NOTE

An Interview with John Dewey on Science Education

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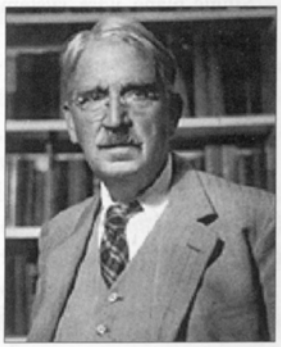
Sooner or later almost all physics teachers are forced by the evidence to conclude that students do not attain understanding of concepts by listening to lectures—no matter how lucid they may be. A more fruitful alternative, which many teachers have arrived at independently, actively involves the students, starting with their own experiences and guiding them from there, through observation and reasoning, towards knowledge *with* understanding. Periodically some form of this approach also has been embodied in more organized reform efforts. Reports of these initiatives, however, seldom make any reference to the considerable body of related work that has preceded them, and this is a serious shortcoming. There is great value in tracing the history of this educational thread: it confirms that the ideas have deep roots and have stood the test of time; it provides clues to the troubling question of why, if this approach is so good, it is still not widely practiced; and, most importantly, it allows new thinking to start from "the shoulders of giants" rather than at ground level.

One of these giants is John Dewey (1859-1952), often cited as the leading American educator of the twentieth century, who based his theory of education on the principle that "all genuine learning comes about through experience." For Dewey, experience was both the means and end of education; education was not preparation for life, it was life itself. It should be no surprise that his ideas apply particularly well to science education and to physics teaching in particular, but it may be a shock, and a bit humbling, to realize that the issues he addressed some 100 years ago are still with us today.

As an introduction to Dewey's thinking in relation to science education, excerpts from his writings are presented here in the form of a mock interview. The author's questions are from the present; the answers are culled from Dewey's work of some 60 to 100 years ago.[1,2]

Interviewer: **First of all, can you say briefly what you mean by "science"?**

Dewey: We define science as systematized knowledge, but the definition is wholly ambiguous. Does it



John Dewey was born in Burlington, Vermont, in 1859 and was educated at the University of Vermont and Johns Hopkins University. Following his first appointment at the University of Michigan, where he became Chairman of the Department of Philosophy, he went to the University of Chicago and from 1894 to 1904 headed a department of philosophy, psychology, and education. Believing that the scientific method should be applied to education, he founded the Laboratory School as a place to test his theories in practice. During that time he also published his first treatise on education, *The School and Society*, which was widely read and proved influential in the rise of the so-called progressive school movement.

In 1904 Dewey moved to Columbia University in New York City where he remained as professor of philosophy for the rest of his teaching career. His major works on education include *Democracy and Education* (1916), *Logic: The Theory of Inquiry* (1938), and *Experience and Education* (1938). Considered to be Dewey's best and most concise statement on education, this last book is recommended as a starting point for further reading.

Retiring from Columbia University in 1930, Dewey remained professionally active and published his last work at age 87. He died in 1952, at the age of 93. His ideas, along with the progressive schools, began to lose favor shortly after his death and are only recently finding a resurgence of interest. A major resource is The Center for Dewey Studies and the Special Collection of the Morris Library at Southern Illinois University at Carbondale, which maintains extensive archives, compiles a list of all works written about Dewey, and has published his complete works in 37 volumes.

Dewey was not the first to see education as basically development from within—he was preceded by thinkers going back as far as Socrates and including such figures as Rousseau, Kant, Pestalozzi, and Froebel. However, he seldom mentions these others and it is not clear how much he was influenced by them. Likewise, although Dewey's career overlapped Piaget's and both had similar interests, there is no clear indication of either one having particular influence on the other. Has current physics teaching been influenced by Dewey? Certainly there are few specific references to him. At best, it seems, after working out their ideas independently, some teachers have later discovered Dewey and found resonance with him.

mean the body of facts, the subject-matter? Or does it mean the processes by which something fit to be called knowledge is brought into existence, and order introduced into the flux of experience? That science means both of these things will doubtless be the reply, and rightly. But in the order both of time and of importance, science as method precedes science as subject-matter. (JDE, 188)

Could you expand on why you find the *process* of science to be of such importance?

Surely if there is any knowledge which is of most worth it is knowledge of the ways by which anything is entitled to be called knowledge instead of being mere opinion or guesswork or dogma. Such knowledge never can be learned by itself; it is not information, but a mode of intelligent practice, an habitual disposition of mind. Only by taking a hand in the making of knowledge, by transferring guess and opinion into belief authorized by inquiry, does one ever get a knowledge of the method of knowing. Because participation in the making of knowledge has been scant, because reliance on the efficacy of acquaintance with certain kinds of facts has been current, science has not accomplished in education what was predicted for it. (JDE, 188)

What do you see as causes for this failure of science education?

The causes...are many and complex...[but I single out] one influential cause,...that science has been so frequently presented just as so much ready-made knowledge, so much subject-matter of fact and law, rather than as the effective method of inquiry into any subject-matter. (JDE, 182)

How then would you recommend changing this?

