Effective April 15, 2022

505-3-.29 SCIENCE EDUCATION PROGRAM

(1) Purpose. This rule states field-specific content standards for approving programs that prepare individuals to teach broad field science and/or the science specialties of life sciences, chemistry, earth space science, and physics in grades 6-12 and supplements requirements in Rule 505-3-.01, REQUIREMENTS AND STANDARDS FOR APPROVING PROFESSIONAL EDUCATION UNITS AND EDUCATOR PREPARATION PROGRAMS. The standards are based on National Science Teaching Association/Association for Science Teacher Education standards (2020) and A Framework for K-12 Science Education – Practices, Crosscutting Concepts, and Core Ideas (2012).

(2) Requirements.

(a) A GaPSC-approved educator preparation provider shall offer an educator preparation program described in program planning forms, catalogs, and syllabi addressing the following standards.

1. Content Knowledge. 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 certification. Preservice teachers will:

   (i) Use and apply the major concepts, principles, theories, laws, and interrelationships of their fields of licensure and supporting fields. Explain the nature of science and the cultural norms and values inherent to the current and historical development of scientific knowledge; and

   (ii) Demonstrate knowledge of how to implement science standards, learning progressions, and sequencing of science content for teaching their certification level to 6-12 students.

2. Content Pedagogy. Effective teachers of science plan learning units of study and equitable, culturally responsive opportunities for all students based upon their understandings of how students learn and develop science knowledge, skills, and habits of mind. Effective teachers engage students in the use of science and engineering practices and crosscutting concepts to develop deep understandings of the core disciplinary ideas in their instructional planning. Preservice teachers will:

   (i) Use 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;

   (ii) Incorporate 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, and identifying natural patterns from phenomena and empirical experiences;

   (iii) Use engineering practices in support of science learning wherein all students design, construct, test and optimize possible solutions to a problem;

   (iv) Align instruction and assessment strategies to support instructional decision making that identifies and addresses student misunderstandings, prior knowledge, and naïve conceptions; and

   (v) Integrate science-specific technologies to support all students' conceptual understanding and application of science and engineering.

3. Learning Environments. 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. Preservice teachers will:

   (i) Plan a variety of lessons 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 learning environment;

   (ii) Plan learning experiences for all students in a variety of environments (e.g., the laboratory, field, virtual, and community) within their fields of certification;

   (iii) Plan lessons in which all students have a variety of opportunities to obtain information, evaluate, communicate, investigate, collaborate, learn from mistakes, and defend their own explanations of phenomena, observations, and data. This includes the proposal and defense of potential solutions to real-world, authentic, scientific and engineering problems; and

   (iv) Plan and implement instruction incorporating universal technologies that support and enhance virtual learning either in person or digitally to include all students in investigation and application of science content, engineering practices, and crosscutting concepts.

4. Safety. 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 certification. Preservice teachers will:

   (i) Implement 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 certification;

   (ii) Demonstrate an ability to: recognize hazardous situations including 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 and national safety standards (e.g., Occupational Safety and Health Administration, National Fire Protection Association, Environmental Protection Agency), and best professional practices (e.g., National Science Teaching Association, Georgia Science Teachers Association, National Science Education Leadership Association). This includes awareness of personal liability, duty of care as it relates to students (face-to-face and remote), fellow staff, and visitors to the classroom;

   (iii) Demonstrate 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 certification; and

(iv) Demonstrate an awareness of safety implications associated with remote learning. This includes awareness of personal responsibility for instructing students on safety precautions for remote learning.

5. Impact on Student Learning. Effective teachers of science provide evidence that students have learned and can apply disciplinary core ideas, crosscutting concepts and science and engineering practices as a result 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. Preservice teachers will:

(i) Design and implement diverse and balanced assessments that allow all students to demonstrate their knowledge and ability to apply, synthesize, evaluate, and communicate their understanding of disciplinary knowledge, nature of science, science and engineering practices, and crosscutting concepts in practical, authentic, and real-world situations;

(ii) Collect, organize, analyze, evaluate and reflect on a variety of formative and summative evidence and use those data to inform future planning and teaching; and

(iii) Analyze 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. 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. Teachers will also possess a deeper understanding of how to apply science and engineering practices for their discipline. They identify with and conduct themselves as part of the science education community. Preservice teachers will:

(i) Engage in critical reflection on their own science teaching to continually improve their instructional effectiveness;

(ii) Participate in professional learning opportunities to deepen their science content knowledge, and knowledge of science and engineering practices; and

(iii) Participate in professional learning opportunities to expand their science-specific pedagogical knowledge.

