Middle Grades STEM Teacher Licensure Standards

The Background:

Over the past two years Tennessee has undergone systemic revisions to almost all aspects of the public education system. To help support these changes it is necessary to examine not only the current force of teachers, but teachers coming through the training pipeline as well. Student curriculum standards have been raised so it follows that teacher content knowledge and pedagogical strategies much keep pace.

A STEM license for middle grades teachers addresses these concerns. These teachers will be licensed to teach in math, science, and technology in grades 5-9. They will be licensed to teach Physical Science and Algebra I along with Exploring Technology (5-6), Inventions and Innovations (7), Technological Systems (8), and Foundations of Technology (9).

At the January 2011 meeting the of the State Board of Education the board unanimously approved the formation of an endorsement area designed to help produce teacher with greater content knowledge for teaching math and science in the middle grades, specifically in grades 5-9.

These standards take a comprehensive approach to STEM instruction. The standards not only address the more common disciplines of math and the sciences, they also incorporate the often neglected areas of technology and engineering. Likewise, there is attention given to adolescent development, reading, writing, speaking and listening, and STEM interdisciplinary principles of instruction. These standards provide well-balanced and in-depth approach to middle grades teacher preparation and are designed to help produce teachers who are prepared to meet the demands of teaching a rigorous curriculum.

Those teachers currently employed with a generalist license will maintain that status, and this program will not change their employability. Likewise, university teachers training programs are not required to shift away from the programs in operation. The STEM license (5-9) serves as another option universities and teacher candidates have.

The work to build this licensure area has been going on over the course of the past two years. Members of the SBE's Advisory Council on Teacher Education and Certification (ACTEC) expressed an interest in creating more subject-specific licensure options for middle grades teachers and after SBE staff consultation with the Tennessee Math, Science, and Technology Education Center (TMSTEC) at MTSU it was decided that they would become the lead organization in the formulation of program recommendations to the SBE. What followed was a series of meetings and conferences including stakeholders statewide. The list of included partners includes TMSTEC, the State Board of Education, the State Department of Education, TBR universities and

the associated STEM centers, The University of Tennessee, the SDE's Principal Study Council, TOSS, ETS, and many others.

These standards have been carefully vetted by many members of the Tennessee STEM community. Also, the State Board's Advisory Council on Teacher Education and Certification had the opportunity to address any concerns and make appropriate recommendations regarding these licensure.

The Master Plan Connection:

This item supports the Board's *Master Plan* by providing for effective teachers.

The Recommendation:

The State Board of Education staff recommends adoption of the STEM 5-9 licensure standards on final reading.

Tennessee Teacher Licensure Standards:
Middle Grades Education
(Endorsement in Middle Grades STEM Education 5-9)

Date Standards Adopted or Most Recent Revision: August 5, 2011
Date Institutions Must Submit to DOE: Current

The acronym STEM describes an interdisciplinary area of study that integrates Science, Technology, Engineering and Mathematics. All Tennessee students should emerge from their K-12 science education experiences fully prepared to transition into higher education, pursue careers in the technical workforce, or offer service to their communities and/or the nation.

Tennessee supports specialized preparation programs for middle grades STEM education (5-9) that enable teacher candidates to meet the academic and developmental needs of all students and improve STEM knowledge and skills in the middle school grades. The performance standards for middle grades STEM education provide teacher preparation programs with guidelines to develop prospective teachers who have the necessary content and pedagogical knowledge as well as the personal dispositions necessary to become successful beginning teachers. Middle grades STEM teaching is a lifelong undertaking that is initiated in college coursework, refined by field experiences and/or clinical practice, and enhanced during professional teaching. The intent of these performance standards is to support teacher preparation programs that offer a comprehensive program of study that integrates the general education core, professional education, an academic major, and a variety of field experiences to ensure teacher candidates meet all of the following standards.

Middle Grades Education (5-9)

Standard 1: Young Adolescent Development

Candidates understand the major concepts, principles, and theories of young adolescent intellectual, physical, social, emotional, and moral development.

Standard Elements

Candidates demonstrate an understanding of the major concepts, principles, and theories of young adolescent development, including intellectual, physical, social, emotional, and moral development. They design and provide opportunities that support positive student development and learning.

1.1 Candidates apply current research regarding the major concepts, principles, and theories of young adolescent development to identify the range of individual differences within the areas and rates of development and to create learning opportunities that address this diversity.

