

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

Date Standards Adopted or Most Recent Revision: \_\_\_\_\_

Date Institutions Must Submit to DOE: \_\_\_\_\_

Date Candidates Must Meet Standards: \_\_\_\_\_

**Introduction**

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 in the middle School grades. The performance standards for middle grades STEM education provide teacher preparation programs guidelines to develop prospective teachers who have the necessary content and pedagogical knowledge as well as the personal dispositions necessary to be successful beginning teachers. Teaching middle grades STEM is a lifelong undertaking that is initiated in college course work, refined in field experiences and/or clinical practice, and enhanced during professional teaching. The intent of these performance standards is to support teacher preparation programs having 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.

**Content Area Standards**

**Middle Grades STEM Education (5-9)**

**Standard 1: Young Adolescent Development**

Candidates demonstrate 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 Candidate use 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 provide for that diversity.
- 1.2 Candidates understand middle school patterns of school organization, infrastructure, and curriculum that support the development of the young adolescent's intellect and character.
- 1.3 Candidates understand the issues of health, mental health, sexuality and peer pressure which prevail during young adolescence.
- 1.4 Candidates reflect an enthusiasm for curriculum that is challenging, exploratory, integrated, and relevant.
- 1.5 Candidates use a variety of developmentally appropriate teaching and classroom management techniques to provide exceptional learning experiences.
- 1.6 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 the involvement at all levels in the educational experience.

## **Standard 2: Middle Level 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.

### **Supporting Explanation**

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

- 2.1. Candidates study and evaluate historical and contemporary models for educating students in the middle grades (5-9), including their advantages and disadvantages, and can employ a contextual understanding of best practices for education in a variety of school organizational plans such as P-8, 5-8, and 7-12.
- 2.2. Candidates can articulate and apply the characteristic components of developmentally responsive middle level schools to solving individual case studies.
- 2.3. Candidates can use an integrated curriculum to plan lessons that make connections within the disciplines, across disciplines, and with the real world, including the world of work.
- 2.4. Candidates learn to design student assessments that foster learning as well as measure it and practice collaboratively analyzing student assessment data as means for school improvement and enhancement of student learning.
- 2.5. Candidates practice effective collaboration in planning and implementation of the major components of middle level education, such as attention to transitions between levels, on-going professional development, and infrastructure; they understand the goal of combined strategies to contribute to school improvement.

## **English Language Arts**

### **Standard 1: Reading**

Candidates know and understand appropriate practices for promoting, developing and integrating reading instruction across all STEM subject matter areas.

### **Supporting Explanation**

Teacher candidates understand that students learn to read within the context of every subject and support a balanced reading program through encouraging explicit instruction in STEM reading throughout the middle grades. For additional information, please refer to Tennessee Reading Standards To Be Integrated into Licensure Standards, Pre-K-4, K-8, and 5-8 (2001).

- 1.1 Candidates know appropriate reading instructional strategies especially useful in supporting the development of STEM processes and conceptual understanding.

- 1.2 Candidates can fluently read mathematical and scientific expressions; in particular they can be read orally equations, scientific symbolism, and verbally explain diagrams.

### **Standard 2: Writing**

Candidates know, understand, and use the writing process for communication, expression, and reflection in all subject areas, for a variety of purposes, in a range of modes, and for multiple audiences.

#### **Supporting Explanation**

Candidates demonstrate a broad understanding of the uses 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 state writing curriculum standards and incorporate that knowledge into their instruction by planning 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-assessors of their written problem-solving explanations/solutions as well as demonstrate ability to help students learn these skills self-evaluation skills.
- 2.4. Candidates understand how to design writing tasks in order to organize and consolidate STEM thinking, promote coherent communication, and the precise expression of STEM ideas.
- 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 presentation of solutions.

### **Standard 3: Elements of Language**

Candidates know and understand basic English usage, mechanics, spelling, grammar, and sentence structure as tools to facilitate the writing process.

#### **Supporting Explanation**

Candidates understand and use the rules and conventions governing the structure and syntax of language as prerequisites to effective communication and as markers of literacy in the context of STEM communications.

- 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/mathematics expressions (formulas, equations, expressions, symbols and in some cases diagrams) are methods of representing communication and are able to use them in a manner that represent grammatically correct written and spoken English communication.

## **Standard 4: Speaking and Listening**

Candidates demonstrate a broad understanding of the uses of writing to learn, inform, explain, defend, support, persuade and express individual voice orally.

