COMPETENCIES FOR TEACHERS OF PHYSICS/MATHEMATICS, GRADES 7-12

In addition to the Arkansas Teaching Standards (ATS) and the competencies for the Teacher Excellence and Support System (TESS), including competencies regarding the knowledge and use of educational technology that reflect the International Society for Technology in Education standards, the teacher of Physics/Mathematics grades 7-12, shall also demonstrate knowledge and competencies in the following areas:

1. CONTENT KNOWLEDGE

NSTA/ASTE: Standard 1

NRC Framework

Praxis 5265

AAPT

AR K-12 Science Standards

NSTA/ASTE Standard 1: *Effective teachers of science understand and articulate the knowledge and practices of contemporary science and engineering. They connect important disciplinary core ideas, crosscutting concepts, and science and engineering practices for their fields of licensure.*

1.1 Uses and applies major concepts, principles, theories, laws, and interrelationships of their fields of licensure and supporting fields. Explains the nature of science and the cultural norms and values inherent to the current and historical development of scientific knowledge

1.2 Demonstrates knowledge of crosscutting concepts, disciplinary core ideas, practices of science and engineering, the supporting role science-specific technologies, and contributions of diverse populations to science

1.3 Demonstrates knowledge of how to implement science standards, learning progressions, and sequencing of science content for teaching their licensure level 7-12 students

NRC Framework: Core Component Ideas in the Physical Sciences:

1.4 Core Idea PS1: Matter and Its Interactions

- PS1.A: Structure and Properties of Matter
- PS1.B: Chemical Reactions
- PS1.C: Nuclear Processes

Key concepts: Coulomb's Law, Nuclear Physics, Properties of Design Material, and Nature of Atomic and Subatomic Structure

1.5 Core Idea PS2: Motion and Stability: Forces and Interactions

- PS2.A: Forces and Motion
- PS2.B: Types of Interaction
- PS.2C: Stability and Instability in Physical Systems

Key concepts: Newton's Laws, Kinematics, Impulse=Change in Momentum, Conservation of Energy, Uni. Gravitation, Coulomb's Law, Current, Magnetism, and Induction, Vectors and Scalars, Dynamics, and Fluid Mechanics

1.6 Core Idea PS3: Energy

- PS3.A: Definitions of Energy
- PS3.B: Conservation of Energy and Energy Transfer
- PS3.C: Relationship Between Energy and Forces
- PS3.D: Energy in Chemical Processes and Everyday Life

Key concepts include: Forms of Energy, Conservation of Energy, Magnetic Fields, Thermodynamics, and Electromagnetic Fields

COMPETENCIES FOR TEACHERS OF PHYSICS/MATHEMATICS, GRADES 7-12

1.7 Core Idea PS4: Waves and Their Applications in Technologies for Information Transfer

- PS4.A: Wave Properties
- PS4.B: Electromagnetic Radiation
- PS4.C: Information Technologies and Instrumentation

Key concepts include: Waves, Refraction, Information Technology, Wave-Particle Duality, Photoelectric Eff., Absorption, Optics, Longitudinal Waves, Simple Harmonic Motion, and E&M Waves

2. CONTENT PEDAGOGY

NSTA/ASTE: Standard 2

AAPT

NSTA/ASTE Standard 2: *Effective teachers of science plan learning units of study and equitable, culturally responsive opportunities for all students based upon their understanding of how students learn and develop science knowledge, skills, and habits of mind. Effective teachers also include appropriate connections to science and engineering practices and crosscutting concepts in their instructional planning.*

2.1 Uses science standards and a variety of appropriate, student-centered, and culturally relevant science disciplinary-based instructional approaches that follow safety procedures and incorporate science and engineering practices, disciplinary core ideas, and crosscutting concepts

2.2 Incorporates appropriate differentiation strategies, wherein all students develop conceptual knowledge and an understanding of the nature of science. Lessons should engage students in applying science practices, clarifying relationships, identifying natural patterns and empirical experiences

2.3 Uses engineering practices in support of science learning wherein all students design, construct, test and optimize possible solutions to a problem

2.4 Aligns instruction and assessment strategies to support instructional decision making that identifies and addresses student misunderstandings, prior knowledge, and naïve conceptions

Possible assessment types to use in instruction:

Summative assessments are performed in periodic intervals to assess a collection of knowledge at a particular point in time. Summative assessments may take the form of traditional assessments, including quizzes, exams, lab reports, and term papers but may also include projects, posters, presentations, etc.

