INQUIRY DESCRIPTIONS

Exploratorium Institute for Inquiry Forum

November 8–9, 1996

In 1996, the Exploratorium Institute for Inquiry held a forum in which researchers, teachers, and professional-development specialists from the fields of science, mathematics, history, writing, and the arts examined the topic of inquiry.

Prior to the forum, participants were asked to write a short description of inquiry from their professional perspectives. Each participant's inquiry description is reprinted here.

ARTISTS, WRITERS, AND HISTORIANS

Daniel DiPierro

Artist/Educator, Exploratorium, San Francisco, CA

I see inquiry teaching as commitment to a highly active social endeavor. The work itself involves a number of critical elements which must be woven together intricately over a prolonged period of time and then practiced as an ongoing evolutionary process.

I want to qualify this belief with an even stronger one. I see inquiry learning to be an essential and basic discovery process for most individuals, especially young children. Inquiry is practiced naturally from birth as a primary way to develop an understanding of the world around us. Utilizing curiosity and intuition, all of the senses and instincts for observation, seeking and questioning and making predictions, playful interactive investigation, and the making of connections and use of memory. These are at the same time tools and skills for learning and understanding, which are naturally there but that can also be nurtured and encouraged through guidance.

The places where I see ongoing need for focus, awareness, and change include not only classrooms and schools, but also in the areas of teacher training and professional development, as well as with tools for assessment. Of course, it should extend throughout the entire education community, from administrations to state departments, right on to the parents and families at home.

I feel an important key towards the success of any inquiry teaching involves an active practice by the teachers or facilitators, themselves, in the inquiry process. It is sort of a "practice what you preach" view, where the process is modeled in the very design of the learning environment and systems within which inquiry is introduced.

Laura Farabough

Artist, Stanford University, Stanford, CA

To be an artist is to ask questions, to probe material in search of its weakness, strength, durability, vulnerability, in search of some unknown thing that is and is not the material, to make associations with or to find the correspondences between the limited matter at hand and the larger world, to articulate—visually, aurally, structurally, metaphorically—something intuitively if not intellectually known, to configure/constrain matter within a conflicting and/or contrapuntal form in order to persuade the invisible (the unknown) to emanate.

Reiko Goto

Artist, Carnegie Mellon University, Pittsburgh, PA

I am a sculptor and installation artist. I have been interested in site issues, places and opportunities for human-nature interface. "Creative inquiry" is an essential process for my art making. The process of that inquiry follows:

1. General observation, questions and hypothesis

2. Observation and research

3. Evaluation and critical thinking

4. Process the evaluation to new hypothesis, repeat 2 and 3. Repeat 2, 3 and 4 until you feel ready for step 5.

5. Final evaluation

6. Modeling

7. Presentation

My product is more often process and human relationship modeling than an actual static product. I am interested in creating interface points of thresholds between the divergent realities of nature and humanity in the urban setting. "Nature and humanity in the

urban setting" is a complex system of inter-relationships. To understand, I need to access other disciplines. Therefore, a key element of my process is considering different aspects of the experience of place. I have increasingly been able to work in an interdisciplinary manner, working with biologists, entomologists and other natural sciences. I think the different views and thoughts mixed or connected together begin to reflect the complex reality that we see, hear and feel. Working in an interdisciplinary manner forces me to communicate outside my own discipline and allows me to begin to understand the way other professionals process the experience of place.

Two and a half years ago my husband and I moved to Pittsburgh, Pennsylvania. Coming to new places has always excited me. It is an opportunity to encounter a different landscape, geography, habitat (plants, insects, birds, fishes, invertebrates and mammals), weather, people and history. After being here for a year, my husband and I were introduced to Nine Mile Run, a historic stream valley. Nine Mile Run was identified in 1910 by Frederick Law Olmstead Jr. for its beauty and potential as a public park. In 1921, the Citizens Committee of Pittsburgh began to plan for its eventual transformation into parkland. It was subsequently bought up by the steel industry looking for a slag heap disposal site. Seventy years later, the 240-acre site has slag piles as high as 20 stories and the same water problems (sewage) that Olmstead identified in his report 80 years earlier. My husband, myself and colleagues from other disciplines starting looking at the site together as a research team interested in the transformation/reclamation of "dump" into public space. We are looking at the site from five points of view: (1) context/history, (2) habitat, (3) land, (4) water and (5) policy. I am the principal investigator looking at habitat issues. I have Frick Park, which is next door to the slag site, to look at as a model. I am still in stage one of my inquiry: 1. Observation; forming a hypothesis and a path of inquiry. Identification of systems.

I don't know what I am looking for yet. It sounds like looking for a treasure in a desert (slag is porous and provides a desert-like atmosphere). The treasure could be a flower, butterfly, bird, rock or small stream. These are not just ordinary flowers, butterflies, birds, rocks and streams. They are very unique and specific to the place. They provide the meaning of place. Once I recognize these specific treasures in the place, I never see the place same as before. My quest as an artist is to provide an opportunity for my audience to experience these treasures. In that experience the dump is reclaimed.

Mildred Howard

Artist, Exploratorium, San Francisco, CA

It is very difficult for me at this time to clearly define inquiry. However, my understanding of inquiry becomes deeper over time, therefore the way I describe it changes.

There are elements of inquiry that I believe remain constant and can be categorized in many ways. Many of these elements have multiple meanings and can be overlaid with others. The elements I came up with thus far are:

- Pursuing an idea, interest or question in a particular area
- Understanding or having a willingness to learn what drives that interest and where the ideas stem from
- Trusting previous knowledge and using that as a vehicle to pursue one's idea, interest or question
- Understanding that there are choices that one can draw from
- Creating an environment that is safe to work and pursue ideas, interests or questions
- Having a choice of materials and developing a dialogue with those materials.
- Developing a knowledge about the relationship of the materials and the connections made to the idea, interest or question
- Allowing the time to do what is necessary using the inquiry approach to working

Process

- Following one's own thinking
- Keeping track of that thinking
- Exploring and using one's gut feeling
- Risk taking and facing the void; that is, you know you want to make something and may or may not know what the end result will be
- Working with accidents and sometimes following that path
- Exploring areas of problem solving
- Making an intangible idea, interest or question tangible
- Making a feeling a visual experience
- Developing an on-going dialogue and creating a visual vocabulary for future use
- Understanding that making art is something that is

yours that also can become someone else's (art that can evoke the viewer in a way that brings up issues that are personal, private and at the same address the artist's concerns).

Amalia Mesa-Bains

Artist, California State University - Monterey Bay, Seaside, CA

Research

Observation

Material experimentation

Evaluation/revision

My creative inquiry process usually includes a period of research, gathering of information and images related to my area of interest. This period of research and investigation allows me to gather bits of information across multiple disciplines: demographic data, photography, theory, literature and visual images. In the form of inquiry I am only looking for fragmentary references that can help me elaborate my original concept. This inquiry is characterized by coincidence, disassociate references and a rather baroque complexity from a beginning premise.

