The Challenges Facing Science Education in Developing Countries and the Way Forward

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Abstract: ***The differences in the scientific and technological infrastructure and in the popularization of science education in the developed and developing countries are the most important causes of differential social and economical levels in the two groups. The paper looked at the challenges facing science education in the developing countries and the way forward. It examined the development of science education in developing countries and contribution of science education to development. It also highlighted the challenges of science education in developing countries. The paper outlined some of the ways of addressing the challenges which include among others; the need to regularly renew and design the science curriculum to make it more practical and market oriented to produce skilled and highly educated graduates for the private sector both at home and abroad instead of traditional civil services. The paper concluded that the social and economic growth of developed countries is dependent on an essential emphasis on education, science and technology visa- vee the basic problems of developing countries which include weak educational and scientific infrastructure, and lack of appreciation of the importance of science as an essential ingredient of economical and social development.***

Keywords: Science education, Science, education, Developing countries, Challenges, Qualified teachers

1. Introduction

Today we hear a lot about educational reform, but our quest for accountability has resulted in many cases in the abandonment of quality educational practices and, in their place, we see what appears to some as perpetual testing in the midst of a curriculum devoid of excitement and the uncertainty of genuine exploration (Ramanathan,1988). There are significant social and economic differences between developed and developing countries. Many of the underlying causes of these differences are rooted in the long history of development of such nations and include social, cultural and economic variables, historical and political elements, international relations, geographical factors. These, however, do not tell the whole story. The differences in the scientific and technological infrastructure and in the popularization of science and technology in the two groups of countries are the most important causes of differential social and economical levels. An essential prerequisite to a country's technological progress is early recognition of necessity of a good educational system (Arthur and sheffrin, 2003).Generally, the number of students taking science courses in developing countries is on the increase because of the governments' affirmative action to fund subjects' key to economic development although the percentage is still below the recommended 40%. Science education is believed to catalyze economic development (Kasozi, 2006).Over 6 billion people are alive today, but the wealthy parts of the world (developed) contain no more than 20 percent of the world's population. Many of the rest struggle for subsistence. Many in the developing countries exist on a level at or below that endured by peasants in ancient Egypt or Babylon.

Only within the past two centuries have ordinary people become able to expect leisure and high consumption standards, and then only in the world's economically developed countries. The richest countries with the highest per capita incomes are referred to by the United Nations as developed countries. These include the United States, Canada, most of the countries of Western Europe, South Africa, Australia, New Zealand, Japan, and a few others. The poorer states are referred to by the UN as the developing countries and include a diverse set of nations. Some, such as Vietnam, Argentina, and China, are growing very rapidly, while others, such as Haiti, Rwanda, and Sierra Leone are actually experiencing negative growth rates of real per capita income. Between these two is another group of nations, called the newly industrialized countries (NICs). They include South Korea, Singapore, Taiwan, and Hong Kong. These countries grew rapidly in the developed countries (Salam, 1998).

Developing countries, also known as third and fourth world countries; face economic challenges that first world countries do not face, on a large scale. Poverty, low literacy rates, poor investments in both human capital and domestic capital, poor nutrition and devastation to populations due to the HIVAIDS pandemic contribute to developing countries moving towards development (Ndubueze, 2011).

Looking at the current economic challenges facing developing countries coupled with the lack of enough creative scientific and engineering skills, it seems it is overdue to take a hard look at some of the challenges facing science education in developing countries and to suggest ways these challenges might be addressed. In the World, science and technology are growing very quickly but scientific and technologic development requires the development of science education (Shishido, 1983).

2. Development of Science Education in Developing Countries

Over the last 20-30 years worldwide, there have been many developments in science and technology. While some countries gave attention to science education, some of them have not. Because of the lack emphasis on science education, some countries (developing countries) could not develop sufficiently. In the past, science was taught as a dogma not as a systematic inquiry. Some superstitions that prevented development were common (Godek, 2004).

In many countries, only elite, minority groups, learned science because they were be able to continue their education in UK and the other industrialized countries. Science was secondary level taught also only to selected groups of school students because of the limited resources. It was accepted that only a few students have the special ability to learn and to benefit from science. Developing countries were borrowing syllabi from the industrialised countries (Black and Harrison, 1985).

