IS THERE ONLY ONE WAY TO DO SCIENCE INQUIRY?

Though inquiry is highly effective for many students, no single teaching method is appropriate in all situations, for all students. In practice, inquiry-based teaching often occurs on a continuum. Depending on the teaching goal, teachers will move along the continuum, choosing strategies and activities that are most appropriate for the situation.

At one end of the continuum is **structured inquiry**, where students engage in a hands-on activity and draw conclusions, but follow precise instructions from the teacher. The purpose of structured inquiry is to exemplify scientific ways of thinking and doing and to initiate student responsibility for the process.

- Students focus on one aspect of inquiry (i.e., data collection), thoroughly discussing and developing the aspect and making connections to the larger problem through teacher intervention.
- Teachers model and guide supporting aspects of inquiry in such a way that the students are provided a rich learning opportunity.
- Teachers guide reasoning individually, in small groups, and in whole class discussions, inviting the expression of student ideas and understandings.

Somewhere in the middle is **guided inquiry**, where students may assume responsibility for determining the procedure for the investigation, but the teacher chooses the question to be investigated. The purpose of guided inquiry is to continue to exemplify scientific ways of thinking and doing while transitioning more responsibility for thinking and doing from the teacher to students.

- Students focus on more than one aspect of inquiry, thoroughly discussing and developing the aspects. Students also actively make connections to the larger problem with teacher guidance.
- Teachers model and guide supporting aspects of inquiry in such a way that students are provided a rich learning opportunity.
- Teachers guide reasoning individually, in small groups, and in whole class discussions, inviting the expression of student ideas and understandings.

At the other end of the continuum is **student-initiated inquiry**, in which students generate their own questions from a topic selected by the teacher, and design their own investigation. Student-initiated inquiry provides opportunities for the student to exemplify thinking and behaving in scientific ways to solve personally and socially important problems.

- Students focus on all aspects of inquiry, designing and exploring an investigation in accordance with sound science practices.
- Teachers frame the investigations by defining learning goals.
- Teachers guide student reasoning with discretion, allowing students to realize and solve most of the technical and conceptual problems.
What Do We Mean by Inquiry?

Inquiry-Based Teaching is the art of creating situations in which students take the role of scientists. In these situations, students take the initiative to observe and question phenomena; pose explanations of what they see; devise and conduct tests to support or contradict their theories; analyze data; draw conclusions from experimental data; design and build models; or any combination of these.

These learning situations are open-ended in that they do not aim to achieve a single "right" answer. Nevertheless, students work under clear standards. They learn to observe keenly and thoroughly and to pose questions that are answerable, in part or in whole, through some meaningful test or exploration. They engage in trial and error, and they learn to analyze and reason carefully.

What Is Inquiry?

Inquiry is a complex idea that means many things to many people in many contexts. Our interest in inquiry at the Center for Inquiry-Based Learning stems from our experiences as scientists, teachers, and students. What follows is a series of snippets to give you the flavor of what we mean by inquiry. A strict definition, if possible, would probably be too restrictive.

- **Inquiry is asking questions.** But not just any questions, *good* questions. Questions that are *accessible*. Questions that can be *answered* in part or in whole. Questions that lead to meaningful tests and explorations.

- **Inquiry is the art and science of asking and answering questions.** It involves observation and measurement, hypothesizing and interpreting, model-building and model-testing. It requires experimentation, reflection, and the recognition of the strengths and weaknesses of its own methods.

- **During inquiry, a teacher may pose a question or cajole students into posing their own questions.** These questions are often open-ended, offering students the opportunity to direct their own investigations and find their own answers (not just the *one right* answer), and in all likelihood, they lead to *more* questions.

- **Inquiry is what scientists do.** They usually do it in a formal and systematic way, and in the process, contribute to the collective body of information we call knowledge.

- **In experiencing science as inquiry, students learn how to be scientists.** Thus, students learn more than just a body of concepts and facts, they learn the processes involved in establishing those concepts and facts.

- **Inquiry provides students with concrete, active learning experiences.** Students take the initiative. They develop problem-solving, decision-making, and research skills that enable them to become lifelong learners.
• Inquiry allows students at different developmental stages to work on similar problems and even collaborate in finding solutions to those problems. Each student gets to bring his or her own special talents into play.

• Inquiry allows for the integration of multiple disciplines. As students explore, they will tend to ask questions that will involve science and math, social studies and language arts, technical and artistic skills.

• Inquiry involves communication. Students must ask coherent, meaningful questions. And they should report their results, orally or in writing. In this way, they both teach and learn from each other.

• Inquiry allows teachers to learn about their students -- who they are, what they know, how their minds work. These insights will enable teachers to be more affective facilitators in their students' pursuit of knowledge.

• When using inquiry, teachers must bite their tongues. Too many hints, too many questions, and too many answers take all the learning out of the process. And all the fun, too.

• Inquiry requires students to take responsibility for their own education.

Inquiry and Teaching Skills

Inquiry creates opportunities for teachers to learn how their students' minds work. Teachers can then apply these insights to set up appropriate learning situations and facilitate students' pursuit of knowledge.

Some of the skills that teachers learn when using inquiry include:

• knowing when to provide a nudge
• knowing what hints to give each particular student
• knowing what not to tell students (not to give away the answer)
• knowing how to read student behaviors as they work through challenges and how to design meaningful learning situations that take those behaviors into account
• knowing how to help students collaborate in solving problems together
• knowing when observations, hypotheses, or experiments are meaningful
• knowing how to tolerate ambiguity
• knowing how to use mistakes constructively
• knowing how to guide students so that giving them control of their explorations does not mean losing control of the classroom

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Advantages of Inquiry Teaching

- Inquiry instruction is supported by brain research.
- It does not emphasize memorization; focuses on exploring questions and understanding.
- Inquiry involves students in thinking about scientific concepts.
- The teacher can address student misconceptions.
- Students learn more when they are active participants.
- Students develop higher-order thinking skills, problem-solving ability, and decision making skills.
- Inquiry may evoke confusion, this allows restructuring of ideas and misconceptions.
- Inquiry suits a variety of learning styles.
- It encourages cooperation and communication.
- Inquiry is fun and motivates students!

Management tends to be the biggest issue for teachers when implementing inquiry based education. The possibility of a large number of student generated procedures introduces an unknown factor that may make teachers feel uncomfortable. Teachers may not have access to materials or a laboratory. Deconstructing the “cookbook” labs in texts is a good beginning in the use of inquiry. Allow students to make decisions by eliminating some instructions or data tables. After students become comfortable with this type of inquiry they can advance to open inquiry. The Internet is also a source of inquiry activities that often involve easily obtained materials.
THREE TYPES OF INQUIRY

Structured Inquiry
Students engaged in hands on activity.
Students follow precise instructions from teacher.
Very often, teacher gives students the answer to problem.

Guided Inquiry
Teacher chooses questions to investigate.
Students develop procedures for investigation.
Students find own answer to problem.

Open Inquiry
Student-initiated
Students generate own questions.
Students design own investigations.
Teacher does not give students the answer.