The preliminary stage of information and image development also sets the stage for the decision of artistic medium and selection of material.

The second phase of inquiry is material and physical in that it pertains to the actual making of the art objects. In this observation play, manipulation and continual observation help determine the direction of the material exploration.

The material experimentation is followed by a third process of evaluation and revision guided by inquiry and judgment. This process of evaluation and revision is a time of testing the material representation against original concepts, relevant to context and aesthetic preferences the process of inquiry is fluid and alternates between cognitive and sensory responses.

Don Rothman

Director, Central California Writing Project, UC Santa Cruz, Santa Cruz, CA

Using writing as an impetus and ally into inquiry, the students and teachers with whom I work discover themselves in each others' presence. By writing, they transform what is taken for granted into something compelling, worthy of attention. By listening to others read their writing, they reconstruct their expectations for what people can do to explore difficult questions, to transform their workplaces, to liberate themselves from the demons and censors that have both kept them from writing and from engaging in creative professional dialogue. The central question in this work is often: "What do our relationships with one another, our aspirations as educators, our lives as citizens have to do with the teaching of writing?"

The summer institutes that I lead and the undergraduate writing classes that I teach are, fundamentally, about learning to ask better questions. At the heart of trying to improve writing instruction is the challenge to determine how one's own experience as a writer can be a useful guide to teaching. What questions are worth asking about one's own writing practice? What do we learn from the intellectually, emotionally and politically charged discussions in our five-week institutes about how our classes can become sites for inquiry? What about our faculty meetings?

From a childhood shaped by a Talmudic tradition of inquiry, in which texts are always presences in one's interrogation of the world, I now teach students to enter conversations with themselves, each other and with the authors and characters peopling our reading. Inquiry, in this way, makes certain kinds of conversations possible...and rewarding.

Mary Anne Smith

Executive Director, California Writing Project, UC Berkeley, Berkeley, CA

Writing is both a tool for inquiry and the subject of inquiry. On the one hand, writing itself unearths new questions or understandings, discoveries or qualifications. On the other, writing invites questions about how writers write, about their processes, about techniques that help them. What writers write—their intentions, their genres, the qualities and merits of their work—these, too, are inquiry subjects in the field of writing.

Inquiry is central in Writing Project professional development where teachers come together, not as recipients of someone else's knowledge, but as scholars whose teaching approaches merit scrutiny and debate. Writing project teachers are themselves researchers, conducting studies in their own classrooms and presenting them at conferences, in in-service workshops, and through publications. Most important, however, is the stance of Writing Project teachers. As models for their own students, they are constantly constructing and revising, whether the construction is a piece of writing or a classroom learning strategy.

David Weitzman

Historian, Covelo, CA

Behavioral Objectives: Inquiry/Discovery Learning

Sometime in the early 1970s it became *de rigueur* for principals to ask teachers to submit lists of "Behavioral Objectives," expecting things like "arrives in class on time every day" and "does homework assignments." But I felt that inquiry learning, for both teachers and students, resulted not so much from new materials and strategies, but from new behaviors more suited to learning by discovery. So I submitted the following list, including my favorite quote on education from Alice in Wonderland:

"I can't believe that!" said Alice.

"Can't you?" the Queen said in a pitying tone. "Try again; draw a long breath, and shut your eyes."

Alice laughed. "There's no use trying," she said; "one can't believe impossible things."

"I dare say you haven't had much practice," said the Queen. "When I was your age I always did it for half an hour a day. Why sometimes I've believed as many as six impossible things before breakfast!"

Basic Skills

- acquires, organizes, stores and retrieves relevant data and concepts
- learns how to learn and constantly improves on personal learning process
- uses feedback mechanisms to monitor and evaluate own behavior
- determines, evaluates and directs own destiny
- increases flexibility of thought without fear of disorientation

Personal Behavior

- adapts to change without fear of losing identity and personal values
- develops increased tolerance for ambiguity
- collaborates effectively in groups while maintaining individuality
- anticipates change and makes adjustments to personal trajectory

Interpersonal Behavior

- understands similarities and differences in all of humanity
- moves freely in and out of groups
- develops a broader repertory of roles, feelings, attitudes, values and relationships
- adapts to and functions in widely diverse cultures and environments
- identifies with many elements of our society

SCIENTISTS AND SCIENCE EDUCATORS

Doris Ash

Science Educator, Exploratorium, San Francisco, CA

Philosophically, I find inquiry a wonderful metaphor for life. Interacting with phenomena in open-ended ways, following individualized learning paths and noticing everything that occurs, especially the oddities, is a fitting way to go through one's days, whether practicing science, the arts, or life.

Since coming to the Exploratorium I have become convinced that, although inquiry can be a highly personalized experience, it has structures and elements that can be explored and described. The "magic" can be examined and transformed into tools for those who want to teach it and practice it.

I am most interested in understanding the commonalities and disjunctures that we may unearth when examining inquiry across the disciplines. This uncharted territory is fascinating.

Understanding better the role of inquiry in learning, the delicate interplay between tried and true processes and the complex content that underlies science is the other aspect of inquiry that fascinates.

Dennis Bartels

Director, Center for Teaching & Learning, Exploratorium, San Francisco, CA

Description of Inquiry in an Organizational Setting

The following is a little different approach since I want to apply inquiry to an organization setting rather than a specific academic discipline. It's an interesting question: Can inquiry be a way of doing business? I think that it is an essential element if an organizational goal is building a learning community.

Inquiry for me, in a teacher development setting, is letting the teachers bring the questions (and hence the curriculum) into the professional-development space. When teachers are provided the opportunity and the structure, the questions they ask tend to be

very authentic, powerful and complex, and not always content-bound but intimately related to teaching and learning. In well-designed experiences, the process is almost fool-proof. Teachers are passionately engaged and motivated because they are asking the questions closest to their hearts and progress towards the answers they seek.

Take that one step further into an organizational setting. In managing a program, center, or entire organization, where is the intellectual and emotional lifeblood being generated? I believe that asking good questions, investigating them, developing responses and asking the next set of questions that emerge is central to a vibrant and thriving organization. It is a way of doing business that is reflected in decision-making, problem-solving, and organizational culture. It starts with the questions that naturally occur to the people inside the organization and builds on the expertise resident in the people who make up the organization. It is reflective, empowering, critical, respectful and open. No one is ever asked to swallow anything whole or set-up to be fixed (deficit model). It welcomes coaching and feedback. And it builds from strengths and what we already know or can do.

Bronwyn Bevan

Assistant Director, Center for Teaching & Learning, Exploratorium, San Francisco, CA

Inquiry is a mode of teaching and learning that is about questioning, hypothesizing, and discovering. I believe it is about a shift in attitude rather than an upheaval in curriculum and classroom.

