

# Mini review on importance of education and training in science, technology and innovation in developing countries

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## Abstract

Research in higher education in regard to technology should contribute directly or indirectly to the satisfaction of the basic needs such as food, clothing, health and education for the broad masses of Ethiopia. Unemployment is a great problem particularly in developing countries including Ethiopia. Of course, every country in the world striving to face with the limitations of the wage employment and public sectors and is turning, either by plan or by plain force of need, to the informal sector and self-employment to help address the unemployment problem. Therefore, for increasing productive employment the remedy would be by boosting the science and technology strategy. Moreover, research should be carried out to generate and adopt environmentally sound, socio-economically relevant (appropriate) technology. The research in higher education should also probe into the methods of carrying out effective teaching by combining theory with practice and teaching with production. The strong industrial and academic origins, therefore, necessitate continued interactive relationships in order to sustain the future growth of this rapidly emerging high technology.

## Introduction

Developing countries including Ethiopia are being increasingly involved in the promotion of science and technology which is enabling biotechnology to make advance in various parts of the world [1]. General advancement in biotechnology in developing countries can be made through partnerships with other industrialized countries [1]. Provision of a sound infrastructure in education and training can give opportunities to realize the high potential of biotechnology thereby involve to share in the benefits of improvements in economic growth and the quality of life.

The creation of a strong workforce depends on a sound educational provision in schools. It is vital to give much more attention, at the school level, to generate interest in science and technology and to provide a sound education and training in the basic skills. This then provides opportunities for progression either to immediate employment or to technical or higher education. Practicing biotechnologists can also play an important role in supporting education in schools and in teacher training by providing appropriate support in the form of advice, materials and equipment in collaboration with the teachers.

The categories of trained staff needed in research, development and production extends widely from technicians to scientists, all of whom require appropriate training for the specific skills needed. There is also a need for industry to appreciate the value to its commercial success of sustaining the morale of the workforce and retaining the services of employees.

Strategies used in more developed countries for promoting the understanding of biotechnology among the general public in order to address the anxieties which are inevitably associated with the introduction of unfamiliar technologies, particularly gene technology should also be taken into consideration to establish thus biotechnology for developing countries as well.

There is an immediate need in developing countries to recognize the increasing dependence on technology by focusing on the provision

of adequate supplies of basic skills. As an example, in fermentation, it is desirable to promote the successful development of indigenous industries, to reduce pollution from industrial waste, and to improve the use of resources [1]. Fermented dough can be made into bread, as in Injera and Kocho in Ethiopia. There is also a pressure to introduce the new skills required to support the establishment of gene cloning techniques and modern fermentation technology to enhance agriculture, healthcare and environmental protection.

In revolutionary science and industrial changes, science and technology has a paramount importance to contribute for socioeconomic development especially in developing countries including Ethiopia. Thus, economic development of a country depends on the growth of science and technology innovation. As an example, fermented dough can be made into bread, as in Injera and Kocho in Ethiopia. Dori reported that information handling capabilities constitute the nervous system of society [2]. It is the green light key to innovation and self-sustaining development, drawing the invention and adaptation of small entrepreneurs into national development effort. It is the conveyance that carries all development efforts in all practices of human effort.

## Promotion of public understanding of science and technology at out-of school scientific activities

It is that, before the development of out-of-school scientific activities, science education was stereotyped and traditional, cast in the mould of the teacher-pupil relationship of a bygone age. The

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coming of out-of-school activities, and their successful development, has brought not only enlightenment and delight to the pupils, but also to the teachers; and it has profoundly altered the attitude of both to the educational process.

According to UNESCO, the seminar considered the following out-of-school activities as constituting the field to be covered and it also adopted the following definitions of some activities: [3]

Science club – An association of young people advised by leaders and governed by rules constituted to promote among its members knowledge of science, the practice of scientific methods, and the development of activities tending to cooperate actively in the solution of problems related to science.

Science fair – A public exhibition of scientific work carried out by young people, at which the latter give explanations of and answer questions about their work, methods and conclusions. A jury judges the work on the basis of the knowledge, originality, scientific thought and skill in presentation shown.

Young people's scientific congresses – Events organized to give young people an opportunity to present, before an informed public, their reports on scientific work, on subjects freely chosen by each competitor, judged by a jury on the basis of their originality, creativity, knowledge and method to work.

