SCIENCE EDUCATION K-12

Teaching and Learning Framework

Introduction / Philosophy

The study of science is a comprehensive and dynamic process in which students continually refine their understanding of natural phenomena in the world and universe. Science is made active by the human capacity to think. The district's program develops *scientifically-literate students* who can make informed, responsible decisions that positively affect their lives and that assists them in understanding the local and global impact of their and others' decisions (NRC, 2013; ODE, 2018).

The program requires students to construct ideas through their own inquiries, investigations and analyses. Teacher instruction models and provides opportunities for students to participate in scientific inquiry. Students are engaged in constructing knowledge through observing, asking questions and defining problems; planning and carrying out investigations; analyzing and interpreting data; constructing explanations and designing solutions; engaging in arguments from evidence; and obtaining, evaluating and communicating current research using technology and other resources. A variety of developmentally-appropriate learning activities and resources are used so that each student experiences challenge and success.

Learner Profile

The K-12 science program aligns with the Bexley Learner Profile (engage, equip, empower). Science instruction supports students in developing scientific literacy. Learning science depends on the accumulation of facts and concepts and on the development of an identity as a competent learner of science, which cultivates motivation and interest to learn more (NRC, 2013). Learning experiences foster students' appreciation of scientific inquiry by providing a close connection between learning of scientific facts and concepts and skills development, while being anchored in experiences that relate to students' personal lives and that may be linked to later educational and career choices (e.g., STEM professions).

What should a Bexley Science Education do for students?	
Knowledge (engage)	Each student will develop scientific literacy in having a working understanding of scientific explanations for how the natural and physical worlds work.
Skills (equip)	Each student will demonstrate scientific literacy by knowing how to integrate scientific knowledge and technological and engineering design in real-world applications.
Mindsets (empower)	Each student will demonstrate an intellectual respect for the value of scientific knowledge and practices as a means of understanding and improving the student's life and for helping the student to make responsible and informed decisions required for participation in local and global communities.

High-Quality Science Programs

High quality programs are aligned to standards for excellence. The district's science program is aligned to Ohio's learning standards for science, which are based on the Next Generation Science Standards (NRC, 2013) and include model science curriculum for K-12 courses (ODE, 2018). The program is also informed by the National Research Council, in partnership with multiple entities, which provides a guiding framework for K-12 science to help leaders improve local education systems (NRC, 2012). Both national and state standards highlight the need to build students' proficiency and appreciation for science over multiple years and indicate that high-quality K-12 programs implement the following:

- Students are provided with a K-12 seamless continuum of science, using technology and design learning.
- District curriculum is developmentally and sequentially appropriate for students at their particular grade level and is infused with reading, writing and applied technology learning experiences and, whenever possible, is connected to other curriculum areas, to societal and environmental issues, and to career opportunities.
- Teachers implement a district-developed aligned science curriculum and work collaboratively for the development of student learning.
- Effective instruction is framed and supported with aligned curriculum maps, high-quality teaching resources, common learning and assessment experiences, differentiated learning options, and ongoing professional development for teachers of science.
- Teachers stay connected to up-to-date science practices and practices that promote collaboration, creativity and critical thinking, such as Project Based Learning (PBL) and Project Zero (Harvard University), and by engaging with professional associations, such as the Science Education Council of Ohio (SECO), the National Science Teachers Association (NSTA), and the National Association for Research in Science Teaching (NARST).
- Instruction and learning experiences prepare students for the post-secondary workplace and education and for being a local and globally responsible citizen.
- The program reflects current trends and patterns in the job market and with cutting-edge science and technology, seeking community partnerships for betterment and preparation of students. For example, the high school science program is enhanced and enriched by the Young Scientist in Residence Program, which is funded via the Bexley Education Foundation (BEF), for bringing experts into the science classrooms.
- Space, facilities, materials, equipment and other resources facilitate effective teaching and learning of science.