1.2 Candidates understand the issues of health, mental health, sexuality, and peer pressure that prevail during young adolescence.
1.3 Candidates reflect an enthusiasm for curriculum that is challenging, exploratory, integrated, and relevant.
1.4 Candidates use a variety of developmentally appropriate teaching and classroom management techniques to provide exceptional learning experiences.
1.5 Candidates understand and demonstrate respect for the complex and dynamic contexts in which development occurs in classrooms, families, peer groups, communities, and society; and, they understand strategies that support involvement at all levels of the educational experience.

Standard 2: Middle Grades Philosophy, Organization, and Instruction
Candidates understand the major concepts, principles, theories, and research underlying the philosophical foundations of developmentally responsive middle level programs and schools.

Standard Elements
Candidates demonstrate an understanding of the major concepts, principles, theories, and research underlying the philosophical foundations of developmentally responsive middle level programs. Candidates understand the responsibility to foster a learning environment that is inviting, safe, inclusive, and supportive of all.

2.1. Candidates study and evaluate contemporary best practice models for educating students in the middle grades (5-9) and can employ a contextual understanding of these practices in a variety of school organizational plans such as P-8, 5-8, and 7-12.
2.2. Candidates understand middle school patterns of school organization, infrastructure, and curriculum that support the development of the young adolescent's intellect and character.
2.3. Candidates can articulate and apply the characteristic components of developmentally responsive middle level schools to interpret and analyze individual case studies.
2.4. Candidates can plan lessons that make connections within the disciplines, across disciplines, and with the real world, including the world of work.
2.5. Candidates learn to design student assessments that foster and measure learning and practice collaborative analysis of student assessment data as a means for school improvement and enhancement of student learning.
2.6. Candidates practice effective collaboration in planning and implementing the major components of middle level education, such as, transitions between levels, on-going professional development, and infrastructure. They understand that the purpose of using combined strategies is to contribute to school improvement.

English Language Arts

Standard 1: Reading
Candidates understand appropriate practices to promote, develop and integrate strategies for interpreting informational text across all STEM subject matter areas.

Standard Elements
Candidates demonstrate an understanding that students learn to read within the context of every subject and support a balanced reading program by practicing explicit instruction in STEM reading throughout the middle grades. For additional information, refer to Tennessee Reading Standards to be integrated into Licensure Standards.

1.1 Candidates know appropriate reading instructional strategies used to support the development of STEM skills and conceptual understanding.
1.2 Candidates can fluently read and interpret mathematical and scientific expressions; in particular equations, scientific symbols, diagrams, and representations.
1.3 Candidates know the Common Core State Standards (CCSS) for reading and incorporate this knowledge into their instruction by providing opportunities for students to read and develop fluency with informational text.

Standard 2: Writing
Candidates understand and use writing processes to communicate, express, and reflect in all subject areas, for a variety of purposes, in a range of modes, and for multiple audiences.

Standard Elements
Candidates demonstrate an understanding of the applications of writing to learn, inform, explain, defend, support, persuade, and express individual voice.

2.1. Candidates demonstrate knowledge of the writing process, especially in the context of instructional writing, technical writing, and writing that presents appropriate conclusions from technical information.
2.2. Candidates know the Common Core State Standards (CCSS) for writing and incorporate this knowledge into their instruction by providing opportunities for students to write within the STEM content areas and in personal, academic, practical, occupational modes.
2.3. Candidates demonstrate the ability to be self-assess their written problem-solving explanations/solutions and can help students learn these self-evaluation skills.
2.4. Candidates understand how to design writing tasks that help students organize and consolidate STEM thinking, promote coherent communication, and clearly express STEM concepts.

2.5. Candidates evaluate written products and assess students' progress both holistically and through the analysis of discrete elements in the context of STEM problem solving, use of rubrics, and their presentation of solutions.

Standard 3: Elements of Language
Candidates know and understand English usage, mechanics, spelling, grammar, and sentence structure as tools to facilitate the writing process.

Standard Elements
Candidates demonstrate an understanding of and apply rules and conventions that govern the structure and syntax of language as prerequisites to effective communication and as markers of literacy in the context of STEM communication.

3.1. Candidates are able to identify and correct errors in spelling and to recognize and use standard vocabulary, phrasing, and notation specific to STEM areas.
3.2. Candidates understand that science/mathematical expressions (formulas, equations, models, expressions, symbols, and diagrams) are used to communicate, and are able to apply these expressions to represent grammatically correct written and spoken English communication.
3.3. Candidates know the Common Core State Standards (CCSS) for language and incorporate this knowledge into their STEM instruction.

Standard 4: Speaking and Listening
Candidates understand the uses of speaking and listening to learn, inform, explain, defend, support, persuade and express individual voice orally.

Standard Elements
Candidates demonstrate an understanding of the use of speech and listening to learn, inform, explain, defend, support, persuade and express individual voice. They provide multiple opportunities for students to learn, inform, explain, defend, support, persuade and express individual voice.