My work at the Exploratorium is about developing, facilitating, and administering programs which are centered around inquiry learning for students, youth, and teachers. A lot of my time is spent on fundraising: seeking out funders and then proposal writing. What I find, as I interact with the funding world, is (not surprisingly nor inappropriately) a concern with outcomes. What does each dollar yield? On a scale of 1 to 100, how much content has been transmitted? How can you graph the results?

Responding (in proposalese) to this concern has made me think more and more, first about how one assesses long-term reform initiatives, and second how the classroom balance of content and process is difficult to test over the short term, but is manifestly critical—over the same short term—for a student's school career. Which has led me to think about the guinea pig nature of the "subject" kids, as their districts' reform efforts are developed and implemented, and about how to assess a project's "outcomes" in the most important sense—that is, in how well the participating or subject students will later find themselves prepared for their lives and careers.

Peter Dow

Director of Education, Buffalo Museum of Science, Buffalo, NY

My interest in inquiry learning derives from my role as Director of Education for a Natural History museum.

Much of the current discussion of inquiry in educational circles turns around the effort to construct learning environments that encourage learners to ask their own questions and to seek answers through the controlled manipulation of the environment. Investigations in the physical sciences (light and color, properties of electricity, behavior of objects in water, etc.) have, for the most part, dominated the discussion of the application of scientific inquiry to the field of education.

Given my present situation, my own concerns about inquiry have focused primarily on the examination of the behavior of plants and animals, and to a lesser extent, human beings. Investigations of this sort are less easily manipulated through controlled experimentation, and tend to involve longer time spans (to allow for changes to occur) and place considerable emphasis on observation, drawing, journal keeping, etc. than on manipulation. The inclination to avoid manipulation, for example, may derive from a desire to understand the behavior of the organism in its natural habitat.

Another interesting aspect of natural science inquiry involves the making and use of collections. Almost all natural history investigations involve the use of carefully documented historical collections as a database for making comparisons and for relating current discoveries to past findings. The significance of coming across a particular insect in a particular location, for example, may depend on where and when this creature has been observed in the past. Thus, the continuous development and maintenance of a research collection may be a critical aspect of natural science inquiry.

To pursue a deeper understanding of natural science inquiry we are planning to open an Inquiry Center in the museum. This center will be a place where museum visitors—children, teachers, parents, interested adults—can pursue their own investigations of the natural environment of western New York. The Center

will contain collections representing the museum's major areas of scientific expertise: botany, entomology, vertebrate zoology, geology, paleontology and anthropology. It will also have tools for investigation such as Wentscopes, a Magicam, an Internet connection, and equipment for carrying out field investigation in the natural sciences. By establishing this facility we hope to create a laboratory for learning more about how to carry out inquiry-based investigations in a natural history museum.

Hubert Dyasi

Director, Workshop Center, City College School of Education, New York, NY

Curiosity is the centerpiece of inquiry—the desire to know (in Greek, *scio*—etymological root for the word science); and curiosity is indicated by a question or questions (voiced or acted out), e.g. "Would Napoleon have won at Waterloo if he had been well on 18 June 1815?"

To inquire is to seek, obtain, and make meaning from answers to one's questions. In science inquiry, questions generally relate to natural and man-made phenomena. I identify the following components of science inquiry:

- Noticing and raising questions about a phenomenon.
- Firsthand inquiry involving exploration; generating investigatable questions and carry out as planned.
- Documentation of inquiries (creating a rich portfolio of information and knowledge): records of questions raised, indicating which ones were answered and which ones were not, procedures followed, materials used and for what purposes, collected and organized data (e.g. in graph form, anecdotes, etc.) and of references consulted; journals and notebooks highlighting inquiries and resulting understandings.
- Articulation of inquiry experiences: giving demonstrations, making oral presentations of investigations carried out; public defense of inquiries, findings and abstractions orally in discussions and also in writing.
- Discourse on other people's related inquiries: comparison of own work with published material dealing with specific related aspects of science inquiries—identify focal points of each source, meanings of the focal points, illustrations used to clarify the focal points, arguments advanced in support of the points, implications (as stated by the source) of accepting the focal points. The inquirer indicated points on which she/he agrees or disagrees with the source, bases for disagreement or agreement, relevance of focal points to own inquiries (sources include science books and journals, scientists and science educators).
- Reflective Abstraction: Inquirer must demonstrate how inquiries constitute science "news" or significant science knowledge; one must also demonstrate how the findings of the investigation can be used to build other significant science knowledge. For example, it is not sufficient for one who investigates densities of different liquids simply to report his/her results; it is necessary to make abstractions that relate to flotation and to ways in which the concept of density might be utilized to illuminate other inquirers. An inquirer also compares his/her "science" news with findings of professional sources in the selected area and test the reliability of both her/his "news" and findings from professional sources.

Jay Hackett

Center for Science, Mathematics & Engineering Education, National Research Council, Washington, DC

My perspectives on inquiry are influenced by my interests in how students develop understanding in science and what that means for improving K–6 science curriculum, instruction and assessment. My favorite "working" definition of inquiry is attributed to the physicist Fred Fox. He looked at scientific inquiry as (paraphrased): "Doing your damnedest, with no holds barred, to develop reasonable solutions to compelling problems and questions." The National Science Education Standards refer to inquiry as "the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world."

Barry Kluger-Bell

Science Educator, Exploratorium, San Francisco, CA

"I can give you answers but I can't give you understanding." That's what I have to keep telling my workshop teachers as they struggle with their questions about the world. Understanding, connections between old experience and new, and sense made of one's

experience in the world is built by interacting with that world and reflecting on those interactions. Exploring, raising questions, trying things out, testing ideas, observing closely, making models and representations, talking with friends, seeking experts and books; all of these are part of the effort to learn and to understand. In the end, the workshop teachers may have some answers and usually have even more questions, but they realize that this process of inquiry is the way that they can build their own understanding of the world.

Jerry Pine

Physicist, California Institute of Technology, Pasadena, CA

Try Webster's: "The act of an instance of seeking truth, information, or knowledge about something." (plus three inches of small print with further definitions and illustrations.) A heavyweight word! A good definition, which covers the ground nicely, but abstractly. The key word "question" is missing, though it could be there.

In my work as a researcher in neuroscience, the big question is how do brains work—too big for anyone's inquiry and suitable for all 10,000 of us. An interesting collaborative inquiry. I have my piece, a question I have been trying to answer for 16 years. Along the way, there have been many sub-inquiries: why cells refuse to grow; what electrical signal should I expect, and what do I see; what is known about CCD cameras; can we succeed in making a microdevise with neurons inside it; and so on. The common denominator is a question. And we are always problem-solving in search of the answer. The approach is sometimes hands-on and sometimes not. Sometimes there is a hypothesis about the answer to the question and sometimes not. (The omnipotent hypothesis in some pedagogical writing is misleading—even dangerous to the training of young inquirers.)

