Teaching Through Inquiry
OSLN PD Webinar Series

Checklist—before we start

- Use the Zoom chat to communicate with Mackenzie (moderator)
- Interactive Polling
- You may ask questions via the Q&A box or raise your hand if you would like to ask your questions out loud
- The slide deck will be emailed to you
- This webinar is being recorded

Ohio STEM Learning Network · Ohio Museum Complex · Ohio University Voinovich School of Leadership and Public Affairs · PORTSfuture · American Electric Power Foundation · U.S. Department of Energy

Teaching Through Inquiry
OSLN PD Webinar Series

Objectives
- *Strengthen understanding of science inquiry*
- *Enhance pedagogical knowledge of science teaching*

Session 1: *Teaching Science Through Inquiry*

Session 2: *Examples of Subtle Shifts for Promoting Student Inquiry*

Session 3: *Incorporate More Student Inquiry in Your Science Lesson*

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Voinovich School of Leadership and Public Affairs
Ohio University
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Today's Agenda

- Define scientific inquiry
- Overview framework for understanding modes of classroom teaching with respect to science inquiry
- Share insight and address common misconceptions

What is Inquiry?

in·qui·ry | \ in-ˈkwī(-ə)r-ē, ˈin-ˌkwī(-ə)r-ē; ˈin-kwə-rē, ˈiŋ-; ˈin-ˌkwir-ē \
plural **inquiries**

Definition of *inquiry*

1 : a request for information

2 : a systematic investigation often of a matter of public interest

3 : examination into facts or principles : RESEARCH

Merriam-Webster SINCE 1828

Inquiry is a *process!*

What is Scientific Inquiry?

<u>The process skills of science</u>

- asking questions
- planning and conducting experiments
- analyzing data to draw conclusions
- communicating results to others

The guiding principles for *Ohio's Learning Standards and Model Curriculum for Science* include:

<u>Scientific and Engineering Practices</u>

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Ohio | Department of Education

National Research Council. 2012. A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: The National Academies Press.

The guiding principles for *Ohio's Learning Standards and Model Curriculum for Science* include:

Table 1: Nature of Science

Nature of Science One goal of science education is to help students become scientifically literate citizens able to use science as a way of knowing about the natural and material world. All students should have sufficient understanding of scientific knowledge and scientific processes to enable them to distinguish what is science from what is not science and to make informed decisions about career choices, health maintenance, quality of life, community and other decisions that impact both themselves and others.	
Categories	K-2
Scientific Inquiry, Practice and Applications All students must use these scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas.	• Apply knowledge of science content to real-world challenges. • Plan and conduct simple scientific investigations using appropriate safety techniques based on explorations, observations and questions. • Employ simple equipment and tools to gather data and extend the senses. • Use data and mathematical thinking to construct reasonable explanations. • Communicate with others about investigations and data.
Science is a Way of Knowing Science assumes the universe is a vast single system in which basic laws are consistent. Natural laws operate today as they did in the past, and they will continue to do so in the future. Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise and extend this knowledge.	• The world is discovered through exploration. • Exploration leads to observation. Observation leads to questions. • Natural events happen today as they happened in the past. • Events happen in regular patterns and cycles in the natural world.
Science is a Human Endeavor Science has been, and continues to be, advanced by individuals of various races, genders, ethnicities, languages, abilities, family backgrounds and incomes.	• Everyone explores the world which generates questions. • The answer is not always as important as the process. • Questions often lead to other questions. • Discoveries are communicated and discussed with others. • People address questions through collaboration with peers and continued exploration. • Everyone can see themselves as scientists.
Scientific Knowledge is Open to Revision in Light of New Evidence Science is not static. Science is constantly changing as we acquire more knowledge.	• It is essential to learn how to identify credible scientific evidence. • Ideas are revised based on new, credible scientific evidence.

*Adapted from Appendix H – Understanding the Scientific Enterprise: The Nature of Science in the Next Generation Science Standards

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What is Teaching Through Inquiry?

Teaching strategies that give students responsibility for applying the process skills of science

- asking questions
- planning and conducting experiments
- analyzing data to draw conclusions
- communicating results to others

Are my science lessons inquiry-based?