4.1. Candidates model the tenets of Standard English usage in spoken language, and can articulate fundamental STEM concepts.
4.2. Candidates are confident and poised in oral presentations of fundamental STEM concepts.
4.3. Candidates understand how to design oral presentations and discussions in order to organize and consolidate STEM thinking, encourage coherent communication, and the precise expression of STEM concepts.
4.4. Candidates articulate good listening and interpretation strategies.
4.5. Candidates know the Common Core State Standards (CCSS) for Speaking and Listening and incorporate this knowledge into their STEM instruction.

STEM Learning

Standard 1: STEM Interdisciplinary Instruction

Candidates understand effective instructional strategies that support STEM learning and integrate STEM content and skills. Candidates develop cross-disciplinary problem-solving skills, reasoning, communication, connections, and representation. Additionally, they plan instructional activities designed to develop these skills in their students.

Standard Elements

Candidates demonstrate an understanding of the importance of instructional approaches and processes that underlie integrated STEM instruction. These processes apply in every STEM activity and support grade appropriate STEM understanding as defined in the Tennessee State Curriculum frameworks.

1.1 Candidates use current Tennessee state curriculum standards and Common Core State Standards to plan lessons and units that incorporate a learning cycle approach to instruction.

1.2 Candidates can choose, modify, and design appropriate learning activities that support higher order thinking, creative problem-solving, and development of the connections among major STEM concepts.

1.3 Candidates demonstrate an understanding of how STEM concepts are related and developed across grade levels and how they are connected to other non-STEM disciplines and the real world. A central theme is the understanding of the strong link between science and mathematics, including representations of data, symbolic modeling, and the linkage among science, mathematics engineering, and technology.

1.4 Candidates know the characteristics of a physically and emotionally safe learning environment that encourages and supports innovation, design, and intellectual problem-solving, and how to establish and maintain that environment.

1.5 Candidates know the principles of using technologically-supported, concrete, and abstract experiences to balance the needs of students from different ethnic and socioeconomic backgrounds and students of different gender, age, and ability.

1.6 Candidates understand how students learn STEM concepts, are adept at analyzing implications of student error, and can establish procedures to alter fundamental misconceptions.

1.7 Candidates understand the imperative in STEM education to continuously update information about the theory of the field, best teaching practices, and the availability of new technologies.

1.8 Candidates demonstrate the ability to design integrated STEM reading, writing, and questioning strategies and integrate a variety of technologies into their instructional practices to support conceptual development.

1.9 Candidates are able to implement a balanced formative and summative assessment system and analyze resultant data to monitor and adjust their instruction across disciplines.

1.10 Candidates develop students' recognition of the parallel steps in the disciplinary progressions of STEM work: scientific experimentation, mathematical proof, engineering design, and technology implementation.

1.11 Candidates develop protocols for managing the practicalities of classroom project design and management of STEM problem solving and group work.

1.12 Candidates can design a logical model that directs the goals, objectives, needed resources, and sequence of events that lead to the completion of specific STEM learning outcomes.

1.13 Candidates can locate and evaluate the usefulness of professional and technical literature in each of the STEM areas; they are also aware of the resources provided by professional publications and organizations (such as NCTM, NSTA, ACS, ITEA, etc.) and know how to access these resources.

1.14 Candidates can use student assessment to detect and address misconceptions. In particular, candidates can collect and appropriately evaluate individual and group work by students, analyze test data and formative assessments, and review student interactions; candidates can apply the analysis of data to modify instruction, and improve individual student learning and classroom behavior.

Standard 2: STEM Interdisciplinary Content

Candidates demonstrate expertise in the application of practices that integrate STEM disciplines.

Standard Elements

Candidates demonstrate expertise in the applying practices that integrate STEM disciplines. They are able to design and implement multiple integrated learning experiences for students.

2.1. Candidates analyze, represent, and describe change in a variety of contexts using graphs, tables and equations, approximate function values from various contexts, and describe relationships from disparate sources of information.

2.2. Candidates can represent real world phenomena through a variety of graphic and numerical functions and with statistical models.

2.3. Candidates understand the process of measurement and limitations related to uncertainty and error.

2.4. Candidates can assess the reasonableness of estimates, establish boundaries on error, and discuss the implications of using technology to approximate non-rational quantities, especially percentage error and scientific notation.

2.5. Candidates can integrate basic fundamental concepts and major principles through connections with historical context.

2.6. Candidates model the problem-solving process including comprehension, analysis, and data interpretation skills that lead to a solution or conclusion, and can evaluate and interpret the success and failure of a particular process.