My other work is as a teacher of pre-service and in-service teachers and also of professional science students. I see an interesting shift in the context of inquiry, to "inquiry teaching." I think the underlying pedagogical task is twofold: To give students experience in the process of inquiry as it plays out in real science (as contrasted to "school science"—a whole other barrel of snakes) and to give students a chance to gain fundamental knowledge, through their own experience and of their own construction—gut-level knowledge. The knowledge is very unlikely to be discovered through inquiries students can invent to answer fundamental questions. For example, does the earth move around the sun or vice versa? What is sound? What is electricity? How does a roller coaster work? These are questions which took hundreds of thousands of years to answer by "free inquiry," by the process we want to teach in fact. If we want this "content," we need to design a structure within which the inquirer can be lead to construct knowledge with the help of designed experiences, and with a knowledgeable facilitator. Content vs. process is not a war. We need both, we need to teach for both, and we need to provide a wide range of instructional structure to do that. Lastly, except for the youngest children, the inquiry cannot be all hands-on. Using the work of colleagues, books, videos, computer simulations, and so on are part of the process, as they are in real science.

Rob Semper

Associate Executive Director, Exploratorium, San Francisco, CA

Inquiry as defined by the Oxford English Dictionary is "The action of seeking, especially for truth, knowledge or information concerning something; search, research, investigation, examination; the action of asking or questioning; interrogation"

For me as a scientist, inquiry is defined by a series of features:

- Scientific inquiry is personally driven
- Scientific inquiry is concerned with content as well as process
- Scientific inquiry is as much about asking good questions as getting good answers
- Scientific inquiry occurs within an existing framework of previous knowledge
- Scientific inquiry is concerned with gathering evidence
- Scientific inquiry is developed in scientists through an individual and group mentoring process over a considerable length of time
- Scientific inquiry involves the skills of directed observation, problem solving, analysis, and experimentation

At its heart, the scientific enterprise is driven by inquiry at both the individual and group level. For the individual scientist, the quest for understanding is fostered by an insatiable curiosity about how things work and why things are the way that they are. For the discipline as a whole, progress is measured by the

successful progression of responses to questions about the fundamental working of nature.

A scientist by definition is naturally an inquirer, and while much of the professional development that a scientist undergoes is seemingly about "learning the lay of the land," the truth of the matter is that a key feature of science schooling is apprenticing oneself to a master inquirer to learn how to ask "good" questions, i.e. ones that lead to fruitful answers.

The practice of inquiry is a way of thinking, of processing, of operating in the world. For me, what is key is having an initial curiosity about something and a framework to ask questions. This need for a personal interest in what is being examined is why inquiry cannot be taught as a process skill only irrespective of the topic of study.

Scientific inquiry is not unbounded, but rather is corralled by a desire to fit into the particular developing self-consistent world view that is the current scientific paradigm. A key feature of this paradigm is the repeatability of results and the use of mathematics as a consistent tool for maintaining self consistency.

The development of inquiry skills is beset by two key tensions, one that occurs between open-ended discovery on the one hand and structured investigation on the other.

Linda Shore

Co-Director, Teacher Institute, Exploratorium, San Francisco, CA

We were born doing science. By randomly touching objects and placing things in our mouths, we learned as toddlers what is hot or cold, sweet or sour, sharp or dull, rough or smooth. We learned almost everything through inquiry. Watching toys sink or float in the bathtub is/was a chance to investigate the principle of buoyancy. By playing catch, we made discoveries about gravity and trajectories. By building towers out of blocks, we explored principles of size, scale and center of mass.

We learned about the world by experimenting and observing—trying things out, watching what happens. We might even create an explanation that helps us make sense of our observations. To me, this is inquiry and the essence of "doing science."

Unfortunately, somewhere along the way we lose our natural curiosity about the world. It seems to happen when we are faced with our first science class. Science becomes a list of facts and formulas to memorize. Our natural instincts to do inquiry are suppressed. In my work at the Exploratorium, I try to help parents and teachers rediscover the child-scientist inside themselves. This is accomplished by modeling inquiry through workshops, institutes and activities described in publications I work on.

Fred Stein

Science Educator, Exploratorium, San Francisco, CA

My description of inquiry within the discipline of science begins with perceptible phenomena. Whether within the physical or life sciences, observations can be made about the behavior of the phenomena of interest. As questions arise in response to what we perceive in the phenomena, they can be acted on through further focused observation, or designed interventions. Predictions and theories can be tested through further observation or intervention. In this process more observations and questions will emerge leading to a more complete familiarity with the behavior of the phenomena.

The key is to ground one's questions within the perceivable phenomena itself. Theories that attempt to answer these question are valid only as they arise compellingly from the phenomena. In this way, the private thinking involved in perceiving and trying to understand phenomena can be made public through the demonstrable behavior of the phenomena of interest.

Understanding is built through an iterative process of alternating between observations and interventions with materials and phenomena and sharing one's understanding of the phenomena through prediction and description. Currently, my work involves trying to understand more fully the elements of this process: the qualities of materials and phenomena that are well suited for inquiry, the types of forums for sharing understanding that increase the opportunity for concept development, and the methods for ongoing facilitation of this process.

Karen Worth

Senior Scientist/Professor, Faculty, Wheelock College, Newton, MA

Children's inquiry in science is at the heart of what I do but it is not where my work lies. It is rather in thinking about how to create the classroom environment in which children's inquiry can and will take place and, more specifically, how to provide the adults

who work with children—the teachers—with the knowledge, skills, art and craft of this thing loosely called inquiry teaching.

I would like to share my image of science inquiry that emerged from a dialogue between Hubert Dyasi and myself during the planning process for a two-week institute on science education for museum educators. In our conversations we felt it was important to have a scaffold or framework within which we all could talk about the inquiry experiences the participants were having, the inquiry experiences they might provide for teachers who came to their museums and the inquiry of children in museums or classrooms. Hubert wrote about inquiry; I drew inquiry. This diagram was the result:

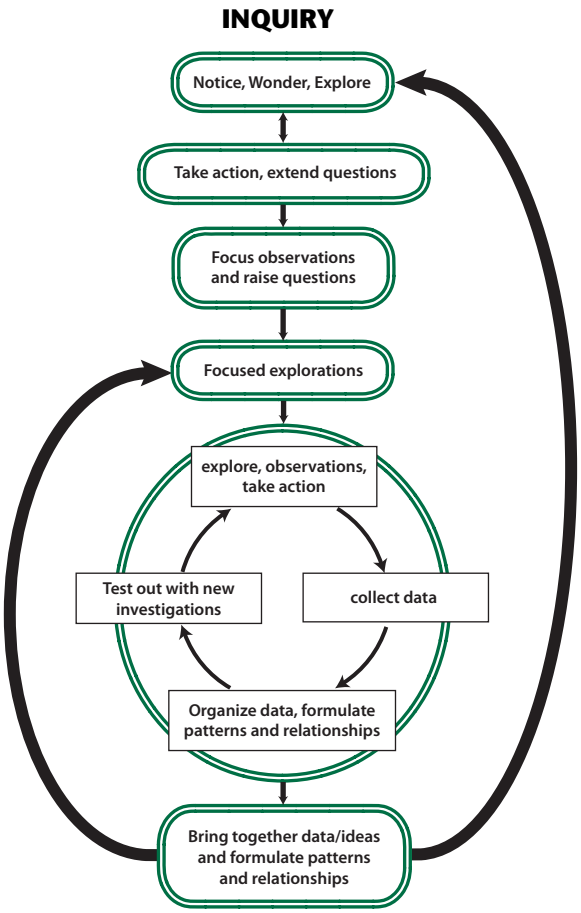

Diagram: Hubert Dyasi, CCNY; Karen Worth, EDC

It is an attempt to focus attention on various elements of inquiry; to suggest the importance not just of the experimental aspect but of deep and open experience with phenomena. Also it emphasizes the moment within inquiry when it becomes important to take early experience and from that ask a question that can then be the substance of an investigation that is more structured. It suggests, though badly, with its arrows and lines that there is only a tentative sequence to the process of inquiry and that the elements of open exploration, finding questions, focused investigation and drawing of conclusions intertwine throughout the search for understanding and for conclusions.

The diagram has proved useful, perhaps most importantly, to promote an understanding of the importance for children of the elements of inquiry that are often missing or underemphasized in classrooms: e.g. David Hawkins' "messing about," children's own searches for questions, and the conclusions, tentative as they may be, that children can draw from good work.

MATHEMATICIANS AND MATH EDUCATORS

Joan Easterday

Project Manager, Mathematics Renaissance, Santa Rosa City School, Santa Rosa, CA

In my work in math and science with students and adults, inquiry creates an image of the open frame of a structure with deep roots spreading into the ground. The tap roots represent the ways in which people learn—many "hands-on" experiences with concrete materials and having a variety of experiences from many perspectives with a concept. Then there are the roots representing mathematical, linguistic, artistic, musical, kinesthetic, inter- and intrapersonal strengths in learning. The ground itself is the support for the learning process—respect for people, a belief that everyone can learn, the expectations that everyone will think and share their thinking, the questioning by all the learners in the group, the comfort level created so people can take risks. The beams of the open frame are the common learning experiences bound together by connections between experiences and the awareness of the bigger ideas of the concept. The open spaces between the beams represent all the potential curiosities of the learner; curiosities and questions that need further explorations and investigations. The frame of previous experiences and understandings offers the support for new connections and new ideas. The open spaces are unknowns, conjectures, hypotheses, adventures awaiting. In my own learning I know that sometimes there are often large parts of the structure that I have built, but will be so unstable that they will disappear for a while until more experiences reaffirm those conceptual understandings.

My work is to provide the learning environment, the experiences, the connections to prior experiences, so that people can build their own structures and have the freedom to seek out their own inquiries. The struggle and art of teaching are the balance, flexibility and timing to create this.

Sha Xin-Wei

Mathematician, Stanford University, Stanford, CA

First, a disclaimer. My discipline is different from my work. I was trained in differential geometry, which is the study of what changes and what remains invariant as we make smooth deformations and transformations of shapes—shapes that may be many-dimensional, or even not drawable in any ordinary computer screen. My current work ranges from the architecture of human-computer systems to philosophy. Here I'll restrict my comments to mathematics.

In mathematics, the aim is to understand what is true and beautiful in structures. One common mathematical approach is to clear away extraneous understandings until one can see why something is true. Another way is to try to recast a situation in terms of a different formal apparatus, a different mathematical language, to see if one can understand it better in the new light (or even more conveniently, apply theorems that are already known in the new domain). But it's crucial to understand that mathematics is not computation. In fact, you might say that mathematicians are the laziest thinkers in the world, because they would work themselves to death to find an elegant way to avoid computation. This may seem to slight the deep contributions that mathematicians have made in the fields of logic, combinatorics and complexity theory inspired by problems from computer science, but I'd like to try to convey the spirit of how mathematicians work, rather than describe the math itself.

There are as many types of mathematical inquiry as there are schools of painting. Let me try to give a flavor of some of these different kinds of thinking. First of all there are problem solvers and there are theory builders. Problem solvers are those who like to carry around as little theoretical baggage as possible—they're like hikers who skip up the mountain with sneakers and a water bottle. Theory builders are more interested in constructing large conceptual apparati from which solutions to specific problems can be read off en masse. Despite master mavericks like the late Paul Erdos, who is one of the patron saints of the problem solvers, the limelight in world class mathematics shines on those who construct wonderful theories. (Recent example: Seiberg-Witten invariants.) Nonetheless, some of the deepest mathematical theories rise out of very concrete, specific problems. In the case of Fermat's Last Theorem, vast theories ranging from hard analysis to algebraic geometry were recently re-focused to show the unsolvability of a very specific equation over the integers.

A second way to distinguish modes of mathematical inquiry is by the kind of mathematics that a person does. Formally different fields of mathematics also engage very different intuitions and modes of thought. These modes are as different from one another as the difference between, say, how a computational linguist and a poet might approach the problem of translating a poem. What are these different modes of thought? They include: algebraic, formulaic-computational, intuitive, geometric, measure-theoretic, probabilistic and discursive-logical. I'll discuss a few of these approaches, but it will necessarily be skewed by the limits of my own experience. As we proceed, I hope you'll get not only a sense of how different mathematicians can be from one another, but also some insight into how anyone can think mathematically.

TEACHERS

Marilyn Austin

Teacher-in-Residence, Exploratorium, San Francisco, CA

As a teacher interested in science, I have researched the delivery of science lessons to young students. My formal training in using an inquiry approach, however, began with the Exploratorium Introductory Summer Institute around light and color in 1987. My perspectives changed radically that summer and I began to experiment with an inquiry approach in my own classroom.

Inquiry, as I understand it, is a process of exploration which is guided by a personal interest or question. It involves risk-taking and experimenting which can lead to pathways where the learner may discover meaningful concepts and understandings.

As I reflect on my continuing growth in this inquiry venture, I realize that I have gone through increments of change. First I discovered that providing a variety of materials would increase hands-on opportunities for learner investigations. Then I discovered that I could guide and promote many of the student discoveries by asking open-ended questions at the right moments.

The step on which I am most focused currently is considering how valuable students' questions are to their own inquiry. Students have an increased ownership of the process of inquiry if they are motivated by their own questions.