Student self-assessment could be in the form of a journal that is used to Student self-assessment could be in the form of a journal that is used to encourage students to reflect and assess their progress

Performance-based assessments have proven to be effective in assessing three-dimensional learning. This requires students to demonstrate content knowledge (DCIs), the ability to make connections (CCCs), and developing solutions to solve a problem (SEPs)

Model-based assessment allows students to demonstrate content knowledge. The creative diagramming aspect of the model means that students, especially English for Speakers of Other Languages (ESOL) can demonstrate content understanding without being bogged down by vocabulary; they can show their comprehension is deeper than vocabulary

COMPETENCIES FOR TEACHERS OF PHYSICS/MATHEMATICS, GRADES 7-12

Third party assessment tools have the advantage of being unbiased and statistically valid. Local, district, and state assessments may be examples of third-party assessments, including end-of-course exams.

2.5 Integrates science-specific technologies to support all students' conceptual understanding of science and engineering

3. LEARNING ENVIRONMENT

NSTA/ASTE: Standard 3

NSTA/ASTE Standard 3: *Effective teachers of science are able to plan for engaging all students in science learning by identifying appropriate learning goals that are consistent with knowledge of how students learn science and are aligned with standards. Plans reflect the selection of phenomena appropriate to the social context of the classroom and community, and safety considerations, to engage students in the nature of science and science and engineering practices. Effective teachers create an anti-bias, multicultural, and social justice-learning environment to achieve these goals.*

3.1 Plans a variety of lesson plans based on science standards that employ strategies that demonstrate their knowledge and understanding of how to select appropriate teaching and motivating learning activities that foster an inclusive, equitable, and anti-bias environment

3.2 Plans learning experiences for all students in a variety of environments (e.g., laboratory, field and community) within their fields of licensure

3.3 Plans lessons in which all students have a variety of opportunities to investigate, collaborate, communicate, evaluate, revise, and defend their own explanations of: scientific phenomena, observations, and data

4. SAFETY

NSTA/ASTE: Standard 4

Praxis 5265

COSSS

NSTA/ASTE Standard 4: *Effective teachers of science demonstrate biological, chemical, and physical safety protocols in their classrooms and workspace. They also implement ethical treatment of living organisms and maintain equipment and chemicals as relevant to their fields of licensure.*

4.1 Implements activities appropriate for the abilities of all students that demonstrate safe techniques for the procurement, preparation, use, storage, dispensing, supervision, and disposal of all chemicals/materials/equipment used within their fields of licensure

4.2 Demonstrates the awareness to recognize, prevent, and appropriately respond to hazardous situations(i.e. manage overcrowding; implement emergency procedures; maintain safety equipment; provide adequate student instruction and supervision; and follow policies and procedures that comply with established state and national guidelines, appropriate legal state (Arkansas Code Annotated § 6-10-113 [2012] for eye protection) and national safety standards (e.g., OSHA, NFPA, EPA), and best professional practices (e.g., NSTA, NSELA))

4.3 Demonstrates ethical decision-making with respect to safe and humane treatment of all living organisms in and out of the classroom, and comply with the legal restrictions and best professional practices on the collection, care, and use of living organisms as relevant to their fields of licensure

COMPETENCIES FOR TEACHERS OF PHYSICS/MATHEMATICS, GRADES 7-12

5. IMPACT ON STUDENT LEARNING

NSTA/ASTE: Standard 5

NSTA/ASTE Standard 5: *Effective teachers of science provide evidence that students have learned and can apply disciplinary core ideas, crosscutting concepts and science and engineering practices because of instruction. Effective teachers analyze learning gains for individual students, the class as a whole, and subgroups of students disaggregated by demographic categories, and use these to inform planning and teaching.*

5.1 Implements assessments that show all students have learned and can apply disciplinary knowledge, nature of science, science and engineering practices, and crosscutting concepts in practical, authentic, and real-world situations