- 4.1. Candidates model the tenets of Standard English usage in spoken language; additionally, they can orally paraphrase fundamental STEM concepts.
- 4.2. Candidates display confidence and poise in oral presentations while effectively explaining 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 ideas.

## **STEM Learning**

### **Standard 1: STEM Interdisciplinary Principles of Instruction**

Candidates demonstrate an understanding of effective instructional strategies that support STEM learning and integrate STEM content and processes. Candidates develop cross-disciplinary problem-solving skills, reasoning, communication, connections, and representation. Additionally, they have the opportunity to plan instructional activities designed to develop these skills in their students.

### **Supporting Explanation**

Candidates demonstrate an understanding of the importance of instructional strategies and processes that allow the development of strongly integrated STEM instruction. These processes are intended to apply specifically in every STEM activity and process to support grade appropriate STEM understanding as defined by the Tennessee State Curriculum.

- 1.1 Candidates use current Tennessee curriculum standards to plan lessons and units that incorporate a learning cycle.
- 1.2 Candidates can choose, modify, and construct appropriate learning activities that support higher order thinking, creative problem-solving and the development of the connections between and among major STEM concepts.
- 1.3 Candidates know the characteristics of a physically and emotionally safe learning environment that encourages, motivates and supports innovation, design, and intellectual problem-solving and know how to work towards establishing that environment.
- 1.4 Candidates know the principles of using technological, concrete, and abstract experiences to balance the different needs of students from different ethnic and socioeconomic backgrounds and of students of different gender, age, and abilities.
- 1.5 Candidates demonstrate an understanding of how STEM concepts are related and developed across grade levels as well as how they are connected to other non-STEM disciplines and the real world; an especially central theme is the understanding of the strong link between science and mathematics, including representation of data and symbolically modeling ideas, and the link between science/mathematics and technology, including technology to both explore new ideas and turn theory into application.

- 1.6 Candidates understand how students learn STEM concepts; they are adept at analyzing implications of student error and can establish procedures to correct fundamental misconceptions.
- 1.7 Candidates understand the imperative in STEM education to continuously update information about the theory of the field, the best teaching practices, and the availability of new teaching and scientific technologies.
- 1.8 Candidates demonstrate the ability to design integrated STEM reading, writing, and questioning strategies and a variety of technologies into their instructional practices to support conceptual and process development.
- 1.9 Candidates use higher order questions and can analyze the results from appropriate formative and summative assessments, especially when looking at information crossing several disciplines.

## **Standard 2: STEM Interdisciplinary Content Concepts**

Candidates demonstrate expertise in practice of those concepts that inherently connect STEM disciplines.

- 2.1. Candidates analyze, represent, and describe change in a variety of contexts using graphs, tables and equations; they can approximate function values from various contexts and can describe relationships from various sources of information.
- 2.2. Candidates can model real world phenomena through a variety of techniques such as graphically, numerically, through functions, and using statistics. Detecting inadequate modeling and understanding the potential problem are thoroughly examined.
- 2.3. Candidates understand the process of measurement and its limitations in terms of uncertainties 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 motivate both basic fundamental concepts and major principles through connections to historical context.
- 2.6. Candidates model the problem-solving process involving comprehension, analysis, and the data interpretation skills that lead to a solution or conclusion; in addition, candidates can evaluate the successes and failures of a particular process and assess the merits of the various attempts.

## **Mathematics**

### **Standards 1: Mathematical Processes**

Candidates demonstrate effective mathematics processes as they reason solve problems, communicate mathematical ideas, chose appropriate representations, and recognize historically or logically motivating connections between mathematical ideas and between STEM disciplines.

### **Supporting Explanation**

Candidates develop the mathematical processes of problem solving, reasoning, communication, connections, and representation; they plan effective instructional activities

to develop these processes in students. In addition, they integrate appropriate strategies and technologies into their instructional practices to support conceptual and process development.

- 1.1 Candidates make and investigate mathematical conjectures and use logical thought in reflecting, explaining, and justifying strategies and solutions; included in solutions, explanations, and reflections are appropriate and accurate vocabulary and symbols of mathematics.
- 1.2 Candidates are comfortable with abstract representations of mathematical ideas which express ideas and extend concrete examples to more broad implications; candidates should be knowledgeable in presenting new concepts both concretely and pictorially in order to connect and interpret abstract ideas.
- 1.3 Candidates are thoroughly knowledgeable about current specialized technologies which assist in calculations, exploration of patterns, demonstration of mathematical properties, and assist with instruction, understanding, and assessment.