Young people's scientific olympiads – Competitions involving knowledge and skills in pre-established subjects or fields.

Excursions – Journeys undertaken with young people to obtain data or collect material for study.

Science camps – Excursions to carry out local scientific work.

These definitions are in accordance with practice in Latin America. However, it may be profitable for Ethiopia to consider carefully the definitions in relation to their own practice.

## Research need for health and health systems

Although there are financial constraints for physical resources, the government has to look for how to keep expanding its human capital by educating more and more highly trained laboratory technicians and then supporting them at the research institutes. For example, the infant mortality in Cuba in 2008 dropped to below 5 deaths per 1,000 live births [4]. This was because they have been able to bring the necessary technology closer to all pregnant women and newborns.

Poor people, uneducated people and people living in marginalized neighbourhoods are more likely to get sick and to die than those who are better off. This tells us that everywhere efforts should be made to prioritize these people's health through prevention strategies, supported by appropriate technologies. In Ethiopia, for instance sustainable health depends more on health promotion and disease prevention than application of technologies for broad health coverage that are appropriate for the socioeconomic environment. Now the biotech industry has become such an important part of Ethiopia's international trade that new research centres have been started to facilitate new kinds of cooperation between universities and industries.

According to Son [5], Pharmaceutical Research and Manufacturers' Report, there are 633 biotech medicines in human trials or under review by the US Food and Drug Administration World Health Organization (WHO, 2010) [6] described that to combat against deadly meningitis outbreaks that announced it in Cuba and Brazil were ready with the

capacity vaccine in the world that effectively neutralizes the type B meningococcal bacteria.

The Cuban Center for Molecular Immunology outside of Havana has developed a number of promising anti-cancer drugs, including Nimotuzumab, a monoclonal antibody that has been proven effective in fighting neck, head, and brain tumors [7]. In addition, the Center for Genetic Engineering and Biotechnology produced a vaccine to fight hepatitis B, which had been responsible for a significant amount of liver disease on the island, and within eight years had completely eliminated all early childhood cases of the disease.

Detailed research is particularly required on the operation of primary healthcare services to determine how they can better provide effective, equitable, and accessible services and promote the health of the communities they serve. There is also an urgent need for more research to be undertaken on why available and affordable technology and knowledge are not used – for example, to prevent millions of children from dying of diarrhoeal disease and acute respiratory infections [8].

## Appropriate technology

Poverty and isolation of the village people make it difficult to practice expensive sophisticated technology. As an alternative every attempt would be made to use materials and personnel and labour appropriate to the local situation. Hospital equipment that is readily available and can be maintained easily would be used. An X-ray machine was needed to help in the diagnosis of tuberculosis or for long bone fractures. A simple X-ray machine powered by ordinary domestic current is sufficient for the purpose. This choice of appropriate equipment and technology considerably reduced the cost for the poor villagers.

## Biotechnology results

Biotechnology has a characteristic of manipulation of living cells and their related molecules for commercial purposes [9]. Biotechnology also produces innovations for biomedical sector [10]. Traditional biotechnology has been used for many years to bake breads, make cheeses, brew alcoholic beverages, and breed better crops and animals. On the other hand, modern biotechnology focuses on four main areas in healthcare: medicines, vaccines, diagnostics and gene therapy. Modern biotechnology also focuses on the modification of cells at the molecular level, for example, in genetic engineering there is a change in DNA molecule by removing, modifying, or adding genes to change the information it contains [9].

Today, biotechnology aspects cover such area of innovations as: energy, food and drink chemistry, chemical engineering, materials, environment, genetics, medicine and biotechnology applications [11]. Industrial biotech is a more specific segment of the biotech sector that includes any molecule that improves the products such as textile, paper, pulp, and chemical manufacturing in industry.

According to study by Harris, six factors were shown to converge for successful commercial innovation: 1) technological knowledge; 2) defined user needs; 3) existence of an advocate; 4) resource availability; 5) favorable risk factors; and 6) timing of the above factors [12].

Environmental biotech is used in waste treatment and to prevent and to remediate environmental pollution. In many cases this process is fairly simple; bacteria are inserted into polluted areas where the bacteria digest the polluted waste into harmless by products. After the bacteria decompose the waste materials, the ecosystem is restored to health.