5.2 Collects, organizes, analyzes, and reflects on formative and summative evidence and uses those data to inform future planning and teaching

5.3 Analyzes science-specific assessment data based upon student demographics, categorizing the levels of learner knowledge, and reflect on results for subsequent lesson plans

6. PROFESSIONAL KNOWLEDGE AND SKILLS

NSTA/ASTE: Standard 6

New America

NSTA/ASTE Standard 6: *Effective teachers of science strive to continuously improve their knowledge of both science content and pedagogy, including approaches for addressing inequities and inclusion for all students in science. They identify with and conduct themselves as part of the science education community.*

6.1 Engages in critical reflection on their own science teaching to continually improve their instructional effectiveness

6.2 Participates in professional development opportunities to deepen their science content knowledge and practices

6.3 Participates in professional development opportunities to expand their science-specific pedagogical knowledge

New America:

6.4 Reflects on one's cultural lens

6.5 Recognizes and redresses biases in the system

6.6 Promotes respect for students' differences

6.7 Collaborates with families and the local community

7. INCORPORATES CROSSCUTTING CONCEPTS

NRC Framework

Praxis 5265

7.1 Understands and exhibits knowledge of patterns

7.2 Understands and exhibits knowledge of cause and effect and mechanism and explanation

7.3 Understands and exhibits knowledge of scale, proportion, and quantity

7.4 Understands and exhibits knowledge of systems and system models

7.5 Understands and exhibits knowledge of energy and matter, flows, cycles, and conservation

7.6 Understands and exhibits knowledge of structure and function

7.7 Understands and exhibits knowledge of stability and change

7.8 Teacher candidates will facilitate opportunities for 7-12 students to identify and demonstrate understanding of these crosscutting concepts paired with the disciplinary core ideas and science and engineering practices

COMPETENCIES FOR TEACHERS OF PHYSICS/MATHEMATICS, GRADES 7-12

8. INCORPORATES SCIENCE AND ENGINEERING PRACTICES

NRC Framework

Praxis 5265

8.1 Knows and practices the eight practices of science and engineering that the Framework (NRC) identifies as essential for all students to learn and describes in detail are listed below:

- Asks questions (for science) and defining problems (for engineering)
- Develops and uses models
- Plans and carries out investigations
- Analyzes and interprets data
- Uses mathematics and computational thinking
- Constructs explanations (for science) and designs solutions (for engineering)
- Engages in argument from evidence
- Obtains, evaluates, and communicates information

8.2 Teacher candidates will facilitate opportunities for 7-12 students to demonstrate application of the Science and Engineering Practices paired with the disciplinary core ideas and the crosscutting concepts

9. INCORPORATES HISTORY AND NATURE OF SCIENCE

NRC Framework

Praxis 5625: Section VI

9.1 Applies appropriate practices and knowledge to show scientific investigations use a variety of methods

9.2 Applies appropriate practices and knowledge to show scientific knowledge is based on empirical evidence

9.3 Applies appropriate practices and knowledge to show scientific knowledge is open to revision in light of new evidence

9.4 Applies appropriate practices and knowledge to scientific models, laws, mechanisms, and theories that explain natural phenomena

9.5 Applies appropriate practices and knowledge to show science is a way of knowing

9.6 Applies appropriate practices and knowledge to demonstrate scientific knowledge assumes an order and consistency in natural systems

9.7 Applies appropriate use of scientific measurement and notation systems (i.e., precision vs accuracy, metric and SI units, unit conversions, scientific notation and significant figures, linear vs. logarithmic scales [e.g., pH])

9.8 Teacher candidates will facilitate opportunities for 7-12 students to demonstrate application of the History and Nature of Science

10. ANCHORING INSTRUCTION IN PHENOMENA

Seeing Students Learn Science: Integrating Assessment and Instruction in the Classroom: National Academies Press

AR K-12 State Standards

10.1 Engages students in active scientific thinking

10.2 Helps students make connections and to understand how science ideas are important

10.3 Identifies phenomena that describe events or facts that can be observed

10.4 Engages students in making sense of novel phenomena to gain conceptual understanding of what they observe in the world

