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ABSTRACT

If curriculum designers conclude, as Jacob Bronowski (author of "The Identity of Man," 1965) does, that the mind is not a machine and that knowledge cannot be programmed into humans like computers, then a model for education must be adopted which takes into consideration Bronowski's definitions of knowledge and self. This model must consider the continuous nature of education and the creativity of the mind, which Bronowski divides into two modes: science and the arts. The scientific mode relies on the process of induction, including concept formation. By including scientific induction in the new model of education, students would take a more active role in their education by pursuing individual or group inquiries. The artistic mode explores alternatives and develops what Bronowski calls sympathy. By including sympathy in the educational process, competition can be diminished and cooperation fostered. Teachers' and students' roles would change in this model and a more open process would result. (IS)

Curriculum Implications of Jacob Bronowski's 'The Identity of Man'

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Jacob Bronowski's book, The Identity of Man, presents a coherent philosophy of man which has relevant implications for makers of curriculum. Bronowski's central theme is that our society faces a crisis of confusion due to a lack of certainty about our identity. Bronowski explains that this crisis "springs from each man's wish to be a mind and a person, in the face of the nagging fear that he is a mechanism," (1) a thought which raises the central question: Can man be both a machine and a self?

A 'machine', according to Bronowski, has an input, a process, and an output, all three which must be mechanized. This definition applies equally well to the bodies and actions of people as well as to those of automobiles. Bronowski would have us consider: "If we did not breathe as simply as an iron lung, we would die. If we did not hold our temperature steady, like a thermostat, the soul would soon spurt out the top of the thermometer with the mercury." (2).

In order to compare man to a more complex machine, like the computer which we more resemble, Bronowski expands his definition of machine to include the function of self-regulation. The new automobile engines with computer controlled fuel-air mixtures illustrate Bronowski's conception of a modern machine able to "feed its output back into itself as a new instruction." (3)

Next, Bronowski asks: Does man operate in such a way that his procedures for getting experience (input) can be formalized so that his actions (output) are directed in an exact and predictable way? Restated, we can understand this question to read: do the messages received from the outside world and inner world together strike man like holes punched in a tape, or magnetic marks on it, directing him in precise and predictable ways?

In this form the question has clear and relevant implications for makers of curriculum. If the answer is yes, knowledge can be programmed into humans like into computers, then educators should be adopting the input-process-output model for teaching, because that is the way computers work. Curriculum within such a framework includes specified experiences chosen to produce a desired outcome, codes them into a language form which all students process in a uniform manner, and yields an output which is as well defined as the input experiences. In other words, educators can justifiably continue to select a quantity of facets and concepts, expose all students to this information via worksheets, books and lectures, and evaluate the students with tests that require the students to restate the information that was to be absorbed. In this traditional model knowledge can be equated with a quantity of facts and concepts, so that the students who demonstrate the most ability to restate the input information presented by the teacher are held to be the most knowledgeable. Behavioral objectives, criterion referenced instruction, convergent questioning and objective tests with one right answer per question fit well within this framework.

If the answer is no, knowledge cannot be programmed into humans like into computers, another model for education must be constructed. That model will have to take into consideration the 'self' of man. As Bronowski explains, "In order to see if there is a self in man which is not mechanical, we have to look not inside his brain, but into his acts of experience. We have to analyze the nature of different experiences, and how they are turned into knowledge." (4)

Bronowski's analysis rests on his definitions of 'knowledge' and 'self'. He defines 'knowledge' as "a re-arrangement of experience, in which we put together those experiences that seem to us to belong together, and put them apart from those that do not." (5) Knowledge in this perspective implies a readiness for action and an expansion of the self. 'Self', according to Bronowski, means "the unending process by which I turn new experience into knowledge." (6)

An analogy makes clearer Bronowski's ideas concerning man as a machine and a self. Consider the relationship of the eye with the brain. Classical thinking right up to several decades ago pictured the brain as kind of a telephone exchange; i.e., it was thought that the brain receives neutral signals (from the eye, for example) and that the signals are then sorted out and interpreted by logical processes which derive messages for action from them.