Mary Di Schino

Teacher, Graham & Parks Alternative School, Cambridge, MA

Inquiry, to me, means pursuing a question and figuring out the solutions to problems through a process of observation, development of explanations (theories), testing these through experimentation, discussing the outcomes and adjusting theories based on the outcomes.

These various steps are developed with the participation of all members of the class and always shared and debated in group discussions. The discussions are carefully guided to elicit everyone's participation. Comments and situations are presented by the teacher to push the development of ideas and enrich the conversation. By listening to one another, and working to make sense of what others say, students are invited to broaden their notions of the topic and to consider new ideas. As explorations progress new questions constantly surface. These work to broaden and enrich the original question adding many facets to the "answer." It is my goal that students go beyond knowledge and to gain understanding. Materials and a "rich" environment sometimes means simply having the right photograph or illustration for the children to look at, while at other times a microscope might be needed through which to look at ear wax.

Embedded in all of this is the assumption that the classroom atmosphere is one in which children feel safe to articulate ideas without fear of ridicule or judgment. One in which they know their comments will be given serious consideration and respect. Also implied is the presence of a structure that permits exploration and experimentation within clearly stated boundaries that insure the children's well-being.

These are the tenets which form the basis of my work with children, particularly in the area of science.

Karen Gallas

Author/Teacher, West Roxbury, MA

Children bring to school many different ways of investigating and understanding their world. Those ways are multi-modal, multi-sensory, and interrelated, that is, they are not separated by artificial boundaries of time and space. As a teacher, I attempt to draw upon children's resources, while also introducing them to the modes of inquiry in discreet disciplines. As such, I build up and support their natural inclinations to learn in an interdisciplinary way and also explicitly teach specific ways of investigating a subject.

As a teacher researcher, my goal is to understand more clearly the different elements that influence children's success as learners in the classroom. Therefore, I investigate how issues such as creativity, imagination, home culture, class, gender, race and classroom culture impact on the learning of both individual children and groups. I also explore with children how different modes of exploration and expression, such as writing, drawing, movement, performance, song and talk further their processes as learners.

Cappy Greene

Science Educator, Exploratorium, San Francisco, CA

An inquiry approach to teaching stimulates curiosity by teaching children how to observe very closely, encourages children to take more than one quick look, provides adequate materials for exploration, and makes it safe for students to ask questions and to take risks. It helps them to make connections to events in their own lives, and gives them ownership of their own learning. I believe that using inquiry can be a means for significant change in teaching in the schools, from providing an education that relies on memorization of facts to one that teaches thinking and problem-solving, and enhances the ability of students to relate what they learn to new problems that come up later. Equally important, teachers need to inquire into their own teaching methods, by closely observing and recording what is happening in the classroom, questioning whether the goals desired are actually being achieved, and constantly reflecting on their own teaching.

We all start our lives as inquirers, learning about the world by exploring. If our methods of teaching in the schools can be turned towards inquiry, it could rekindle that early curiosity and instill a joy of learning that enriches a person's life in many areas, including the appreciation of the natural world as well as the world of art.

Rhoda Kanevsky

Teacher, Powel School, Philadelphia, PA

I'm interested in the relationship of observation, description and inquiry. To illustrate this, I'd like to give an example from my classroom.

In the spring, the children have their own silkworm caterpillars which they observe every day and even take home on weekends. They have many opportunities to describe the changes they see from eggs to caterpillars to cocoons to moths, by writing, drawing and through talk, informally and in more formal whole class discussions. Through these ways of describing they raise questions individually and collectively; this leads them back to closer observation and more detailed descriptions. They develop theories and make connections to other work we've done. They design ways of answering their questions. Their language becomes more concrete and more poetic, their drawings more detailed and expressive.

My own inquiry is largely about how these kinds of observations and descriptions give rise to understanding and how an inquiry community forms in the classroom around ideas and experiences. I'm interested in what comes from each child individually and what comes as a result of their being part of a lively, inclusive group: evidence of their learning and ideas that emerge from collaborative talk. Using collaborative processes grounded in observation and description, my colleagues help me to examine the drawing, writing and class discussions that document children's work with others, the more I see their work. Questions and issues continue to arise for me from this reflective process.

Carol Walker

Teacher, Horace Mann School, Newton, MA

I have never thought about the word inquiry as a particular way to think about my teaching/learning. That is until this opportunity to participate in Exploratorium's Institute for Inquiry Forum! I realized with delight how perfectly this word encompasses so much of what I hold most valuable in my work, how many entry points there are in considering it and how thrilling it is to come together with others to explore its significance. When I think about teaching I immediately think about questioning. I work very consciously to make my questioning of students, of myself, of curriculum decisions, of work with parents and most recently my work with colleagues sincere and honest. To do this I seek questions that I truly want answers to. I look for confusing moments (or hours!) in all of my work to better understand as many facets of the confusion as possible. I try to let my curiosity lead me in my questioning and I work to be as open as possible to what answers I might find.

RESEARCHERS

Mike Atkin

Professor of Education, Stanford University, Stanford, CA

My interests focus on practical inquiry—that is, thought directed toward action.

Scientific inquiry usually aims primarily at the understanding of general principles that are assumed to have broad explanatory power; at any one time, furthermore, there usually is general agreement within the scientific community about what those principles are (the laws of motion, for example).

Practical thought, on the other hand, is not usually directed toward arriving at some generally accepted understanding, but rather toward consideration of several different possible lines of action in a certain set of circumstances; each of them may be "correct." Practical reasoning is highly contextualized, and the choices that are made depend on local knowledge and constraints—and on such considerations as what is prudent, what is traditional, what is obligatory and what is moral. Thus, practical inquiry tends to be concrete rather than abstract, timely rather than timeless, proximate rather than remote, local rather than general. It strives as much for wisdom as for knowledge.

Schools tend to stress thinking directed toward scientific understanding, rather than toward justifiable action. So some of my work centers on introducing the practical into the curriculum: What might be done in this community to mitigate the effects of water pollution? What might constitute a nutritious and economical diet for a Cambodian family living in Oakland? What kind of AIDS-prevention program makes sense among a group of mostly undocumented farm workers? Scientific knowledge is necessary in addressing all these issues; it is never sufficient.

Two broad areas of science-related practical reasoning are emerging in the schools. One is environmental education (at least some approaches to environmental education). Another is the move toward establishing programs of technology education—that is, education about technology, including, quintessentially for my interests, design. (We are not here talking necessarily about "high" technology.) Technology, unlike science, is an enterprise directed almost exclusively toward altering the human condition, and it necessarily involves considerations of worth as well as the utilization of knowledge. My hope is that such thought will be more highly valued in schools of the future.

