Biology Education in the Elementary School: The First Task and Central Purpose

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Assistant Editor Alexenberg tells here of his belief that elementary science must permit and encourage "the joy and excitement" of science.

"There is a joy in the search for knowledge; there is excitement in learning about the workings of the physical universe and the biological world; there is intellectual power in the scientist's ways of asking questions and seeking answers to them. The first task and central purpose of science education in the elementary school is to awaken in the child a sense of this joy and excitement in the intellectual power of science." (American Association for the Advancement of Science, 1963)

Current textbooks on the methods of teaching science in the elementary school, teacher's manuals for elementary school science textbook series, and state and local curriculum guides invariably state the primary objectives of elementary school science in terms of the child's understanding the process and product of science. The objectives of biology education are generally stated in terms of (1) the development of knowledge of scientific concepts and facts about living things and (2) the development of understanding of the scientific method employed in discovering these concepts and facts.

Statements of the first task and central purpose of biology education (as of all science education) stress the cognitive aspects of learning—knowledge and understanding. Statements that stress the affective aspects of learning, which include "joy and excitement," are conspicuously absent from the literature of elementary school science.

I shall attempt to validate the idea that the first task and central purpose of biology education in the elementary school is the awakening in the child a sense of joy and excitement. Validating evidence will be drawn from (1) comments of professional scientists on the nature of their motivation and work, and from (2) comments of educators on the psychology of the child as a learner. I shall attempt to demonstrate that the affective objectives of biology education necessarily precede the cognitive objectives.

In order to place the comments of scientists from whom I shall quote in proper perspective, I shall differentiate between two aspects of biology—public biology and private biology. Public biology is the biology that is communicated through the public vehicles of scientific journals and scientific meetings. This public biology is formal, organized, logical, concise, and impersonal. Unfortunately, educators generally consider that the form of this communicated, public biology indicates the methods and activities of the scientist whose work is being reported. These educators then believe that they can teach children the methods and activities of the scientist through programs, textbooks,

and lessons based upon the public biology.

Private biology is the activity of the biologist as he goes about his work in the laboratory or in the field. This private biology is seldom formal, organized, logical, concise, and impersonal. The distinction between the private research activity and the public research report is simply stated by the nuclear physicist, H. D. Smyth; "We have a paradox in the method of science. The research man may often think and work like an artist, but he has to talk like a bookkeeper, in terms of facts, figures, and logical sequence of thought" (Holton, 1958).

A particularly clear expression of the nature of private science is made by Warren Weaver in his essay, "A Great Age for Science:" "Science is an adventure of the human spirit; it is an essentially artistic enterprise, stimulated largely by curiosity, served largely by disciplined imagination, and based largely on faith in the reasonableness, order, and beauty of the universe of which man is a part" (Weaver, 1961).

In order for the child to gain a personal understanding and feeling for the methods of the biological sciences, the major part of the child's activities should be drawn from the domain of private biology (the scientist's activities) rather than from the domain of public biology (the scientist's report). David Hawkins (former Director of ESI's Elementary School Science Study and presently Professor of Philosophy at the University of Colorado) draws from the domain of private science in his wonderful article, "Messing About in Science." He pleads for more of the private, child-centered, "Messing About" phase and less of the public, teacher-directed, "Multiply Programmed" phase. We are all familiar with the "Multiply Programmed" phase; it is the prevailing style of biology teaching in the elementary school. The "Messing About" phase is described by the Water Rat in Kenneth Grahame's classic childrens' book, *The Wind in the Willows.* " 'Nice? It's the only thing,' said the Water Rat solemnly, as he leaned forward for his stroke. 'Believe me, my young friend, there is nothing—absolutely nothing—half so much worth doing as simply messing about in boats. Simply messing,' he went on dreamily, 'messing — about — in — boats — messing —about in boats—or with boats. . . . In or out of 'em it doesn't matter. Nothing seems really to matter, that's the charm of it. Whether you get away, or whether you don't; whether you arrive at your destination or whether you reach somewhere else, or whether you never get anywhere at all, you're always busy and never do anything in particular; and when you've done it there's always something else to do' " (Hawkins, 1965).

Albert Szent-Gorgyi, who was awarded the Nobel Prize for his isolation of vitamin C, discussed these same ideas in a recent interview: "Like all other scientists, when I publish or speak about my work, I like to make it appear as though it has been one straight line, one preconceived logical unit. But while I work I usually do not know where I am going. I just follow hunches. I dream up all sorts of theories at night and then disprove them in the laboratory the next day. Checking a hunch, sometimes I see some discrepancy, something unexpected—then I follow it up. I just wander about, without especially clear ideas or preconceived notions so far as I know, and now and then something pops up—boom!—something that is entirely new, that leads to new lines of research" (Szent-Gorgyi, 1966).

