GUIDELINES FOR INQUIRY

The following *Guidelines for Inquiry* were written to set the tone and educational approach for the development of a children's television program called *SciSquad*. The premise of the program was that three teenagers formed a group called SciSquad, and they went about solving problems or finding the answers to questions that other children sent to them. Topics related to sound, flight, rockets, weather, amusement park rides, sports, etc.

Thirteen episodes were produced which were broadcast by the Discovery Channel in the 1999-2000 season. Although well received, the show unfortunately did not get funded for additional episodes.

SciSquad
Guidelines for Inquiry

1. Inquiry: What It Means

A. The primary goal is **understanding** our **experiences**

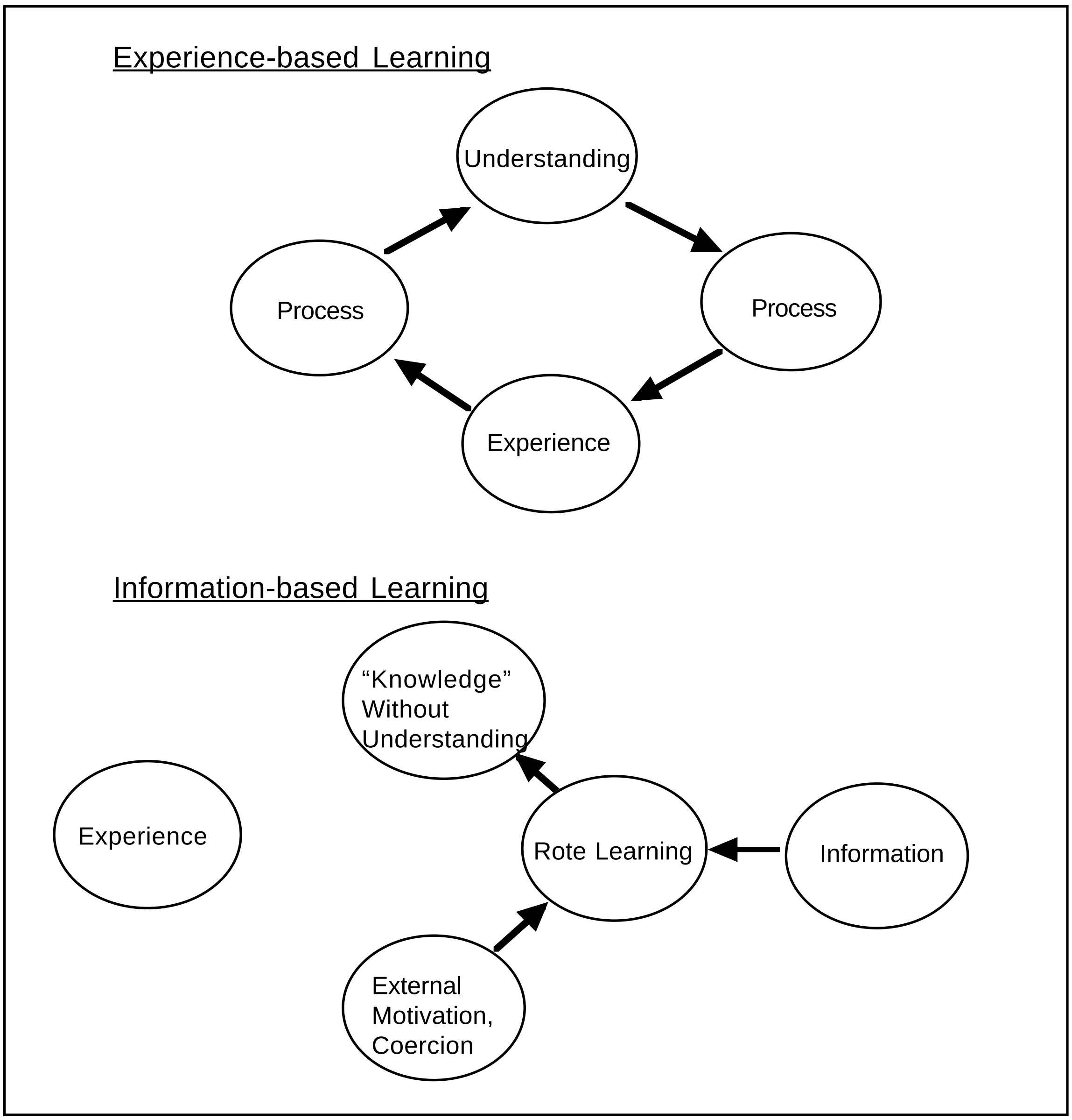
1. Understanding means finding regularities and relationships (cause and effect), and general ideas that bring together individual bits of experience under a larger umbrella.
2. Experience refers to our encounters with the physical world—all of our sensory input.
3. This contrasts with the goal more commonly found in the schools of having students learn what other people have already found out—the facts, laws, principles, etc. This amounts to getting the answers to questions they never asked, which becomes an uninteresting and ineffective activity. The result is often memorized words, names, and formulas, which may pass for knowledge, with little understanding of what they mean.