After 1960s, some national curriculum units or centres were established, with the help of the industrialized countries for buildings, equipment and staff for example, in 1963 on one of the first national development centres was established in Sri Lanka. UNESCO supported science education development projects, programmes and institutions, for example; The African Primary Science Programme (APSP), The African Association for the Advancement of Science and Technology, The West African Association of Science Teacher were formed. They were linked to international networks such as; The International Council of Associations of Science Education (ICASE) (Godek, 2004).

The developments of developing countries were influenced by the industrialized countries. They started to change. Their textbooks, workbooks and teacher guides were re-written. Some countries renovated their pre-service and in-service teacher training and also their public examining and assessment systems. At the beginning such changes were only copying from the industrialized countries and Expatriate staff from the developed world imposed on developing countries not only their \professional knowledge but also their cultures. At the end of 1970s, however, some developing countries realized that they needed to indigenize their curriculum materials. Meanwhile, more graduate level scientists and technologists were required all over the world and in the 1970s-1980s for social and economic goals, developing countries tried to redistribute employment opportunities and reduce educational disparities for social groups (Black and Harrison, 1985).

In some countries female participation becomes as an important issue in science education. Developing countries wanted to reduce their dependence on imported expertise and technology, and to shift education away from an academic orientation towards extending scientific literacy to larger proportions of the population. It has been presented by Fensham as cited in Lewis and Kelly (1987: 67) that the new curricula emphasized the place of activity or laboratories and intellectual processes such as classifying, measuring, inferring, predicting, problem solving skills. Primary curricula set out to teach the basic conceptual ideas of science. Some progress was made but few of the attempts of developing countries could be developed sufficiently because of all kinds of inadequacies generally caused by economical failure.

According to Lewin (1992) in Africa, after independence, some countries' educational systems changed. UNESCO and other aid agencies provided them with some financial assistance, laboratory equipment, textbooks, films, slides, teachers, the training of curriculum specialists. In those countries, education changed from rote learning to inquiry activities, problem solving skills and from teacher centred approaches to student/discipline centred approaches, more subject integration, less depend on traditional text books and more concern for the intellectual skills.

In Nigeria the change was from "Universal Primary Education (UPE) to Universal Basic Education (UBE). In Uganda the change was from "job-seekers" to "job-makers". In Tanzania "Education for self reliance" has been emphasized. Other African countries have emphasized "the dignity of labour", "rural transformation" and "rural integration". All countries gave some scholarships for science courses and teacher training their technological scientific skilled work-force outcome increased. From the 1970s the opportunity to study science has increased from primary to university level (Ogunniyi, 1986).

Additionally, there were two important movements. One of them was "The Environmental Movement". After 1970, almost every country became interested in environmental problems such as atmospheric and water pollution, soil loss, resource destruction, endangering of species. The other one was Science and Society or Science, Society and Technology (SS & T). Some countries emphasised social aspects of science because in Fensham's opinion as cited in Lewis and Kelly (1987) "society and all its citizens need to be much better informed and aware of the great contribution that science has made to human happiness and social well being, and need to be better able to distinguish science's potential for good outcomes from its reputation for evil ones."

3. Contribution of Science Education to Development

The practical use of science through technology created the climate for ever increasing emphasis on the pursuit of science and education in developed countries, where funding scientific enterprises is widely accepted as a vital and long-term investment. What is emerging from this priority is the close association of education and economical growth. Accelerating the rate of growth and rate of productivity can basically be accomplished by stimulating and supporting scientific education in universities by stimulating and nurturing scientific and technical talent, and to the concomitant training of students (Sinclair, 1988).

According to Salam (1988) we live in a highly sophisticated world where everything is almost achievable. There would probably have been no changes between the world of today and that of three centuries ago if necessity and serendipitous discoveries had not driven men to achieve great things. Science education has had huge positive effects on every society. The world today has gone digital, even human thought. Our world has been reduced to a global village and is better for it.

