

Readopt with amendment Ed 507.25, effective 5/14/2010 (Doc #9715), to read as follows:

Ed 507.25 Mathematics Teacher; General Requirements.

(a) To be certified as a-mathematics teacher, the candidate shall:

- (1) Have at least a bachelor's degree;
- (2) Obtain certification through one of the alternatives in Ed 505.01 – Ed 505.05;
- (3) Meet the requirements of (c) below; and
- (4) Meet the requirements of either Ed 507.26, Ed 507.27, or both.

(b) For candidates seeking certification through an alternative 3, 4 or 5 pathway, pursuant to Ed 505.03, Ed 505.04, or Ed 505.05, the department of education shall assess the skills, competencies, and knowledge of candidates for certification as mathematics teachers by reviewing evidence, such as, but not limited to, college course work, documented professional experience, letters of recommendation, professional development hours or CEUs (continuing education unit), and artifacts of professional practice.

(c) A candidate for certification as a mathematics teacher shall have skills, competencies, and knowledge in the following areas:

(1) In the area of knowledge of pedagogy, the candidate shall have the ability to:

a. Plan and conduct units and lessons, appropriate for the grade range, and which:

1. Enable students to construct new concepts through active participation in mathematical modeling, investigations, and problem- solving;
2. Include multiple explanations and representations, including, but not limited to informal and formal arguments or proofs;
3. Incorporate literacy strategies that assist students in reading and understanding mathematics;
4. Provide opportunities for students to use written, oral, and other creative expressions to demonstrate their understanding of mathematical concepts to a variety of audiences;
5. Emphasize connections within and between mathematics and other disciplines;
6. Select and use instructional tools, including, but not limited to, manipulatives and physical models, drawings, virtual environments, spreadsheets, presentation tools, and mathematics-specific technologies such as graphing tools and interactive geometry software, computer algebra systems, and statistical packages;

7. Make sound decisions about when instructional tools enhance teaching and learning, recognizing both the insights to be gained and possible limitations of such tools; and

8. Model and develop the following 8 standards of mathematical practices:

- (i) Make sense of problems and persevere in solving them;
- (ii) Reason abstractly and quantitatively;
- (iii) Construct viable arguments and critique the reasoning of others;
- (iv) Model with mathematics;
- (v) Use appropriate tools strategically;
- (vi) Attend to precision;
- (vii) Look for and make use of structure; and
- (viii) Look for an express regularity in repeated reasoning;

b. Apply an understanding of learning theories and equitable teaching practices to the teaching of mathematics appropriate for students within the grade range which articulate:

- 1. Why conceptual knowledge of mathematics is needed in conjunction with the teaching of procedures or algorithms; and
- 2. Foundations of pedagogical knowledge, effective and equitable mathematics teaching practices, and positive and productive dispositions toward teaching mathematics to support students' sense making, understanding, and reasoning; and

c. Plan and conduct a variety of assessments and evaluations appropriate for the grade range that:

- 1. Diagnose students' preconceptions, misconceptions, and understandings of mathematics and continuously monitor students' understandings; and
- 2. Evaluate procedural and conceptual understanding, and interpret students' mathematical processes and communication skills.

(2) In the area of knowledge of mathematical processes and habits of mind, the candidate shall have the ability to:

a. Use problem-solving to investigate and understand increasingly complex mathematical content, including, but not limited to, the ability to:

1. Apply and adapt a problem-solving process using a variety of heuristics or strategies to solve problems that arise in mathematics and other contexts;
 2. Use problem-solving to develop one's own mathematical knowledge;
 3. Reflect upon one's own and others' solutions and the problem-solving process; and
 4. Refine problem-solving strategies, as needed;
- b. Use mathematical reasoning and proof, including, but not limited to, the ability to:
1. Develop and evaluate mathematical conjectures;
 2. Construct and evaluate proofs and logical arguments to verify conjectures;
 3. Select and use various types of reasoning and methods of proof; and
 4. Demonstrate the capacity to articulate an understanding of how reasoning and proof are integral components of mathematics;
- c. Communicate an understanding of mathematics, including, but not limited to, the ability to:
1. Demonstrate the capacity to communicate clearly about mathematics and mathematics education in both written and oral forms using accurate and appropriate mathematical language and notation;
 2. Interpret and explain mathematical ideas acquired through reading mathematics in professional publications; and
 3. Analyze and assess the mathematical thinking and strategies of others;
- d. Create and use representations, including, but not limited to, the ability to:
1. Illustrate learning progression from concrete to abstract representations;
 2. Articulate how the use of formal language and notation increases in importance as mathematical concepts are developed in the mathematics curriculum;
 3. Select, apply, and translate among mathematical representations to investigate mathematical concepts and solve mathematical problems; and
 4. Develop and use models to explain mathematical concepts;
- e. Recognize, explore, and develop mathematical connections, both within mathematics and across disciplines, including, but not limited to, the ability to:
1. Provide examples of how mathematics is practiced in various fields; and

2. Build mathematical understanding by showing how ideas build on one another across grade levels to form a coherent discipline; and

f. Develop additional habits of the mind related to mathematics, including, but not limited to, the ability to:

1. Learn mathematics independently;
2. Exhibit a curiosity for mathematics;
3. Recognize that learning from mistakes is an essential component when working mathematically;
4. Recognize the power and value of estimation and mental computation when working mathematically;
5. Understand the value and power of strategic use of technology when solving mathematical problems;
6. Recognize that mathematics is the language of science and nature; and
7. Recognize that mathematics is a tool for quantitative reasoning;

(3) In the area of knowledge of the learner, including developmental and environmental characteristics appropriate for the grade range, the candidate shall have the ability to:

a. Demonstrate appropriate strategies for supporting students to:

1. Move from concrete to abstract representations of mathematical concepts; and
2. Connect conceptual and procedural knowledge;

b. Communicate understanding of mathematics anxiety, including signs of it, issues related to it, and supporting students to respond to and overcome it;

c. Recognize that attitudes about mathematics can change across a lifespan and therefore teachers need to address the affective domain; and

d. Demonstrate knowledge of how exceptional students learn mathematics and strategies to use with exceptional students;

(4) In the area of number and operations, the candidate shall have the ability to:

a. Demonstrate a capacity to use models to explore and explain relationships, including magnitude, among fractions, decimals, percents, ratios, and proportions;

b. Apply, explain, and justify concepts in number and number theory;

- c. Demonstrate computational proficiency and fluency, including the use of a variety of algorithms, estimation strategies, and mental mathematics techniques to judge the reasonableness of answers or approximate solutions;
 - d. Demonstrate knowledge of concepts and applications of limits and infinity;
 - e. Demonstrate a capacity to apply the concepts of proportional reasoning;
 - f. Demonstrate a capacity to make sense of large and small numbers and use scientific notation in mathematical and scientific modeling;
 - g. Demonstrate a capacity to use physical materials and models to explore and explain the operations and properties of real and complex numbers with extensions to matrices and vectors; and
 - h. Demonstrate a capacity to apply the concepts of exponents, including integer and rational, through modeling and applications;
- (5) In the area of geometry and measurement, the candidate shall have the ability to:
- a. Build and manipulate representations of 2-and 3-dimensional objects and perceive an object from different perspectives;
 - b. Analyze properties of and relationships among geometric shapes and structures;
 - c. Apply transformations with connections to congruency and similarity;
 - d. Demonstrate knowledge of non-Euclidean geometries;
 - e. Connect the ideas of algebra and geometry through the use of coordinate geometry, graphing, vectors, and motion geometry;
 - f. Recognize measurement attributes and their effect on the choice of appropriate tools and units;
 - g. Apply strategies, techniques, tools, and formulas to determine measurements and their application in a variety of contexts;
 - h. Employ estimation as a way of understanding measurement processes and units;
 - i. Complete error analysis through determination of the reliability of numbers obtained from measurement;
 - j. Understand and apply measurement conversion strategies;
 - k. Apply geometric ideas and tools relating to the Pythagorean theorem, similar triangles, and trigonometry to solve problems;