Pedagogy of Science Teaching

WESTERN MICHIGAN UNIVERSITY

Mallinson Institute for Science Education

https://wmich.edu/science/inquiry-items

Theoretical framework for understanding inquiry-based teaching

- **Inquiry-based instruction is NOT dichotomous!!!**
- **For any given science lesson, the degree of student inquiry should be considered as existing across a continuum:**

No Student Inquiry ⟷ *Everything In-Between!!!* ⟷ Full Student Inquiry

Inquiry Spectrum

less student inquiry — more student inquiry

Didactic Direct

Teacher presents and explains science content directly, illustrates with example or demo

No student activities

Active Direct

Teacher presents and explains science content directly, illustrates with example or demo

Students actively follow instructions

Guided Inquiry

Students actively explore phenomenon or idea with teacher guidance toward desired science content

Open Inquiry

Students actively explore phenomenon or idea as they choose

Teacher facilitates process but does not prescribe

Cobern et al., International Journal of Science Education, 2014, 36(13), 2265-2288.

Classroom Vignette:

Mr. Goodchild is designing a frog dissection lesson for his 8th graders to help teach them about anatomy.

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Didactic Direct

It is taught as a step-by-step demonstration while the teacher explicitly points out what students need to know about frog anatomy

Active Direct

Student pairs follow step-by-step instructions to perform the dissection after the teacher explains exactly what students need to know about frog anatomy

Guided Inquiry

It is taught as a step-by-step student activity while answering probing questions, followed up by teacher-led discussion and clarifications

Open Inquiry

It is taught as a step-by-step activity for students to explore the frog's anatomy and raise discussion questions on their own

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Didactic Direct

The teacher demonstrates to the class by counting how many beans can fit in two different sized jars. Then, the teacher explains how the beans can serve as a way for comparing the amount of space, or volume, inside the jars.

Active Direct

The teacher explains that beans can be used as a way of comparing the amount of space, or volume, inside jars. Students are then given two different sized jars and instructed to count how many beans can fit in each.

Guided Inquiry

The teacher distributes beans and different sized jars to students. The students are then asked to come up with a way to determine and compare the amount of space inside the different jars. Afterwards, the teacher defines "volume".

Open Inquiry

The teacher first allows her students to experiment by filling beans into jars of different sizes and shapes. She then elicits the students' ideas about what the different numbers of beans is describing about the different jars.