10.5 Elicits students' natural curiosity about something that can be explained scientifically

10.6 Develops a range of activities that allow students to develop three-dimensional understanding of the core ideas and cross cutting concepts while using science and engineering skills

COMPETENCIES FOR TEACHERS OF PHYSICS/MATHEMATICS, GRADES 7-12

11. SUPPORTING COMPETENCIES

NSTA-P

NRC Framework

AR K-12 State Standards

Praxis 5625

11.1 Mathematics:
- Understands how mathematical and statistical models evaluate the strength of a conclusion
- Understands how mathematical models are used in physics
- Understands what are the applications of calculus and differential equations in physics
- Understands how to use logarithms, trigonometric functions, Pythagorean theorem, vector resolution and addition

11.2 Chemistry:
- Understands what is matter
- Understands nature of atomic and subatomic structure, including atomic models
- Understands nuclear chemistry
- Knows what trends exist in the Periodic Table and how do those trends reflect atomic structure
- Understands in what ways do atoms combine to form novel substances
- Understands relationship of atomic spectra to electron energy levels

11.3 Earth and Space Sciences:
- Understands what are the predictable patterns caused by Earth's motion in the Solar System

11.4 Engineering, Technology and Applications:
- Understands that the engineering design process begins with identifying a problem and developing clear goals that the final product or system must meet
- Understands the process for developing potential design solutions, including models or prototypes
- Understands how to compare and improve various proposed design solutions

12. SCIENTIFIC PROCEDURES AND TECHNIQUES

Praxis 5265: Section VI (B)

12.1 Understands how to collect, evaluate, manipulate, interpret, and report data
- Significant figures in collected data and calculations
- Organization and presentation of data
- Knows how to interpret and draw conclusions from data presented in tables, graphs, and charts (e.g., trends in data, relationships between variable, predictions, and conclusions based on data)

12.2 Understands basic error analysis
- Determining mean
- Accuracy and precision
- Identifying sources and effects of error and its impact on percent error

COMPETENCIES FOR TEACHERS OF PHYSICS/MATHEMATICS, GRADES 7-12

13. KNOWING AND UNDERSTANDING MATHEMATICS

NCTM/CAEP: Standard 1

Praxis 5161: Sections I & II

AR Algebra I, II, III, Calculus, Geometry, Statistics, and Quantitative Literacy Standards

NCTM/CAEP Standard 1: *Demonstrate and apply understandings of major mathematics concepts, procedures, knowledge, and applications within and among mathematical domains of: Number; Algebra and Functions; Calculus; Statistics and Probability; Geometry, Trigonometry and Measurement.*
Arkansas teachers should exhibit knowledge and understanding of the essential concepts in each mathematical domain. Additional, specific competencies from Praxis content knowledge test specifications and Arkansas Standards are included. The intention of this is to augment and provide additional detail to the essential concepts.

13.1 **Essential Concepts in Number.** Demonstrate and apply understandings of major mathematics concepts, procedures, knowledge, and applications of number including flexibly applying procedures, using real and rational numbers in contexts, developing solution strategies, and evaluating the correctness of conclusion. Major mathematical concepts in Number include number systems (particularly rational numbers); algorithmic and recursive thinking; number and set theory; ratio, rate of change, and proportional reasoning; and structure, relationships, operations, and representations
Additional specific competencies in Number required for Arkansas teachers include:

- Understand the structure of the natural, integer, rational, real, and complex number systems and how basic operations on numbers in these systems are performed
- Understand and apply the properties of exponents, including working with rational exponents and radicals
- Reason quantitatively and use understanding of units to solve problems (e.g., dimensional analysis, reasonableness of solutions)
- Understand how to solve problems involving ratios, proportions, averages, percents, and metric and traditional unit conversions
- Understand how to perform operations on matrices and apply matrices to solve problems, including in programming applications
- Represent and compare very large and very small numbers (e.g., scientific notation, orders of magnitude) and estimate and perform calculations on these numbers
- Use number sense and proportional reasoning in real world settings to make and communicate decisions in quantitative analysis
- Understand how to use counting techniques such as the multiplication principle, permutations, and combinations
- Understand basic set theory (e.g., unions, differences, Venn diagrams)
- Understand the differences between discrete and continuous representations (e.g., data, functions) and how each can be used to model various phenomena

