



THE OHIO CORE CURRICULUM:
WHAT'S REQUIRED FOR SCIENCE?
is a White Paper of
The OHIO ACADEMY of SCIENCE
1500 West Third Avenue Suite 228
Columbus OH 43212-2817
Phone 614.488.2228 • Fax 614.488.7629
oas@iwaynet.net • <http://www.ohiosci.org>
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THE OHIO CORE CURRICULUM: WHAT'S REQUIRED FOR SCIENCE?

BEGINNING WITH STUDENTS WHO ENTER NINTH GRADE for the first time on or after July 1, 2010, with some exceptions, the requirements for graduation from every public and chartered nonpublic high school shall include twenty units that are designed to prepare students for the workforce and college. Three units of science will be required with ***inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.*** The new law requires that Ohio high school science units be ***inquiry-based instead of simply including scientific inquiry*** as a part of the entire course. This distinction is a paradigm-shift in the way high school science must be taught and is at the heart of the Ohio Core.

The OHIO ACADEMY of SCIENCE

Fostering curiosity, discovery and innovation to benefit society.

The Ohio Core Curriculum: What's Required for Science?

BEGINNING WITH STUDENTS WHO ENTER NINTH GRADE for the first time on or after July 1, 2010, with some exceptions, the requirements for graduation from every public and chartered nonpublic high school shall include twenty units that are designed to prepare students for the workforce and college. Three units of science will be required **with inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information**, which shall include the following, or their equivalent: (a) Physical sciences, one unit; (b) Biology, one unit; (c) Advanced study in one or more of the following sciences, one unit: (i) Chemistry, physics, or other physical science; (ii) Advanced biology or other life science; (iii) Astronomy, physical geology, or other earth or space science. [**Emphasis added.**]

—Summarized from AM. SUB. S.B. 311
126th Ohio General Assembly
Signed into law January 3, 2007

The question remains: What Is “Inquiry-Based Laboratory Experience?”

The Ohio Core Curriculum was signed into law on January 3, 2007, by Governor Bob Taft. It's the law, but what does it mean for science education and for science educators? The concept of 'laboratory experience' should be clear because the Ohio Revised Code defines a high school laboratory science course as one that requires at least 150 hours of instructional time as opposed to 120 hours of required instructional time for non-laboratory courses. The question remains, though, to clarify what is intended by 'inquiry-based' laboratory experience.

The Ohio Academy of Science has worked long and hard to establish the importance of true inquiry as a central component of science education. Through its untiring efforts to promote student research in Ohio the Academy has been at the forefront of promoting inquiry-based approaches to learning. Over the past 56 years the Academy's State Science Day has rewarded the inquiry-based science projects of over 50,000 students from grades 7-12. Since 1985, with support from the Technology Division of the Ohio Department of Development, the cooperation of four different Governors and the Ohio Department of Education, the Academy has recognized hundreds of schools and teachers and thousands of students with Governor's Awards for Excellence in Youth Science Opportunities and Student Research. More than \$10 million in scholarships and awards has been offered to students at State Science Day since the early 1980s.

Thus, it is natural for the Academy to be at the heart of the Ohio Core Curriculum's declaration of the importance of inquiry-based laboratory experiences in science classrooms. **But again, what is meant by inquiry-based laboratory experience?**

The National Academy of Sciences defines scientific inquiry in the *National Science Education Standards* (NSES p. 23) as:

...the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which students develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world.

Furthermore, the National Science Teachers Association states:

Scientific inquiry is a powerful way of understanding science content. Students learn how to ask questions and use evidence to answer them. In the process of learning the strategies of scientific inquiry, students learn to conduct an investigation and collect evidence from a variety of sources, develop an explanation from the data, and communicate and defend their conclusions.

The newly signed Ohio Core Curriculum has a rather brief but important description of “inquiry-based laboratory experience” included in the law’s language:

Science, three units with *inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information...* [**Emphasis added.**]

The current Ohio Standards Based Science Curriculum includes even more detailed help to define “Inquiry Science.” In its introductory remarks about the Ohio Science curriculum the Ohio Department of Education includes a list of skills the student must develop to be successful in science:

Students need rich learning experiences in the classroom to enhance their understanding of science and develop skills of science inquiry.