B. The primary mode to achieve understanding may be called *inquiry* or *experience-based learning*—seeking the answers to genuine questions, or the solutions to genuine problems, and checking the answers and solutions against the real world.

1. A *genuine question* is one that is asked out of a desire to know, and is phrased in a way that can lead to inquiry. A *genuine problem* is a puzzling situation to which *you*, as compared to your teacher or textbook, want to find a solution. The questions and problems arise from experiences.
2. For SciSquad, this means that the shows are problem or question driven, and that these problems are *real* problems for the kids. As part of the inquiry process, the initial question or problem often gets reworked to be more specific or to suggest other paths of investigation.
3. Seeking out what others already know and benefiting from other people's experience is a valid part of inquiry, but that in itself is not the end, is a *means* to an end—the end of understanding, of solving the problem.
4. Inquiry is the natural mode by which young children learn; it is also the method of science, where it is applied consciously and rigorously. A major goal for SciSquad is to help viewers apply inquiry more consciously and effectively in their own lives.
5. An integral part of inquiry is being *skeptical*, in the sense of not taking things on their face value, probing for the meaning behind the words and pat answers often give out as "knowledge," and asking for the evidence to back up claims.
6. The immense satisfaction of figuring out and understanding something on one's own—sometimes called the "Ah Hah!" experience—is its own reward, and it is a powerful motivator to further inquiry.

C. The names, such as "inquiry," "discovery," "hands-on," and "experience-based" learning do not have specific or even generally-agreed-upon definitions.

1. The common denominator is the belief that learning is a result of activity of the learner, processes both mental and physical, and is based on his/her own *experience* and serves to increase understanding of that experience. This contrasts with the idea that learning is the transferring of knowledge from the teacher or text to the student and is based on *information.* The result of this is often memorized terms with little understanding and no relation to the learner's own experience.
2. These two approaches are shown as diagrams below.



Diagrams for two models of learning

3. Much discussion about the various approaches to science education is like the "blind men and the elephant." Science and science education have many aspects; no single approach covers all the bases. It is not an "either-or" situation, however, and different modes can complement each other. It is also possible for different modes to negate each other. For example, if after doing a "hands-on" activity children are told what they should have seen or what principles they were supposed to "discover," their own experience and inquiry will be effectively wiped out.

