GUEST EDITARTICLES

Science and Technology Education Imperatives for the World's "Have Nots"

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This is based on experience and contacts with numerous science educators who have been concerned with "HAVE NOT" (less advantaged/disadvantaged/socially, culturally, and economically different) students around the world. I conclude that recent curricular efforts in science and technology education offer no solutions for these students.

The failure is partly due to the structure of the present system of science and technology education—a structure which is based on the assumption that individuals in various subcultures will respond to the opportunity to receive science and technology education, and that individuals will understand its value to themselves, their families, and their communities. If students do not demonstrate this level of understanding, they are regarded as dumb—that they do not want to or are unable to cope with modern society.

Manipulation of the physical world is the strength that the material culture has to offer and we say, "If only we could teach these 'have-not' students to think logically, that is, scientifically, to bring them into the 20th century and get them to abandon their obviously unsuccessful customs, they would be better equipped to handle the problems and live more productive lives." There is enough truth in this thinking to validate demands for more technological education; but there is also enough narrowness and over-simplification to trap the unwary into believing that technology is a complete system of thought and, therefore, the key to heaven's gate.

If we identify a weakness of various ethnic cultures as their resistance to scientific thinking, then an equal stubbornness on the part of Western-scientific culture exists in its over-commitment to technology.

The historical record of all great civilizations tells us that cultural idealism and technology exist side by side. Great engineering masterpieces in all ethnic cultures testify that science and technology are many thousands of years old. What Westerners call the "industrial revolution" only means an unprecedented acceleration and exceedingly strong emphasis on the technological aspect of human activity. The fact is that five or six thousand years ago, the rise of the great civilizations was not brought about by technology alone, but by radically new social inventions. Keep in mind that the overwhelming commitment to industrial affluence in the West appears to be at the expense of health and mental balance, and with the advent of the nuclear bomb, survival itself.

Today, less advantaged students are aware of the phenomenal advancements of Europe and post-European cultures. At the same time, they perceive that their own culture has contributed little to the current syndrome of technology. They feel it is too late for them to make a significant contribution to the society in which they must live. Nowhere is ruthless effacement of a people's pride in their own achievements more evident than in current education practice as it affects less advantaged pupils. These students may be of people whose culture was solidly science-based long before modern technology came into existence, yet this fact is ignored in the present teaching curriculum. Have their achievements in applied science, agriculture, construction, and mathematical manipulations been so useless as to be given no consideration in the present science and technology education curriculum? I am not consciously digressing from my purpose here, but only seek to suggest new directions for imparting meaningful science and technology education of our less advantaged (have-not) students.

Now the following question arises:

What, then, should be the nature of science and technology education for these students?

In my opinion, a totally new system of science and technology education is needed that will enable these "have-not" students to develop skills and acquire knowledge, which has a higher probability of producing a better understanding of their environment, and which will make possible for the students an acquaintance with the process or discovery of knowledge. Such a curriculum in science and technology education would lay emphasis on the practical understanding of science and not on theoretical and scientific principles that are unrelated to the students' daily lives. Rather, the emphasis would be placed on the application of scientific knowledge to improve living conditions and to other aspects of everyday life.

Furthermore, science and technology education must be correlated with scientific and technological achievements of the cultural heritage of these less advantaged people. Hopefully, these students may develop pride in their scientifically and technologically rich heritage, develop an interest in learning and understanding of science and technology education, and, consequently, achieve satisfaction from success.

To understand adequately the role of science and technology education in the tribal areas, urban slums, Native Indian reserves, American ghettos, or Mohri Natives in New Zealand, it is necessary to ask the following question:

What are the major problems of our "have not" people that science and technology education should prepare the students to tackle intelligently and purposefully?

In the first place, whether it is a ghetto, a reserve, or urban slum where the majority of less advantaged students live and assuming minimal socially healthy conditions, all should work. And this work is practical. In these places there are many problems such as sanitation, health, hygiene, and water pollution, and basic life facilities are very few. The economic condition of these people is really pathetic. Such a situation calls for a science and technology education program to be closely related to the real problems of community life. It must be so presented that the conventional gap between science and technological knowledge and life situation disappears. If such a curriculum could be developed, schools may be transformed into miniature communities where students learn by applying knowledge. Such a curriculum effort may also bring theoretical scientific and technological knowledge out of its isolation and connect it with all the worthy aspects of community life. It calls for schools to utilize students' outside experiences and basing and integrating studies upon the knowledge and information and interests students bring to school. The school thus becomes the center of community life.

With these factors in mind, the author has piloted a teaching and evaluation approach that appears to have promise for success with these students. It is a science and technology teaching program based on environment and is aimed at raising the level of knowledge, skills, and attitudes of these students to allow them to be more productive in their home environments. To achieve this, science and technology education are taught on four levels: the facts level, the concepts level, the values level, and work experience (technology) level. The author taught a course based on this concept to Native Americans in Canada.