As students move into middle and high school, inquiry becomes a more complete and natural multifaceted activity that involves:

- *Making observations*
- *Posing questions*
- *Examining books and other sources of information*
- *Planning investigations*
- *Reviewing what is already known in light of experimental evidence*
- *Using tools to gather, analyze and interpret data*
- *Proposing answers, explanations, and predictions*
- *Communicating the results*
- *Identifying assumptions*
- *Using critical and logical thinking*
- *Considering alternative explanations.*

Does the Ohio Core language mandate something *new* for Ohio science education? The *Ohio Science Standards* have included scientific inquiry since the first draft. In fact, Scientific Inquiry is one of the six science standards that make up Ohio’s science education program. A few excerpts from the *Standards* exemplify this.

K-12 Science

Overview

Students’ success in meeting the expectations of the standards depends on teaching and learning as an active inquiry process. This means that all teachers need the opportunity to teach science as something in which students are actively engaged. When participating in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge and communicate their ideas to others. This includes engaging all students’ with relevant, real-world activities that develop students’ knowledge, communication skills and scientific process skills.

Scientific Inquiry Standard

*Students develop scientific habits of mind as they use the processes of scientific inquiry to **ask valid questions and to gather and analyze information**. They understand how to develop hypotheses and make predictions. They are able to reflect on scientific practices as they develop plans of action to create and evaluate a variety of conclusions. Students are also able to demonstrate the ability to communicate their findings to others. [Emphasis added.]*

9th Grade—

Students continue to develop a deeper understanding of the processes of scientific inquiry and how these processes use evidence to support conclusions based on logical reasoning. Students investigate ways in which science and technologies combine to meet human needs and solve human problems.

10th Grade—

Embedded throughout this study are the basic science processes of inquiry, modeling investigations and the nature of science.

11th Grade—

Students have the opportunity to use basic science processes of inquiry, scientific investigation, and the nature of science to examine past events, current situations, and to develop and revise scientific predictions, ideas or theories.

12th grade—

Integrated with these topics are historical perspectives, the process of inquiry, nature of science, ethical practices and use of appropriate technology.

By the end of the K-2 program:	By the end of the 3-5 program:	By the end of the 6-8 program:
<p><i>A. Ask a testable question.</i></p> <p><i>B. Design and conduct a simple investigation to explore a question.</i></p> <p><i>C. Gather and communicate information from careful observations and simple investigation through a variety of methods.</i></p>	<p><i>A. Use appropriate instruments safely to observe, measure and collect data when conducting a scientific investigation.</i></p> <p><i>B. Organize and evaluate observations, measurements and other data to formulate inferences and conclusions.</i></p> <p><i>C. Develop, design and safely conduct scientific investigations and communicate the results.</i></p>	<p><i>A. Explain that there are differing sets of procedures for guiding scientific investigations and procedures are determined by the nature of the investigation, safety considerations and appropriate tools.</i></p> <p><i>B. Analyze and interpret data from scientific investigations using appropriate mathematical skills in order to draw valid conclusions.</i></p>

By the end of the 9-10 program:	By the end of the 11-12 program:
<i>A. Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.</i>	<i>A. Make appropriate choices when designing and participating in scientific investigations by using cognitive and manipulative skills when collecting data and formulating conclusions from the data.</i>

Then what did the Ohio Core law change for Ohio’s science curriculum in regard to its scientific inquiry mandate if it was already aligned well with the Standards document? In addition to mandating that all three units of science be laboratory courses (or “experience” as the law’s language reads), the new law requires that Ohio high school science units be **inquiry-based** instead of simply **including** scientific inquiry as part of the course. **This distinction is a paradigm-shift in the way high school science must be taught and is at the heart of the Ohio Core.**

From Demonstrating to Doing Science

Rather than teachers **demonstrating** science, or simply explaining scientific concepts, now students will be expected to **do science**. The roles of teachers and students must change. No longer will a science teacher be viewed as “sage on the stage.” Now he or she must become a “guide on the side.” The student will be actively engaged to learn science, or as the Ohio Core language says: the students will be immersed in an ***inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.***

Doing science means understanding what science is. The Ohio Academy of Science says:

Science is a systematic method of continuing investigation, based on observation, hypothesis testing, measurement, experimentation, and theory building, which leads to more adequate explanations of natural phenomena, explanations that are open to further testing, revision, and falsification, and while not “believed in” through faith, may be accepted or rejected on the basis of evidence.

Further answers to the basic question of *What is Science?* are posted at: <http://www.ohiosci.org/Whatisscience.pdf> (Short version). A longer paper posted at [http://www.ohiosci.org/WhatisscienceOJS106\(4\)130-135.pdf](http://www.ohiosci.org/WhatisscienceOJS106(4)130-135.pdf) (Long version) clarifies

- what is science
- the scientific method
- a scientific hypothesis
- a scientific theory
- the importance of science, and
- what is not science.

