Inquiry in the National Science Standards NSES & NGSS

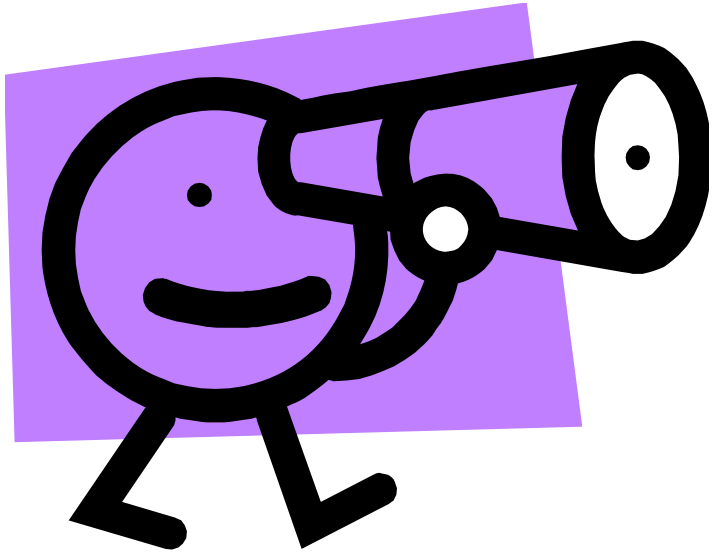
Types of Science Inquiry Learning Found in Classrooms

Dennis Sunal

University of Alabama

What is Inquiry?

- What is your understanding?



Inquiry: What is it? Which statements are true?

- All science subject matter should be taught through inquiry.
- True inquiry occurs only when students generate and pursue their own questions.
- Hands-on science teaching is inquiry teaching.
- Inquiry teaching occurs easily with “kit” science curricula.
- Inquiry science can be taught with little attention to subject matter.

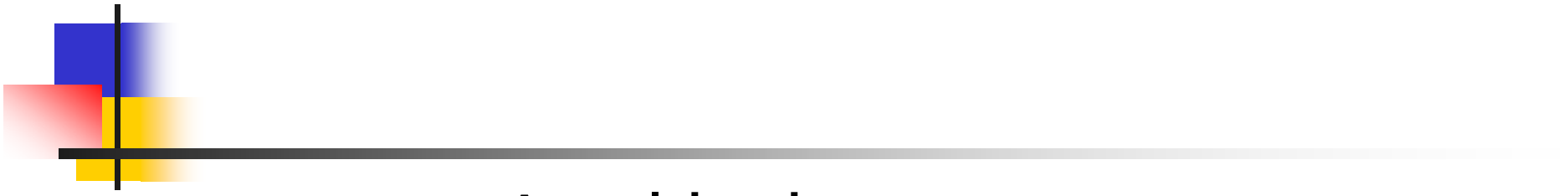
What is Inquiry?

- What is inquiry for a scientist?
- What is inquiry for a teacher of science?
- How are they the same? Different
- In what they do?
- In their goals?

Inquiry refers to 3 categories of activities…

- What scientists do – e.g. conducting investigations using scientific methods
- How students learn – e.g. actively inquiring through thinking and doing into a phenomenon or problem
- Pedagogical approach that teachers use – e.g. designing or using curricula that allow for extended investigations (Minner, 2009)
- For the scientist, student or teacher the act itself has the same core components

What is inquiry-based learning?



An old adage states:

“tell me and I forget, show me and I remember, involve me and I understand”

Inquiry skills are what learners use to make sense of the world around them.

Inquiry is……

- involvement that leads to understanding
- thinking skills that allow one to seek resolutions to questions and problems
- the pursuit of open questions
- defined as -- seeking information and knowledge by questioning and seeking answers

Assessment of Inquiry Learning is…

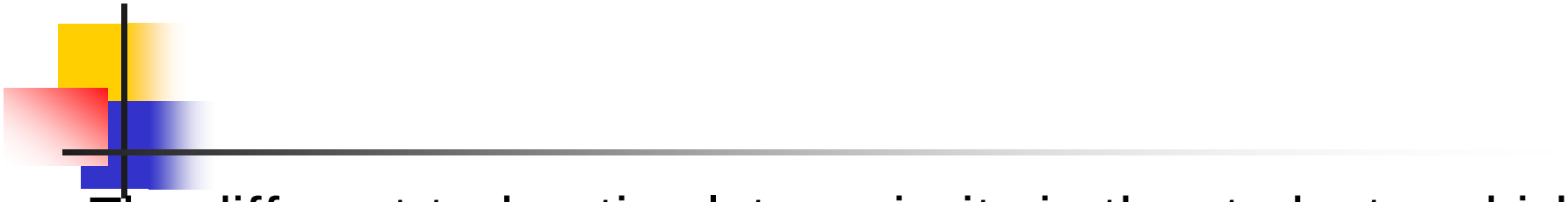
1. A process of evidentiary reasoning based on
   A. A theory of cognition of how studnets represent knowledge and develop competence in a domain, including practices, cross-cutting concepts, and disciplinary core ideas (NRC, 2001, and NGSS, 2012)
   B. observation of student's capabilities in the contexts of the learning tasks
   C. Interpretation through appropriate and aligned assessment methods and tools