Conditions to Support Student Learning

Proficiency in science is multi-faceted and requires a range of experiences to support students' learning. Students should be engaged in learning experiences that support their understanding of science as a way of knowing, which requires their productive participation in scientific practices and discourse:

Each student will…	Teachers will involve students in…
Develop a working understanding of scientific explanations for how the natural and physical world works (AAAS, 2007; NRC, 2011, 2012, 2013; NSTA, 2014, 2016a, 2016b, 2016c; ODE, 2018).	Generating, understanding, remembering, and using concepts, explanations, arguments, models, and facts related to science.
	Observing and asking questions of the natural and physical world that can be answered through scientific investigations.
	Thinking critically and logically to connect evidence and explanations, also recognizing and analyzing alternative explanations and predictions.
Demonstrate scientific literacy by knowing how to integrate scientific knowledge and technological and engineering design in real-world applications (AAAS, 2007; NRC, 2011, 2012, 2013; NSTA, 2014, 2016a, 2016b, 2016c; ODE, 2018).	Hands-on science that is rigorous and intellectually challenging and that provides students with authentic inquiry-based learning.
	Planning and conducting investigations.
	Using appropriate mathematics, tools and techniques to gather data and information and to assist with analyzing and interpreting data.
	Evaluating scientific evidence, making connections to existing scientific knowledge, and considering information within the framework of local and global issues.
	Communicating about observations, investigations and explanations.
Develop an intellectual respect for the value of scientific knowledge and practice as a means of understanding and improving our world (AAAS, 2007; NRC, 2011, 2012, 2013; NSTA, 2014, 2016a, 2016b, 2016c; ODE, 2018).	Evaluating science as it affects their lives and their local and global communities.
	Recognizing how scientific and technology advances may affect the environment positively or negatively.
	Making responsible and informed decisions and addressing ethical challenges.

K-12 Program Overview

The district's program consists of a *standards-based curriculum* anchored in the study of life science, earth and space science, and physical science (ODE, 2018). Ohio's standards require that students develop an understanding of the interconnections within the sciences and the interactions among science, society and environment. The standards are based on *inquiry*, which requires students' to have *hands-on involvement and application and synthesis* of their knowledge of science in real-world situations. Teaching and learning science also overlaps with applications of technology, engineering, design, mathematics, and writing (i.e., informational, argumentation). This overlap is manifested in scientific inquiry that begins with a problem finding and solving approach using these multiple applications.

Elementary Science

Science in grades K-5 consists of three strands: Life Science, Earth and Space Science, and Physical Science. Each grade engages students in units that align with each strand. Science is taught weekly in every quarter and may be infused with reading, writing, social studies and mathematics lessons, and applied technology learning experiences. Scientific inquiry and applications are addressed explicitly in units of instruction. Typically, grades K-2 students receive instruction by their homeroom teachers, whereas grades 3-5 students may be instructed by teachers specializing in science at those grades.

K-5 Science Strands and Units of Instruction			
Grade	Earth and Space Science	Physical Science	Life Science
K	Daily and Seasonal Changes	Properties of Everyday Objects and Materials	Physical and Behavioral Traits
1	Sun, Energy and Weather	Motion and Materials	Basic Needs of Living Things
2	Atmosphere	Changes in Motion	Interactions within Habitats
3	Earth's Resources	Matter and Forms of Energy	Behavior, Growth and Changes
4	Earth's Surface	Electricity, Heat and Matter	Earth's Living History
5	Cycles and Patterns in Solar Systems	Light, Sound and Motion	Interactions within Ecosystems

Middle School Science

Science in grades 6-8 consists of three strands: Life Science, Earth and Space Science, and Physical Science. Within these strands are concepts that provide focus for units; these concepts develop in sophistication as students move from one grade to the next. The focus at every grade is inquiry-based, hands-on instruction where students learn science by experimentation and immersion to make connections and create understanding of natural phenomena. Increasing emphasis is placed on critical thinking, using technical reading and writing skills while engaging in scientific inquiry and applications.