NSTA position statement on scientific inquiry

The National Science Teachers’ (NSTA) position statement on scientific inquiry might be a very helpful tool for school districts in Ohio as they work toward compliance with the new Ohio Core requirements. NSTA’s position statement, endorsed by the Academy, is included here as a useful aid for schools as they work to create their “inquiry-based laboratory” science curricula, and as they assure parents, students and their communities that all high school science classes under the Ohio Core will meet for at least 150 hours of instruction. **The Academy especially supports the concepts (1) that as a part of their teacher preparation program, teachers should experience science as inquiry and (2) students should communicate and defend their results to their peers and others.**



NSTA Position Statement

Scientific Inquiry

Introduction

The *National Science Education Standards* (NSES p. 23) defines scientific inquiry as "the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which students develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world." The Science as Inquiry Standard in NSES includes the abilities necessary to do scientific inquiry and understanding about scientific inquiry.

Scientific inquiry reflects how scientists come to understand the natural world, and it is at the heart of how students learn. From a very early age, children interact with their environment, ask questions, and seek ways to answer those questions. Understanding science content is significantly enhanced when ideas are anchored to inquiry experiences.

Scientific inquiry is a powerful way of understanding science content. Students learn how to ask questions and use evidence to answer them. In the process of learning the strategies of scientific inquiry, students learn to conduct an investigation and collect evidence from a variety of sources, develop an explanation from the data, and communicate and defend their conclusions.

The National Science Teachers Association (NSTA) recommends that all K-16 teachers embrace scientific inquiry and is committed to helping educators make it the centerpiece of the science classroom. The use of scientific inquiry will help ensure that students develop a deep understanding of science and scientific inquiry.

Declarations

Regarding the use of scientific inquiry as a teaching approach, NSTA recommends that science teachers

- Plan an inquiry-based science program for their students by developing both short- and long-term goals that incorporate appropriate content knowledge.
- Implement approaches to teaching science that cause students to question and explore and to use those experiences to raise and answer questions about the natural world. The learning cycle approach is one of many effective strategies for bringing explorations and questioning into the classroom.

- Guide and facilitate learning using inquiry by selecting teaching strategies that nurture and assess student's developing understandings and abilities.
- Design and manage learning environments that provide students with the time, space, and resources needed for learning science through inquiry.
- Receive adequate administrative support for the pursuit of science as inquiry in the classroom. Support can take the form of professional development on how to teach scientific inquiry, content, and the nature of science; the allocation of time to do scientific inquiry effectively; and the availability of necessary materials and equipment.
- Experience science as inquiry as a part of their teacher preparation program. Preparation should include learning how to develop questioning strategies, writing lesson plans that promote abilities and understanding of scientific inquiry, and analyzing instructional materials to determine whether they promote scientific inquiry.

Regarding students' abilities to do scientific inquiry, NSTA recommends that teachers help students

- Learn how to identify and ask appropriate questions that can be answered through scientific investigations.
- Design and conduct investigations to collect the evidence needed to answer a variety of questions.
- Use appropriate equipment and tools to interpret and analyze data.
- Learn how to draw conclusions and think critically and logically to create explanations based on their evidence.
- Communicate and defend their results to their peers and others.

Regarding students' understanding about scientific inquiry, NSTA recommends that teachers help students understand

- That science involves asking questions about the world and then developing scientific investigations to answer their questions.
- That there is no fixed sequence of steps that all scientific investigations follow. Different kinds of questions suggest different kinds of scientific investigations.
- That scientific inquiry is central to the learning of science and reflects how science is done.
- The importance of gathering empirical data using appropriate tools and instruments.
- That the evidence they collect can change their perceptions about the world and increase their scientific knowledge.
- The importance of being skeptical when they assess their own work and the work of others.

- That the scientific community, in the end, seeks explanations that are empirically based and logically consistent.

--Adopted by the NSTA Board of Directors
October 2004

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This document can be found online at
www.nsta.org/positionstatement&psid=43

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About The Ohio Academy of Science

THE MISSION OF THE OHIO ACADEMY OF SCIENCE, a non-profit organization of those interested in science, engineering, technology, and education, is **to foster curiosity, discovery and innovation** by stimulating interest in the sciences, engineering and technology, promoting and supporting research, encouraging interaction among and between fields of interest, improving science education, disseminating scientific knowledge, and recognizing and publicizing high achievement in attaining these objectives. The Ohio Academy of Science provides support activities, conducts annual meetings and science days, and publishes, worldwide, a multidisciplinary journal that reports developments in science, engineering, technology, and education.