Assessment of Inquiry Learning is…

2. Both Formative & Summative
3. Assessment Aligned with
   a) educational goals and objectives,
   b) classroom pedagogy, and
   c) curriculum materials use in the lessons
4. Based on a Learning Progression of ideas (concepts)

Some of the key characteristics of inquiry based learning are:

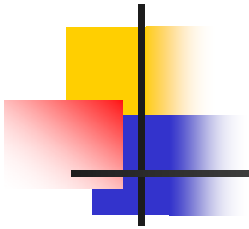
- Students are fully engaged with a difficult problem or situation that is open-ended to such a degree that a variety of solutions or responses are conceivable. *(formative use of the assessment data is essential to guide the pedagogy)*
- Students have control over the direction of the inquiry and the methods or approaches that are taken. *(variety of ways in which learners might respond to the new ideas require a variety of assessment formats)*
- Students draw upon their existing knowledge and they identify what their learning needs are. *(assessment of prior knowledge for student and teacher use is critical)*



- The different tasks stimulate curiosity in the students, which encourages them to continue to search for new data or evidence. *(teacher must use assessment data to scaffold the next stage in learning)*
- The students are responsible for the analysis of the evidence and for presenting evidence in a manner which defends their solution to the initial problem (Kahn & O'Rourke, 2005). *(learner is assessed on several different occasions and contexts thereby sampling the full range of learning aims)*
- In summary, inquiry skills are developed and experienced through working collaboratively with others and so communication, teamwork, and peer support are vital components of inquiry classrooms.

Ten Questions Physics Teachers have About Inquiry-Based Learning

- I have students do many labs as part of my physics course. Isn't that the same as doing inquiry?
- In my physics course, I start the year off by introducing students to the scientific method, and then we use it throughout the year. Is that the same as doing inquiry?
- When I observe a physics classroom where students learn through inquiry, the lesson appears to be unstructured and open-ended. Is that good teaching?
- During my physics class lectures and discussions, I ask students a lot of questions. Isn't that doing inquiry?



- Can all physics lessons be taught through inquiry?
- Inquiry may be appropriate for elementary and middle school students, but how can I teach through inquiry when I am expected to get students ready to pass a final exam at the end of the course? I do not have time for inquiry in my physics classes.
- I have been teaching high school physics for 25 years and have seen a lot of “bandwagons” come and go in my lifetime. Isn’t inquiry the latest thing for science education?

- I see inquiry as “soft science” and not physics content-related. Is that true?
- I always thought inquiry is for high-achieving, college-bound science students. Can students with learning disabilities learn through inquiry?
- How do you assess inquiry-based learning?

Range of Science Instructional Methods
Roles of the Teacher & Student

Activity	Role of Student	Role of Teacher
Expository	**Attends to what the teacher is doing and saying**	**Provides problem, carries out activity/investigation, determines appropriateness of results, e.g. short lecture with demonstration**
Verification	**Perform activity**	**Provides problem, procedure, materials, expected results and determines appropriateness of student results**

Range of Science Instructional Methods Roles of the Teacher & Student

Activity	Role of Student	Role of Teacher
Guided Discovery	Investigate and determine answers	Provides problem, procedure and materials to carry out an investigation and determines appropriateness of results.
Coupled Inquiry (Discovery)	Determine procedure, materials needed and perform investigation	Provides problem, determines appropriateness of results, and facilitates student decisions

Range of Science Instructional Methods & Roles of the Teacher & Student

Activity	Role of Student	Role of Teacher
Full Inquiry	Determine problem, procedure, materials, perform investigation, and determine appropriateness of results	Facilitates student decisions