How many classroom biology activities permit a child to "just wander about?" It is through this wandering about that children (as well as professional scientists) maintain wonder in the mysteries and the beauties of their world. It was Albert Einstein who said: "The fairest thing we can experience is the mysterious. It is the fundamental emotion which stands at the cradle of true art and true science. He who knows it not and can no longer wonder, no longer feel amazement, is as good as dead, a snuffed-out candle" (Einstein, 1949). Robert Oppenheimer considers the "whole function" of science as "the rendering of the physical world understandable and beautiful" (Morgan, 1966). Henri Poincaré persuasively supports the primacy of these aesthetic objectives of scientists in his statement: "The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is beautiful. If nature were not beautiful, it would not be worth knowing, and if nature were not worth knowing, life would not be worth living" (Poincaré, 1952). Unfortunately, I have rarely seen

children learning biology in an elementary school classroom by messing about, by wandering about, and by wondering about things mysterious and beautiful. Most teachers act as if the whole of learning biology was knowing facts, understanding concepts, and being able to follow a fixed sequence of steps in the scientific method.

The role of the teacher needs to change if children are to become involved in biology experiences that lead to what Louis Pasteur described as "one of the greatest joys that can be felt by the human soul," or to what Johannes Kepler felt as "sacred ecstasy" (Holton, 1958). No teacher can pre-plan one set of experiences for all his students that will lead to such joy and ecstasy. Three oversimplified stages in the history of American education, will help the reader view what I am proposing as the role of the teacher. The first stage is the "learn what I want you to learn—or else" stage; the "or else" ranges from the swat of a rod to bad grades; the second stage is the "learn what I want you to learn—and I'll love you" stage; this stage was promoted by the so-called Progressive Education movement in the first half of this century. It is time for teachers to begin the journey into the Twenty-First Century with the third stage, the "learn what *you* want—and I'll help you" stage.

We can see this third stage in action (as it is related to the biology education of children) in the following excerpt from a talk with the anthropologist, Loren C. Eiseley.

"Fenner (Editor of *NEA Journal*) Dr. Eiseley, I'm here to explore for teachers the kinds of thinking that lie behind what you have described in one of your books as 'maintaining a feeling of wonder.' Did you develop your enthusiasm on your own or did someone at school or at home arouse it?

Eiseley. Well, I was brought up in considerable isolation. Not only did we live at the edge of our Nebraska town, but my mother was almost stone-deaf, and my father worked long hours. Under such circumstances children frequently find inner resources, and I guess this is what I did. When still quite young, I'd go out by myself and collect various kinds of water animals and then go home and make aquaria. I went out in mid-winter with a homemade net, chopped a hole in the ice, and dredged up things that were sleeping in the mud at the bottom of the pond.

Fenner. So you developed your enthusiasm for nature on your own?

Eiseley. No, I wouldn't say that. My family never impeded my pursuits or interests, and my father, whom I admired very much and tried to model myself after, influenced me tremendously. A person can be a great teacher even if he teaches only one person, and in this sense, my father was a great teacher. He turned me loose to pursue my interests wherever they led. He bought me books on the subjects that interested me and encouraged me to browse in the town library. I began to read natural history and related subjects at an early age and learned a lot that had nothing to do with formal courses in school. Perhaps this kind of self-education is one source of the sense of wonder.

Fenner. Couldn't an elementary teacher do for some pupils, maybe even on an individual basis, what your father did for you?

Eiseley. Surely, and I think that the elementary school is a very good place to start this sort of thing. The sense of wonder that leads to self-education will frequently survive if young children realize that becoming educated doesn't mean they will have to dismiss everything remarkable or mysterious in the universe as being somehow detrimental to learning. On the other hand, if they don't realize this at an early stage, they are apt to become so conditioned that they're afraid to step across the border of a discipline; they feel they're going to be criticized if they look at the world with what I have called 'a kind of owl-eyed wonder'" (Fenner, 1966).

We cannot teach owl-eyed wonderness; we cannot teach joy and excitement; and we cannot teach mystery, beauty, and ecstasy. Teachers can only provide an environment in which each child feels free to find these things for himself. Sylvia Ashton-Warner, through her experiences teaching Maori children in New Zealand, came to this realization: "What a dangerous activity teaching is. All this plastering on of foreign stuff. Why plaster on at all when there's so much inside already? So much locked in? If only I could get it out and use it as working material. And not draw it out either. If I had a light enough touch it would just come out under its own volcanic power" (Ashton-Warner, 1963).