D. The major benefits to viewers watching SciSquad will be
   1. An increased range of experience with the physical world. Granted this will be experience via television rather than *direct* experience, but if done well this can be assimilated by the viewer and become part of the basis for learning.
   2. An increased understanding of the specific areas of experience dealt with in each program.
   3. Heightened awareness and interest, and active curiosity in their own experiences with the world around them. A sense that they *can* ask questions and pursue solutions and derive deep satisfaction from the results.
   4. Confidence in and a critical attitude towards their own understanding, and a willingness to question information and explanations that are given to them by "authorities."
   5. Increased skill in framing questions, in observation and measurement, in finding the regularities and relationships among those observations, and in testing their ideas in the real world. They will see these skills modeled by their peers on the show and, it is hoped, be encouraged to adapt them to their own lives.
   6. This can be nicely summed by saying that SciSquad will "show the range of questions that come up, the variety of things there are to do in searching for answers, how hard people work at trying to understand each other, how complicated seemingly simple ideas really are, and now engrossing ordinary phenomena can be."[1]

2. Inquiry: How To Do It

A. Like doing detective work, inquiry is not a straightforward, follow-the-recipe kind of thing. If you could get right to the answer, then you wouldn't really have a problem. But there are some general strategies and skills that are used, which are described below (with examples taken from the Flight episode). Almost all of these will be used in solving any

[1] Paraphrased from Eleanor Duckworth, "Opening the World," in E. Duckworth et al., *Science Education: A Minds-On Approach for the Elementary Years* (Erlbaum, Hillsdale, NJ, 1990). This gives an excellent written account of inquiry learning in action, and is highly recommended reading.

given problem, but they do not necessarily follow this specific order. In the end it all has to come together and fit a pattern with the answers confirmed or ruled out by experience in the real world. Of course, also like detective work, there are sometimes unsolved mysteries.

B. Start with experience. Since the question or problem arises from some experience with the physical world, the place to start is to go back and reexamine that experience. What was it that prompted the question? Does more careful observation (seeing, touching, hearing, smelling, tasting), which can include measurement and observations using instruments, yield anything additional. Example— Well, in Flight the problem doesn't really arise from the physical world, but still one might start where it did originate, with comic book superheros and do some more searching into their "flying." (And it is a fact, the original Superman could not fly, only jump very high.)

C. Clarify the question. What is really being asked? What kind of answer/solution are you looking for? Can the question be made more specific? Can the question be asked in a different way? Example— Fly? How far, how high, how fast. Or will she be content with a video that makes her look like she is flying?

D. Look for similar experiences; organize them and make comparisons. What is alike; what is different? If some of the experiences are better understood, can that understanding also apply to the problem at hand? Can you find some organization or patterns that connect the experiences? Does this lead to any changes of the initial question or breaking down into sub-questions? Example— Here is where the Flight inquiry really gets going. There are lots of things to look at that seem to stay up in the air: birds, planes, helicopters, blimps, balloons, kites, thrown balls, frisbees, etc. SciSquad can begin to sort them out: some stay up and keep going; some stay up, but just coast along; some don't really stay up at all. Do the ones that stay up have anything in common?

E. Come up with ideas that are possible answers/solutions. There is no recipe for doing this except to think, guess, or follow your intuition. Why do you think those are possible answers? Discuss your ideas with people who have different ideas. Example— Ideas about why things stay up: they are light; are turning/spinning; have wings. Ideas and discussion about how wings work: moving air (wind) pushes on things vs. moving air "sucks" on things.

F. Test the ideas by checking with the real world. This follows the form of "*If* my idea is correct, *and* we look at this particular situation in the real world, *then* the following should happen." The more specific you can be about the expected outcome— what you will get if you do measurements—the better the test will be. You then actually do the thing, and if the expected result does *not* happen, that means either a) that your idea was not correct to begin with, b) that something was faulty in your if-then reasoning, or c) that you made some actual errors in carrying the whole thing out. If the expected result *does* happen, that means either a) that your idea was correct, at least in this instance, b) same as above, or c) same as above. The desired option is choice (a) in either case, and if you can confidently make that choice, your experiment has been a success and you can proceed to the next round of inquiry—more observations, questions, ideas, and testing. If your choices are (b) or (c) in either case, then your experiment has not been a success and you have to go about fixing it or trying something different. Example— Some of the ideas can be tested just by thinking about them. *If* heavy things can't fly, *and* an airplane is heavy, *then* an airplane won't be able to fly. Try it (look at an airplane); it does fly; so the original idea is not correct, some heavy things *do* fly. On the other hand, the role of moving air, pushing or "sucking," is not a simple one to sort out. This will take more careful observations of demonstrations, framing of ideas, and "wind tunnel" or other experiments to test them.