13.2 **Essential Concepts in Algebra and Functions.** Demonstrate and apply understandings of major mathematics concepts, procedures, knowledge, and applications of algebra and functions including how mathematics can be used systematically to represent patterns and relationships including proportional reasoning, to analyze change, and to model everyday events and problems of life and society. Essential Concepts in Algebra and Functions include algebra that connects mathematical structure to symbolic, graphical, and tabular descriptions; connecting algebra to functions; and developing families of functions as a fundamental concept of mathematics. Advanced concepts should include algebra from a more theoretical approach including relationship between structures (e.g., groups, rings, and fields) as well as formal structures for number systems and numerical and symbolic calculations.
Rewrite algebraic expressions in equivalent forms and choose the appropriate form of an algebraic expression for a given purpose

Additional specific competencies in Algebra required for Arkansas teachers include:

- Understand how to perform arithmetic operations on polynomials and rational expressions
- Understand and utilize the relationship between zeros of polynomial functions (including non-real complex zeros and graphical representations of real zeros) and factors of the related polynomial expressions
- Understand how to use polynomial identities (e.g., difference of squares, sum and difference of cubes) to solve problems
- Use equations and inequalities to describe relationships
- Justify the reasoning process used to solve equations, including analysis of potential extraneous solutions
- Use varied techniques (e.g., graphical, algebraic) to solve equations and inequalities in one variable
- Understand how varied techniques (e.g., graphical, algebraic, matrix) are used to solve systems of equations and inequalities
- Understand the concept of average rate of change over an interval for nonlinear functions and utilize it in problem-solving contexts
- Recognize, extract, and interpret information about a linear equation presented in various forms (e.g., slope-intercept, point-slope, standard), including within a modeling context
- Understand sequences and define them recursively (e.g., arithmetic, geometric)

Additional specific competencies in Functions required for Arkansas teachers include:

- Understand the function concept and the use of function notation
- Understand how to find the domain and range of a function and a relation
- Analyze function behavior using different representations (e.g., graphs, mappings, tables, recursively-defined functions)

- Understand how to find and interpret the zero(s) of functions
- Understand how functions and relations are used to model relationships between quantities
- Understand how new functions are obtained from existing functions (e.g., compositions, transformations, inverses)
- Understand differences between linear, quadratic, and exponential models, including how their equations are created and used to solve problems
- Understand the relationship between points on the unit circle and the values of trigonometric functions for any given angle measure
- Understand how periodic phenomena are modeled using trigonometric functions
- Understand the derivation and application of trigonometric identities (e.g., Pythagorean, double angle, half angle, sum of angles, difference of angles)
- Understand how to interpret representations of functions of two variables (e.g., three-dimensional graphs, tables)
- Understand how to solve trigonometric, logarithmic, and exponential equations
- Apply knowledge of functions and equations in programming applications

13.3 **Essential Concepts in Calculus.** Demonstrate and apply understandings of major mathematics concepts, procedures, knowledge, and applications of calculus including the mathematical study of the calculation of instantaneous rates of change and the summation of infinitely many small factors to determine some whole. Essential Concepts in *Calculus* include limits, continuity, the Fundamental Theorem of Calculus, and the meaning and techniques of differentiation and integration.

Additional specific competencies in Calculus required for Arkansas teachers include:

- Understand the meaning of a limit of a function and how to calculate limits of functions, conditions when the limit does not exist, and solve problems using the properties of limits
- Understand the derivative of a function as a limit, as the slope of a line tangent to a curve, and as a rate of change
- Understand what it means that a particular function is continuous at a given point
- Know the relationship between continuity and differentiability
- Understand how and when to use standard differentiation and integration techniques
- Understand how to analyze the behavior of a function (e.g., extrema, concavity, symmetry)
- Understanding how to apply derivatives to solve problems both theoretically and in a real-world context (e.g., related rates, optimization)
- Understand the foundational theorems of calculus (e.g., fundamental theorems of calculus, mean value theorem, intermediate value theorem)
- Understand integration as a limit of Riemann sums to compute area, volume, distance, or other accumulation processes

