Standards for 9 - 12 Mathematics Teachers

Introduction

As students prepare for the demands of a changing world, away from preparation for existing jobs, but toward the management of yet existing information, they need a strong grounding in logic and deduction; in short, mathematical thinking. They need mathematics teachers who value all students by recognizing and accommodating their unique needs. Students need teachers who assess, who plan and who evaluate so that all children develop mathematical thinking. Our students especially need teachers who establish and maintain high expectations for every student and who use effective methods to make understanding and application of mathematics a central theme for all.

These standards set forth the basic knowledge and skills necessary to teach mathematics. They are organized to reflect the Core Standards for Teachers developed by the NC Professional Teaching Standards Commission.

The overarching themes of a coherent mathematics content intertwined with process, pedagogical knowledge, equity and access for all students in mathematics, and knowledge of the role of technology in mathematics education are assumptions in the standards. They are essential components of the skills and knowledge mathematics teachers should possess. National standards from the Mathematical Association of America (MAA) and the National Council of Teachers of Mathematics (NCTM), as well as the North Carolina Standard Course of Study, influenced the development of this document.

Central to developing teachers who have the skill and preparation for mathematics teaching is the nature of the mathematics curriculum and the processes that drive it. The curriculum presented in Section I of this document contains important mathematics content knowledge that K-12 teachers should possess. This curriculum focuses on the important mathematics content that teachers entering teaching should possess and is articulated across three levels of mathematics teaching. This curriculum is grounded in the processes through which students learn mathematics: problem solving, reasoning, connections, representations, and communication. Teachers of mathematics must have a commitment to the development of students' mathematical understanding, therefore have a thorough understanding of how these processes can be used to promote student learning. They should be adept in using these instructional processes based on their students' prior knowledge and experiences.

Additionally, teachers should have knowledge of how technology, including computer software, calculators, and the internet, can influence the mathematics that is taught and their students' understanding of the mathematics. This requires that mathematics teachers understand how to use technology and also understand the research related to technology and mathematics learning, how to select appropriate software, and how to make decisions about when technology should be used.

Just as teachers must have content knowledge in mathematics, they must know their students as learners of mathematics and have pedagogical knowledge. With this knowledge, teachers are able to make important decisions that affect how students learn mathematics. Teachers who possess pedagogical knowledge understand a wide range of teaching strategies and can determine and use the appropriate strategies for teaching their students mathematics. They can make strong curricular judgements, use instructional materials effectively, and create classrooms that support students' learning of mathematics.

Teachers of mathematics must understand the students they teach. They must have high expectations for their students and provide opportunities for all students to be mathematics learners. This means challenging the notion that mathematics understanding is for a few, not all. Teaching equitably with concern for student diversity is addressed throughout this document. Teachers must understand the needs and strengths of students who are non-native speakers of English, are gifted in mathematics, have disabilities, are culturally and ethnically different, are female, or are poor. They know that some of these students
students may need special accommodations in mathematics classrooms. Teachers are role models for their students, as learners and problem solvers who value and enjoy mathematics. Teachers should model and encourage positive attitudes and beliefs about mathematics in the classroom and the community. The mathematics teacher is the key to changing the learning environment so that stereotypes, misunderstandings, and myths are not perpetuated.

Teachers act as advocates of mathematics students both in and out of the classrooms while providing leadership for the improvement of mathematics teaching and practice. Teachers support the mathematics teaching profession and continue to grow professionally. For K-12 teachers, teaching is a complex and demanding process that requires intensive lifelong learning. Teachers must have not only extensive knowledge of mathematics, but also deep understanding of how students learn mathematics.
Standards and Indicators

Teachers know the essential mathematical knowledge and concepts and are able to communicate their understanding and appreciation of mathematics integrating content through the use of problem solving, communication, connections, reasoning/proof and representation.

Standard 1: Number sense, numeration, and numerical operation.
Mathematics teachers have an in depth understanding of concrete algebraic systems and applications.

Mathematics Teachers:

Indicator 1: demonstrate an understanding of the properties of, and operations on real and complex numbers, polynomials, vectors, matrices, and other concrete algebraic systems;

Indicator 2: demonstrate an understanding of algebra and algebraic systems, including linear and abstract algebra;

Indicator 3: demonstrate an understanding of elementary number theory;

Indicator 4: demonstrate an understanding of set theory;

Indicator 5: use computational tools and strategies and estimate appropriately.