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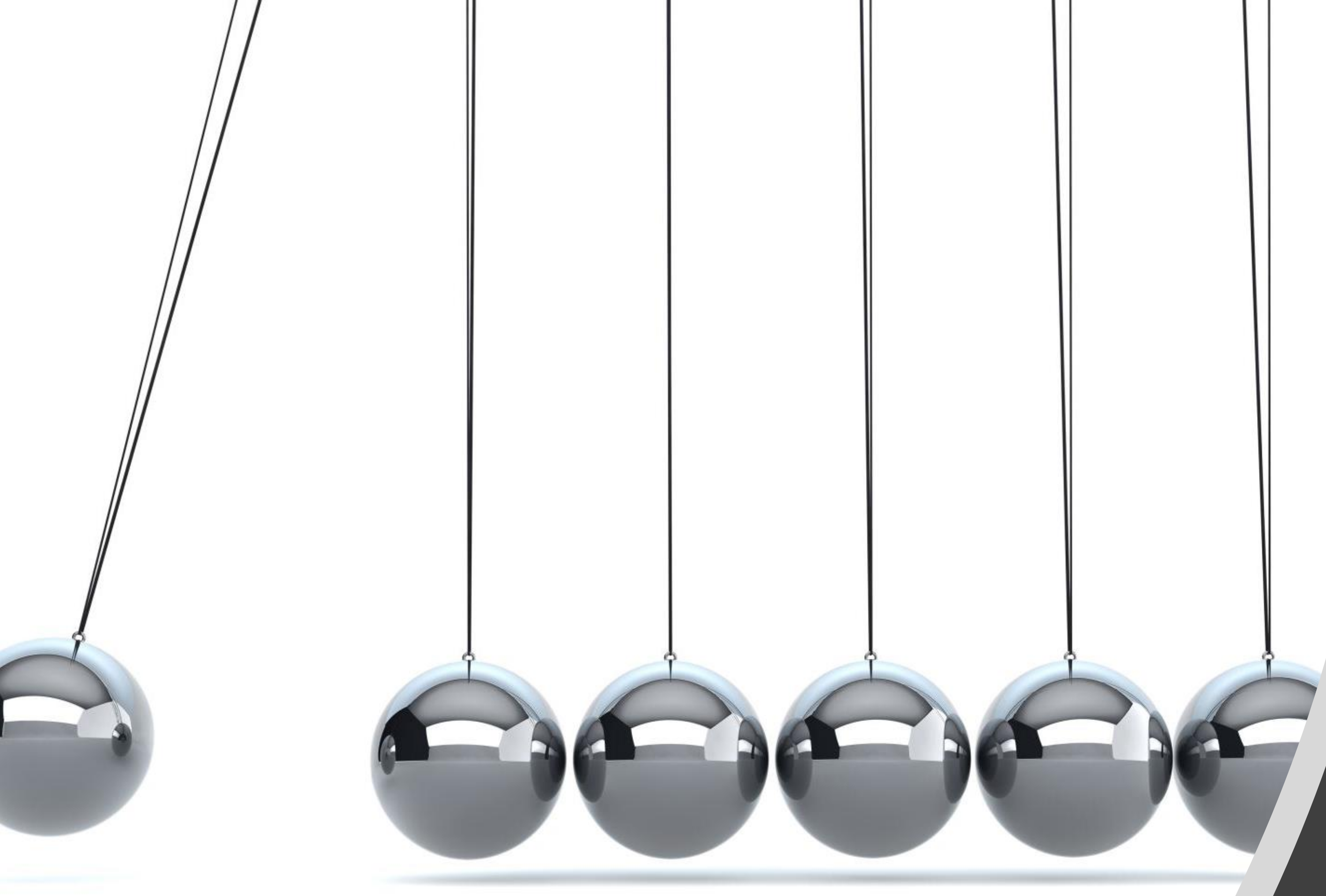
Didactic Direct	Active Direct	Guided Inquiry	Open Inquiry
During the field trip, the teacher points out and explains to the class the examples of food web interactions that are encountered at the nature center.	Before the field trip, the teacher provides students with a checklist of specific examples of food webs. During the field trip, students are to mark off each example they encounter.	During the field trip, students are asked to make a list of all food web interactions they encounter while at the nature center. Students share their observations at a later time and discuss as a group.	During the field trip, students are asked to make a list of anything they found interesting while at the nature center. Afterwards the class discusses if anything related to food webs was observed.



Classroom Vignette:

Ms. Brandt is preparing a lesson to introduce her 5th grade students to the relationship between force and motion, namely that a net force will cause an object to speed up or slow down(Newton's 2nd Law). The classroom has available a loaded wagon to which a pulling force can be applied.

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Didactic Direct

Newton's 2nd Law is written on the board and explained to students. The teacher then demonstrates the law by pulling on a loaded wagon with a constant force as students observe the motion.

Learning Check: Which of the following would be best classified as Active Direct instruction???

1. **Newton's 2nd Law is written on the board and explained to students. Students are then instructed to verify the law by pulling on a loaded wagon themselves and to confirm the type of motion that results.**

2. **Students are given a loaded wagon and asked to explore the question of what kind of motion results from a constant force. From their evidence they would then propose a possible law.**

Open Inquiry

The teacher raises the question of whether there is any relationship between force and motion. Students then freely and safely explore this using any materials available in the classroom. A class discussion of their findings follows.

