Institute for the Study of Knowledge Management in Education

Defining Inquiry and STEM Literacy

Background on Lab and Text-based Inquiry

The term "inquiry" is defined by Merriam-Webster as a "request for information." In our classrooms, the goal is to create independent learners who are interested in guiding their own learning and who are capable of complex and critical analysis. In science classrooms, the term inquiry is commonly used to describe different levels of experiments or "wet labs." The same assumption is common in other types of labs (e.g. "dry labs" used in technology and math courses.)

However, as you know, scientists build knowledge both through performing their own empirical investigations, *and* through collecting, analyzing, and synthesizing existing information from scientific literature and sources. This IMLS Project views *literacy* as an important aspect of scientific inquiry, and emphasizes concept learning and questioning, searching for information, and the synthesis of text-based scientific data and information as important skills for doing and understanding science.

Science literacy standards already address inquiry in the following Common Core State Standards (and the associated Grade, 6-8, and 11-12 Standards):

CCSS.ELA-LITERACY.RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

CCSS.ELA-LITERACY.RST.9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

CCSS.ELA-LITERACY.RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

CCSS.ELA-LITERACY.RST.9-10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

New Hampshire's science standards also include the following, which can involve both lab experiments and text-based inquiry:

1.Making observations and asking questions (lab-based inquiry)
Use literacy skills of reading, observing and asking questions (text-based inquiry)

2.Designing scientific investigations (lab-based inquiry)
Use literacy skills of developing of essential and supporting questions, identifying and accessing relevant sources (text-based inquiry)

3.Conducting scientific investigations (lab-based inquiry)
Use literacy skills of close reading and text-based questioning, extraction of meaningful data and information (text-based inquiry)

4.Representing and understanding results of an investigation (lab-based inquiry)
Use literacy skills of synthesizing and summarizing or arguing findings to support the findings of the investigation (text-based inquiry)

5.Evaluating scientific investigations (lab-based inquiry)
Use literacy skills of evaluating sources, findings, and inquiry processes (text-based inquiry)

To understand how inquiry can be scaffolded to support students, Heather Banchi and Randy Bell published an article for the National Science Teachers' Association. This article examines the continuum of inquiry. The figure below was created by Banchi and Bell and can be used to explain both lab experiments and science literacy. http://www.miseagrant.umich.edu/lessons/files/2013/05/The-Many-Levels-of-Inquiry-NSTA-article.pdf

Figure 1.

The four levels of inquiry and the information given to the student in each one.

Inquiry Level	Question	Procedure	Solution
1—Confirmation Inquiry *Students confirm a principle through an activity when the results are known in advance.*	✔	✔	✔
2—Structured Inquiry *Students investigate a teacher-presented question through a prescribed procedure.*	✔	✔	
3—Guided Inquiry *Students investigate a teacher-presented question using student designed/selected procedures.*	✔		
4—Open Inquiry *Students investigate questions that are student formulated through student designed/selected procedures.*			

Science Lab Example	4 Levels of Inquiry	Text-Based Example
Students who already understand how chemical bonding affects solubility are asked to determine which lead compounds would be soluble in water. Students are given steps to follow during the experiment. Students confirm what they already knew would happen.	**1) Confirmation Inquiry - Question, procedure and solution are all given**	Students are asked to research how solubility principles resulted in lead leaching into the drinking water of Flint, Michigan. Students are given specific websites or texts from which to collect information or data. Students confirm what has already been reported.
Students are asked how different lead compounds interact with water. Students are given steps to follow during the experiment. Students use their data to discover a phenomena of increasing bond strength decreases solubility.	**2) Structured Inquiry - Question and procedure are given. Students discover an unknown solution.**	Students are asked to form a research question to research how solubility principles may have resulted in lead leaching into their hometown water supply. Students are given specific websites or texts that contain relevant information or data. Students discover phenomena about solubility principles.
Students are asked how different lead compounds interact with water. Students must design their own steps including variances in types of lead compounds. Students use their data to discover a phenomena of increasing bond strength decreases solubility.	**3. Guided Inquiry - The question is given to the students. Students design their own procedure and discover their own results.**	Students are asked to research how solubility principles resulted in lead leaching into the drinking water of Flint, Michigan. Students design their own research process and discover details that connect to solubility.
Students design their own question about lead and solubility. Students design their own experiment and collect their own data to analyze.	**4. Open Inquiry - Students develop their own questions and procedures. They discover their own results.**	Students are guided to design their own research question about solubility principles. Students design their own research process and reveal details that connect to solubility.