One of the greatest difficulties in the present teaching of science is that the material is presented in purely objective form, or is treated as a new peculiar kind of experience which the child can add to that which he has already had. In reality, science is of value because it gives the ability to interpret and control the experience already had. It should be introduced, not as so much new subject-matter, but as showing the factors already involved in previous experience and as furnishing tools by which that experience can be more easily and effectively regulated. (JDE, 434)

Can you state for us what you see as the guiding principle for the kind of experience-based education you are describing?

Education must be conceived as a continuing reconstruction of experience; that the process and the goal of education are one and the same thing. (JDE, 434) [It does not mean, as it is often misunderstood,] that we have no choice save either to leave the child to his own unguided spontaneity or to inspire direction upon him from without. But [it recognizes] that no such thing as...insertion of truth from without is possible. All depends upon the activity which the mind itself undergoes in responding to what is presented from without. (JDE, 357)

This sounds in line with what today is called the *constructivist* position. What role, then, does this leave for the teacher?

[The role of] the educator is *to determine the environment of the child*, and thus by indirection to direct. (JDE, 357)

Growth depends upon the presence of difficulty to be overcome by the exercise of intelligence. It is part of the educator's responsibility to see equally to two things: First, that the problem grows out of the conditions of the experience being had in the present, and that it is within the range of the capacity of students; and, secondly, that it is such that it arouses in the learner an active quest for information and for production of new ideas. The new facts and new ideas thus obtained become the ground for further experiences in which new problems are presented. The process is a continuous spiral. (E&E, 79)

Again, that seems close to what now goes under the name of *inquiry learning*. Some educators argue, however, that this process, which amounts to actually *doing* science, is not suitable for most students. How would you answer those critics?

The basic error [of this position is to] ignore and virtually deny the fact that tendencies toward a reflective and truly logical activity are native to the mind.... The mind at every stage of growth has its own logic. It entertains suggestions, tests them by observation of objects and events, reaches conclusions, tries them in action, finds them confirmed or in need of correction or rejection. (JDE, 253)

You make it sound as if using scientific method in everyday life is a natural thing; yet surely the experience of many sci-

ence teachers would not confirm this. Is there something that these teachers are missing?

Any teacher who is alive to the modes of thought operative in the natural experience of the normal child...will have no difficulty in seeing that the real problem of intellectual education is the *transformation* of natural powers into expert, tested powers: the transformation of more or less casual curiosity and sporadic suggestion into attitudes of alert, cautious, and thorough inquiry. He will see that the *psychological* and the *logical*, instead of being opposed to each other (or even independent of each other), are connected as the earlier and the terminal, or concluding, stages of the same process. (JDE, 253)

The view of science education as a *transformation of natural abilities* strikes me as a key insight. What can a teacher do to facilitate a student's shift from his or her "natural" logical thought to the more formal thought of the scientist?

The only way in which a person can reach ability to make accurate definitions, penetrating classifications, and comprehensive generalizations is by thinking alertly and carefully on his own *present* level. Some kind of intellectual organization must be required, or else habits of vagueness, disorder, and incoherent "thinking" will be formed. But the organization need not be that which would satisfy the mature expert. ...It is absurd to suppose that the beginner can commence where the adept stops. But the beginner should be trained to demand from himself careful examination, consecutiveness, and some sort of summary and formulation of his conclusions, together with a statement of the reasons for them. (JDE, 254)

With this view of science education, where does learning the established knowledge of science, the more traditional content, come in?

One consideration stands out clearly when education is conceived in terms of experience. Anything which can be called a study, whether arithmetic, history, geography, or one of the natural sciences, must be derived from materials which at the outset fall within the scope of ordinary life-experience. (E&E, 73) Nevertheless, the organized subject matter of the specialist represents the goal toward which education should continuously move. (E&E, 83)

Does this mean that students are expected to somehow discover or recreate science principles for themselves, from their own experience? This seems inefficient at best, and perhaps in most cases impossible. Wouldn't it be reasonable to introduce the principles and structure of the subject first?

There is a strong temptation to assume that presenting subject matter in its perfected form provides a royal road to learning. What more natural than to suppose that the immature can be saved time and energy, and be protected from needless error by commencing where competent inquirers have left off? The outcome is written large in the history of education. ...The pupils learn a "science" instead of learning the scientific way of treating the familiar material of ordinary experience. ...The method which begins with the experience of the learner...is often called the "psychological" method in distinction from the logical method of the expert. The apparent loss of time involved is more than made up for by the superior understanding and vital interest secured. What the pupil learns he at least understands. (D&E, 220-221)

Then what is the role of structured subject matter for teachers as they work with their students?

[Let me use the analogy of] the difference between...an explorer blazing a trail in a new country and the finished map that is constructed after the country has been thoroughly explored. ...Well, we may first tell what the map is not. The map is not a substitute for a personal experience. The map does not take the place of an actual journey. The logically formulated material of a science...is no substitute for the having of individual experiences. But the map, a summary, an arranged and orderly view of previous experiences, serves as a guide to future experience; it gives direction;...pointing out the paths which lead most quickly and most certainly to a desired result. ...That which we call a science or study puts the net product of past experience in the form which makes it most available for the future. (JDE, 350-351)

In view of your assertion that learning is based on experience, I assume you would endorse laboratory instruction and current "hands-on" approaches to science teaching.