Standard 2: Spatial sense, measurement, and geometry.
Mathematics teachers understand measurement, spatial sense, and the properties of relationships of two- and three-dimensional space.

Mathematics Teachers:

Indicator 1: demonstrate an understanding of Euclidean and non-Euclidean geometry;

Indicator 2: recognize geometry as an example of a deductive system, built from undefined terms, axioms, definitions, and theorems;

Indicator 3: use deduction to establish the validity of geometric conjectures and to prove theorems;

Indicator 4: demonstrate an ability to connect geometry to other strands of mathematics and use it to solve problems;

Indicator 5: demonstrate an understanding of the properties of two- and three-dimensional geometric objects;

Indicator 6: demonstrate an ability to solve geometric problems using vectors in two- and three-dimensions;

Indicator 7: demonstrate an understanding of other coordinate systems and representational models and their uses;
Indicator 8: demonstrate an ability to use trigonometric relationships to solve problems;

Indicator 9: use appropriate technology to explore geometric concepts.

Standard 3: Patterns, relationships, and functions
Mathematics teachers understand patterns, relationships, functions, symbols and models.

Mathematics Teachers:

Indicator 1: demonstrate an ability to model and analyze situations and number patterns with numerical, graphical, and symbolic representations; and explore their connections;

Indicator 2: demonstrate an ability to use methods of proof to prove theorems and verify conjectures;

Indicator 3: demonstrate an ability to analyze tables and graphs to identify properties and relationships;

Indicator 4: demonstrate an understanding of differential and integral calculus;

Indicator 5: demonstrate the ability to use mathematics and technological tools to solve “real world” problems that arise in social sciences, biological sciences, physical sciences, and other mathematical sciences;

Indicator 6: demonstrate an understanding of different classes of functions and relations and the use of technology to investigate their properties.

Standard 4: Data, probability, and statistics
Mathematics teachers understand the major concepts of probability and statistics including collecting, displaying, analyzing, and drawing conclusions from data.

Mathematics Teachers:

Indicator 1: demonstrate the ability to use a variety of standard techniques for organizing and displaying data in order to detect patterns and departures from patterns;

Indicator 2: demonstrate the ability to use surveys to estimate population characteristics and experiments to test conjectured cause-and-effect relationships;

Indicator 3: demonstrate the ability to use theory and simulations to produce, analyze, and apply probability distribution models;

Indicator 4: demonstrate the ability to use probability models to draw conclusions from data and measure the uncertainty of those conclusions;

Indicator 5: demonstrate an understanding of topics in discrete mathematics such as finite difference equations, graph and network theory, combinatorics, and models for social decision-making;

Indicator 6: use appropriate technology to collect, display, organize, and interpret data;
Indicator 7: develop computer programs in a structured language.

Teachers use varied processes in the teaching of mathematics and make decisions regarding appropriate instruction and assessment.

Standard 5: Process Skills
Teachers understand and use the processes of problem solving, reasoning and proof, communication, connection, and representation as the foundation for the teaching and learning of mathematics.

Mathematics Teachers develop instructional programs that enable all students to:

Problem Solving
Indicator 1: build new mathematical knowledge through problem solving;
Indicator 2: solve problems that arise in mathematics and in other contexts;
Indicator 3: apply and adapt a variety of appropriate strategies to solve problems;
Indicator 4: monitor and reflect on the process of mathematical problem solving.

Reasoning and Proof
Indicator 5: recognize reasoning and proof as fundamental aspects of mathematics;
Indicator 6: make and investigate mathematical conjectures;
Indicator 7: develop and evaluate mathematical arguments and proofs;
Indicator 8: select and use various types of reasoning and methods of proof.

Communication
Indicator 9: organize and consolidate their mathematical thinking through communication;
Indicator 10: communicate their mathematical thinking coherently and clearly to peers, teachers, and others;
Indicator 11: analyze and evaluate the mathematical thinking and strategies of others;
Indicator 12: use the language of mathematics to express mathematical ideas precisely.

Connections
Indicator 13: recognize and use connections among mathematical ideas;
Indicator 14: understand how mathematical ideas interconnect and build on one another to produce a coherent whole;
Indicator 15: recognize and apply mathematics in contexts outside of mathematics.