## **Standard 2: Number and Operations**

Candidates demonstrate understanding of mathematical concepts, operations, properties, and relations necessary for number and operation sense.

### **Supporting Explanation**

Candidates have the ability to apply those numerical and operation concepts, properties, and procedures in problem-solving situations.

- 2.1 Candidates can perform computations involving radicals, exponents, trigonometric, and rational expressions flexibly, accurately, efficiently, and can assess the reasonableness of their computations.
- 2.2 Candidates are able to explain arithmetic operations and properties of the integers, rational numbers and the complex numbers in terms of an axiomatic construction.
- 2.3 Candidates demonstrate understanding of the ways that basic ideas of number theory and algebraic structures underlie the rules for operations on expressions, equations, and inequalities.
- 2.4 Candidates can establish various properties of the integers using mathematical induction.
- 2.5 Candidates model operations on various sets of elements and examine the existence (or failure) of common operational properties are examined in these differing contexts. Contexts should include vectors, modular arithmetic, and complex numbers.

## **Standard 3: Algebra**

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

### **Supporting Explanation**

Candidates can generalize patterns as they represent and analyze quantitative relationships and change in a variety of contexts and problem-solving situations. They also demonstrate

knowledge of effective instructional practices necessary for fostering algebraic proficiency in students.

- 3.1 Candidates appropriately use, simplify, and manipulate algebraic expressions that involve polynomials, radical expressions, and fractions of polynomials to analyze situations, solve or model real world problems.
- 3.2 Candidates can completely 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.
- 3.3 Candidates thoroughly understand the role that linear functions play in modeling and the use of regression to model and understand real world phenomena.
- 3.4 Candidates extend and generalize patterns to describe relations and functions, including linear and non-linear functions, as well as establishing the fundamental properties of exponential functions.
- 3.5 Candidates demonstrate understanding of ways to 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.

#### **Supporting Explanation**

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

- 4.1 Candidates analyze, describe characteristics, and calculate appropriate measurements related to the properties of two- and three-dimensional geometric figures; they can relate these processes to science concepts in physics, astronomy and chemistry.
- 4.2 Candidates can calculate various quantities connected to special figures and composite figures; in this context, fundamental figures will include circles, polygons, 3-dimensional equivalent figures, and portions of any of the previous figures.
- 4.3 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.
- 4.4 Candidates understand the various methods of measuring angles and relate them to right triangles and unit circle trigonometry, engineering, chemistry, and physics.
- 4.5 Candidates can utilize basic trigonometric constructions to solve geometric and contextual problems.
- 4.6 Candidates specify locations and explain spatial relationships using coordinate geometry, vectors, vector operations, and scaling.
- 4.7 Candidates are able to use dynamic drawing tools and other emerging technologies to conduct geometric investigations emphasizing visualization and pattern recognition that lead to conjecturing and proof construction.

## **Standard 5: Data Analysis 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.

### **Supporting Explanation**

Candidates apply basic statistical and probability concepts in order to organize and analyze data to make predictions and conjectures.

- 5.1 Candidate 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.
- 5.2 Candidates understand basic concepts of probability such as conditional probability and independence and develop skill in calculating probabilities associated with those concepts.
- 5.3 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 the data and the analysis in order to answer the relevant questions.
- 5.4 Candidates make and evaluate inferences and predictions that are based on data and theoretical probabilities and communicate their predictions in clear layman's language and through well-constructed graphical displays.
- 5.5 Candidates can analyze experimental designs and discuss types of sample bias, calculate descriptive statistics, and collect data to describe different characteristics within one population or between two populations.

## **Standard 6: Advanced Mathematics**

Candidates understand and can intuitively and formally describe mathematical concepts underlying set theory, functions, and the fundamental principles of calculus; they can connect these concepts to motivation scientific questions.

### **Supporting Explanation**

Candidates develop sufficient expertise in beginning areas of advanced mathematics topics so that they can develop correct and consistent explanations for mathematical concepts that will provide an accurate basis for future mathematical learning in 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**

### **Standard 1: Elements of Effective Science Instruction**

Candidates demonstrate understanding of science and technology in daily life through the use of inquiry-based, student-designed, open-ended and materials-based laboratory investigation including student-designed investigation. They incorporate habits of mind and pedagogical techniques that have been demonstrated to deliver the content effectively in a safe environment.

#### **Supporting Explanation**

Candidates know, understand and use strategies and pedagogy to enhance science instruction for all students.