13.4 **Essential Concepts in Statistics and Probability.** Demonstrate and apply understandings of statistical thinking and the major concepts, procedures, knowledge, and applications of statistics and probability, including how statistical problem solving and decision making depend on understanding, explaining, and quantifying the variability in a set of data to make decisions and understanding the role of randomization and chance in determining the probability of events. Essential Concepts in Statistics and Probability include quantitative literacy, visualizing and summarizing data, statistical inference, probability, and applied problems

Additional specific competencies in Statistics and Probability required for Arkansas teachers include:

- Understand how to summarize, represent, and interpret data collected from measurements on a single variable (e.g., box plots, dot plots, normal distributions)
- Understand how to summarize, represent, and interpret data collected from measurements on two variables, either categorical or quantitative (e.g., scatterplots, time series)
- Understand how to create and interpret linear regression models (e.g., rate of change, intercepts, correlation coefficient)
- Understand how to make inferences and justify conclusions from samples, experiments, and observational studies
- Understand the concept of independence and understand how to compute probabilities of simple events, probabilities of compound events, and conditional probabilities
- Know how to make informed decisions using probabilities and expected values
- Understand how to find probabilities involving finite sample spaces and independent trials, including the use of the counting techniques (e.g., fundamental counting principles, permutations, combinations)
- Understand normal distributions
- Using statistical and probabilistic reasoning to draw conclusions, to make decisions, and to evaluate outcomes of decision

13.5 **Essential Concepts in Geometry, Trigonometry, and Measurement.** Demonstrate and apply understandings of major mathematics concepts, procedures, knowledge, and applications of geometry, including using visual representations for numerical functions and relations, data and statistics, and networks, to provide a lens for solving problems in the physical world. Essential Concepts in *Geometry*, *Trigonometry*, *and Measurement* include transformations, geometric arguments, reasoning and proof, applied problems, and non-Euclidean geometries

Additional specific competencies in Geometry required for Arkansas teachers include:

- Know the properties of lines (e.g., parallel, perpendicular, intersecting) and angles
- Know and apply properties of triangles, quadrilaterals (e.g., parallelogram, rectangle, rhombus) and other polygons
- Understand and investigate transformations in the plane and apply their properties

COMPETENCIES FOR TEACHERS OF PHYSICS/MATHEMATICS, GRADES 7-12

- Understand congruence and similarity, including congruence and similarity theorems and use of transformations to define congruence and similarity
- Know how to prove geometric theorems, such as those about lines and angles, triangles, and parallelograms
- Understand how geometric constructions are made with a variety of tools and methods
- Understanding how trigonometry is applied to triangles, including the definition of trigonometric functions in right triangles
- Understand and apply theorems about circles
- Find arc length and area measurements of sectors of circles
- Know how to translate between a geometric description (e.g., focus, asymptotes, directrix) and an equation for a conic section
- Understand how to represent geometric objects incoordinate geometry to algebraically prove simple geometric theorems
- Use perimeter, area, surface area, and volume formulas to solve problems
- Know how to visualize relationships (e.g., cross section, nets, rotations) between two-dimensional and three-dimensional objects
- Apply geometric concepts in modeling and real world situation

14. KNOWING AND USING MATHEMATICAL PROCESSES

NCTM/CAEP: Standard 2

NCTM-MP

NCTM/CAEP Standard 2: *Demonstrate, within or across mathematical domains, their knowledge of and ability to apply the mathematical processes of problem solving; reason and communicate mathematically; and engage in mathematical modeling. Apply technology appropriately within these mathematical processes.*

14.1 Demonstrate a range of mathematical problem-solving strategies to make sense of and solve non-routine problems (both contextual and non-contextual) across mathematical domains

14.2 Organize mathematical reasoning and use the language of mathematics to express mathematical reasoning precisely, both orally and in writing, to multiple audiences

14.3 Understand the difference between the mathematical modeling process and models in mathematics; engage in the mathematical modeling process and demonstrate ability to model mathematics

NCTM-MP: *The Standards for Mathematical Practices describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important "processes and proficiencies" with longstanding importance in mathematics education.*

- Make sense of problems and persevere in solving them
- Reason abstractly and quantitatively
- Construct viable arguments and the critique the reasoning of others
- Model with mathematics
- Use appropriate tools strategically
- Attend to precision
- Look for and make use of structure
- Look for and express regularity in repeated reasoning