Mathematics

Standards 1: Mathematical Practices
Candidates demonstrate effective mathematics processes as they reason, solve problems, communicate mathematical ideas, chose appropriate representations, and recognize connections between mathematical concepts and other STEM disciplines.

Standard Elements
Candidates demonstrate an understanding of the mathematical processes of problem solving, reasoning, communication, connections, and representation, plan effective instructional activities to develop these processes in students, and integrate appropriate strategies and technologies into their instructional practices to support conceptual and process development.

1.1 Candidates know the Common Core State Standards (CCSS) for Mathematical Practices and incorporate this knowledge into their STEM instruction.
1.2 Candidates make and investigate mathematical conjectures and use logical thinking to reflect, explain, and justify strategies and solutions.
1.3 Candidates are comfortable with abstract representations of mathematical ideas that express ideas and extend concrete examples to more broad implications.
1.4 Candidates are thoroughly knowledgeable about current specialized technologies that assist in calculation, exploration of patterns, demonstration of mathematical properties, and assist with instruction, knowledge development, and assessment.

Standard 2: The Number System
Candidates understand mathematical concepts, operations, properties, and relations necessary for number and operation sense.

Standard Elements
Candidates demonstrate an understanding of how and when to apply numerical and operation concepts, properties, and procedures to problem-solving situations.

2.1 Candidates know the Common Core State Standards (CCSS) for the Number System and incorporate this knowledge into their STEM instruction.

2.2. Candidates can perform computations involving radicals, exponents, trigonometric, and rational expressions flexibly, accurately, efficiently, and can assess the reasonableness of their computations.
2.3. Candidates are able to explain arithmetic operations and properties of the integers, rational numbers and the complex numbers in terms of an axiomatic construction.
2.4. Candidates demonstrate understanding of how basic ideas of number theory and algebraic structures underlie the rules for operations on expressions, equations, and inequalities.
2.5. Candidates can establish various properties of integers using mathematical induction.
2.6. Candidates model operations on various sets of elements and examine the existence of common operational properties in different contexts.

Standard 3: Equations and Expressions

Candidates know, understand, and use algebraic concepts and create learning experiences that develop algebraic thinking, including use of patterns, functions, and modeling.

Standard Elements

Candidates demonstrate an understanding of and can generalize patterns as they represent and analyze quantitative relationships and change in a variety of contexts and problem-solving situations. They demonstrate effective instructional practices necessary to foster algebraic proficiency in students.

3.1 Candidates know the Common Core State Standards (CCSS) for Algebra and incorporate this knowledge into their STEM instruction.
3.2 Candidates appropriately use, simplify, and manipulate algebraic expressions that involve polynomials, radical expressions, and fractions of polynomials to analyze situations, and solve or model real world problems.
3.3 Candidates can factor higher degree polynomials into quadratic and linear products, simplify complex rational expressions, and connect roots of polynomials to their graphic representations as well as to complex numbers.
3.4 Candidates understand the role that linear functions play in modeling and the use of regression to model and understand real world phenomena.
3.5 Candidates extend and generalize patterns to describe relations and functions, including linear and non-linear functions and the fundamental properties of exponential functions.
3.6 Candidates can use graphing calculators and spreadsheets as tools to explore algebraic ideas, algebraic representations of information, and algebraic problem- solving.

Standard 4: Geometry
Candidates know, understand and use geometric concepts and create learning experiences that develop geometric concepts and spatial reasoning.

Standard Elements
Candidates demonstrate an understanding of geometric concepts and relationships and can apply them in real-world problem solving situations. They demonstrate knowledge of effective instructional practices necessary for developing geometric proficiency in students.

4.1 Candidates know the Common Core State Standards (CCSS) for Geometry and incorporate this knowledge into their STEM instruction.
4.2 Candidates analyze, describe characteristics, and calculate appropriate measurements related to properties of two- and three-dimensional geometric figures; they can relate these processes to science concepts in physics, astronomy and chemistry.
4.3 Candidates can calculate various quantities connected to special figures and composite figures.
4.4 Candidates can connect the various fundamental properties of triangles, including similar triangles and the Pythagorean Theorem, to both non-algebraic functions and applications of mathematics.
4.5 Candidates understand various methods of measuring angles and relate them to right triangles and unit circle trigonometry, engineering, chemistry, and physics.
4.6 Candidates can utilize basic trigonometric constructions to solve geometric and contextual problems.
4.7 Candidates specify locations and explain spatial relationships using coordinate geometry, vectors, vector operations, and scaling.
4.8 Candidates use dynamic drawing tools and other emerging technologies to conduct geometric investigations that emphasize visualization and pattern recognition.

