Standards for Mathematics Teacher Candidates (High School)

What mathematical knowledge do teacher candidates need to know? Content knowledge that pre-service teachers learn in mathematics education must strongly emphasize “mathematical knowledge for teaching.” This includes an understanding of the ways learners think, knowledge of didactic representations, the ability to make pedagogical judgments about students’ questions and solutions to mathematical problems, and the ability to make judgments about the mathematical quality of instructional materials. The advanced mathematics in a traditional college mathematics program, while important, may be “remote from the core content of the K-12 curriculum.” It is important that the mathematics curriculum of a teacher licensure program include content necessary for teacher licensure candidates to develop deep understanding of the mathematics that they will teach.

An accredited teacher licensure program provides bridges from traditional mathematics content to the mathematics knowledge for teaching. Ideally, such bridges are integrated in mathematics coursework. However, given that this is not always possible, then other special courses may need to be designed specifically for pre-service teachers. Elementary grades teachers must be provided with substantial opportunities to focus on real numbers, data analysis and probability, geometry and measurement, and algebra. Similar and possibly more extensive opportunities are recommended for middle grade teachers, focusing on real and imaginary numbers with an emphasis on rational numbers and proportional reasoning, geometry, algebra, and data analysis and probability. Secondary mathematics teachers need substantial opportunities to address the mathematical knowledge for teaching 9-12 school mathematics. The focus needs to address knowledge of the mathematical understandings and skills that students acquire in elementary and middle school and how they affect learning in high school. In addition secondary mathematics teachers need a deep understanding of the fundamental mathematical ideas in grades 9-12 mathematics curricula and strong technical skills for application of those ideas (e.g., Algebra I/II, Geometry).


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Standard 1: Mathematics teacher candidates possess the mathematical knowledge needed to enable students to understand numbers, ways of representing numbers, and relationships among numbers and number systems and to enable students to understand meanings of operations and how they relate to one another. Candidates enable students to develop computational fluency and to make reasonable estimates. At the middle and secondary grade levels, teacher candidates need the mathematical knowledge to enable students to transfer their understanding of numbers and number operations to symbolic expressions involving variables. **Number sense, numeration, numerical operation, and algebraic thinking**

**High School**
- Understand and apply the mathematics of natural, integer, rational, real, and complex number systems.
- Understand and apply the mathematics of algebraic structures (e.g. groups, rings and fields) and rules for operations on expressions, equations, inequalities, vectors and matrices.
- Demonstrate skill in using algebra to model real-world applications.

Standard 2: Mathematics teacher candidates possess the mathematical knowledge needed to enable students to analyze the characteristics and properties of 2- and 3-dimensional geometric shapes; to develop mathematical arguments about geometric relationships; to understand units, processes of measure, and measurable attributes of objects; and to apply appropriate techniques, tools, and formulas to determine measurements. They enable students to develop the visualization, spatial reasoning, and geometric modeling to solve problems. Teacher candidates particularly at middle and secondary grade levels need the mathematical knowledge to enable students to use coordinate geometry in solving problems, to understand concepts of symmetry, and to apply transformations. **Spatial sense, measurement and geometry**

**High School**
- Understand core concepts and principles of Euclidean geometry in the plane and space.
- Use axiomatic reasoning and demonstrate facility with proof.
- Understand and apply the use of coordinates in 2- and 3-dimensional geometry, vectors and transformations, including matrix representations of transformations.
- Understand and apply trigonometry from a geometric perspective and demonstrate skill in using trigonometry to solve problems.

Standard 3: Mathematics teacher candidates possess the mathematical knowledge needed to enable students to understand patterns, relations, and functions. This includes the use of algebraic symbols to represent and analyze mathematical situations, the use of mathematical models to represent and understand quantitative relationships, and the analysis of “change” in various contexts. **Patterns, relationships, and functions**

**High School**
- Understand and move flexibly among algebraic representations (e.g. tables, graphs, or formulas).
- Understand and recognize patterns in data that are modeled by important classes of functions.
- Understand and perform transformations of functions by arithmetically combining, composing, and inverting.
- Demonstrate and apply knowledge of important classes of functions (e.g., polynomial, exponential and logarithmic, rational, and periodic), including the effect of changing parameters within these classes of functions.
• Use functions to solve problems in calculus, linear algebra, geometry, statistics, and discrete mathematics.

**Standard 4:** Mathematics teacher candidates possess the mathematical knowledge needed to enable students to formulate questions that can be addressed with data, along with the necessary skills to collect, organize, and display relevant data to answer those questions. They enable students to select and use appropriate statistical methods to analyze data, to understand and apply basic concepts of probability, and to develop and evaluate inferences and predictions that are based on data. **Data analysis, probability and statistics**

**High School**

• Engage in data investigations, including formulating questions and collecting data to answer questions.
• Understand and use standard techniques for organizing, displaying and analyzing univariate data, with the ability to detect patterns and departures from patterns.
• Understand and use standard techniques for displaying and analyzing bivariate data (e.g. scatter plots, correlation and regression).
• Understand and use theory and simulations to study probability distributions
• Use probability models to draw conclusions from data and measure the uncertainty of those conclusions (e.g. confidence intervals and hypothesis tests).
• Understand and use basic rules and knowledge of probability such as conditional probability and independence, and develop skill in calculating probabilities associated with these concepts.
• Understand and use basic concepts of discrete mathematics (e.g. graph theory, combinatorics, iteration and recursion, modeling).

**Standard 5:** Mathematics teacher candidates possess the mathematical knowledge needed to enable students to develop skills in problem solving, making connections between various branches of mathematics, reasoning and proof, and communication and representation of mathematical ideas. **Mathematical process skills**

**High School**

• Use algebraic reasoning effectively for problem solving and proof in number theory, geometry, discrete mathematics, and statistics.
• Judge the reasonableness of numerical computations and their results.
• Judge the meaning, utility, and reasonableness of the results of symbolic manipulations, including those carried out by technology.

**Standard 6:** Mathematics teacher candidates must be versed in the appropriate use of mathematical tools and manipulatives. **Mathematical tools**

**High School**

• Understand appropriate use of technology (e.g. graphing calculators, computer algebra systems, dynamic drawing tools, spreadsheets, or statistical graphing software) to explore algebraic, geometric and data analysis concepts.
• Use appropriate math manipulatives (e.g., algebra tiles, computer virtual manipulatives, or computer applets) to clarify and develop mathematical concepts.