

Interpret functions that arise in applications in terms of the context.

F.IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.★ (EMPHASIZE QUADRATIC, LINEAR, AND EXPONENTIAL FUNCTIONS AND COMPARISONS AMONG THEM)

F.IF.5 Interpret functions that arise in applications in terms of the context. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.★

F.IF.6 Interpret functions that arise in applications in terms of the context. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.★

Analyze functions using different representations

F.IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.★

b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.★

e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.★ (EMPHASIZE EXPONENTIAL FUNCTIONS; LOGARITHMIC AND TRIGONOMETRIC FUNCTIONS ARE INTRODUCED AND FULLY TREATED IN ALGEBRA II)

F.IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{(12t)}$, $y = (1.2)^{(t/10)}$, and classify them as representing exponential growth and decay.

F.IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Building Functions F.BF

Build a function that models a relationship between two quantities.

F.BF.1 Write a function that describes a relationship between two quantities. (EMPHASIZE LINEAR, QUADRATIC, AND EXPONENTIAL FUNCTIONS.)

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

F.BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.★

Build new functions from existing functions.

F.BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. (EMPHASIZE LINEAR, QUADRATIC, AND EXPONENTIAL FUNCTIONS.)

F.BF.4 Build new functions from existing functions. Find inverse functions.

a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, $f(x) = 2x^3$ or f(x) = (x+1)/(x-1) for x ≠ 1 (x not equal to 1). (EMPHASIZE LINEAR FUNCTIONS AND QUADRATIC FUNCTIONS WHERE THE INVERSE EXISTS.)

Linear and Exponential Functions — F.LE

Construct and compare linear, quadratic, and exponential models and solve problems.

F.LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.

a. Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.★

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.★

c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.★

F.LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).★

F.LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.★ (INCLUDES AN INTRODUCTION TO POLYNOMIAL FUNCTIONS.)

Interpret expression for functions in terms of the situation they model

F.LE.5 Interpret the parameters in a linear or exponential function in terms of a context.★

STATISTICS AND PROBABILITY (S)

Interpreting Categorical and Quantitative Data — S.ID

Summarize, represent, and interpret data on a single count or measurement variable.

S.ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).★

S.ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.★

S.ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).★

Summarize, represent, and interpret data on two categorical and quantitative variables.

S.ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.★

S.ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.★

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear and exponential models.★ (EMPHASIZE LINEAR FUNCTIONS.)

b. Informally assess the fit of a function by plotting and analyzing residuals.★

c. Fit a linear function for a scatter plot that suggests a linear association.★

Interpret linear models.

S.ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.★

S.ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.★

S.ID.9 Distinguish between correlation and causation.★

Recommended Content

N.CN.1 Know there is a complex number *i,* such that $i^2 = -1$, and every complex number has the form a + *bi* with *a* and *b* real.

KEY:

(+) Additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics is indicated by (+). All standards without a (+) symbol should be in the common mathematics curriculum for all college and career ready students. Standards with a (+) symbol may also appear in courses intended for all students.

★ Making mathematical models is a Standard for Mathematical Practice, and specific modeling standards appear throughout the high school standards indicated by a star symbol (★). The star symbol sometimes appears on the heading for a group of standards; in that case, it should be understood to apply to all standards in that group.

APPENDIX I: Strategies to implement the Common Core State Standards

Curriculum Unit Design

One of the ultimate goals of teaching is for students to acquire transferable knowledge across mathematics concepts as well as other disciplines, such as social studies, science, and technical subjects. 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
- substantial opportunities for students to receive peer and teacher feedback
- varied flexible instruction for diverse learners
- research-based instructional strategies
- appropriate explicit and systematic instruction with teacher modeling and guided practice
- opportunities for students to construct their own understanding based on both direct instruction and hands-on experiences
- well-planned formative and interim/summative assessment
- 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 as well as those that promote career readiness.