14.4 Understand the importance of providing students with opportunities to learn mathematics that enable them to think analytically and creatively for everyday problem-solving and preparation for the workforce, college, citizenship, and life

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15. KNOWING STUDENTS AND PLANNING FOR MATHEMATICAL LEARNING

NCTM/CAEP: Standard 3

NCTM/CAEP Standard 3: *Apply knowledge of students and mathematics to plan rigorous and engaging mathematics instruction supporting students' access and learning, and develop mathematics instruction that provides equitable, culturally responsive opportunities for all students to learn and apply mathematics concepts, skills, and practices.*

15.1 Identify and use students' individual and group differences to plan rigorous and engaging mathematics instruction that supports students' meaningful participation and learning

15.2 Identify and use students' mathematical strengths to plan rigorous and engaging mathematics instruction that supports students' meaningful participation and learning

15.3 Understand that teachers' interactions impact individual students by influencing and reinforcing students' mathematical identities, positive or negative, and plan experiences and instruction to develop and foster positive mathematical identities

16. TEACHING MEANINGFUL MATHEMATICS

NCTM/CAEP: Standard 4

NCTM-PA

NCTM/CAEP Standard 4: *Implement effective and equitable teaching practices to support rigorous mathematical learning for a full range of students. Establish rigorous mathematics learning goals, engage students in high cognitive demand learning, use mathematics specific tools and representations, elicit and use student responses, develop conceptual understanding and procedural fluency, and pose purposeful questions to facilitate student discourse.*

16.1 Establish rigorous mathematics learning goals for students based on mathematics standards and practices

16.2 Select or develop and implement high cognitive demand tasks to engage students in mathematical learning experiences that promote reasoning and sense making

16.3 Select mathematics-specific tools, including technology, to support students' learning, understanding, and application of mathematics and to integrate tools into instruction

16.4 Select and use mathematical representations to engage students in examining understandings of mathematics concepts and the connections to other representations

16.5 Use multiple student responses, potential challenges, and misconceptions, and they highlight students' thinking as a central aspect of mathematics teaching and learning

16.6 Use conceptual understanding to build procedural fluency for students through instruction that includes explicit connections between concepts and procedures

16.7 Pose purposeful questions to facilitate discourse among students that ensures that each student learns rigorous mathematics and builds a shared understanding of mathematical ideas

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17. ASSESSING IMPACT ON STUDENT LEARNING

NCTM/CAEP: Standard 5

NCTM/CAEP Standard 5: *Assess and use evidence of students' learning of rigorous mathematics to improve instruction and subsequent student learning. Analyze learning gains from formal and informal assessments for individual students, the class as a whole, and subgroups of students disaggregated by demographic categories, and they use this information to inform planning and teaching.*

17.1 Select, modify, or create both informal and formal assessments to elicit information on students' progress toward rigorous mathematics learning goals

17.2 Collect information on students' progress and use data from informal and formal assessments to analyze progress of individual students, the class as a whole, and subgroups of students disaggregated by demographic categories toward rigorous mathematics learning goals

17.3 Use the evidence of student learning of individual students, the class as a whole, and subgroups of students disaggregated by demographic categories to analyze the effectiveness of their instruction with respect to these groups. Propose adjustments to instruction to improve student learning for each and every student based on the analysis

18. SOCIAL AND PROFESSIONAL CONTEXT OF MATHEMATICS AND LEARNING

NCTM/CAEP: Standard 6

NCTM/CAEP Standard 6: *Aspire to become reflective mathematics educators who collaborate with colleagues and other stakeholders to grow professionally, to support student learning, and to create more equitable mathematics learning environments.*

18.1 Seek to create more equitable learning environments by identifying beliefs about teaching and learning mathematics, and associated classroom practices that produce equitable or inequitable mathematical learning for students

18.2 Reflect on their impact on students' mathematical identities and develop professional learning goals that promote students' positive mathematical identities

18.3 Communicate with families to share and discuss strategies for ensuring the mathematical success of their children

18.4 Collaborate with colleagues to grow professionally and support student learning of mathematics