Standard 5: Statistics and Probability,
Candidates know, understand and use data analysis and probability concepts; they can design instructional activities to teach students to understand and apply basic statistical and probability concepts. Candidates can use data collected in STEM settings and from existing databases to connect mathematics, technology, and the sciences.

Standard Elements
Candidates demonstrate an understanding of the basic statistical and probability concepts.

5.1 Candidates know the Common Core State Standards (CCSS) for Mathematical Practices and incorporate this knowledge into their STEM instruction.
5.2 Candidates can solve problems involving fundamental set operations such as union, intersection and complement; they can illustrate these

concepts with Venn Diagrams and apply these calculations to probability concepts.

5.3 Candidates understand basic concepts of probability such as conditional probability and independence and develop skill in calculating probabilities associated with those concepts.

5.4 Candidates formulate real-world questions that can be addressed with data, present appropriate methods for data gathering and analysis, including measures of central tendency, and create multiple visual representations of data.

5.5 Candidates make and evaluate inferences and predictions based on data and theoretical probabilities and communicate their predictions in clear language and through well-constructed graphical displays.

5.6 Candidates can analyze experimental designs and discuss types of sample bias, calculate descriptive statistics, and collect data to describe different characteristics within or among populations.

Standard 6: Advanced Mathematics

Candidates understand and can describe mathematical concepts underlying set theory, functions, and the fundamental principles of calculus, and can connect these concepts to explore scientific questions.

Standard Elements

Candidates demonstrate an understanding of the beginning areas of advanced mathematics topics to develop correct and consistent explanations for mathematical concepts that provide the underpinnings of mathematical learning in grades 9-12.

6.1 Candidates understand the fundamental concepts, calculations, and processes that distinguish calculus, including limits, differentiation and integration.

6.2 Candidates can correctly identify, negate, and use logical connectives and quantifiers.

6.3 Candidates understand verbal descriptions of function behavior, including increasing/decreasing, concavity, and extrema.

6.4 Candidate can discuss optimization of functions from a variety of perspectives, including closed and open intervals.

6.5 Candidates can determine, explain, and use technology and real world problems to provide context for vertical and horizontal asymptotes.

Science

Standards 1: Life Science

Candidates know, understand and can explain the central concepts of life science.

Standard Elements
Candidates demonstrate an understanding of the major concepts, issues and processes related to cells, diversity of life, interdependence among living things and the environment, heredity and reproduction, flow of matter and energy in nature, and biological change.

1.1 Candidates demonstrate knowledge and understanding of the structure and function of plant and animal cells and their organelles.

1.2 Candidates demonstrate understanding that living things are related across generations by hereditary information transmitted from parent to offspring in the form of DNA, genes and chromosomes during the reproductive processes, and can distinguish between inherited and environmental characteristics.

1.3 Candidates can identify examples and processes related to recessive and dominant traits, use standard techniques to predict genotypes and phenotypes; and use probability and data to reinforce these principles.

1.4 Candidates can represent the organization of organ systems and their contributions to survival.

1.5 Candidates demonstrate an understanding of the process of photosynthesis as the source of all energy available to living organisms and the dynamic interplay between photosynthesis and respiration.

1.6 Candidates understand that organisms are dependent on resources provided by the physical environment, relationships within food chains, and interdependence among organisms.

1.7 Candidates understand the process of natural selection and the nature of biological change over time as indicated by fossil record, and can interpret diversity among living things in terms of adaptive responses to the environment.

Standard 2: Earth/Space Science
Candidates know, understand and can explain the central concepts of Earth and space science.

Supporting Explanation
Candidates demonstrate an understanding of the Earth's resources, features, cycles and place in the universe.

2.1 Candidates can classify the objects of the universe, discuss relative distances between objects, and model the movement of objects in space as governed by the force of gravity as well as the factors that influence its strength; they can express the nature of mathematical models that allow conclusions to be drawn across vast distances and in places that cannot be touched.

2.2 Candidates can identify star patterns in charts as well as identify methods and tools for researching seasonal star patterns.

2.3 Candidates can describe, illustrate, and use models to explain the motion, relative position, and alignment of the Sun, Moon, and Earth that determine seasons, time increments, tides, and phase changes of the moon, eclipses, and seasonal changes in the night sky.

2.4 Candidates understand the characteristics of planets and can draw conclusions about planets from analysis of comparative data; candidates can discuss the relationship between data and theory that supports current theories about planet formation and stellar evolution.

2.5 Candidates can discuss the historical methods of measuring time and identify the physical attributes of the Earth and sky that inspired these methods of measurement.

2.6 Candidates demonstrate understanding that the Earth is characterized by many land and water features that are affected by forces, such as weathering, erosion, plate tectonics and human activity.