Bronowski uses the work of two scientists to show that this analogy is wrong. He cites studies by H.K. Hartline which showed that the rods and cones in the eye's retina are connected together in complex groups whose function is to integrate individual sensations before they leave the eye. Thus, the eye does not give the brain a simple, neutral signal such as light or no-light; instead it tries to find a pattern, and the pattern the eye finds is the shape of things. So the message sent to the brain is an interpretation of the light which carries meaning to alert the attention. Here the distinction between machine and self can be seen: a machine sends neutral information throughout its system, while the self integrates, interprets and rearranges experiences.

Bronowski also describes a study by John Von Neumann which looked comparatively at the precision (i.e. the number of logical steps for a message to be

'carried out) of the human brain and a computer. He found that the brain is at least 10 million times too coarse to work by the logical methods of the man-made computer. Von Neumann concluded that humans do therefore not use the same statistical based logic as computers. Man's brain uses another, as yet undeciphered logic and language; and in this way is distinctly different from a machine.

If curriculum makers conclude, like Bronowski, that man's mind is not a machine and that knowledge cannot be programmed into humans like computers, then another model for education must be adopted which takes into consideration Bronowski's definitions of 'knowledge' and 'self'. To see that man is both machine and self is to see that man is learning at every moment. He is constantly enlarged by the rearrangement of his experiences. A new model for education must then take into account that education is continuous. In contrast to the input-output model, the new model would not allow one to conclude that a student has not learned anything because his tests do not show progress. The new model would weaken the traditional role of the school as the central institution of containing and communicating knowledge, and highlight the concept that learning goes on outside the school as well as inside.

A closer look at the way man's mind works adds another dimension to the model. From Von Neumann's research which suggests that the brain cannot reach its inner conclusions by any logic of statistical certainty, Bronowski concludes that the brain must then do two things:

> It must be content to accept less than certain knowledge. And it must have statistical methods which are different in kind from ours, by which it reaches its acceptable level of uncertainty. By these means, the brain constructs a picture of the world which is less than certain yet highly interlocked in its parts. (7)

The picture produced by the brain is not a passive description of the 'way the world looks' but rather our unique, active way of looking at it. The picture is not how the world strikes us, but how we construct it. Thus another dimension to be taken account for the new educational model is that education is creative. Man creates the way the world looks by continuously rearranging his experiences.

In order to see more distinctly why education is creative, one must examine the way man's mind works with uncertainty. According to Bronowski there are two ways in which man's mind rearranges the ever expanding amount of experiences to reduce uncertainty. These two ways he labels the modes of knowledge; they are: science and the arts.

The scientific mode of knowledge relies on the process of induction, reasoning from the specific to the general. Bronowski defines induction in science as, "the search for the unattainable laws that describe the powers by which bodies operate." (8) It is first important to recognize that the laws are unattainable; this is due to the uncertainty of knowledge. What this implies to curriculum makers is that science is more accurately described as a process of a continuous, historical development of ideas rather than a product consisting of the ideas presently held.

Secondly, for Bronowski, scientific induction includes concept formation. He explains that in science, new experiments are designed to be decisive in knocking out one of two alternative simple hypotheses each of which explains the previous results. When the new results are in, ideas are rearranged and a concept is formed which holds together the total complex of evidence. Again it is the element of uncertainty which makes the concept formation a creative

process, for man must use his imagination to accomodate new relations in an uncertain world. Consider this example: if mass is defined, as it was for centuries, in a logically or operationally exact way, it is impossible to discover that mass is also equivalent to energy. But if it is recognized that mass is still an ambiguous idea, as Einstein did, then the discovery of new concepts of mass, as in the special theory of relativity, awaits only enough creativity and imagination.