The benefits of science education far outweigh every perceived shortcoming. Some of the biggest effects of science education are in the area of communication; through the internet and mobile phones. There is advancement of communication and expansions of economic commerce. Today we hear of information and communication technology (ICT). Any institution worth its name must have it in place to be really outstanding. Information technology has become boosted in today's generation; from the field of communication, business, education, and down to the entertainment industry (Bilsel, 1995).

Science education expands society's knowledge. Science helps humans gain increased understanding of how the world works, while technology helps scientists make these discoveries. Learning has maximized because of different media that are being developed which are all interactive and which bring learning experiences to the next level. Businesses have grown and expanded because of breakthroughs in advertising (Salam, 1987).

Modern science education has changed the way many companies produce their goods and handle their business. The idea and use of video and web conferencing, for instance, has helped companies remove geographical barriers and given them the opportunity to reach out to employees and clients throughout the world. In today's economy, it has helped companies reduce the cost and inconveniences of travelling, allowing them to meet as often as they could like without having to worry about finding the budget to settle it. Modern science and technology helps companies reduce their carbon footprint and become green due to the fact that almost anything can be done from a computer (Rajagopalan and Rajan, 1987).

To the extent that science education raises agricultural productivity, it should be the major factor in creating these positive effects. Advances in crop management technology have also occurred but these are often less visible and tend to be under-reported compared to the spread of new varieties, but these too have made significant contributions to increased agricultural productivity (FAO 2003).

According to Wilkerson et al. (2009) several educational shortcomings arising from the increasing pre-clinical / clinical divide soon became more apparent. Firstly, the delivery of basic science knowledge in medical education became driven more and more by the academic content of each discipline, as well as the research initiatives of the basic science teachers. Thus, much of basic science teaching focused on in-depth scientific facts rather than on the relevance of the discipline to and in the context of contemporary medical practice. Clinical teachers also complained that students seemed to have a poor grasp and recall of and, therefore, the inability to apply basic science knowledge, concepts and principles acquired in the preclinical years to medical problems encountered in the clinics (Pawlina, 2009).

4. Challenges Facing Science Education in Developing Countries

Industrialized countries are giving emphasis to science education some non industrial countries are not able to succeed, because of deficiencies such as curriculum, inadequate resources, shortages, etc. The rapidly changing socio-political conditions and attendant contradictory educational policies, Lack of adequate textbooks, reading difficulty of the textbooks, Lack of co-operation between school administrators, Overcrowded classroom, laboratory and arranging the time table, Lack of motivations among the teachers, The rapid rate in which teachers are transferred from school to another or out of profession, The use of archaic teaching methods, Poor implementation procedures, Lack of clear-cut goals, Prevalence of superstitious beliefs, The general lack of reinforcing home environment, Labour shortages, The lack of scientific and technologic qualified staff, Inadequate national policies, Inadequate problem diagnosis, Lack of skilled curriculum developers, Ineffective planning, Economic uncertainty, Rapid technological change, Enrolments rising faster than national income, Educational expenditures per child have declined to levels below Altbach et. al. (1989).

The social and economic growth of the developed countries is dependent on an essential emphasis on education, science, and technology. The basic problems of developing countries therefore, are the weak educational and scientific infrastructure, and a lack of appreciation of the importance of science as an essential ingredient of economical and social development. As such science education in developing countries is influenced by complex factors that have their roots in commercialization, general funding, and human population growth (David, 2009).

1) Inadequate Scientific Infrastructure

Inadequate scientific infrastructure is a critical factor which creates strong barriers to the path of advancement in developing countries. The critical size of human resources and infrastructure, and the amount of investments in these areas, illustrates how science and technology are of neglected importance in developing countries. Industry and universities in Turkey face shortages of researchers-10 for every 100,000 of population compared with 280 in US, 240 in Japan, 150 in Germany, 140 in the UK. In 1984, in Turkey non-defence research expenditures were 0.20% of GNP, while in the US they were 2.74%, 2.65%in Japan, and 2.54 %in Germany. Thus, developing countries have principal shortcomings in their funding and supporting scientific infrastructure (David, 2009).