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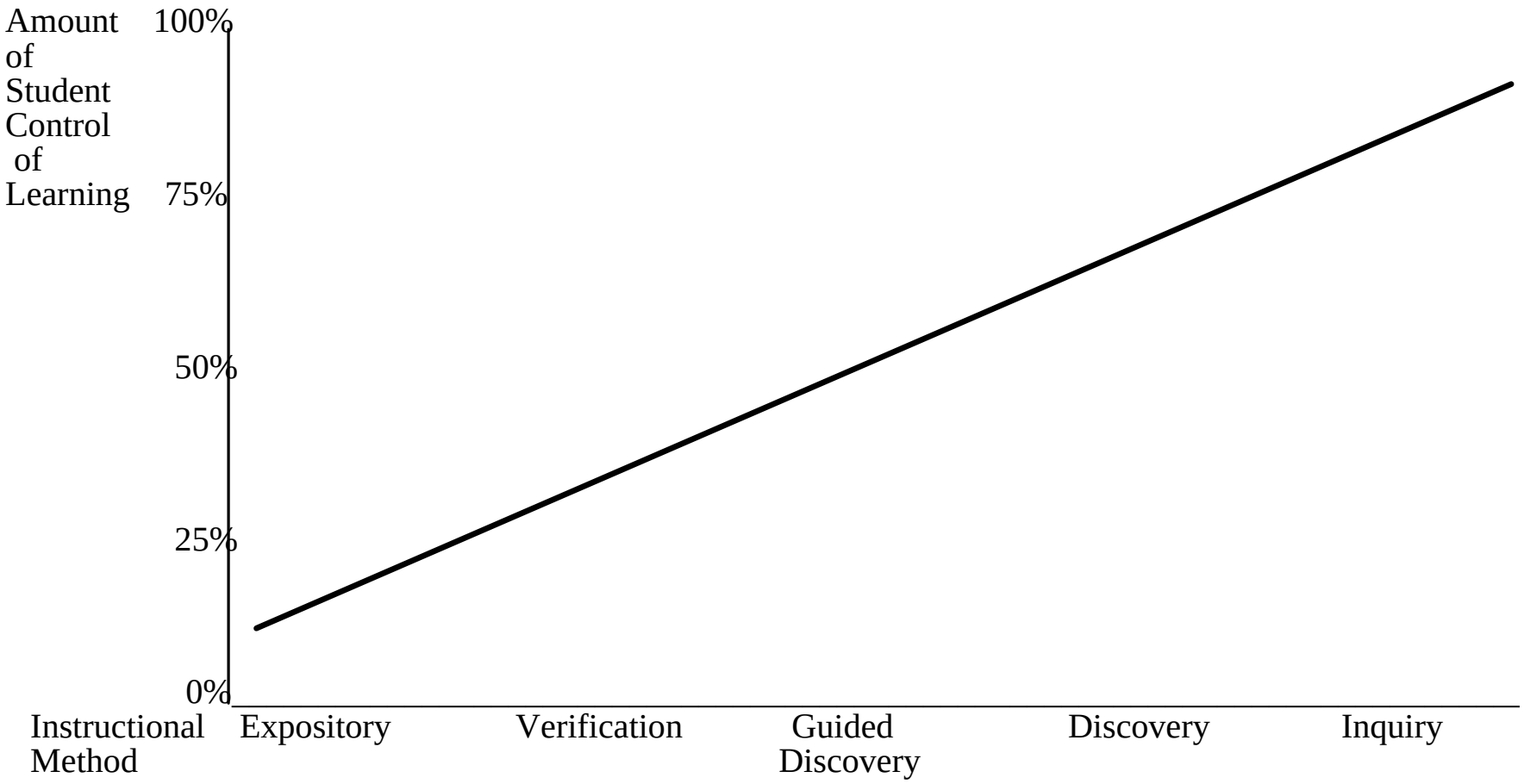
Matching Learning Outcomes to Instructional Methods



Primary Student Learning Outcome with Instructional Method

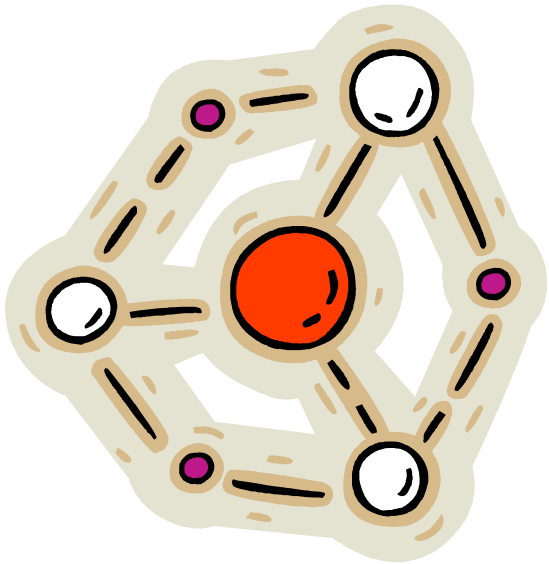
Expository – Verification – Guided – Discovery - Inquiry Discovery

Goal	***Specific Learning Outcomes***	
Content Facts	– Concepts	– Generalizations
Inquiry Skills Low Level (use a balance)	– Mid Level (predicting)	– High Level (experimenting)
Affective & Dispositions Attending	– Responding	– Valuing

What are the Fundamental Abilities of Inquiry to be Learned by Students?