G. Inquiry is not just one cycle of observation-idea-test, but more of a spiral, continually going around and growing and branching.

H. Putting these steps into everyday language is not to imply that they are either easy or obvious. There are both intellectual and physical skills involved in carrying them out which need to be developed and improved through practice. My vision for the SciSquad is that they are "science street-smart," that is, they are clever and resourceful in their inquiry activities, but not full of textbook science and big words, or tied to rigid "scientific method." A model for learning a skill is the coaching or apprentice model—you watch a thing being done well and then try to do it yourself with a coach or mentor who guides you. Children almost *never* see inquiry learning in action, yet somehow they are supposed to learn the skills involved. SciSquad can make a real contribution here by modeling good inquiry.

3. Some General Guidelines

A. Idea first, name afterwards. It is understanding—concepts and ideas—that we are after, and a name is only a *label* for the idea. We should avoid the common error of using the name as if the knowledge were actually contained in it. Example— Poor: "In order to fly you need lift. And I don't know how to get lift." Better: "I keep hearing this word *lift* and I don't know what it means or how you get it." Once an idea is developed, it is fine to give it a name, but we still need to be careful about how we use it. Remember, "inquiry learning" itself is just a name.

B. Don't answer "Why . . .?" questions with "Because. . . ." answers. This implies a pat answer that is already known by the "authority" and tends to shut off rather than encourage further inquiry. Example— "Why do airplanes stay up?" Poor: "Because the wings give them lift." Better: "Well, I don't understand it very well yet, but it must have something to do with the wings and how they move through the air."

C. SciSquad kids should be willing to call people on their B.S. explanations of things; going along with their street-smart (but not smart aleck) image. There are an unbelievable number of unintelligible, incorrect, or just plain nonsense explanations given in children's science books and even textbooks. An actual example— A book for children describes an interesting-enough activity: stand with your heels against a wall; lean over and place your hands on the seat of a chair that is facing you; you will not be able to stand back up. The "explanation" that is given: The earth is a giant magnet. Its magnetic force is called *gravity*. Gravity pulls things down. It is pulling you down because you are off balance. Without a center of balance, you cannot fight the pull of gravity." SciSquad members confronted with something like this should have enough confidence in their own understanding to say (politely) something like "What are you talking about. Don't give me that crap."

4. How This Relates to Science

A. But is this "inquiry stuff" really Science? Yes it is, or at least it is one very important part of it. By one definition, science is a method for describing and understanding our experience with the world. So it is both a human activity, the method, and the accumulated understanding that has been built up by the combined work of many people over thousands of years.

B. The inquiry approach emphasizes the activity, the method of science.

1. This is important because it is directly useful in most everyday dealings with the physical world and its technologies, and because you need to know the method of science in order to appreciate its outcomes. It is the methods behind them that distinguish, for example, astronomy from astrology and evolution from creation theories. Of the two parts of science, the method and the product, the former is the more important but also the one more neglected by schools.
2. The method of inquiry is essentially the same for everyday problems, as described here for Sci Squad, or for cutting-edge science research. In the formal language of science, we first have *observation* and *measurement*; and then organize those *data* by *classification* and finding patterns and regularities which are called *concepts, principles, laws, and theories*. Coming up with these ideas is called making *hypotheses;* the if-then reasoning is called making a *prediction*; and the testing is called doing an *experiment*. The difference between SciSquad and the research scientist is in the level of skill with which these processes are carried out, but they are nevertheless the same processes.

C. The accumulated understanding of science, its laws and theories, are the result of a great many inquiry cycles. Reaching them is generally beyond the scope of SciSquad, but it is the inquiry approach that makes it possible not only to learn this content of science, but also to *understand* it. So a program like SciSquad does not cover all of science, but complements in an important way other approaches to science.

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