Teaching Scientific Inquiry: Exploration, Directed, Guided, and Opened-Ended Levels

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THE TEACHING AND LEARNING OF SCIENTIFIC INQUIRY is viewed as an essential component of all current K-12 science curricula. Science educators have historically been concerned with students’ ability to apply their science knowledge to make informed decisions regarding personal and societal problems. The ability to use scientific knowledge to make informed personal and societal decisions is the essence of what contemporary science educators and reform documents define as scientific literacy. However, many scientists and science educators have difficulty agreeing on what scientific literacy is, let alone knowing how to teach and assess it. This paper presents the various perspectives of scientific inquiry as well as the continuum of levels of instruction of inquiry necessary to engage students in authentic scientific experiences.

What is Scientific Inquiry?

Although closely related to science processes, scientific inquiry extends beyond the mere development of process skills such as observing, inferring, classifying, predicting, measuring, questioning, interpreting and analyzing data. Scientific inquiry includes the traditional science processes, but also refers to the combining of these processes with scientific knowledge, scientific reasoning and critical thinking to develop scientific knowledge. From the perspective of the National Science Education Standards (NRC, 1996), students are expected to be able to develop scientific questions and then design and conduct investigations that will yield the data necessary for arriving at conclusions for the stated questions. The Benchmarks for Science Literacy (AAAS, 1993) expects all students at least be able to understand the rationale of an investigation and be able to critically analyze the claims made from the data collected. Scientific inquiry, in short, refers to the systematic approaches used by scientists in an effort to answer their questions of interest.
Scientific inquiry is a complex concept possessing many nuances and facets.
curious and ask more questions!

Level 2. Direct Inquiry
The problem and procedure are given directly, but the students are left to reach their own conclusions. Students are often asked to make predictions about what they believe will be the outcome of the investigation. In this type of activity, students investigate a problem presented by the teacher using a prescribed procedure provided by the teacher. Here they now have the opportunity to develop their own conclusions by analyzing the data and coming up with their own evidence-based conclusions.

Level 3. Guided Inquiry
The research problem or question, is provided, but students are left to devise their own methods and solutions. During this level of inquiry, students have the opportunity to apply their analytical skills to support their own evidence-based conclusions to the question being investigated. Guided inquiry provides opportunities for students to take more responsibility during the investigation. Students may have choices of methods, materials, data organization and analysis, and conclusions.

Level 4. Open-ended Inquiry
Problems as well as methods and solutions are left open at this level of Inquiry. The goal is for students to take full responsibility for all aspects of the investigation. These activities involve students in formulating their own research questions, developing procedures to answer their research questions, collecting and analyzing data, and using evidence to reach their own conclusions.

Conclusion
 Obviously, the four levels Inquiry are hierarchical. In other words, students cannot be expected to successfully complete a Guided activity without plenty of experience with Exploration and Directed Inquiry activities. Furthermore, although it may be desirable for elementary students to participate in some Guided and Open-ended investigations, it is not meant to imply the ultimate goal is to make all inquiry activities Open-ended investigations. Rather, teachers should strive for a mix of inquiry levels appropriate to the abilities of their students. However, providing students only with activities at Exploration levels denies them the opportunity to develop and practice important inquiry skills and gives them an incomplete view of how science is done. It is only with experience with all of these levels and methods of Scientific Inquiry that our students will achieve the ultimate goal of becoming “Scientifically Literate!”
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