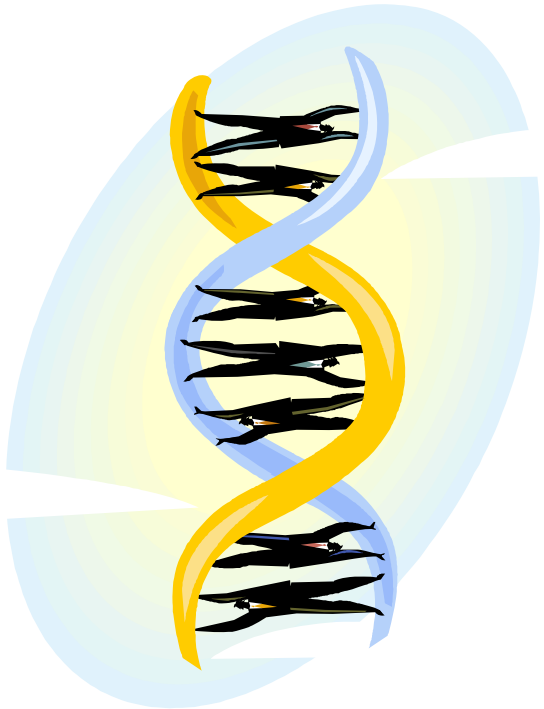
Essential Features of Inquiry

- Learner engages in scientifically oriented questions
- Learner gives priority to evidence in responding to questions



- *See full page handout- Essential Features of Inquiry*

- Learner formulates explanations from evidence
- Learner connects explanations to knowledge
- Learner communicates and justifies explanations



Fundamental Abilities of Inquiry: Grades 5-8

- Identify questions that can be answered through scientific investigations
- Design and conduct a scientific investigation
- Use appropriate tools and techniques to gather, analyze, and interpret data
- Develop descriptions, explanations, predictions, and models using evidence.

Grades 5-8

- Think critically and logically to make the relationships between evidence and explanations.Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Fundamental Abilities of Inquiry: Grades 9-12

- Identify questions and concepts that guide scientific investigations
- Design and conduct scientific investigations
- Use technology and mathematics to improve investigations and communications

Grades 9-12

- Formulate and revise scientific explanations and models using logic and evidence
- Recognize and analyze alternative explanations and models
- Communicate and defend a scientific argument

What Are the Fundamental Understandings of Inquiry to be Learned by Students?

Fundamental Understandings of Inquiry: Grades 5-8

- Different kinds of questions suggest different kinds of scientific investigations
- Current scientific knowledge and understanding guide scientific investigations

Grades 5-8

- Mathematics is important in all aspects of scientific inquiry
- Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations

Grades 5-8

- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories
- Science advances through legitimate skepticism

Grades 5-8

- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data.

Fundamental Understandings of Inquiry: Grades 9-12

- Scientists usually inquire about how physical, living, or designed systems function
- Scientists conduct investigations for a wide variety of reasons
- Scientists rely on technology to enhance the gathering and manipulation of data

Grades 9-12

- Mathematics is essential in scientific inquiry
- Scientific explanations must adhere to criteria such as: a proposed explanation must be logically consistent; it must abide by the rules of evidence; it must be open to questions and possible modification; and it must be based on historical and current scientific knowledge

Grades 9-12

- Results of scientific inquiry – new knowledge and methods – emerge from different types of investigations and public communication among scientists

Questions for Analyzing Alignment for Inquiry

Questions to guide the analysis of science instructional materials and their eventual selection.

- Is “science as inquiry” evident as content in the materials?
- Is the presentation of inquiry as science, content accurate?

Questions for Analyzing Alignment for Inquiry

- Is inquiry-based teaching evident in the materials and in classroom instruction/learning?
- Is there adequate time and opportunity for students to develop the abilities and understandings of scientific inquiry and an understanding of science subject matter concepts?

References

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National Science Education Standards

Types of Science Inquiry Learning Found in Classrooms at Various Grade Levels

Dennis Sunal
University of Alabama