Meaningful biology education will come about only after we do away with teaching

as it is all too commonly practiced. The teacher has to give up his role as the talking book, as the infallible authority, and as the omnipotent planner. In a lecture at Harvard University, the psychologist Carl R. Rogers, stimulated his audience by saying: "It seems to me that anything that can be taught to another is relatively inconsequential, and has little or no significant influence on behavior. I have come to feel that the only learning which significantly influences behavior is self-discovered, self-appropriated learning. Such self-discovered learning, truth that has been personally appropriated and assimilated in experience, cannot be directly communicated to another. Such experience would imply that we would do away with teaching. People would get together if they wished to learn" (Rogers, 1961).

Each child needs to find his own problems in his own world. Presenting a child with teacher-planned problems deprives him of what may be one of the most essential parts of the process of science. Einstein believed that "the formation of a problem is often far more essential than its solution, which may be merely a matter of mathematical or experimental skill."

The child's problems should be real problems based on actual confrontations with puzzling situations in nature. Real problems elicit joy and excitement in the search for solutions. Contrived sequences of problems can too easily lead to apathy. In an article, "What Do We Know About Learning," Columbia University psychologist Goodwin Watson, wrote: "Children are more likely to throw themselves whole-heartedly into any learning project if they themselves have participated in the selection and planning of the project. Genuine participation (not pretended sharing) increases motivation, adaptability, and speed of learning. Excessive direction by the teacher is likely to result in apathetic conformity, defiance, scapegoating, or escape from the whole affair" (Watson, 1964).

One essential feature of the professional research enterprise that maximizes the possibility of new concepts being generated is the freedom granted to the scientist. This freedom is granted even though the scientist needs to convert his private, personal concepts into public, communicated concepts. Certainly a child in a classroom who generates concepts that can remain private, should be granted equal freedom. R. E. Marshak, in his article on basic research in *Science,* provides the following description of the role of freedom in science: "The basic research enterprise starts with wonder and an intense curiosity about the nature of the world, is fed by devoted and almost passionate activity in search of new knowledge by truly creative individuals, and yields ordering principles where none existed before and powers of prediction which could only be dimly envisioned when the work was started. The objectives of the basic research enterprise are furthered by allowing the individual scientist complete freedom both to choose the subject matter of his investigations and to draw the conclusions to which they lead, consistent with the laws of logic and nature" (Marshak, 1966).

If children are to have freedom in choosing their subject matter, a school environment that encourages diversified learning situations must be developed. Ernest N. Poll describes such a program at the Laboratory School of the University of Chicago in his article, "Diversified Learning Situations and Student Choice," in *School Science and Mathematics.* (Poll, 1965).

Before joy and excitement in the intellectual power of science can become the first task and central purpose of biology education, teachers should have faith in children and love them. We must dare believe, as does A. S. Neill of Summerhill, that the aim of education is for each individual "to find happiness—to find interest" (Neill, 1960). We must dare believe that each child can best build his own model of reality as John Holt writes in his book, *How Children Fail:* "We cannot have real learning in school if we think it is our duty and our right to tell children what they must learn. We cannot know, at any moment, what particular bit of knowledge or understanding a child needs most, will most strengthen and best fit his model of reality. Only he can do this. He may not do it very well, but he can do it a hundred times better than we can. The most we can do is try to help, by letting him know roughly what is available and where he can look for it. Choosing what he wants to learn and what he does not is something he must

do for himself" (Holt, 1964).

From my experiences I have found that children want to learn. They want to learn desperately. But they want to learn what they want to learn when they want to learn it. Children want their teachers to provide materials, to share in the excitement of their discoveries, and to offer support in moments of frustration. Children want the "learn what you want—and I'll help you" stage of American education to become a reality. Children want their teachers to have faith in them as human beings.

Children cannot gain a genuine sense of joy and excitement in a coercive and threatening environment. Coercion and threat are central in the "learn what I want you to learn—or else" stage of education. Do we dare have faith enough in children to enter into the "learn what you want—and I'll help you" stage?

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Can You Identify Key

The following are the identifications of the pictures shown on page 225.

1. American Beech (*Fagus grandifolia* Ehrh.)
2. Chinese Elm (*Ulmus*)
3. Red Oak (*Quercus rubra* L.)
4. Tulip Tree (*Liriodendron tulipfera* L.)
5. Sugar Maple (*Acer saccharum* Marsh.)
6. Red Maple (*Acer rubrum* L.)
7. White Ash (*Fraxinus americana* L.)
8. Sycamore (*Platanus occidentalis* L.)
9. Red Gum (*Liquidambar styraciflua* L.)
10. Flowering Dogwood (*Cornus florida* L.)

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