Another indicator of how science is of neglected importance in developing countries is that most of these countries fail to stress that, for long term effectiveness, technology transfer should always be accompanied by science transfer. From the simplest to the most highly complex industrial products are based upon the rapid advances and accumulation of scientific knowledge in various related areas (Kahn, 2008).

2) Shortage of Qualified Teachers

Each student need to have access to highly qualified teachers. And yet, in the areas of mathematics and science, such teachers seem to be in short supply. This challenge has become so severe that some countries are importing qualified teachers from other nations. "The strongest influence on the performance of students in a class is whether they have a teacher with a bachelor's degree in the subject they teach." Getting students through college in the sciences and engineering is a challenge that affects the pool of qualified teachers. The need to encourage teachers to work in the sciences must cut across all those interested in a future in education. (David, 2009).

3)Inadequate Teaching and Learning Materials

Hands-on science education seems to be in short supply in our schools. Science instruction at all in the heart of developing countries' technology enclave should be taken as a serious wake-up call. Even in classes where science is being taught, too much of it seems limited to lectures based on textbooks.

The major benefit of doing actual experiments comes from observing those inevitable Variations in experimental results from those predicted by theory. Experiments also allow students to observe non-intuitive phenomena they can then study in the course of resolving the gap between their intuition and the underlying physics or chemistry of an experiment. In this setting, a well-equipped laboratory can take advantage of versatile probe-ware and handheld devices to capture real data that can be transferred to a computer for further analysis and inclusion in a report. In other words, students benefit when they do science, not just learn about science (David, 2009).

4)Lack of Adequate Practical Exposure

It seems that too much science instruction is based on imparting a body of knowledge to the students and then having them apply this knowledge to some pre-defined problems (complete with answers in the teacher's edition of the text!) The process of having students explore new questions on their own falls outside most State standards, and thus gets left out of the curriculum. Students are expected to use a foundational knowledge of a field as a springboard to asking (and answering) their own questions. To start with, this is what real scientists do – they spend their lives answering questions that they ask of themselves. This move to a more student-directed approach which in turn promote acquisition of scientific skills. To start with, there is still a need for basic knowledge to be shared. The challenge comes in finding the place for teachers to stop lecturing and the open the class up to student designed projects based on questions they ask themselves. To assist in this process, there is a rubric students can apply to their own questions to evaluate if they are worth spending time on to answer (David, 2009).

5)Curriculum Deficiencies

It should be noted that there are many factors that have a negative effect on curriculum implementation, it has been observed that, the nation's economy plays a vital role in as far as the implementations of the curriculum is concerned. The availability of all resources required in the education system to facilitate effective teaching and learning processes depend on the money available. To a larger extent even the learner's well-being in terms of good health and nutrition is also determined by the nation's economy (Okello and Kagoiren, 1996).

In addition, Weaver (1964) as cited in Ogunniyi (1986) remarked that in the Western region of Nigeria "...the type of science education could not prepare students adequately for future careers in science". Most developing countries spend a lot of money on their education systems but their poor planning and implementation procedures prevented their development. The scientists of developing countries publish their findings in international journals because international journals provide them with more prestige than their local journals, and consequently their developments in science stay abroad and they cannot benefit from them (Altbach et. al., 1989).

5. The Way Forward

In developing countries, science education is recognized as a key force for modernization and development. This has caused an increase in the demand for its access, accompanied by a number of challenges. The quality of science education in developing countries is influenced by socio–cultural, academic, economic, policy, political and administrative factors all of which are inextricably interwoven. Quality is an issue that cannot be avoided in education at present and what institutions do to ascertain quality turns out to be most important and effective of all efforts and initiatives (Okwakol, 2009).

Salam (1988) states that science in developing countries has been treated as a ``marginal activity" and perceived even as an ``ornament." Indeed, most of the developing countries do not realize that their situation can only be rectified with the infusion of modern science and technology into their societies. Although some of the developing countries are aware of the importance of science and technology, this awareness does not necessarily make it easy to develop, and popularize science.

In order to make a realistic plan, not only a vision, but also scientific leadership, and investment in scientific enterprise both by government and private sectors are required. Short-term financial considerations in investment decisions that have been observed so far in developing countries will always be more costly and time consuming.