2.7 Candidates compare and contrast climates in various locations in terms of latitude, altitude, and regional geologic features such as mountain ranges, plains, and coastal regions. They can analyze weather data to predict weather patterns and distinguish between local weather and global climate.

2.8 Candidates demonstrate an understanding of the hydrologic cycle and factors that affect it, such as how bodies of water affect the water cycle, effects of solar energy, the influence on global patterns of oceanic and atmospheric movements that result in weather and climate.

2.9 Candidates demonstrate understanding of major geologic processes and the rock cycle as well as the related changes in Earth's features and the timescales over which they occur, and processes that lead to observable events such as earthquakes, tsunamis, and volcanic eruptions.

2.10 Candidates can model Earth's layers and plate tectonics, identify types of rocks, and discuss features and events of the earth that are connected to plate movement.

Standard 3: Physical Science

Candidates know, understand and can explain the central concepts of physical science.

Supporting Explanation

Candidates demonstrate an understanding of the major concepts, issues and processes that surround matter – its composition, properties and interactions – and the relationships that exist among force, matter, and energy.

3.1 Candidates understand and can manipulate and combine the fundamental units of mass, distance, and time.

3.2 Candidates classify and identify matter according to physical and chemical properties, distinguish between physical and chemical changes, and discuss different states of matter and factors that cause a change in state.

3.3. Candidates understand evidence that supports the idea that matter is made of very small, discrete individual particles; they can discuss the differences between elements, compounds, and mixtures.

3.4 Candidates understand what a chemical equation represents and how chemical symbols, formulas, and balanced chemical equations are

used to describe chemical reactions; they understand the organizing principles of the periodic table.

3.5 Candidates demonstrate understanding of the differences between acids and bases and the use of indicators.

3.6 Candidates can discuss the scientific principles that underlie gravity and electromagnetism and design investigations to illustrate these principles.

3.7 Candidates understand, mathematically model, and demonstrate how force affects motion, including Newton's Laws and the influence of mass.

3.8 Candidates can demonstrate and design experiments to show the difference between potential and kinetic energy and the means of energy transfer and the relevant technological and economic implications.

3.9 Candidates discuss the implications of the law of conservation of energy.

3.10 Candidates understand the concept of work as a particular means of energy transfer and can demonstrate the use of simple machines to facilitate work.

3.11 Candidates can discuss and model the fundamental properties of both physical and electromagnetic waves. They can relate the frequency of a wave to observable phenomena, such as color and pitch, and to appropriate mathematical models.

3.12 Candidates can construct simple electrical circuits for demonstrating the characteristics of conductors and insulators.

Engineering and Technology

Standard 1: The Nature of Engineering and Technology

Candidates understand real world applications of engineering and technology.

Standard Elements

Candidates demonstrate an understanding of the characteristics, risks, and benefits of technology and engineering.

1.1 Candidates can explain the characteristics and scope of technology and engineering and their role through history.

1.2 Candidates can research and discuss the merits of engineering and technology based on risk versus reward and ethical considerations.

1.3 Candidates can trace the development of scientific principles, process of creative utilization, and engineering leading to new technologies for use in the world.

1.4 Candidates can explain the components of the Engineering Design Cycle and its relationship to the human-made world.

Standard 2: Phases of Technological Production
Candidates demonstrate an understanding of the basic processes and types of technology.

Standard Elements
Candidates demonstrate an understanding of the processes of technological production and can draw connections to mathematics and science.

2.1 Candidates can relate the phases of technological production to problem solving.
2.2 Candidates can identify major types of technology, its use and effectiveness.
2.3 Candidates understand the fundamental use of units to analyze problems and maintain accuracy of technological solutions.
2.4 Candidates can relate a designed product to its underlying scientific principles.

Standard 3: Impact of Technological Advances
Candidates understand benchmark technologies and discuss the impact of these technologies on society.

Supporting Explanation
Candidates demonstrate an understanding of and can identify specific benchmark technologies for discussing their impact on human society and the advancement of science and technology.

3.1. Candidates can identify current examples of technology that have impacted Earth and the Earth's resources, and lead appropriate discussions based on these examples.
3.2. Candidates utilize research findings, maps, tables, diagrams, and charts to interpret the economic and environmental impact of technological advances.
3.3. Candidates recognize fundamental aspects of STEM by examining the historical and current major STEM advances and the associated problem-solving processes.
3.4. Candidates can research current developments in technology and scientific knowledge and discuss the merits of the technology in terms of risk versus reward and ethical considerations.