- l. Use constructions, models, and dynamic geometric software to explore geometric relationships;
 - m. Derive and explain formulas found in Euclidean geometry; and
 - n. Construct proofs using the axioms of Euclidean and non-Euclidean geometries;
- (6) In the area of functions and algebra, the candidate shall have the ability to:
- a. Model and analyze change and rates of change in various contexts;
 - b. Use mathematical models to understand, represent, and communicate quantitative relationships, including, but not limited to equality, equations, inequalities, and proportional relationships;
 - c. Explore, analyze, and generalize a wide variety of patterns and functions using multiple representations including, but not limited to, tables, graphs, written word, and symbolic rules;
 - d. Represent information and solve problems using matrices;
 - e. Use graphing utilities and other technological tools to represent, explain, and explore algebraic ideas including functions, equations, and expressions;
 - f. Generalize patterns and functions using recursive and explicit representations;
 - g. Articulate the meaning of functions and their inverse relationships, both formally and informally, with the use of concrete materials and graphing utilities; and
 - h. Understand and compare the properties of classes of functions and their inverses, including exponential, polynomial, rational, step, absolute value, root, logarithmic, and periodic, including trigonometric;
- (7) In the area of data, statistics, and probability, the candidate shall have the ability to:
- a. Design investigations, collect data, display data in a variety of ways, and interpret data representations including bivariate data, conditional probability and geometric probability;
 - b. Use appropriate methods to estimate population characteristics, test conjectured relationships among variables, and analyze data;
 - c. Use appropriate statistical methods and technology to analyze data and describe shape, spread, and center;
 - d. Use both descriptive and inferential statistics to analyze data, make predictions, test hypotheses, and make decisions;

- e. Apply probability concepts in identifying odds, fair games, mathematical expectation, and invalid conclusions;
 - f. Judge the validity of a statistical argument, including evaluating the sample from which the statistics were developed and identify misuses of statistics;
 - g. Determine and compare experimental, theoretical, and conditional probabilities; and
 - h. Use statistical models to explore the connections between statistics and probability including correlation, regression, and analysis of variance;
- (8) In the area of calculus, the candidate shall have the ability to:
- a. Use mathematical modeling and the concepts of calculus to represent and solve problems from real-world contexts;
 - b. Use technology to explore and represent fundamental concepts of calculus; and
 - d. Understand and describe the connection of calculus to middle and high school mathematics topics;
- (9) In the area of discrete mathematics, the candidate shall have the ability to:
- a. Apply the fundamental ideas of discrete mathematics in the formulation and solution of problems arising from real-world situations; and
 - b. Use technology to solve problems involving the use of discrete structures; and
- (10) In the area of history of mathematics, demonstrate a knowledge of the historical development of numbers and number systems, measurement and measurement systems, geometry, including non-euclidean geometry, algebra, probability and statistics, calculus, and discrete mathematics.

Adopt Ed 507.26 to read as follows:

Ed 507.26 Mathematics Teacher – Middle Level.

- (a) To be certified as a middle level mathematics teacher, the candidate shall:
- (1) Obtain certification to teach upper level elementary mathematics through algebra I or integrated I through one of the alternatives in Ed 505.01-Ed 505.05; and
 - (2) Meet the requirements of Ed 507.25 and Ed 507.26(c) below.
- (b) For candidates seeking certification through an alternative 3, 4 or 5 pathway, pursuant to Ed 505.03, Ed 505.04, or Ed 505.05, the department of education shall assess the skills, competencies, and knowledge of candidates for certification as teachers in middle level mathematics by reviewing evidence, such as, but not limited to, college course work, documented professional experience, letters of recommendation, professional development hours or CEUs, and artifacts of professional practice.

