SCIENCE, TECHNOLOGY AND DEVELOPMENT

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- Importance of science and Technology for socio-economic development
- Comparison of the newly developed countries and Africa
- Science and technology as necessary but not sufficient factors for development
- Effects of high technology on the Third World economy
- The role of basic science in the development of science and technology
- Promotion of science and technology
- International cooperation

Role of scientific knowledge in development

Until recently economists considered land, labor and capital as the only important economic factors

Intellectual pursuits and knowledge were seen as unrelated to and without any utility for concrete things.

It is now recognized that scientific knowledge is more essential for wealth creation of nations today than either capital or land

Unique property of knowledge

Physical resources like energy and materials are mostly depleted when utilized

On the other hand knowledge is inexhaustible

The more people have access to knowledge the more knowledge is produced

Professor Freeman J. Dyson, of Institute of Advanced Studies, Princeton, in his book "*Infinite in all Directions,*" had this to say about Technology:

> "*Technology is a gift of God. After the gift of Life, it is perhaps the greatest of God's gifts. It is the mother of civilization, of Arts and of Sciences. Technology continues to grow to liberate mankind from the constraints of the past. The most revolutionary aspect of technology is its mobility. Anybody can learn it. It jumps easily over barriers of race and language. And its mobility is still increasing.*"

On science and technology depends the standard of living of a nation whether in

agriculture
food production
good health
good housing
communication
better roads

Technology changes were more important than changes in capital and labor during the growth of US economy in the first half of the century

In the 1940's and 1950's a full 20% of US economic growth stemmed from research and development

Using science and technology 3.5% of the labor force in the north are in food production

In Africa because of lack of scientific and technology input 70% of the labor force are in food production and yet cannot produce enough

The widening gap in the economy between the north and south is essentially a manifestation of science and technology gap

The Newly Industrialized Nations

Hong Kong
South Korea
Taiwan
Singapore

Had the same economic conditions as many African countries

South Korea and Ghana in the 1960's had per capita GNP of $230

South Korea is now ten times more prosperous than Ghana

Both had a colonial history

Why South Korea is successful but not Ghana

In 1960's

Ghana government was Marxism oriented

The economy was centrally planned

There was a national commitment to science and technology

Literacy was low

South Korea had a free market economy

There was a national commitment to science and technology

Literacy was high

Literacy rates in some Southeast Asian countries in 1990

Japan 99%	China 77.7%
South Korea 96%	Taiwan 90%
Singapore 90%	Malaysia 78.4%

Literacy rates in some African countries

Ghana 60.3%	Sierra Leone 20.7%
Kenya 69%	Tanzania 43%
Uganda 48%	Senegal 28.6%
Zaire 38.2%	Burkina Faso 18%
Nigeria 50.7%	Togo 43%

This low literacy in subsaharan Africa explains

the poor agricultural and industrial productivity
lower standard of living
lower life expectancy

Adult Literacy Rate and Living Standard in 1990

	Percentage of Adult Literacy Rate 15 years and over	Life Expectancy at Birth in years	1990 GNP per Capita in US Dollars
Japan	99	76.1	28,220
Singapore	90	72.3	12,890
Taiwan	92.8	71.8	10,196
Hong Kong	88.1	75.1	16,500
Malaysia	78.4	69.0	2,490
South Korea	96.3	69.0	6,340
Nigeria	50.7	50.8	320
Ghana	60.4	54.2	440
Cote D'Ivoire	53.8	54.0	700
Ethiopia	4.8	45.4	110
Togo	43	54.0	390

Number of scientists and engineers per million of population (1989)

Japan	3,548
US	2,685
Europe	1,632
Arab states	202
Asia (minus Japan)	99
Africa	53

Why low literacy rates in Africa

Lack of adequate funding of education
particularly at primary and secondary levels

The expenditure for primary and high schools in 1988 was $70 per people in Africa

In developed countries it was $1,980 per people

Traditional and cultural practices

Lack of foreign exchange

Lack of trained teachers

In the field of higher education in 1988

South Korea with a population of 43 million had
1.4 million in higher education

as many engineering students graduating from their institutions as in the United Kingdom, West Germany and Sweden combined

Ethiopia with a population of 55 million had
26,000 students

Nigeria with a population 95 million had
335,000 students

Ghana with a population of 16 million had
9,000 students

Kenya with a population of 28 million had
88,000 students

Senegal with a population of 8 million had
23,000 students

Some of the major factors for the rapid economic growth in the southeast Asia are

- Good education
- High literacy rates
- Strong scientific and technological base
- Free market economy
- National commitment

It is essential to have a high literacy rate and technology know-how for socio-economic growth

They are only necessary conditions

They are not sufficient

Compare Russia under Marxism, South Africa under Apartheid

They had a high level of literacy and scientific knowledge
Because of lack of free choice and competitive market they were unable to translate their knowledge into socio-economic development of their people

Compare the free market economy of the newly industrialized countries (Taiwan, Singapore, South Korea, Hong Kong) and Marxist states in the same region (Burma, North Korea, Vietnam, Cambodia)

Effects of high technology on the economy of Third World

Negative impact on economies of some countries that export raw materials

Photonics will have economic repercussions for countries like Zambia, Zaire and Zimbabwe whose economy is based on copper

Genetically engineered cocoa, palm oil, coconut oil will make developed countries undercut what is a vital cash crop for several developing countries

Positive impact will outweigh any negative impact

The Role of Basic Sciences

Basic Sciences:

Physics
Biology
Chemistry and
Mathematics

form the foundation from which Applied Sciences, Technology and Engineering are built.