- 1.1. Candidates engage in multiple levels of scientific inquiry that incorporate the multiple aspects of experimental design: asking questions, hypothesizing, planning investigations, recording data, observing, interpreting patterns, analyzing data, inferring from results, and providing evidence to communicate results.
- 1.2. Candidates understand and apply the unifying concepts of science such as scale and model, form and function, organization, interaction, change and conservation.
- 1.3. Candidates demonstrate the ability to manage and maintain a safe laboratory environment, including proper materials and chemical storage, safe laboratory procedures and practices and appropriate student behavior.
- 1.4. Candidates select and use a wide variety of scientific instruments for measurement and observation including laboratory glassware, electronic balances, metersticks, calipers, microscopes, computers, calculators, probes and the variety of emerging technologies.
- 1.5. Candidates use a variety of appropriate formative and summative assessments as methods of an ongoing, continuous process to evaluate student learning and make decisions about future learning opportunities and activities. Candidates should be equally comfortable with written and oral responses directed at both theory and application of concepts.

### **Standards 2: Life Science**

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

#### **Supporting Explanation**

Candidates have a solid knowledge base in 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.

- 2.1. Candidates demonstrate knowledge and understanding of the structure and function of plant and animal cells and the organelles contained in them as well as being able to compare and contrast the two types of cells.
- 2.2. 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 in reproductive processes; candidates can distinguish between inherited and environmental characteristics and the interactions between the two.
- 2.3. Candidates can identify examples and processes relating to recessive and dominant traits as well as use standard techniques to predict genotypes, probable appearance of offspring, and include the use of probability and data to reinforce these principles.
  - 2.4. Candidates can present an organization of the various organ systems and their contributions to organism survival.
  - 2.5. Candidates demonstrate an understanding of the process of photosynthesis as the source of all energy available to living organisms and the interplay between photosynthesis and respiration.
  - 2.6. Candidates understand that organisms are dependent on resources provided by the physical environment and can demonstrate the relationships and hierarchies within the food chain as well as the interdependence between and contributions of each member makes to the chain.
  - 2.7. Candidates can lead discussions concerning the contributions and the damages made to the ecosystem by various members of the system using current research and data.
  - 2.8. Candidates demonstrate knowledge of the process of natural selection and the nature of biological change over time as indicated by fossil record; candidates can discuss how the variety found in living things may be related to adaptations for survival in certain environments while the fundamental characteristics remain common.

### **Standard 3: Earth/Space Science**

Candidates know, understand and can explain the central concepts of earth/space science.

#### **Supporting Evidence:**

Candidates have knowledge of the earth's resources, features, cycles and place in the universe. Candidates can discuss astronomical concepts and reflect on the expression of these in characteristics of earth.

- 3.1. 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.
- 3.2. Candidates can identify star patterns in charts as well as identify methods and tools for researching seasonal star patterns.
- 3.3. 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.
- 3.4. 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 has led to current theories about planet formation and stellar evolution.

- 3.5. 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; they can relate this to the differences in arithmetic inspired by these methods.
- 3.6. Candidates demonstrate understanding that the earth is characterized by many different land and water features that are affected by external and internal forces, such as weathering, erosion, plate tectonics and human activity.
- 3.7. 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 direct the collection and analysis of weather data to predict weather patterns and can distinguish between local weather and global climate.
- 3.8. Candidates demonstrate an understanding of the hydrologic (water) cycle as well as the changes related to it, such as how bodies of water affect the water cycle, effects of solar energy, the influence on global patterns of oceanic and atmospheric movement resulting in weather and climate.
- 3.9. Candidates demonstrate understanding of geologic processes and the rock cycle as well as the related changes in earth's features and the timescales over which they occur. They can describe the processes that lead to observable events such as earthquakes, tsunamis and volcanic eruptions.
- 3.10. Candidates can model earth's layers and plate tectonics, identify types of rocks, and discuss features and events of the earth which are connected to movement of the major plates.

#### **Standard 4: Physical Science**

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

#### **Supporting Explanation**

Candidates demonstrate a solid base of 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.

- 4.1. Candidates understand the role units of measure in the theory of physics; they can manipulate and combine the fundamental units of mass, distance and time.
- 4.2. Candidates classify and identify matter by physical and chemical properties and distinguish between physical and chemical changes; candidates can discuss different states of matter and the interaction of factors that can cause a change in state.
- 4.3. Candidates understand and can demonstrate observable evidence to support the idea that matter is made of very small, discrete individual particles; they can discuss the differences between elements, compounds, and mixtures.
- 4.4. Candidates understand what a chemical equation represents and how chemical symbols, formulas, and balanced chemical equations are used to describe a chemical reaction; they understand the organizing principles of the periodic table.
- 4.5. Candidates demonstrate understanding of the differences between acids and bases and the use of indicators.

