SCIENTIFIC AND TECHNOLOGICAL REVOLUTION AND EDUCATION: IMPLICATIONS FOR COMPARATIVE STUDIES.

Zhang Ren-jie & Jin Shi-bo

Beijing - Shanghai
P.R. China

Scientific and technological revolution takes different forms and has different social implications under different social systems and in different economic and cultural development backgrounds. Thus, in discussing the influences of scientific revolution on education, one cannot make simplistic comparisons in isolation from the specific conditions of relevant countries. Nations of different social systems and different economic development levels should and could exchange their views and experiences in this regard. This is in the interests of international understanding and friendship, and in accordance with the requisites of our inter-dependent, internationalizing age. As for China, we need to know the outside world and benefit from all useful educational experiences while the outside world is, we believe, interested in understanding China.

We regard it a duty and a pleasure to talk about the positive and negative experiences of educational development in China. As is well-known, since the end of the internal turmoil during 1966-76, the Chinese Government has taken decisive steps in formulating and implementing long-term basic national policies of opening up to the outside world and enlivening the internal economy. Along with the major shifts in national political and economic life, studies in comparative education are attracting increasing attention in our country, and international exchanges are developing on a wider scale. The publication of Deng Xiao-ping's inscription "Education should be oriented toward modernization, toward the world, and toward the future" has led to nation-wide discussion on education issues, and educational circles responded actively to the ideas embodied in the inscription. Not long ago the Central Committee of the Chinese Communist Party issued a Decision on the Reform of the Education System, which called for the universalization of nine years of compulsory education, the transformation of the secondary education structure, the energetic expansion of vocational and technical education, and many other reforms of strategic significance. We are convinced that, in building a highly civilized, highly democratic, modernized socialist
power, the key factor is the supply of highly qualified manpower, and this manpower must be trained through appropriate education.

What are the challenges made on education by and how can we meet these challenges? What is the relationship between the revolution and education? How can the findings of the scientific revolution be applied to the field of education? Scholars not only in China but the world over are most concerned with these questions. We feel it a great pleasure to be here and to present some of our views on this issue from a comparative perspective and in relation to the situation in China today, and we cordially invite comments and criticisms from our colleagues present at this meeting.

I

The essence of scientific and technological revolution lies in the application of science in production and its change into productive forces and thereby the raising of the productive force to a new level. Science not only determines the direction of industrial and agricultural production, but also exerts great influences on education.

Thirty-five years ago more than 90% of adults in China were directly involved in agriculture and only 5% or so in industry. At present though over 60% are still in agriculture, the percentage of those in industry has risen to about 30%.

Fifty years ago more than 80% of adults in Russia were directly and indirectly engaged in agriculture and only 10% in industry. Now the former percentage is only 20% while the latter has risen to 60%, and the remaining 20% in other sectors.

These changes in the structure of social production are closely related to educational developments. According to the second national census of China in 1982, 4.417 million university graduates were trained during 1949-1982, and, if including the graduating class of 1982, the total rose to 6.02 million. Although the percentage of university-educated manpower in the whole population was only 0.6%, it was a great increase over that before liberation.

In terms of percentage of intellectuals in the work force, the field of education ranks first among all social sectors; intellectuals working in the educational field amount to 31.9% of all intellectuals
in the country. At present we have 902 full-time higher education institutions, an increase of 99 over 1984, with 1,385,600 undergraduates. In addition, adult higher education institutions enrol 1,292,100. At the graduate level, there were 56,500 master's and doctoral students in 1984, and 35,000 are to be enrolled in 1985, an increase of 12.1% over 1984.

However, despite these expansions, education in China still falls short of the urgent demands of the scientific and technological revolution and the diversified needs of the economic modernization drive of the country. On the one hand, the broad masses of young people aspire to a higher education, yet they face very high competition in the college-entrance examination, the difficult situation being like thousands upon thousands of soldiers and horses competing for passing a single-plank bridge. On the other hand, China has a tremendous task in universalizing literacy and 9-year compulsory education and thereby improving the quality of the labour force. All these raise the question of how we can efficiently train the large numbers of qualified manpower badly needed by the present modernization drive and future technological society.

China is undergoing a major transformation of its educational system, with the aim of better orienting education toward modernization, toward the outside world, and toward the future, and better integrating the results of the social and scientific revolution in educational practice. We are much interested in the educational reforms going on in many other countries, for we fully realize that education has become a major global issue, that it will be quite impossible to completely solve education problems if a country tries to rely on its own material and intellectual resources in an internationalizing age of increasing interdependence, in which the development of human resources to a large degree means the improvement of education, information and knowledge.