Without a proper foundation in basic sciences it is very difficult if not impossible to achieve a sustainable scientific development

At an international conference in Sweden in 1995, the following declaration and Recommendations for Action were made on basic sciences:

> a foundation in basic science is essential for all research in the applied sciences and for long-term support
>
> adequate funding for basic sciences from domestic support and external aid programs
> is necessary to ensure that such a foundation exists for appropriate technology and specific fields of applied research and quality is maintained at all levels of education
>
> support to development oriented research in the Third World should include emphasis on the basic sciences
>
> a strategy for support to the basic sciences should be articulated by each developing country and
>
> research questions within the basic sciences must be chosen judiciously with the future needs of the specific country in mind

Decisive technical progress in science has been made without a defined particular aim

“1. One might ask whether an electronic industry could exist without the previous discovery of electrons by people like J. J. Thompson and H. A. Lorentz.

It did not happen that way.

2. One might ask whether basic circuits in computers might have been found by people who wanted to build computers. As it happens, they were discovered in the thirties by physicists dealing with counting of nuclear particles.

3. Or whether in an urge to provide better communication, one might have found electromagnetic waves. They were not found that way. They were found by Hertz who emphasized the beauty of physics and who based his work on the theoretical considerations of Clerk Maxwell.

4. One might ask whether there would be nuclear power because people wanted new power sources or whether the urge to have new power would have led to the discovery of the nucleus. Perhaps - only it did not happen that way, and there were the Curies and Rutherford and Fermi and a few others.

5. One might ask even induction coils in motor cars might have been made by enterprises which wanted to make motor transport and whether then they would have stumbled on the laws of induction. But the laws of induction had been found by Faraday many decades ago.

6. Certainly, one might speculate idly whether transistors might have been discovered by people who had not been trained in and had contributed to wave mechanics or the theory of electrons in solids. It so happened that the inventors of transistors were versed in and contributed to the quantum theory of solids."

“If solar energy is to provide the solution to the world’s fuel crisis, that solution will not emerge from low-technology roof top radiators - which rely on nineteenth century science. A breakthrough will come from applying quantum physics, biochemistry and other sciences of the twentieth century. Today’s technology - based industries all depend on new science.”

How to promote science and technology in a community

Adequate funding

Creation of favorable science and technology environment

National commitment

Popularization of science

Informal science education to educate children, parents, politicians, etc.

Usage of modern communication technologies including cyberspace, computer-aided education and distant education to reach more people

Importance of science and technology journalists

Exploit fully the potential of the mass media, particularly films, video, radio and television

The Edward A. Bouchet Institute

An association of scientists formed by African physicists affiliated with the ICTP and the National Society of Black Physicists (USA)

The aim of the Institute is to provide African physicists and Black American physicists with an arena in which to:

share their research results

discuss current topical issues in physics, mathematics (and fundamental sciences)

give rise to mutually beneficial collaboration and continuing relationships

To accomplish the objectives, the following program has been planned:

From Africa to USA:

Visiting Scholars

Extended visits of African physicists to the institutions collaborating with the Black American physicists will be arranged.

Student research facilitations and guidance

Advanced graduate students matriculating at African Universities will use facilities for their Ph.D. degrees. After the stay with the American co-mentor, the student should return to the home institution and complete the work on the dissertation.

From USA to Africa:

Visiting Lecturers

The Black American physicists participating in this program will establish a continuing collaboration with the African host for a period of at least two or three years. This collaboration will include several visits to the African hosting institute for lectures and discussions with the faculty and students.

Equipment transfer

As part of the continuing relationship between the American physicists and the African recipient, responses to specific requests for equipment by the African host institute will be developed.

The Edward Bouchet International Conferences:

A series of biennial international conferences to be held in one of the African countries is planned. The purpose is to provide a vehicle to continue to effect and to institutionalize the collaboration between African and Black American Physicists, as well as to disseminate scientific results and to develop new ideas in the current frontiers of science.

Since its inception the institute has held

two activities in the USA both in Atlanta in 1992 and 1995

one activity in Trieste, Italy in 1988

three activities in Accra, Ghana in 1990, 1995 and 1996

There has been a number of exchanges of professors and students between USA and Africa

Conclusion

- Science and technology are necessary but not sufficient for socio-economic development
- A free market environment is essential
- There should be a national commitment
- There should be a good basic education
- Funding for research should not be regarded as cost but as an investment
- Need for international cooperation in science and technology development
- Developed countries should minimize funding for food aid and subsidy for arms
  But increase funding for education, science and technology