Program Implementation Standards

1. The program of study in middle grades STEM education enables teacher candidates to meet the performance standards for the middle grades STEM comprehensive program of study that integrates the standards in the general education core, professional education, and the science and mathematics majors. The program of study assists candidates in teaching the middle grades STEM concepts, and provides the ability to

apply developmentally appropriate teaching practices to the STEM content areas.

2. Candidates in middle grades education complete a major, consisting of courses offered primarily by faculty from arts and sciences disciplines. The major includes in-depth study of one or more fields, provides candidates the opportunity to demonstrate the integration of knowledge across disciplines, and promotes an understanding of the processes of inquiry, problem-solving, and research. The major may be combined with study in other fields related to how children learn in the context of their environment. Enrollment in such a major is open to students who are preparing for licensure in middle grades education and to students who are not. Examples are the following:

    A. An interdisciplinary major, which includes study in mathematics and science;
    B. An interdisciplinary major in two disciplines from the areas of mathematics, engineering, and the sciences. The major may include any combination of STEM subjects taught in grades 5 – 9 within the areas delineated above; and/or
    C. A major in a single discipline from the areas of mathematics, engineering, or the sciences with an area of emphasis (approximately 10% of the undergraduate curriculum) in at least one additional STEM discipline outside of the major.

3. Teacher preparation programs provide field experiences and clinical practice (enhanced student teaching or internship) that are well designed and sequenced to provide opportunities for candidates to apply their knowledge, skills and dispositions in a variety of settings appropriate to the content and level of the program. Field experiences are on-going school-based opportunities in which candidates may observe, assist, tutor, instruct, or conduct applied research. Candidates study and practice in a variety of settings that include student populations of diverse backgrounds and learning needs. Clinical practice provides candidates with experiences that allow for full immersion in the school-based community, allowing candidates to demonstrate competence in the professional role for which they are preparing.

4. Teacher candidates have internship or student teaching experiences in middle school grades (5 -8), that are not self-contained classroom placements. To the extent possible, teacher candidates have experiences-either in field experiences or internship/student teaching – in a variety of instructional patterns, including teaming, departmentalization and in a STEM content area.

5. Teacher preparation programs use the following documents (as they may be amended) when planning, implementing, and evaluating teacher

preparation programs: Model Standards for Beginning Teacher Licensing: A Resource for State Dialogue, developed by the Interstate New Teacher Assessment and Support Consortium (1992); National Middle School Association Middle Level Teacher Preparation Standards (2002); other current research on middle level education; Tennessee Curriculum Standards, ELA and Mathematics Common Core in related subject areas; national standards in the content areas; and Tennessee Reading Standards To Be Integrated Into Licensure Standards (2001).

6. These standards become effective for candidates seeking licensure on August 5, 2011.

FAQ for Middle School STEM Licensure Standards and their Development

Q. What was the imperative to change these standards?

A. Tennessee student testing scores and teacher professional development raised concerns as did the national data regarding STEM performance at the middle grades level. The State Board of Education saw these concerns and initiated a plan to examine middle school STEM education in Tennessee. The results of the initial study were presented in the minutes for the Tennessee State Advisory Board and include reports on research and data both nationally and within the state. The Board of Education voted to implement a Middle School STEM license (5-9) based on these facts. Additionally, the new math and science curriculum standards for grades 4 – 8 induced a disconnect between the mathematics and science licensure portions of the Middle School (4-8) Teaching Licensure Standards and the training that teachers need to be able to teach the new curriculum.

Q. What process was used to develop these standards?

A. MTSU had a federal grant that could be used to develop a collaborative state-wide process; they invited 43 math/science educators of all levels along with businessmen and individuals from state policy positions to spend two days discussing and directing a direction for middle school STEM education. These discussions produced several planning documents and elaborated philosophies for the direction of middle school STEM education in Tennessee. Once the new licensure was passed, the licensure standards had to be written. The appropriate documents were examined and used to write a focused STEM licensure document for grades 5 -9.

Q. What process was used to write these standards?

A. The current licensure standards were the beginning base document. Reviewing the Tennessee State Curriculum standards for Math and Science grades 4, the material that focused on grades 4 content teaching as well as material for Humanities, Social Sciences, and other non-STEM disciplines was removed. At that point, the Tennessee State Curriculum standards for Math and Science grades 5 -8 as well as Algebra I and Physical Science were reviewed and used to develop up-to-date as well as extended teaching standards (extended so that Algebra I and Physical Science are properly supported by the licensure requirements). Also reviewed were the relevant Praxis exam descriptions. For a complete list of these documents, see the table below.