This assertion is not quite identical with the commonplace of scientific instruction that text-book and lecture are not enough; that the student must have laboratory exercises. A student may acquire laboratory methods as so much isolated and final stuff, just as he may so acquire material from a text-book.... Many a student has acquired dexterity and skill in laboratory methods without its ever occurring to him that they have anything to do with constructing beliefs that are alone worthy of the title of knowledge.... This problem of turning laboratory technique to intellectual account is even more pressing than that of utilization of information derived from books. (JDE, 189)

Are there other pitfalls in science instruction that you would warn against?

Studies [can be] grouped under three heads: 1) ...the acquisition of skill; 2) ...acquiring knowledge; and 3) [those which] appeal to abstract thinking and reasoning.... In the case of the disciplinary studies, there is a danger of the isolation of intellectual activity from the ordinary affairs of life. The danger in those studies where the main emphasis is upon acquisition of skill is just the reverse. ...The pupil

is enjoined to do [a] specific thing, with no knowledge of any reason.... Practical skills...can be intelligently...used only when intelligence has played a part in their *acquisition*. (JDE, 235-236)

You did not mention pitfalls associated with the acquisition of knowledge, which many people still regard as the primary goal of education. Are there also practices here to be avoided?

In school, amassing information always tends to escape from the idea of wisdom or good judgment. The aim often seems to be...to make the pupil what has been called a "cyclopedia of useless information." "Covering the ground" is the primary necessity; the nurture of mind a bad second. Thinking cannot, of course, go on in a vacuum; suggestions and inferences can occur only to a mind that possesses information as to matters of fact. But there is all the difference in the world whether the acquisition of information is treated as an end in itself, or is made an integral portion of the training of thought. (JDE, 237)

Let me end this interview by asking your opinion of two current developments. First, there is a growing movement to raise the level of science education by establishing state and national standards. Do you see this as a helpful development?

In instruction, the external standard manifests itself in the importance attached to the "correct answer." No other thing, probably, works so fatally against focusing the attention of teachers upon the training of mind as the domination of *their* minds by the idea that the chief thing is to get pupils to recite their lessons correctly. ...There is no great difficulty in understanding why this ideal has such vogue. [It satisfies] the tendency of parents and school authorities to demand speedy and tangible evidence of progress...[and it] lends itself naturally to the mechanics of school administration—to examinations, marks, gradings, promotions, and so on. (JDE, 238)

Second, there is the sense in a number of institutions—including theme parks, science centers, software companies, and television—that their contribution to education is to make learning "fun." What is your opinion of this approach, combining entertainment and education?

Somehow and somewhere motive must be appealed to, connection must be established between the mind and its material. ...The only question is whether it be such as grows out of the material itself...or be imported and hitched on from some outside source. ...Human nature being what it is, it tends to seek its motivation in the agreeable rather than in the disagreeable.... And so has come up the modern theory and practice of the "interesting," in the false sense of that term. The legitimate way...is to transform the material...to take it and to develop it within the range and scope of the child's life. But it is easier and simpler to leave it as it is, and then by trick of method to *arouse* interest, to *make* it *interesting*; to cover it with sugar-coating...to get the child to swallow and digest the unpalatable morsel while he is enjoying tasting something quite different. But alas...if the attention has not been playing upon the actual material, that has not been apprehended, not worked into faculty. (JDE, 354-357)

Do you have any final thoughts you would like to leave with us?

I do not wish to close without recording my firm belief that the fundamental issue is not of new versus old education nor of progressive against traditional education but a question of what anything whatever must be to be worthy of the name *education*.... What we want and need is education pure and simple, and we shall make surer and faster progress when we devote ourselves to finding out just what education is and what conditions have to be satisfied in order that education may be a reality and not a name or a slogan. It is for this reason alone that I have emphasized the need for a sound philosophy of experience. (E&E, 90)

***Thank you.* This has been a most enlightening discussion.**

References

1. An earlier version of this article appeared in *The Informal Learning Review*, No. 34, Jan/Feb 1999, a publication of Informal Learning Experiences, Inc., Washington, DC.
2. Quotations are from one of the following books, which are also recommended for further reading on Dewey. Page references are given after each quote in the text, with the books abbreviated as E&E, D&E, and JDE respectively.

   John Dewey, *Experience and Education* (Kappa Delta Pi, 1938). Currently available as a Simon & Schuster Touchstone Book (1997). A short, readable book written late in Dewey's career. The best place to start reading.

   John Dewey, *Democracy and Education* (Macmillan, New York, 1916). Currently available as a Simon & Schuster Free Press Book (1966). Dewey's most comprehensive writing on education. Longer and more difficult than E&E.

   John Dewey on Education: Selected Writings, edited by Reginald D. Archambault (Random House, New York, 1964). Currently available from University of Chicago Press (1974). As the title says, a useful compilation of his writings with an introduction summarizing Dewey's educational philosophy.