In conjunction with the course taught at the different levels, I utilized a personally developed evaluation system. This system took into consideration the unique learning and cultural needs of the students. It provided opportunities for student-teacher interaction. To a large extent, it provided for contract learning based upon pre-testing to determine the students' knowledge and skills; and it provided mastery learning opportunities (i.e., the students had several opportunities to demonstrate improvement in meeting course criterion measures without penalty).

Very encouraging results were achieved from implementing the evaluation system with the culturally different children in Canada. The students' increased progress and interest in the subject were quite evident.

In my opinion, there is a striking resemblance between culturally different children in Canada (in this case, American indigenous Indians) and "have not" students around the world. These students are generally disinterested in science, and this lack of interest is often a major factor in failure in the subject. It is obvious, also, that these students need individual recognition and attention.

As we internationalize science and technology education, the special needs of the "have nots" of the world must be addressed or we will fail to reach a significant portion of the world's inhabitants. I have attempted to outline in general terms the nature and needs of this group. I have also tried a promising instructional approach with "have nots." I hope that all curriculum developers and instructors will consider the general guideposts I have discussed.

Students attained more when the author's evaluation system was used than with the traditional system. That they learned more is suggested by an increase in average test grades when viewed as a single criterion. There was a general increase in each class. Admittedly, the study is not experimentally "clean," and one certainly cannot infer any causative relationship. Still, subjective observation suggests that some of the components built into the proposed evaluation scheme of Schematic I are tied to a positive shift in interest in the course. The writer believes that the proposed scheme builds on a feeling of reduced failure potential by the students, resulting in a reduced antipathy toward science. In the absence of a thoroughly controlled experiment, this is a tempting explanation of increased achievement.

These results are, of course, highly subjective in interpretation, but the writer's strong feeling is that two very important factors are operating. First, the system makes it clear to the students that their grades are not entirely the result of their rote-learning performance as reflected in test grades. Second, the cycle of teaching and testing activities described reduces the feeling of finality and hopelessness attached to any given evaluation.

The success of these evaluation procedures in stimulating "have-not" students to improve performances has significance for the meaningful science and technology education for these students because of being different by virtue of a vastly different environment and lifestyle from that of the other major population groups.

No matter what is put in print to ensure that a given science and technology education program will be executed in such a way as to de-emphasize memorization and emphasize understanding in the context of real problems, if science educators do not sympathize with this approach or understand it, the outcome may not be positive. The most important contribution of science educators must always be their ability to make interpretations, make innovations, invent their own study units, and make them close by adapting to opportunities in their classroom and living environment. They must be inventive in demonstrating examples for an idea from the resources at hand in specific situations.

Let us think, organize, and strive together as professionals so that our "have-not" (less advantaged) students can discover for themselves the value of logical inquiry, tested intuition, and the general process of innovation for themselves and their community.

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Skills in Education: A Philosopher's View

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Skill and knowledge intertwine. The choice between them for education is traditionally based on concern for social stability plus the view that knowledge is superior to skill. This must change to let education accord with the need to replace knowledge with the skill of literacy and stability with the skill of democratic control.

Skills Versus Knowledge

Learning and knowledge belong to different subjects—philosophy, psychology, education, and sociology. These differ greatly from each other. In philosophy the theory of knowledge (epistemology) and of method (methodology) concern foundations—what can be known and how? This is of no relevance to education, or to psychology, or least of all to sociology. In psychology the concern is with individual ability and performance; in education it is their acquisition; in sociology it is their institutions.

Some philosophers shift their concern from knowledge to recognized skill and proficiency. Interest in this stems from concern with the problem of knowledge: knowledge claims are more questionable than skill claims. Obviously, knowledge involves skills. Even literacy is generally considered a skill rather than a knowledge, and it is vital for the acquisition of knowledge. Obviously, skill involves knowledge, it is goal-directed, and its application assumes some knowledge of ends and means. The paradigm is language: its acquisition is the mastery of a skill plus the possession of some knowledge.

This suggests to view knowledge as a skill, the skill of answering correctly some questions. It is a reduction of all knowledge to skill. It is an error: mathematics is rightly viewed by mathematicians as knowledge and by engineers as a skill.

Despite the popularity of the view of knowledge as skill, the study of skill is still neglected. Psychological and educational studies describe specific skills and techniques of their transmission and acquisition. General studies on knowledge and learning abound, but studies on skills in general are scarce. The reason seems obvious: skills as such are mere facilities. There can be specific knowledge about them, about mastery over them, and about their acquisition. More cannot and need not be said. So philosophers suppose that there is nothing to say about skills in general; to acquire and cultivate and exercise them is specific. This is irrationalism. Do not think, do! Act! Live!

This version of irrationalism is Hegel's. It was endorsed not only by his followers. Gilbert Ryle is known for his distinction between knowing that and knowing how. Michael Polanyi spoke of skills as of personal knowledge or as tacit knowledge, to stress that the skilled are able to transmit their skills in workshops but not to explain how. Polanyi is im-