Tennessee Middle School Licensure Standard Grades 4- 8	www.tennessee.gov/education/lic/doc/accttchlicstds.pdf p. 64 – 81
Tennessee Math Standards grade 5	www.tennessee.gov/education/ci/math/doc/MA_Grade_5.pdf
Tennessee Math Standards grade 6	www.tennessee.gov/education/ci/math/doc/MA_Grade_6.pdf
Tennessee Math Standards grade 7	www.tennessee.gov/education/ci/math/doc/MA_Grade_7.pdf
Tennessee Math Standards grade 8	www.tennessee.gov/education/ci/math/doc/MA_Grade_9.pdf
Tennessee Math Standards Algebra I	www.tennessee.gov/education/ci/math/doc/MA_3102.pdf
Praxis Middle School Math (0069)	www.ets.org/Media/Tests/PRAXIS/pdf/0069.pdf

Tennessee Science Standards grade 5	www.tennessee.gov/education/ci/sci/doc/SCI_Grade_5.pdf
Tennessee Science Standards grade 6	www.tennessee.gov/education/ci/sci/doc/SCI_Grade_6.pdf
Tennessee Science Standards grade 7	www.tennessee.gov/education/ci/sci/doc/SCI_Grade_7.pdf
Tennessee Science Standards grade 8	www.tennessee.gov/education/ci/sci/doc/SCI_Grade_8.pdf
Tennessee Science Standards Physical Science	www.tennessee.gov/education/ci/sci/doc/SCI_3202.pdf
Praxis Middle School Science (0439)	www.ets.org/Media/Tests/PRAXIS/pdf/0439.pdf
Praxis Technical Education (0050)	www.ets.org/Media/Tests/PRAXIS/pdf/0050.pdf

After information from these documents was included, the resulting Middle School (5-9) document was sent out to 20 more individuals to assess and comment. Those comments were all used in refining the Middle School (5-9) document and the result, with editing and organizing, is the document that has been provided.

Q. What types of individuals reviewed these standards during the second review?

The following types of individuals reviewed the document during the production of the document being referred to the State Board of Education.

Individuals with experience at the following level:	
University/Teacher training and content specialists	16
Middle school and high school teachers	7
Central Office and Principals	3
State Policy Officials	4
Science Instructors	9
Mathematics Instructors	11
Education Instructors (University level)	4

Note: There are some individuals who have experience in more than one category.

Q. How do these standards relate to the current Middle School 4-8 standards?

A. These standards began with the current Middle School 4-8 standards. Educational and content material that was focused at a lower grade level or in disciplines other than STEM was removed. The content was then reviewed for coherence with current 4-8 Tennessee Curriculum to ensure it was current with those requirements. Finally, any special material needed to support the Algebra I and Physical Science was included.

Q. Are these standards obtainable?

A. Yes. Because the grade band was narrowed to focus on young adolescent (instead of two bands of childhood/young adult development) and because the content areas are so much more coherent, the focus of training will be ambitious but possible. These standards are closely integrating STEM ideas and therefore the design of training can be written with sufficient overlap to manage the extent of the topics.

STEM 5-9 LICENSURE REVIEWERS

Dr. JoAnn Cady	University Math Ed Faculty
Ms Kathryn Dillard	Middle Math School Teacher, Principal, Numeracy Coach
Ms. Jennifer Dye	High School Science Teacher
Dr. Scott Eddins	Middle School Math Teacher, High School Math Teacher, former State Administrator
Dr. Susan Gore	University Faculty
Ms. Tammy Jones	Math Consultant, K-12 Math Licensed Teacher
Dr. Dovie Kimmins	University Math Ed Faculty
Mr. Mark LaPorte	University Science Ed Faculty
Dr. Mary Martin	University Math Faculty
Dr. Ryan Nivens	University Math Ed Faculty
Mr. Jamie Parris	Central Office, Math Teacher
Dr. Pat Patterson	University Science Ed Faculty
Dr. Amy Phelps	University Science Ed Faculty
Ms. Brenda Pless	High School Science Teacher
Dr. Steve Robinson	University Science Faculty
Ms. Dale Rudolph	Central Office, SBE Advisory Council on Teacher Education & Certification
Dr. Allen Seed	University Education Faculty
Dr. Donald Snead	University Education Faculty
Dr. Monte Tatom	University Education Faculty, SBE Advisory Council on Teacher Education & Certification
Dr. Rick Vanosdall	University Science Ed Faculty
Dr. Jackie Vogel	University Math Ed Faculty
Ms. Joy Wilson	High School Math Teacher
Dr. Jeremy Winters	University Education Faculty
Dr. Mary Lou Witherspoon	University Math Ed Faculty

Affiliations

University	Teacher	Central Office	State
16	7	3	4

Math	Science	Education
11	9	4