For teachers, my interest in practical reasoning leads me to facilitate and study collaborative teacher-devised research, inquiry in which teachers themselves work together, using their own classrooms as "laboratories," to change their practices based on matters they decide are important. In such groups, teachers with similar goals share the results of their inquiry. They usually embark on a cycle in which they try things, discuss what happened, and try something new as a result of the deliberations. (An action-research focus for a group of teachers might be, for example, how better to get students involved in practical inquiry. They first must value the common goal, and then begin to devise new ways of getting closer to their evolving views of what constitutes a desirable curriculum.)

Ted Chittenden

Research Psychologist, Educational Testing Service, Princeton, NJ

Much of our current work with schools and districts is guided by the idea that the first purpose of assessment —for primary science—is to help teachers document and understand children's learning. The assessment stance is one of inquiry, of "finding out." When a teacher asks: What have you noticed lately about our mealworms? or What are some things you know about shadows?—the questions are not tests in disguise, but rather reflect the teacher's attempt to support children's observations and to gain some sense of the direction of children's interests and thinking.

Assessment as inquiry is intended to guide instructional decisions, not grade pupils. It represents an attitude as much as a method, and may be contrasted to the more common stance of educational assessment—testing of "checking up"—to determine whether children know the expected or desired answer. In primary science, there generally are no single right answers to children's investigations; correspondingly, assessment strategies need to be responsive to multiple, and sometimes unexpected, outcomes.

Brenda S. Engel

Senior Research Associate, Lesley College, Cambridge, MA

What is inquiry? The response to this question has to be influenced by beliefs about knowledge: how we think we know what we think we know. Those who are keen about inquiry as a basic pedagogy usually view knowledge as culturally embedded and formative, open to discussion, discovery and revision. (Inquiry plays a lesser role in traditional transmission models of education where knowledge is considered stable and teachers are meant to teach, students to learn.) Inquiry implies active seeking for explanations—experimenting, observing thinking, researching (in books) and communicating—using, in short, all available resources.

John Dewey, a strong advocate of inquiry in education, made a case against absolute answers[1]; he saw knowledge as always unfinished, deriving from judgment and belief and revealed though action—through doing and making. His educational views were supplemented and supported by the findings of Piaget: that learning occurs developmentally through interactions between the individual and the environment. In terms of practice, the Piagetians ("constructivists") and Deweyans ("progressive educators") advocate inquiry as central to the teaching/learning process.

More recently, Neil Postman suggests a "narrative" as a basis for educational practice: "Knowing that we do not know and cannot know the whole truth, we may move toward it inch by inch by discarding what we know to be false. And then watch the truth move further and further away."[2] Postman suggests an educational program that can be seen as inquiry-based—that students, rather than being instructed in the "truth," study the history of errors in every field of learning. Thus students would learn to question, explore and analyze, their findings remaining tentative.

The theorists cited above are mainly (although not exclusively) concerned with knowledge in the areas of math, science, and history of ideas. Michael Craig Martin, an art historian, makes an air-tight, elegant rationale for understanding art through observation (a form of inquiry): "Every work of art needs to carry within it the terms by which it may be understood."[3] This deceptively simple statement might be broadened to include all areas of knowledge even though, in some cases, "the terms" may be hard to perceive, take time, consultation or even advanced technologies to dig out.

[1]Dewey, John (1929) *The Quest for Certainty*. New York: Minton, Balch & Co.

[2]Postman, Neil (1965) *The End of Education: Defining the value of school*. New York: Alfred A. Knopf, page 67.

[3]Martin, Michael Craig (1995) *Drawing the Line*. London: Arts Council exhibit catalogue. Introduction, page 7.

Wynne Harlen

Director, Scottish Council for Research in Education, Edinburgh, Scotland

In the context of science education, inquiry is a major means for learners to extend their understanding of the natural and made environment. It is essentially active learning, inseparably combining both mental and physical activity. The motivation for inquiry is within the learner and the learner's relation to the things around him or her. Inquiry starts with something that intrigues, that raises a question in the mind of the learner—although it is not necessarily expressed as a question—something that is not presently understood, that does not fit with expectations, or just something that the learner wants to know about, defining the cutting edge of learning in a particular area.

The process of inquiry involves linking previous experience to the new experience in an attempt to make sense of the new. Thus it starts from what is already known or believed about how the world works. There may be several possible explanations, or hypotheses, drawing on different previous experience. In science this first step will be followed by some exploration or investigation to see whether what happens in a practical situation fits with what the hypotheses predict. There may be different possible interpretations and other evidence may need to be sought to decide what makes most sense. The fit between the evidence and the interpretation in terms of the ideas underlying the hypotheses should be the essential test of its applicability. But even though the evidence may fit, its limitation has to be realized and the idea accepted only tentatively, to be challenged by possible further evidence.

Learning through inquiry is consolidated by reflection on how ideas or understanding have changed and by reviewing and improving the process of working towards answering the initial questions. The latter is essential, since the learning by inquiry depends on how the testing (processing) of ideas and evidence proceeds. If it lacks the rigor of the scientific approach (controlling variables as necessary, for example) then ideas which should be rejected or changed may be retained and vice versa. The value for learning depends on the processes of the inquiry—the linking, the hypothesizing, the gathering of evidence, the interpretation, the communication, the reflection. Thus the development of inquiry skills is essential to the development of understanding through inquiry.

George E. Hein

Director, Program Evaluation & Research Group, Lesley College, Cambridge, MA

How inquiry is defined depends on one's definition of education. I have described a model for classifying educational theories in the two papers on Constructivism contained in the TEN web pages.

Inquiry as a pedagogic method is a process that occurs within the bounds of theories. For Discovery Education, inquiry is the process that leads learners to "discover" the concepts. For Constructivism, inquiry must include the second component mentioned below.

My chief concern, from my perspective, is that scientific inquiry be recognized as including two main characteristics. For me, these are necessary components of inquiry.

a) Science inquiry involves the natural world, that those who inquire subject themselves to the possibility that nature will get in their way. Inquiry in science must involve doing, it cannot be limited to theory.

b) Science inquiry consists of actions in the world that allow for multiple results. Any activity that is intended to lead to one result only (or in which the manipulation of the world is such that possible alternative lines of experimentation are prohibited) should not be labeled as inquiry. The definition excludes almost all school laboratory work, since that usually is intended to demonstrate a concept, not generate novel or diverse activity.

Barbara Scott Nelson

Director, Center for the Development of Teaching, Education Development Center, Newton, MA

My current work is not discipline-based, but consists of working with school and district administrators on the ways in which their own administrative practice might be affected by the mathematics education reform movement.