In the future, biotechnology will be characterized by consolidation of small companies with large companies, immobilization and downstream processing technology will play important roles in commercialization, molecular engineering will yield improved products, and monoclonal antibody technology will lead to improved human diagnostics and eventual human therapy. With biotech methods *Escherichia coli* can be used to make insulin. Biotechnologies are being studied in gene therapies to explore treatments for cystic fibrosis, AIDS, and cancer. Biotech also used for DNA finger printing which is used to determine human and animal origins by geographical regions, as well as paternity [9].

### **Collaboration with industrialized countries**

The intensification of postgraduate training programs with regional missions and outlooks is considered to be a very worthwhile effort for Ethiopian universities. It is suggested that new collaborative schemes be developed with the newly industrialized and other countries.

School of Graduate Studies has made a remarkable progress by implementing various types of programs and producing graduates in various disciplines. This has led to increased research activities within the university. However, graduate training has to be started in a number of key fields. The expansion of such training in all fields and at all levels is a paramount importance because of its contribution towards enhancing the country's development efforts. A number of key issues have arisen with the increase in local graduate training programs. These include: a) evolving a sound and efficient management and organizational structure of graduate training and research, b) developing mechanisms for monitoring standards and evaluating programs of training and research, c) developing appropriate university-industry interaction for disseminating and applying research results, and d) fostering useful contacts and linkages with other universities.

### **Need of education and training for school-university-industry linkage**

Biotechnology is deeply grounded in fundamental science – because it is research based, biotechnology is much more deeply embedded the university system than many alternative disciplines such as information technology and engineering. Consequently, most of biotechnology's research is in university labs. Until recently, commercial organizations did not engage directly in basic research and universities did not engage in commercialization of knowledge to create economic value. The wall between research and commercialization – between universities and business – became much more porous with the passage of Bayh-Dole Act in 1980 because it enabled universities to capture some of economic value of publicly funded research.

Industries in Ethiopia, both large and small should have their own research and development laboratories headed by well qualified personnel. These industries should be placed to know the research capabilities of the universities. In those areas where applied research is crucial such as engineering and agriculture, there is a need to a built-in mechanism in the universities to ensure smooth interaction with industries. Research should help to increase production by solving practical and realistic problems faced by present industries in Ethiopia, as in agricultural processing plants. In the university there is a need to appoint to head such an applied research group with adequate experience relating to industries.

### **Capacity building for science, technology and innovation**

National innovation capacity consists of the capacity of scientific discovery, technological invention, commercialization, production

and marketing, and capacity of social diffusion and application among other sub-capacities. All these capacities synergize to promote national innovative development [13]. Moreover, the capacity for and the success of innovation are influenced by varieties of customers of innovation for example scientists, technologists, entrepreneurs, organizations (research institutes, universities, and social entities).

Science and technology school clubs can contribute immensely to science learning if established with clear plans of activity and sustainability. Students can practice the science they learn in class after school period of time or during weekends in the clubs. Making competitions among students with creative and innovative showings will motivate them and help to develop their skills. Integrating the activities of these clubs to community services and needs will be of much help to enhance scientific and technological development. Thus, the organization of school science and technology clubs in schools is of the most important to promote science and technology and capacity building efforts in the country.

### **Integrated skills training for self-employment**

In recognition of the role of small and micro-enterprises as the main vehicle for employment generation, and to further integrate women into industry, upgrade indigenous technologies and increase use of local resources, the government has initiated a number of measures to provide full support for the development of the enterprise sector.

### **Conclusion**

Science teachers and students in the universities have to be involved in order to improve technology and innovation knowledge and skill in our society.

Ideally, training the technology and innovation to students mean teaching them how to critically think, learn, and solve problems. This mini review shows the need of basic concepts of science, technology, and innovation for the community in developing countries.

### **The way forward**

Priorities for advances in education lie in strengthening the school sector, removing social and cultural barriers to work practices and enhancing interactions between scientists and decision makers. The main focus of training should be to enhance the exploitation of indigenous opportunities by introducing innovations, if necessary derived and adapted from appropriate technology and good practice in use elsewhere, this comprises improvements in the use of technology transfer [1].

There has to be ways to sustain continuing interactions among schools, universities and industries as rapid advances in education and training are vital to the success of biotechnology in developing countries as these days are a period of likely increase in dependence on technology.

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