Student Assessment

The assessment process can be a powerful tool for learning if 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. Michigan is a governing member of the SMARTER Balanced Assessment Consortium (SBAC) which will bring together states to create a common, innovative assessment system for Mathematics and English Language Arts that is aligned with the Common Core State Standards and helps prepare students for college and careers. Sound assessments:

- align with learning goals
- vary in type and format
- use authentic performance tasks
- use criteria scoring tools such as rubrics or exemplars
- include substantial, frequent formative assessment with rich, actionable feedback to students
- 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

Connecting the Standards for Mathematical Practice to the Standards for Mathematical Content

The Standards for Mathematical Practice describe ways in which developing student practitioners of the discipline of mathematics increasingly ought to engage with the subject matter as they grow in mathematical maturity and expertise throughout the elementary, middle and high school years. Designers of curricula, assessments, and professional development should all attend to the need to connect the mathematical practices to mathematical content in mathematics instruction.

The Standards for Mathematical Content are a balanced combination of procedure and understanding. Expectations that begin with the word "understand" are often especially good opportunities to connect the practices to the content. Students who lack understanding of a topic may rely on procedures too heavily. Without a flexible base from which to work, they may be less likely to consider analogous problems, represent problems coherently, justify conclusions, apply the mathematics to practical situations, use technology mindfully to work with the mathematics, explain the mathematics accurately to other students, step back for an overview, or deviate from a known procedure to find a shortcut. In short, a lack of understanding effectively prevents a student from engaging in the mathematical practices.

In this respect, those content standards which set an expectation of understanding are potential "points of intersection" between the Standards for Mathematical Content and the Standards for Mathematical Practice. These points of intersection are intended to be weighted toward central and generative concepts in the school mathematics curriculum that most merit the time, resources, innovative energies, and focus necessary to qualitatively improve the curriculum, instruction, assessment, professional development, and student achievement in mathematics.

APPENDIX II: Changes to the Algebra I Course/Credit Requirements

The adoption of the CCSS has resulted in some changes in the content defined by the Algebra I Course/Credit Requirements document. Prior to the CCSS, the Michigan GLCEs defined a fairly in depth treatment of quadratic functions in 8^{th} grade. While the topic of quadratics is still within the CCSS for 8^{th} grade it is included only in a very basic,

introductory sense. Algebra I now includes a more thorough introduction to quadratics as well as the in-depth analysis that was defined previously. Polynomials are now primarily addressed in Algebra II, with only a brief introduction in Algebra I. Arithmetic and geometric sequences are now addressed in both Algebra I and Algebra II with the emphasis in Algebra I defined by standards F.LE.2 and F.BF.4. Additionally, Algebra I now includes content specific to univariate data that that expects students to summarize, represent and interpret single count data. Two of the Michigan expectations that were specific to power functions (A1.2.6 and A3.5.2) align with standards A.REI.2 and F.IF.4, respectively; now define content that is in Algebra II. An additional power function expectation (A3.4.2) has a partial alignment with 8.EE.5 and is now found in 8^{th} grade.
The following table illustrates Michigan expectations that will no longer be required as content for Algebra I.

ALGEBRA I CONTENT THAT IS DIFFERENT	
MICHIGAN CONTENT THAT DOES NOT TO ALIGN TO THE COMMON CORE STATE STANDARDS	
Michigan High School Content Expectations	**Common Core State Standards**
Number Systems and Number Sense 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	*No alignment*
Representations and Relationships L1.2.2 Interpret representations that reflect absolute value relationships in such contexts as error tolerance.	*No alignment*
Calculation Using Real and Complex Numbers L2.1.1 Explain the meaning and uses of weighted averages.	*No alignment*
Power Functions A3.4.2 Power Functions: Express direct and inverse relationships as functions and recognize their characteristics. A3.4.3 Power Functions: Analyze the graphs of power functions, noting reflectional or rotational symmetry.	*No alignment*

APPENDIX III: Timeline for Common Core State Standards Transition

TBD