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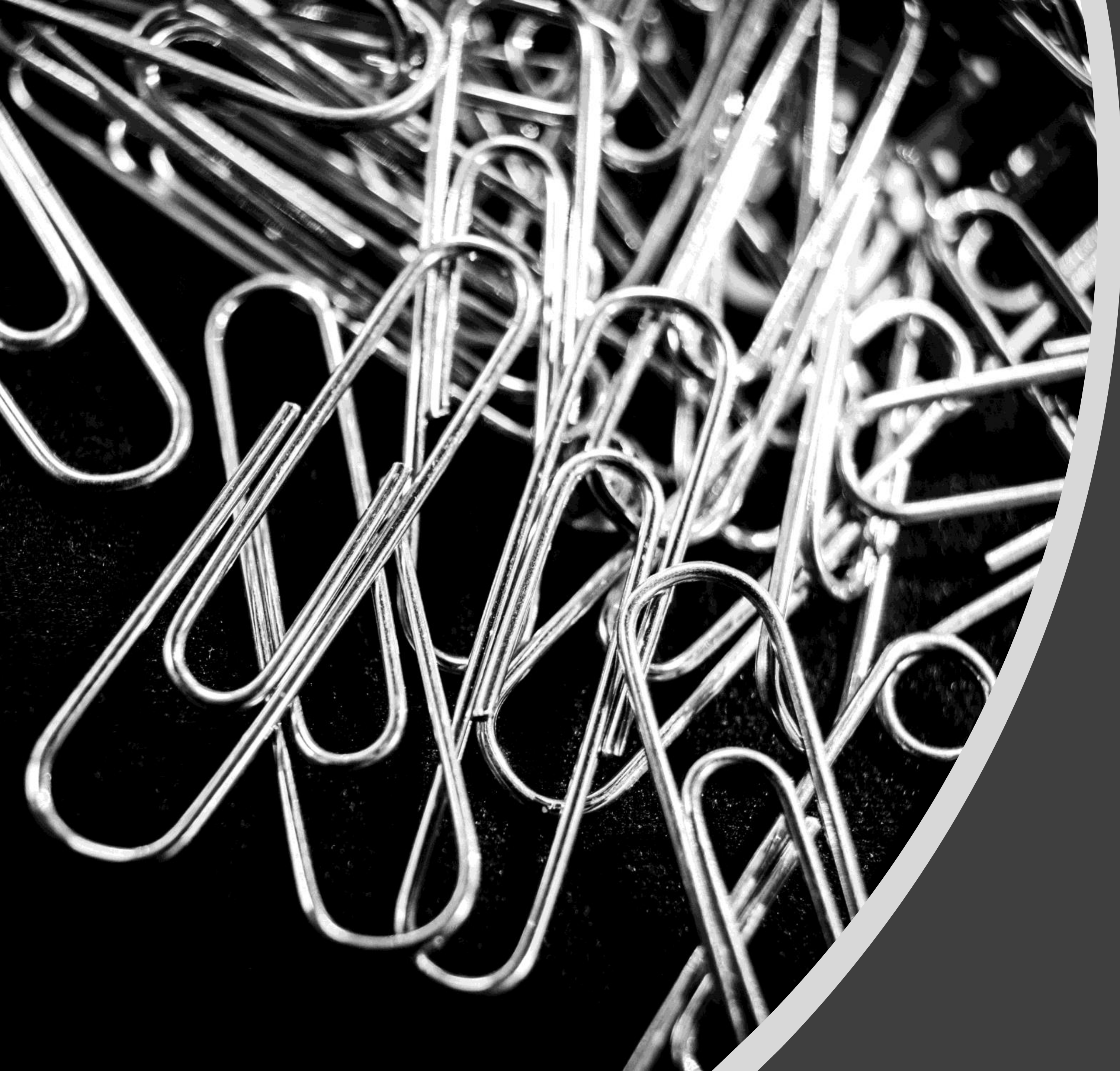

Classroom Vignette:

Mr. Golden has introduced the topic of magnetism to his 1st grade students, and they have learned that bar magnets attract certain kinds of materials that have iron in them. For today's new lesson, he has available bar magnets and a variety of food containers made of plastic, iron, aluminum, steel, and glass.

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less student inquiry ⟷ **more student inquiry**

Didactic Direct

The teacher first reminds the class that magnets attract materials which contain iron, and then shows them how the bar magnet attracts the containers made of iron, but not any of the other containers.

Learning Check: Which of the following would be best classified as Guided Inquiry instruction???

1. **The teacher first reminds the class that magnets attract materials which contain iron. Then, small groups of students are instructed to use bar magnets to sort the food containers into those which do contain iron and those which do not.**

2. **Students are told to think about how to solve the puzzle of which food containers contain iron and which do not. They would either come up with or be prompted to use bar magnets to test the various kinds of food containers.**

Open Inquiry

Students are provided with a bar magnet and the various kinds of food containers. The teacher does not outline a specific task but asks them to find out what they can about the collection, and report back their observations and conclusions.

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Summary & Take Home Messages

For any given science lesson, the degree of student inquiry should be considered as existing across a continuum

- Inquiry-based instruction is NOT dichotomous
- Open-inquiry is NOT always best or always expected; didactic instruction is sometimes advantageous

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Significant Portion of Science Curriculum

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- Q&A

THANK YOU!!!

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Ohio STEM Learning Network
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PORTSFUTURE
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U.S. DEPARTMENT OF ENERGY