7. Commitment to Three-dimensional Learning. Effective teachers of 6-12 science and engineering should focus on a limited number of disciplinary core ideas and crosscutting concepts that are designed so that students continually build on and revise their knowledge and abilities over multiple years while supporting the integration of such knowledge and abilities with the practices needed to engage in scientific inquiry and engineering design. There are three major dimensions, Scientific and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts. All three dimensions need to be integrated into standards, curriculum, instruction, and assessment. Preservice teachers will:

(i) Emphasize science and engineering practices in their planning and implementation of lessons and units for all science students.

(I) Asking questions (for science) and defining problems (for engineering);

(II) Developing and using models;

(III) Planning and carrying out investigations;

(IV) Analyzing and interpreting data;

(V) Using mathematics and computational thinking;

(VI) Constructing explanations (for science) and designing solutions (for engineering);

(VII) Engaging in argument from evidence; and

(VIII) Obtaining, evaluating, and communicating information.

(ii) Focus deeply on a limited number of Disciplinary Core Ideas within each major category of science disciplines.

(I) Life Sciences

I. From Molecules to Organisms: Structures and processes

A. Cell structure and function

B. Growth and development of organisms

C. Organization for matter and energy flow in organisms

D. Information processing

II. Ecosystems: Interactions, Energy, and Dynamics

A. Interdependent relationships in ecosystems

B. Cycles of matter and energy transfer in ecosystems

C. Ecosystem dynamics, functioning, and resilience

D. Social interactions and group behavior

III. Heredity: Inheritance and Variation of Traits

A. Inheritance of traits

B. Variation of traits

IV. Biological Evolution: Unity and Diversity

A. Evidence of common ancestry and diversity

B. Natural selection

C. Adaptation

D. Biodiversity and humans

(II) Chemistry

I. Matter and Its Interaction

A. Structure and properties of matter

B. Chemical reactions

C. Nuclear processes

D. Atomic bonding

E. Solutions

II. Energy

A. Kinetic molecular theory

B. Conservation of energy and energy transfer

C. Electromagnetic radiation

(III) Earth Space Science

I. Earth's Place in the Universe

A. The universe and its stars

B. Earth and the solar system

C. History of planet Earth

II. Earth's Systems

A. Earth materials and systems

B. Plate tectonics and large system interactions

C. The roles of water in Earth's surface processes

D. Weather and climate

E. Bio-geology

III. Earth and Human Activity

A. Natural resources

B. Natural hazards

C. Human impacts on Earth systems

D. Global climate change

(IV) Physics

I. Matter and Its Interactions

A. Nuclear processes

II. Motion and Stability: Forces and Interactions

A. Forces and motion

B. Types of interactions

C. Stability and instability in physical systems

III. Energy

A. Work-energy theorem

B. Conservation of energy and energy transfer

C. Relationship between energy and forces

D. Energy in chemical processes and everyday life

IV. Waves and their applications in technologies for information transfer

A. Wave properties

B. Electromagnetic and mechanical waves

C. Information technologies and instrumentation

(iii) Consistently bear in mind crosscutting concepts as a means to provide linkages between science disciplines across multiple grades.

(I) Patterns

(II) Cause and effect: Mechanism and explanation

(III) Scale, proportion, and quantity

(IV) Systems and system models

(V) Energy and matter: Flows, cycles, and conservation

(VI) Structure and function

(VII) Stability and change

(b) Single-field Program Requirements. The program shall require a major or equivalent in one of the science areas listed in paragraph 7(ii). A major or equivalent shall be defined as a minimum of twenty-one semester hours of upper division content coursework that addresses the appropriate content area standards.

(c) Dual-field Program Requirements. The program shall require a major or equivalent in two of the content areas listed in paragraph 7 (ii). A major or equivalent shall be defined as a minimum of twenty-one semester hours of upper division content coursework that addresses the appropriate content area standards.

(d) Broad Field Program Requirements. The program shall require a major or equivalent in one of the science content areas listed in paragraph 7 (ii) and at least two additional areas of concentration listed in (ii). A major or equivalent shall be defined as a minimum of twenty-one semester hours of upper division content coursework that addresses the appropriate content area standards. An area of concentration shall be defined as a minimum of fifteen semester hours of content that address the appropriate content area standards listed in 7 (ii).

Authority O.C.G.A. 20-2-200