By including Bronowski's process of scientific induction in the new model of education, new directions for curricular change are revealed. First, activities in the school would call for a more central role for the student in the process of his/her education. In the place of classrooms where the focus of attention is centered on the teacher, new situations could be created where students pursue individual or group inquiries. From the outset of schooling important elements of inquiry learning could be modeled and taught using Piaget-type tasks, such as discovering the law of conservation of volume through pouring water from tall skinny jars into small stout ones.

Secondly, the students would play a more active role in their learning. The inductive process implies an active 'search' for general laws through experimentation and decision making, i.e., choosing among alternative explanations. Again, from the outset of schooling, experimentation and the scientific method could be modeled and taught using materials such as the manipulative math programs.

Thirdly, students would get more practice in and reinforcement for divergent thinking. Opportunities for generating a wide ranging variety of responses would be frequent for students involved in predicting outcomes of experiments and in creating concepts to explain the results of their inquiries.

The other mode of knowledge which Bronowski describes is the arts. Knowledge from the arts, or literature--as Bronowski uses to represent the arts-- is the way mans learns about his 'self'. As Bronowski explains, "a profound poem is not an exercise in resolution, and does not teach us to opt for one kind of action rather than another. The knowledge we get from it does not tell us how to act, but how to be." (9) Knowledge of literature is similar to knowledge of science in that both imply learning processes which depend on creativity. In understanding literature, a student must be able to use imagination (i.e. create mental pictures to accomodate the rearrangement of experiences) and also to think divergently (i.e. explore a variety of alternatives).

The difference between knowledge of science and the knowledge of literature is that in understanding literature the imagination explores the alternatives <u>without</u> ever deciding for one rather than the other. In other words, more than one interpretation of a poem, story or novel may be held by a person all at the same time. While the knowledge of science seeks for unattainable laws of nature, the knowledge of literature reaches out to other selves. As the knowledge of science relies on induction, the knowledge of literature relies on sympathy. Sympathy, in this context, means feeling what others have felt. Bronowski explains that the knowledge of literature "steeps man in the human predicament and the predicament of life; it makes him one with all creatures." (10)

To include Bronowski's notion of sympathy in the new education model also reveals directions for curricular change. In contrast to the educational system today which fosters competition among students by giving all students the same tests and then ranking them on the basis of the scores, a school system whose goal is to develop sympathy among students would foster cooperation. Such a school system would attempt to maximize the quantity and

quality of student interaction. Ideally, in such a system students would respect the feelings and ideas of fellow students as much as they respect the teachers.

To facilitate the development of sympathy among students the curriculum would include many opportunities to examine feelings and values. Examples of relevant activities include using dyads, gestalt techniques, and values clarification. Divergent thinking activities would also be included within this realm of the curriculum to examine the wide range of feelings and values humans have had in the past and to underscore the limitless possibilities of human experience to come.

As the student role changed, so would the teacher's. The teacher whose aim it is to develop sympathy among students would first have to be able to motivate students through mutual trust. S/he would have to create an open atmosphere of feelings within which students could learn about and accept their own feelings and the feelings of others.

In this, the dawning on the computer age, thinkers who help us understand how our humanity broadens, rather than limits, our learning capabilities are worth their weight in 512K chips. Bronowski, in The Identity of Man , shows he deserves to be valued as such. The directions for curriculum change conveyed by a model of education based on Bronowski's ideas are twofold: education needs to be creative and sympathetic. When such concepts will supersede current notions like, the "basics" or "computer literacy", cannot be foretold. But in the likely event that new knowledge about computers will teach us more about our humanity, then consideration of Bronowski's ideas will be only a matter of time.

References

1. Bronowski, J. The Identity of Man. New York: Natural History Press, 1965, p. 9.

2. Ibid. p. 21.

3. Ibid. p. 23.

4. Ibid. p. 27.

5. Ibid. p. 18.

6. Ibid. p. 34.

7. Ibid. p. 45.

8. Ibid. p. 66.

9. Ibid. p. 114.