The institutions for scientific education and research oriented, professors, well-equipped laboratories, modern libraries and archives within these institutions, constitute the minimum requirements of a scientific infrastructure any developing country must provide for. In order to establish this infrastructure then, the support and funding for universities should be increased.

The science policy in a developing country should be determined in collaboration with the government, universities and industry. This collaboration should take into account technological needs, resources and practices. For this purpose, government efforts must be addressed to establish an industry-university cooperation to communicate technological advances to potential users.

As Salam (1995) says, developing countries which plan to have a rapid economic growth should first consider if they have provided ideal opportunities for their high-level scientists and nurtured their talents for the nations' well-being. Furthermore, these countries must ensure the economic and social well-being of their scientist and provide an attractive and well equipped research environment to their migration to countries with enriched scientific and social opportunities. Science education should be identified as a major source of economic growth and a means of addressing important social problems as well.

In developing countries economic growth can mainly be enhanced by a science education. However, science can play a role in development only when the integrity of the whole enterprise-research institutions, universities, publications research priorities and emphasis and the education of creative scientists, as well as those active in science is preserved. Thus, the simplest strategy in developing countries is first of all, to increase the percentage of GNP that is to be devoted to universities and research institutions.

Developing countries should understand the fact that perceiving investment in sciences as a time-consuming, wasteful and costly activity will bring further limitations on their economic growth. Political decision on the part of those who decide on the future of developing countries to take proper steps toward creating, mastering and utilizing the resources of science education (salam, 1988).

There should be effective supervision of all institutional services and facilities: the teaching process, medical, water and power supply, handling power supply, handling of results and other records. Create more teaching space and recruit more staff so that students are put in small manageable groups.

There is need for constructive transfer of science education to the local community if they are to become more efficient. The partnership may be in the form of knowledge networks, or transferring academic knowledge into industrial and socially relevant applications. (Okwakal 2009).

There is need to regularly renew and design the science curriculum to make it more practical and market oriented to produce skilled and highly educated graduates for the private sector both at home and abroad instead of traditional civil services.

6. Conclusion

In conclusion, the social and economic growth of the developed countries is dependent on an essential emphasis on education, science, and technology. The basic problems of developing countries therefore, are the weak educational and scientific infrastructure, and a lack of appreciation of the importance of science as an essential ingredient of economical and social development. As such science education in developing countries is influenced by complex factors that have their roots in commercialization, general funding, and human population growth. Appropriate policies and homebred professionals (both academic and administrative) are necessary for improving the quality of science education in developing countries.

7. Recommendations

In view of the above challenges and solutions the paper recommends the following;

1. The funding of the institutions should be improved to enhance effective teaching and learning of science education as it is the bed rock of all other facets of development in the society. When funding is taken as a prime issue and government agencies have been established to foster and sponsor science programmes such as conferencing, workshops, seminar etc. it will go a long way in improving the quality of instruction in our schools.
2. Since teachers are considered as pivot on which achievement mechanism of any educational objective revolves therefore, there is need for government to embark on massive training and retraining of science teachers particularly at the grass root though in-service training, conferencing, seminar and workshops.
3. The government should provide enough infrastructural facilities through partnership with the private agencies who can also be good contributors.
4. Equipment are central to effective teaching and learning of science as well as vital in promoting the development of scientific attitudes and skills as such enough and well equip laboratories should be provided particularly by the government to enhance effective teaching and learning of science
5. Library with current and enough text books should be provided at all levels of educational systems. Where they are not available they should be provided to give students opportunity to carry out research on their own and consult in case they want to update their knowledge.
6. In view of this, curriculum developers, adopters and implementers should be mindful of destructors such as these and address them adequately in order to minimize the impediments to curriculum implementation in learning institutions.
7. The science policy in developing countries should be determined in collaboration with the government, universities and industry. This collaboration should take into account technological needs, resources and practices. For this purpose, government efforts must be addressed to establish an industry-university cooperation to communicate technological advances to potential users.
8. Political decision on the part of those who decide on the future of developing countries to take proper steps toward creating, mastering and utilizing the resources of science education.

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