(c) A candidate for certification as a middle level mathematics teacher for grades 5-8 shall have skills, competencies, and knowledge in the following areas:

- (1) In the area of number and number operations the candidate shall have the ability to:
 - a. Represent, use, and apply introductory concepts and properties of complex numbers;
 - b. Identify and illustrate the mathematics that underlies the procedures and operations involving real numbers and their subsets; and
 - c. Explain the distinctions among real numbers and their subsets with connection to field axioms;
- (2) In the area of functions and algebra the candidate shall have the ability to:
 - a. Understand, identify, and apply arithmetic and geometric sequences; and
 - b. Represent and analyze group and field properties of real numbers and other mathematical structures;
- (3) In the area of calculus the candidate shall have the ability to demonstrate an understanding of calculus concepts including limits, continuity, differentiation, and integration; and
- (4) In the area of discrete mathematics demonstrate a conceptual understanding of the fundamental ideas of discrete mathematics, including, but not limited to:
 - a. Finite graphs;
 - b. Trees;
 - c. Networks;
 - d. Propositional logic; and
 - e. Combinatorics.

Readopt with amendment Ed 507.26, effective 5/14/2010 (Doc #9715), and renumber as Ed 507.27, and renumber the existing Ed 507.27 through Ed 507.54 as Ed 507.28 through Ed 507.55 so that Ed 507.27 reads as follows:

Ed 507.27 Mathematics Teacher – Upper Level

- (a) To be certified as an upper level mathematics teacher, the candidate shall:
 - (1) Obtain certification to teach pre-algebra through advanced placement math courses through one of the alternatives in Ed 505.01-Ed 505.05; and

(2) Meet the requirements of Ed 507.25 and Ed 507.27(c) below.

(b) For candidates seeking certification through an alternative 3, 4 or 5 pathway, pursuant to Ed 505.03, Ed 505.04, or Ed 505.05, the department of education shall assess the skills, competencies, and knowledge of candidates for certification as teachers in upper level mathematics by reviewing evidence, such as, but not limited to, college course work, documented professional experience, letters of recommendation, professional development hours or CEUs, and artifacts of professional practice.

(c) A candidate for certification as an upper level mathematics teacher shall have skills, competencies, and knowledge as follows:

(1) In the area of number and operations, the candidate shall have the ability to identify and illustrate the mathematics underlying the theory of groups, rings, and fields and the relationships among them;

(2) In the area of functions and algebra, the candidate shall have the ability to:

a. Understand and apply major concepts of:

1. Linear algebra, including vector spaces and matrices; and
2. Abstract algebra, including groups, rings, and fields;

b. Connect major concepts of linear and abstract algebra to the complex number system and other mathematical structures; and

c. Understand, identify, and apply arithmetic and geometric sequences, including partial sums of infinite arithmetic and geometric sequences, with connections to linear and exponential functions;

(3) In the area of calculus, the candidate shall have the ability to:

a. Demonstrate a conceptual understanding of and procedural facility with basic calculus concepts including limits, continuity, differentiation, and integration; and

b. Demonstrate an understanding of the basic concepts of multivariable calculus; and

(4) In the subject area of discrete mathematics, the candidate shall demonstrate a conceptual understanding of, and procedural facilitation of, the knowledge of the basic elements of discrete mathematics, including but not limited to:

1. Graph theory;
2. Propositional logic;
3. Mathematical induction;
4. Recurrence relations;

- 5. Finite differences;
- 6. Linear programming; and
- 7. Combinatorics.

Readopt with amendment Ed 612.17, effective 5/14/2010 (Doc #9715), to read as follows:

Ed 612.17 Mathematics – Middle Level.

(a) The middle level mathematics program shall provide the candidate with the skills, competencies, and knowledge gained through a combination of academic and supervised field-based experiences as required in Ed 507.25 and Ed 507.26.

Readopt with amendment Ed 612.18, effective 5/14/2010 (Doc #9715), to read as follows:

Ed 612.18 Mathematics – Upper Level.

(a) The upper level mathematics program shall provide the teaching candidate with the skills, competencies, and knowledge gained through a combination of academic and supervised field-based experiences as required in Ed 507.25 and Ed 507.27.

Appendix I

Rule	Statute
Ed 507.25 - Ed 507.26	RSA 186:8, III- IV, RSA 186:11,X(a), RSA 21-N:9,II(s)
Ed 507.27 (formerly Ed 507.26)	RSA 186:8, III- IV, RSA 186:11,X(a), RSA 21-N:9,II(s)
Ed 612.17 – Ed 612.18	RSA 186:8, IV; RSA 186:11, X(c)