We are therefore more interested in knowing more about theories and practices of educational reforms in other countries and about other educators' viewpoints in this regard.

In 1978 the Vice President of the Soviet Academy of Pedagogical Sciences pointed out, in his report submitted to 'the Seminar on the Future of Education and the Education for the Future' sponsored by the International Institute for Educational Planning, that modern technology implies new structures in production and is paving new ways for social progress. There will be profound changes in human living and working conditions prior to the 21st
century. Many studies have been made on the theme of "scientific and technological revolution and education". Much of the literature is concerned with the trends in technological development, but the influences of the technological revolution on education have not been related to social issues. In fact the positive influence of scientific revolution on education and the desirable development of man depend upon the interactions between scientific, technological and social progress and the personalization of the scientific revolution.

In 1981 Unesco organized a second seminar on "the future Development of Education". It was stated in the general report that, in discussing the complications of science and technology on education tomorrow, the concept of "science" must be interpreted in the broadest sense, that is, it must include not only precision science and natural science but also social sciences and humanities.

In 1983 the President of Erland-Nürnberg University of the Federal Republic of Germany, in his speech delivered at the International University Council held in Munich, emphasized again and again that when we put priority on technology, we should pay full attention to social and cultural development. He pointed out, "though developments in science and technology bring about great changes and promising prospects and though the rise of productivity is an essential goal for developing countries, the maladjustment of technological development to ethical values might cause a country the loss of national identity and culture and the damage of environment."

We share many of these viewpoints, and hold that scientific and technological revolution is a comprehensive and integrative process. Technological revolution means in the first place the raise of level of scientific understanding and creation but also the enhancing of human behaviour and the raising of the social development level.

The integration of natural sciences in the contemporary world has become a historical trend. Some well-known scholars in our country have always emphasized the necessity of avoiding one-sidedness and studying the issue from holistic and systematic viewpoints. Dr Qian Wue-sen, a famous Chinese scientist pointed out that we cannot take "science" merely as natural sciences, for "the formation of the productive force includes the organisation and management of the production system". Since economic and social development and technological evolution influence each other and are prerequisites of each other, and since what we study is a
total development strategy, the goal of development cannot be reached if due to attention is only paid to one or two aspects of development; even if some success is achieved it cannot be continued.

Many Chinese scholars, like Professor Qian Wei-chang, president of Shanghai Polytechnic University, also criticized the tendency in educational work to see material factors to the neglect of human ones. In modernizing our country we emphasize both material and spiritual or moral civilization. We put forth this requirement on the basis of our own historical experiences in building socialism in China; at the same time the phenomenon of moral decline in highly developed material civilizations of some societies has been brought to our notice and has aroused vigilance. As regards the influences of the scientific and technological revolution and their social implications, there seem to be two major schools of thought. One is "optimistic", which views scientific and technological progress as a universal, magic means of solving all social problems, or exaggerate the significance of technology and regard it as the only important factor in productivity. The other school of thought is "pessimistic", which predicts the inevitable destruction of mankind on the way technological civilization. We hold that these two kinds of ideas are somewhat one-sided. Both the positive and negative social implications of the technological revolution should be taken into account. Though we should be good at taking full advantage of the positive sides of technology, we should pay full attention to its negative effects and try to overcome them. It has become prevailing in China that science and technology are the key to our four modernizations whereas education is their foundation. Education must serve national development whereas development is dependent on education.

Therefore, in studying and trying to understand technological revolution and its multi-facet influences on social life including education, an all-round, integral evaluation and analysis should be made in close relation to the whole social process. Fantasies will not bring about a correct understanding of the nature of the scientific and technological revolution and a correct evaluation of the prospect of future development of the technological revolution and of the new possibility of human progress brought about by the technological revolution.

II

The scientific and technological revolution, together with the changes which it has led to in industrial structure and in the
content and means of production, has set new demands on the quantity, quality and knowledge structure of manpower. The rapid developments of science and technology are making new challenges to education, especially to educational values and systems. Though views are diverse on issues of educational reform and the ways to implement these reforms, there is so far one point which is becoming more and more self-evident and which most people agree upon, that is, a unitary educational system will not be able to meet the diverse needs of technological revolution and national development. The educational system must be diversified, and, under conditions of technological development, students must be trained to develop adaptability, creativity and other capabilities. These cannot be achieved by increasing the learning load or prolonging the length of study. While making a series of reforms, more opportunities must be provided for second-chance and third-chance education, thereby gradually making the whole society a learning society. This process will involve many changes in educational ideas and values and corresponding transformations of educational systems, content, and methods.