Representation
Indicator 16: create and use representations to organize, record, and communicate mathematical
ideas;

Indicator 17: select, apply, and translate among mathematical representations to solve problems;

Indicator 18: use representations to model and interpret physical, social, and mathematical phenomena.

Standard 6: Curriculum pacing and alignment
Mathematics teachers are aware of the importance of and implement effective instructional pacing and alignment.

Mathematics Teachers are:

Indicator 1: knowledgeable of the NC Standard Course of Study, LEA (district) standards and pacing guides, and the NCTM standards;

Indicator 2: able to locate and use various resources that support daily classroom practices (e.g. NCDPI, LEARN-NC, NCTM Publications, etc.).

Standard 7: Instructional strategies
Mathematics teachers use a variety of instructional strategies to promote student understanding of mathematics. They recognize students’ level of mathematical understanding in order to implement the appropriate instructional practice.

Mathematics Teachers:

Indicator 1: use varied strategies, including problem-based learning, inquiry, investigations, direct instruction, exposition;

Indicator 2: are knowledgeable of current research on best practices;

Indicator 3: match the appropriate strategy with the appropriate tools;

Indicator 4: are knowledgeable about and sensitive toward various teaching/learning styles;

Indicator 5: are aware that it will take a variety of teaching methods to lead all students to excel in mathematics.

Standard 8: Instructional tools
K-12 mathematics teachers understand and use effectively the hierarchy of the use of instructional tools.

Mathematics Teachers are able to identify, prescribe, and use appropriate:
Indicator 1: hands-on tools (e.g. cubes, counters, rods, etc.);

Indicator 2: representational tools (e.g. base-ten blocks, calculators, computer applications, algebra tiles/blocks, fraction bars, decimal squares, geometric blocks, etc.);

Indicator 3: transitional tools (e.g. expanded notation, paper and pencil, calculator and computer methods, metaphors, analogies, etc.) that enable students to make connections between representational and symbolic levels of understanding;

Indicator 4: symbolic tools (e.g. standard and alternative algorithms, calculator and computer applications, etc.).

Standard 9. Assessment practices
Teachers of mathematics understand a variety of formative and summative assessment tools, strategies, and practices and their appropriate use.

Mathematics Teachers are able to:

Indicator 1: use assessment to inform instructional practice;
Indicator 2: recognize and use formative and summative assessment;
Indicator 3: match assessment strategies to instructional strategies;
Indicator 4: use assessment to enhance student learning.

Teachers believe that all students can learn mathematics. They exhibit an enthusiasm for teaching mathematics and view diversity as a strength in the classroom.

Standard 10: Ethnicity, gender, race, and socioeconomic status
Mathematics teachers recognize that all students, regardless of their personal characteristics, backgrounds, or physical challenges, must have opportunities to study and learn mathematics.

Mathematics Teachers:

Indicator 1: are sensitive to the needs and strengths of the mathematical backgrounds and abilities of individual students and have high expectations for all students;
Indicator 2: treat students equitably, not necessarily equally, by accommodating individual student needs;
Indicator 3: understand the need to encourage parental involvement in all students’ education and frequently communicate with parents or guardians of their students;
Indicator 4: strive to dispel the myths regarding the learning of mathematics, challenging derogatory and/or stereotypical beliefs based on ethnicity, gender, race, or socioeconomic status;
Indicator 5: understand and confront their own beliefs and biases to effectively and sensitively accommodate differences among students.
Standard 11: Accommodating individual needs
To promote diversity as a strength, teachers are knowledgeable about and sensitive toward various teaching/learning styles.

Mathematics Teachers:

Indicator 1: stay abreast of current research which indicates the optimal teaching methods to address students’ diverse learning styles, non-native speakers of English, students with disabilities, and gifted students.

Indicator 2: are aware that it will take a variety of teaching methods to lead all students to excel in mathematics.

Standard 12: Historical perspective
Mathematics teachers understand that historically based pedagogy can give all students, regardless of their learning preferences, the opportunity to learn mathematics. It provides an opportunity to focus on special interests, and it provides the teacher with insights into the diversity in the development of mathematics.

Mathematics Teachers:

Indicator 1: are able to plan instructional topics of particular interest through the use of the historical development of mathematics;

Indicator 2: understand that the investigation of historical topics in mathematics requires the use of substantial mathematics;

Indicator 3: understand and incorporate the mathematical contributions of all cultures into their lessons
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