If the norms and values embedded in the current mathematics education reform movement are to become a permanent part of school life, there will need to be not only large-scale change in the nature of mathematics instruction but also a virtual "reculturing" of school. The implications of the vision of the NCTM Standards go far beyond what would result if many individual classrooms changed, one by one. What is at issue is a new intellectual culture for schools—a culture that legitimates and supports curiosity and challenges as the engines of learning,

continuous exploration of mathematics and mathematical thinking on the part of both students and teachers, an orientation of reflection toward one's teaching and children's learning, and intellectual colleagueship among teachers and between teachers and administrators. That is, not only will it be necessary for teachers to reinvent mathematics instruction from within a new conceptual frame, it also will be necessary for teachers and administrators together to reinvent school culture from within a new conceptual frame.

There is currently a paradox in the education reform movement. While many discipline-based reform efforts give only slight attention to administrators, systemic reform efforts, aimed largely at administrative structures and practices, tend to be derived from principles of collaborative governance rather than from specific knowledge about how to support inquiry-based teaching and learning. And so there may be a disconnect between reform efforts aimed at classrooms and reform efforts aimed at school and district structures and practices.

In the Mathematics For Tomorrow project we are in the process of developing a discipline-based intervention program for administrators and are doing research on the process of conceptual change and change in practice for administration. One element of this work is to explore administrators' understanding of the nature of inquiry-based learning and teaching and to explore with them the nature of a school culture that supports inquiry-based learning and teaching. This work is just beginning. But the administrators with whom we have worked have been clear that in order for their own work together to be inquiry-based, the questions being discussed need to matter to them. That is, the questions must be very real ones. They told us that in order to examine real and difficult questions in an open-minded way, asking each other honest and tough questions, it helps to be part of an ongoing group of people who have made a clear commitment to thinking hard together. In such a context, trust and honesty develop. It was clear that these administrators saw that what obtained for them would obtain for teachers and children as well.

See: Nelson, B. S. (in press). "Lenses on Learning: How administrators' ideas about mathematics, learning and teaching influence their approaches to action in an era of reform."

Barbara Rogoff

Professor of Education, UC Santa Cruz, Santa Cruz, CA

Inquiry? What is it? There you go.

Within my area of work—cognitive development and learning—I'd emphasize that inquiry learning involves the active effort to understand a phenomenon, event, or idea.

The purpose of inquiry learning could be pure curiosity and fooling around, though it can also focus on seeking understanding for solving a problem or reaching a desired goal. In either case, I assume that the inquirer is INTERESTED in finding out.

This contrasts with many other learning situations, where the information is not necessarily of interest to the learner; if there is a purpose it may not be clear to the learner, and the goal of understanding may be less emphasized than the goal of memorizing.

Although inquiry learning thus involves an active learner, this does not mean that the learner is solitary or cannot be involved with others who may provide leadership in the inquiry. I have the impression that many who value inquiry learning shy away from providing leadership in learning situations, perhaps because most of our experience has been with teaching that is more didactic rather than providing support and guidance in inquiry. I think that this is one of the main issues for both schools (at all levels) and museums—how to foster inquiry with intellectual leadership.

Ann Rosebery

Project Co-Director, Chéche Konen Center, TERC, Cambridge, MA

For me, inquiry is a way of being in the world. It is a stance about one's relationship to the world, to people, to one's work, to knowledge. When I am able to take it on, inquiry enables me to ask "What do I think this means?" before making assumptions about meaning. It helps me listen to the perspectives of others, before assuming I know what they are going to say.

Having said this, it is important for me to note that most of the time I find myself not adopting an inquiring perspective toward the world. I find, for example, that I charge headlong into a situation—a discussion among elementary teachers about why boats float, a discussion among students about where earwax comes from, or a discussion among colleagues about what a student was meaning in a particular transcript—thinking that I know the why or the where or the what.

This sense of certainty can lead me to trouble—not understanding someone's meaning or missing the complexity of the problem at hand. On good days, someone or something in the situation will reach out,

upend my sense of certainty, and force me to slow down, to retrace the tracks of my own assumptions, and listen again to what is being said. For me, inquiry represents the unending struggle to recognize what I don't know.

Laura Stokes

Research Associate, Inverness Research Associates, Inverness, CA

People in education usually use this definition of action research: a form of collective self-reflective inquiry undertaken by participants in social situations in order to improve the rationality and justice of their own social or educational practices, as well as their understanding of these practices and the situations in which these practices are carried out.

People who focus on teacher research usually use something like this: systematic and intentional inquiry carried out by teachers.

"Practitioner inquiry" is used as a synonym for action research or teacher research.

What distinguishes practitioner inquiry as a form of learning is that it engages teachers in direct investigation of the phenomena of their own practices, change processes and circumstances. Typically, teacher learning is viewed as teachers' responses (translations, adaptations, implementations) to general knowledge other people construct about teaching practice or other problems of schooling. Also, teachers usually find themselves in learning environments structured as in-service workshops or courses. Practitioner inquiry, on the other hand, connects theorizing and practicing in the person of the practitioner/researcher, aims to create context-specific and relevant knowledge (rather than general) and takes place within the teachers' own workplace context.

Beth Warren

Project Co-Director, Chéche Konen Center, TERC, Cambridge, MA

I don't know quite how to approach this question. Over the course of my life I have experienced inquiry in a variety of disciplines: literature, literacy, cognitive science, biology, classroom discourse, teacher research. This list is itself a little odd: Is teacher research a discipline in the way, say, that biology is? Embodied as a certain stance toward classroom teaching and learning, teacher research assumes, in my view of it, a strongly integrated set of analytic perspectives, tools and concerns—chiefly, ethnographic, sociolinguistic, cognitive—that can help shed light on questions about learning in a discipline, e.g., how do my students make sense of adaptation or buoyancy? What can I learn about my students' discourse and activity?

As I've briefly described it here, then teacher research is a heterogeneous practice of inquiry, one that derives its power from bringing into a single focus perspectives and tools from various fields and grounded, engaged, concerned questions about students' learning. But I think I would argue that the other, more tradition bound disciplines I mentioned above are also heterogeneous, and grounded in particular content and concerns. From my own perspective as a learner or practitioner who has experienced inquiry in various degrees in each, I think I engage in a lot of border crossing while in any one domain. For example, the particular sensibilities I bring from having learned to look carefully at texts are useful to me as I work with both historical and empirical evidence on adaptation. And so on. Whether this is a matter of pragmatic end or idiosyncratic practice or truth, I cannot say. I seem to use my wits each case, balancing strengths in one area against weaknesses in another.

Not knowing how I would approach this as I began, I am quite a bit surprised by where I ended up. This captures for me an important quality of inquiry that I think is often overlooked, sometimes even derided: the meaning potential of ambiguity, of not knowing exactly where one is, of not being sure exactly what one means, of not knowing where one is going, of being confused, of shifts in significance, of incompleteness. In learning theory we tend to privilege clarity and explicitness, and while these certainly play their part, our emphasis on them may blind us to this other, deeply situated quality of human experience.