Furthermore, education itself is a system in which every kind and level of education relies on the coordination of all levels of education for its full functioning. In China, the development of primary, secondary, and higher education was unbalanced. On the one hand, curricula in secondary and primary schools have not been kept up to date to new advances in science and technology; on the other hand the structure of higher-education and programmes are not in accordance with economic and technological development needs. That's why we are making major transformations and reforms in our educational system.

If we examine the history of educational development in the Third World countries after the Second World War, it can be seen that there have been two major strategies in dealing with the internal relationships within the education system. One of them is giving priority to the development of higher education and, to a lesser degree, secondary education, while the other is giving priority to universalizing primary education. However we notice that many developing countries, though facing a tremendous task in promoting basic literacy and primary education, lay more stress on secondary and especially higher education. The reasons for this might be two-fold. First, there was a prevailing idea in the 1950s and 1960s that the more education an individual had, the more easily he/she could find a job, especially one which was not accessible to those with less education, and therefore the higher the economic benefits of education to the individual. Thus people
demanded more and higher education, leading to an increasing social pressure for more higher education. Today, as stated in the book Education Today for the World Tomorrow by Charles Hummel, people notice that, generally speaking, the shortage of qualified manpower is still a factor impeding their development. The over-development of higher education in some developing countries which still have an urgent task in universalizing literacy and primary education is not based on the demands of economic and technological development in these countries but is the result of the governments' concessions to the social pressure for more higher education.

Secondly, it is often thought that higher education has greater social economic benefits than secondary and primary education, and therefore many authorities are more willing to develop higher education. However, a number of existing studies show that primary rather than higher education has more social/economic returns. The conclusions derived from these studies would mean that the above-mentioned educational policy should be reoriented and the priority of development for developing countries especially shifted from higher to primary education. Unfortunately the Third World is not progressing in this direction.

It is evident that, in comparative studies on the new demands for manpower set forth by the technological revolution, attention should be paid to distinguishing practical experiences of other countries from objective laws governing the development process. Although the technological revolution has put new demands on manpower needs, it will be groundless to regard the expansion of enrolments and graduates of higher education institutions as the main necessity made by the scientific and technological revolution. Similarly it seems oversimplified when some study reports in our countries propose a fourfold expansion of college enrolments merely because the gross national product is scheduled to be four-times as high by the end of this century as that in 1981. We hold that integral and systematic thinking should also be applied to this kind of issue.

In light of the situation in China and the findings of relevant studies abroad, it seems that, in discussing the demands put forth by the technological revolution on manpower, it is more urgent and important to give priority to the adjustment of the structure of specialized education programmes and of multi-level manpower than overdue stress on quantitative expansion. For example, in the field of forestry, China has graduated only over 30,000 college students since its liberation in 1949. According to statistics of the Agriculture Ministry, China has 1.490 million mu
(9.93 million hectares) of cultivable land, 1.830 million mu (12.2 million hectares) of forest, and 3.300 million mu (22 million hectares) of usable grassland. Accordingly there is only one college graduate in the field of agriculture for every 6,000 mu (400 hectare) and one in the forestry for every 45,000 mu (3,000 hectare) of forest and usable grassland. In the field of finance and economics, China had only over 40,000 college graduates in 1979 while there were 400,000 factories, mines, and other enterprises. This means that on an average for every enterprise there is less than one college graduate in the field of finance and economics. These statistics illustrate the maladjustment in specialized education programmes. In terms of levels of manpower education, there also exists in China a maladjustment of mid-level and high-level personnel because of the slow development of secondary technical education. According to the National Statistics Bureau, there are more college graduates in fields of engineering than those from secondary technical schools. Many facts have shown us that the wastage and loss resulting from the above two maladjustments were not less than those from the shortage of qualified manpower. That's why it has become an urgent task for us to adjust the ratios of manpower of different fields of study and at different levels.

Along with increasing information, most countries are paying more and more attention to applying information technology in schools. Statistics showed that in 1983 in the USA there were one or several micro-computers in 85% of senior high schools, 77% of junior high schools and 62.4% of primary schools. About 30% of schools made use of computers in instruction. In Britain, 5,500 secondary schools have been equipped with one or several micro-computers, and more than 50% of primary schools have had computers. The Government of France is planning to popularize computer education in senior high schools by 1986 and in junior high schools by 1988. In Japan some secondary and primary schools have been selected for experiments in extra-curricular computer education. In the USSR instruction in computers will be begun in the 9th grade from September 1, 1985.