6-8 Science Strands and Units of Instruction			
Grade	Earth and Space Science	Physical Science	Life Science
6	Rocks, Minerals and Soil	Matter and Motion	Cellular to Multicellular
7	Cycles and Patterns of Earth and Moon	Conservation of Mass and Energy	Cycles of Matter and Flow of Energy
8	Earth's Structure, History, and Geologic Processes	Forces and Motion	Species and Reproduction

High School Science

The high school program consists of study of the major scientific fields: Biology, Chemistry, Environmental Science, Geology and Physics. Courses are aligned to multiple strands addressed in a variety of courses. As with middle school science, within these strands are concepts that provide focus for specific course content.

For high school graduation, students are required to earn three credits in science: (1) one unit of physical sciences, (2) one unit of life sciences, and (3) one unit of advanced science in one or more of the

following: chemistry, physics or other physical science; advanced biology or other life science; astronomy, physical geology or other earth or space science (e.g., Environmental Science or Physics). Students expand their studies by selecting elective and additional College Board/Advanced Placement (AP) science courses.

High School Courses – Science Strands and Focus for Units of Instruction		
Physical Science	▪ Study of Matter ▪ Energy and Waves	▪ Forces and Motion ▪ The Universe
Biology, Honors Biology, AP Biology	▪ Heredity ▪ Evolution	▪ Diversity and Interdependence of Life ▪ Cells
Chemistry, Honors Chemistry, AP Chemistry	▪ Structure and Properties of Matter ▪ Interactions of Matter	
Physics, AP Physics 1, AP Physics 2	▪ Motion ▪ Forces, Momentum and Motion ▪ Energy	▪ Waves ▪ Electricity and Magnetism
Physical Geology	▪ Minerals ▪ Igneous, Metamorphic and Sedimentary Rocks ▪ Earth's History	▪ Plate Tectonics ▪ Earth's Resources ▪ Glacial Geology
AP Environmental Science	▪ Earth Systems: Interconnected Spheres of Earth ▪ Earth's Resources	▪ Global Environmental Problems and Issues

References

American Association for the Advancement of Science (AAAS). (2007). *The Atlas of science literacy, Volumes 1 and 2: Mapping K-12 science learning*. Washington, DC: Author.

National Research Council (NRC). (2011). *Successful K-12 STEM Education: Identifying effective approaches in science, technology, engineering, and mathematics*. Washington, DC: National Academies Press.

National Research Council (NRC). (2012). *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: National Academies Press. Retrieved Feb. 26, 2018 from http://www.doe.in.gov/sites/default/files/science/next-generation-science-standards-framework-science-education.pdf

National Research Council. (NRC). (2013). *Next generation science standards*. Retrieved Feb. 26, 2018 from https://www.nap.edu/catalog/18290/next-generation-science-standards-for-states-by-states

National Science Teachers Association (NSTA). (2014). *Early childhood science education*. Retrieved Feb. 26, 2018 from https://www.nsta.org/about/positions/earlychildhood.aspx

National Science Teachers Association (NSTA). (2016a). *The next generation science standards*. Retrieved Feb. 26, 2018 from http://static.nsta.org/pdfs/PositionStatement_NGSS.pdf

National Science Teachers Association (NSTA). (2016b). *Science education for middle level students*. Retrieved Feb. 26, 2018 from http://www.nsta.org/about/positions/middlelevel.aspx

National Science Teachers Association (NSTA). (2016c). *Teaching science in the context of societal and personal issues*. Retrieved Feb. 26, 2018 from http://static.nsta.org/pdfs/PositionStatement_SocietalAndPersonalIssues.pdf

Ohio Department of Education (ODE). (2018). *Ohio's new learning standards: Science standards*. Columbus, OH: Author. Retrieved July 13, 2018 from http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/SciFinalStandards061518.pdf.aspx?lang=en-US

Board of Education Policies

IF, Curriculum Development
IF-R, Curriculum Review and Development
IIAA, Textbook Selection and Adoption