- 4.6. Candidates can discuss the scientific principles of fields that underlie gravity and electromagnetism and design investigations to illustrate these principles.
- 4.7. Candidates understand, mathematically model, and demonstrate how force affects motion, including Newton's Laws and the influence of mass.
- 4.8. 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.
- 4.9. Candidates discuss the implications of the comprehension of the law of conservation of energy and that energy exists in many forms and can be transferred, converted, or conserved, but not lost.
- 4.10. Candidates understand the concept of work as a particular means of energy transfer and can demonstrate the use of simple machines to facilitate work.
- 4.11. 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 the appropriate mathematical models.
- 4.12. Candidates can construct simple electrical circuits and use them to demonstrate the characteristics of conductors and insulators.

## **Engineering and Technology**

### **Standard 1: Technology and Engineering Teaching Processes**

Candidates understand the role that engineering and technology play in the implementation of science and mathematics into human activities as well as the systems that reinforce and further this implementation.

#### **Supporting Explanation**

Candidates understand and can use the technology processes to organize good STEM teaching practices.

- 1.1. Candidates develop students' recognition of the parallel steps in the disciplinary progressions of STEM work: scientific experimentation, mathematical proof, engineering production, and technology implementation.
- 1.2. Candidates develop their own protocols for managing the practicalities of classroom project design and management of STEM problem solving and group work.
- 1.3. Candidates can design a logical model that directs the goals, objectives, needed resources, and sequence of events that lead to the completion of a specific STEM learning outcome; this should include decisions about the resources needed be it chemical or physical supplies, equipment, or technology.
- 1.4. Candidate 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.
- 1.5. Candidates can use student assessment to detect and correct 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 then use the complete analysis of data to modify instruction, and improve individual student learning and classroom behavior.

## **Standard 2: The Nature of Engineering and Technology**

Candidates demonstrate an understanding of engineering and technology as means of embedding science and mathematics into the activities of human endeavor.

### **Supporting Explanation**

Candidates understand the characteristics and benefits of technology, its role in human design in the world as well as the risks and moral considerations to be considered.

- 2.1. Candidate can explain the characteristics and scope of technology and understand the role of technology throughout history.
- 2.2. Candidates can research current developments in technology and can discuss the merits of them based on risk/reward and ethical considerations.
- 2.3. Candidates can trace the process of scientific principle, development of creative utilization, and engineering leading to new technologies for use in the world.

## **Standard 3: Phases of Technological Production**

Candidates can describe the basic processes and types of technology.

### **Supporting Explanation**

Candidates understand the processes of technological production as well as its role in inserting science and mathematics into human endeavors.

- 3.1. Candidates can relate the phases of technological production to problem solving.
- 3.2. Candidates can identify the types of machines, the use and effectiveness of classes of tools, and the major classifications of technology.
- 3.3. Candidates understand the fundamental use of units to analyze problems and maintain accuracy of technological solutions to the problems.
- 3.4. Candidates can relate a designed product to underlying key scientific principles.

## **Standard 3: Impact of Technological Advances**

Candidates can identify specific benchmark technologies and discuss the impact these technologies have made on human society and advancement.

### **Supporting Explanation**

- 3.1. Candidates can identify current examples of human activity impacting earth and earth's resources; candidates can design and lead appropriate discussions based on these examples.
- 3.2. Candidates utilize maps, tables, diagrams, and charts to interpret impact of technological advances, including project effectiveness, economic impact, and environmental impact.
- 3.3. Candidates can teach fundamental aspects of STEM through examining the historical and current major STEM advances and the problem-solving processes involved.

- 3.4. Candidates can research current developments in technology and scientific knowledge and can discuss the merits of the technology based on risk/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 major. The program of study assists candidates in teaching the middle grades STEM subjects, particularly, mathematics and science, and helps establish the ability to apply developmentally appropriate practices to the various 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 the disciplines, and promotes an understanding of the processes of inquiry 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.
  - C. A major in a single discipline from the areas of mathematics, engineering, and the sciences with an area of emphasis (approximately 10% of the undergraduate curriculum) in at least one additional STEM discipline outside the major.
3. Institutions of higher education 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 students 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), 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. Institutions of higher education 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 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 no later than September 1, \_\_\_\_\_. Institutions will submit standards for conditional approval no later than September 1, \_\_\_\_\_.