In recent years China has also been active in promoting modernization of instructional technology. The progress in this respect is more obvious in large cities such as Beijing and Shanghai. For example in Shenzhen High School "computers" has become a compulsory course for all senior high and some junior high students. The school purchased 40 computers and allocated 5 full-time teachers for the instruction of that course. There are three computer rooms, one language laboratory, and one video-recording room. The students devote two periods to the course
every week, one for theoretical instruction, and the other for practice.

III

In exploring educational aims, content, methods and technology, and relevant models for tomorrow, nearly all countries take the needs of the "information society" as a guiding principle.

In building a modernized socialist country, we fully realize the significance of understanding our national conditions. Our goal is to establish a socialist education system with Chinese characteristics. While we observe the objective laws of the educational process itself, we will pay close attention to world trends and adapt experiences of other countries to Chinese conditions. From our own experiences, the development of education is not only a response to the needs of technological revolution but mainly a reflection of the development of social productive force and the changes in social relations. The challenges facing education are mainly the information explosion of scientific knowledge and the changes in economic and political life. The essence of these challenges lies in whether education can train qualified manpower of appropriate quantity and quality in accordance with the needs of national development.

As regards this issue we would also like to present some of our viewpoints for the comments of experts and scholars from other countries.

First, one fundamental change in education is that of educational ideas. Since industry, agriculture and commerce, based on new technologies, are knowledge-intensive, the future society not only needs a large number of experts, but also demands of ordinary workers the combination of physical labour with mental labour. Therefore basic education should be further strengthened while attention is paid to the necessary development of higher education. There should be a diversified multi-level, multi-format system of education. For this system to be fully functioning there must be relevant changes in people's outlook on education. As in our country, there are still some people who emphasise production to the neglect of education and science. Therefore the leaders of our country stress the necessity again and again of valuing knowledge and talents.

Secondly, no matter how rapid the technological innovations are, people will have the necessary adaptability to adjust to the
changes in technology so long as they have a solid, sound education in basic knowledge and solid training in basic skills. It is a one-sided, wrong view that in a technologically developed society it is necessary only to learn math, physics, and chemistry, not social sciences and humanities. It goes without saying that the number and content of basic courses are always changing. In view of the needs of social and technological development, new advances in science and technology should be incorporated into curriculum and textbooks, those out-of-date or minor materials omitted, and new courses added or new implications given to existing disciplines and courses. In addition to "electronic computers" as an additional feasible compulsory subject in secondary and primary schools, foreign languages should be given more importance, for production in a technologically developed society production is often international in nature and the open-door policy of our country also demands better learning of foreign languages for a better understanding of social, economic and technological developments abroad.

Thirdly, in order to adjust to the drastic increase in knowledge and rapid change of technology, the personnel needed by the new age must be capable of processing a large amount of information, that is, continuously and independently collecting and communicating information, and making innovations. Many secondary and primary schools in our country are organizing various extracurricular activities of out-of-school activities, which are called in China "the second classroom" or "the second information channel".

Fourthly, the "information society" demands that teaching, research, and production in universities and colleges be made into "allies". The over-emphasis on basic research in academies and the artificial divorce of basic, applied, and development research are increasingly challenged by the scientific and technological revolution. Practice has proven that it is both feasible and efficient in our country to establish and develop various forms of "combinations" or "allies" of teaching, research, and production between higher education institutions and industrial enterprises. In recent years "research-production entities" in China have made new developments. Statistics show that in 1983 more than ten universities and colleges set up thirty "teaching-research-production entities". Since the Patent Act was effected in April, 1985, universities and colleges which are under the direct administration of the Education Ministry have obtained patent rights for 629 technological inventions and innovations, amounting to 24% of all patents in our country. The application to production of research carried out in these institutions in recent
years has brought large amounts of profit. There were 153 research projects, each of which resulted in more than one million yuan of annual economic return, and 40 projects among them each produced over 5 million yuan, totalling 810 million yuan of profit. This year these higher education institutions can recommend 1,912 items of technological innovations to 13 occupations.

Fifthly, it should be stressed that technological progress cannot by itself bring about fundamental changes in social values and ethical ideas. The problems of drugs, violence, and crimes will not be eliminated due to technological advances. We are aware that, when in the process of social, economic, and technological development in a socialist system, we must be on guard against the phenomenon of "spiritual poverty in an abundantly rich material society". One basic principle in our educational reforms is to lay the stress on both material and spiritual civilization and to train the young generation to be good citizens who have lofty ideals, high morale, solid education, and are disciplined, and who love their motherland and the socialist cause, are dedicated to the prosperity of the nation and the welfare of the people, and are enthusiastic in pursuing new knowledge and courageous in making inventions and innovations. What we are striving for is a highly developed civilization with education as its solid foundation and technology as an efficient means.