THE DEVELOPMENT OF SCIENCE EDUCATION IN DEVELOPING COUNTRIES

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ABSTRACT

This study aims to determine the importance of science education, to present a brief historical development of science education and to analyse which factors are effective for its development.

This paper consists of three parts: The importance, aims, and objectives of science and technology education will be pointed out in the first part of this paper. Secondly, a brief historical development of science education will be presented. Then, some factors and reasons which can cause failure in science education will be discussed. Finally, some suggestions for development will be considered.

Key Words: *Science education, historical development of science education, developing countries.*

GELİŞMEKTE OLAN ÜLKELERDE FEN BİLİMLERİ EĞİTİMİNİN GELİŞİMİ

ÖZET

Bu çalışma fen bilimleri eğitiminin önemini tespit etmeyi, fen bilimleri eğitiminin tarihi gelişimini, ve bu gelişimde etkili olan faktörleri analiz etmeyi amaçlamaktadır.

Bu makale üç kısımdan oluşmaktadır: fen bilimleri ve teknoloji eğitiminin önemi ve amaçları birinci kısımda işaret edilecektir. Ikinci olarak, fen bilimleri eğitiminin kısaca tarihi gelişimi verilecektir, ve daha sonra, fen bilimleri eğitiminin başarısızlığına sebep olabilecek bazı faktörler ve bunların sebepleri tartışılacaktır. Son olarak da, fen bilimleri eğitiminin gelişimi için bazı tavsiyelerde bulunulacaktır.

Anahtar Kelimeler: *Fen Bilimleri ve teknoloji Eğitimi, Fen Bilimleri Eğitiminin tarihi gelişimi, gelişmekte olan ülkeler.*

1. Introduction

In the World, science and technology are growing very quickly but scientific and technologic development requires the development of science education. Science Education provides good standards for people and leads to cultural development. While industrialised 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.

In this paper, the main purpose is to determine the importance of science education, to present a brief historical development of science education and to analyse which factors are effective for its development.

This paper consists of three parts: Firstly, the importance, aims, and objectives of science and technology education will be determined. Secondly, a brief historical development of science education will be analysed. In the third part, some factors and reasons which can cause failure in science education will be discussed. Finally, some suggestions for development will be considered.

2. The Importance, Aims and Objectives of Science and Technology Education

Science Education is one of the most important areas of the curriculum. It is an essential vehicle to provide human resource development, modernisation and overall development of countries. Science education is related to some important aspects of development. These essential aspects are Health, Food, Agriculture, Energy resources, Industry and Technology, The Environment, Information transfer, Ethics and Social responsibility. Scientific development is the most affective factor in enabling on Less Developing Countries to enter the main stream of contemporary technology and commerce. It has been defined by Black & Harrison (1985: 3) that "...technology is the practical method which has enabled us to raise ourselves above the animals and to create not only our habitats, our food supply, our comfort and our means of health, travel and communication but also our arts-painting, sculpture, music and literature."

Technology is necessary for achieving a wide range of human purposes. Science and Technology are both crucial for our life and a country's development and there is a very close relationship between them.

It has been emphasised by UNESCO Congress report (1981) as cited in Lewis & Kelly (1987) that Science and Technology and their teaching in formal and non-formal education are an essential factor in improving the material and cultural conditions of people's lives and a priority objective of cultural development. The assertion of cultural identity and independence is provided by scientific and technologic knowledge.

The general aims of science education are;

- to promote agricultural development, industrial production, scientific research and social development
- to provide pupils with a scientific spirit of curiosity and inquiry
- to understand and change the natural world
- to encourage people to question and search for data (Black & Harrison, 1985: 3-4).

Additionally science education improves the education of future scientists and fosters a greater and more relevant understanding of nature and the findings of science among the population as a whole (Lewis & Kelly, 1987).

Science education gives children an awareness of technology and develops their personal experiences. Practical skills, encouraged in technological activities, help children to acquire resources of knowledge and intellectual and physical skills.

Science Education requires financial support, professionals, effecting planning, resources for effective implementation, scientific literacy, development of intellectual skills and sequencing of material.

In the words of Fensham as cited in Lewis & Kelly (1987: 73) that:

> "At both the personal and national levels, health, nutrition, sanitation, agriculture, industry and the improvement of the environment are seen as field in which scientific knowledge can be used as a powerful tool for solving human problems. Science education has a role to play in developing in the whole population - scientifically trained personnel and citizens alike- the capacity to use these powers responsibility and to appreciate their potential for good."

Ogunniyi (1986) determined the objectives of science education as;

- The development of a spirit of inquiry,
- Understanding of valid views of the nature of science,
- The teaching of problem solving, using scientific techniques such as observation, measurement,
- formulating or testing hypotheses, experimentation, drawing valid conclusions,
- Impartation of science literacy,
- Development of manipulative skills and scientific attitudes,
- Understanding the interaction between science and the society,
- The transformation of the environment,
- The production of individuals who are capable of participating in socially useful and productive activities,
- The production of citizens who are better consumers of scientific products,
- Accelerating the development of potential scientific and technological manpower.

2.1. Developing Countries

In the words of Lewin (1992: 1) developing countries is a term used "as a general category for non-industrialised countries with low to mid range incomes per capita."

The World Bank's Human Development Report (1996) has indicated that

- Low income is GNP per capita $695 and below in 1993
- Middle income is GNP per capita $696 to $8,625 in 1993
- High income is GNP per capita above to $ 8,625 in 1993.

3. A Brief Historical Development of Science Education

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.

In many countries, only elite, minority groups, learned science because they were be able to continue their education in UK and the other industrialised 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.

After 1960s, some national curriculum units or centres were established, with the help of the Industrialised 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).

The developments of developing countries were influenced by the industrialised 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 industrialised 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 realised that they needed to indigenise 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. 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 & Kelly (1987: 67) that the new curricula emphasised 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.

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 Uganda the change was from "job-seekers" to "job-makers". In Tanzania "Education for self reliance" has been emphasised.

Other African countries have emphasised "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 & Kelly (1987: 69)

> "*...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*."

There are many criteria for science curricula. Fensham also analysed the development of science education as moving from the 1960s-1970s when science education was based on science for itself, into the 1970s-1980s when other criteria became apparent, and:

a) real situations and practical skills (useful in the real world) became the focus for learning in science;
b) the content areas changed;
c) new sorts of understandings, concepts and intellectual skills were deployed for solving environmental problem and the like.

4. Some Problems and Factors Which Effect Development of Science Education

The Problems of Developing countries because in enhancing science education identified by UNESCO and writers like Ogunniyi (1986) from a long list.

- shortage of funds to purchase equipment,
- Poorly equipped laboratories,
- Inadequate facilities and basic services,
- Lack of well trained laboratory assistants,
- Qualified science teacher in short supply,
- Poor quality science teaching,
- Rapid increase in student population,
- The negative influence of external examinations,

- 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.

Weaver (1964) as cited in Ogunniyi (1986) remarked that in the Western region of Nigeria "...the type of science 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.

Language is also one of the most important problems of science education and its development. The main international language of science, English, is used in some countries for example in Singapore as an educational, scientific and technological, commercial and governmental language. Local people speaking local languages are excluded from science and its benefits.

The migration of scientists is an another problem which prevents development of science education. Many countries in the world send their students to learn new scientific techniques and developments. After finishing their courses many do not return to their countries. It has been indicated by Altbach *et. al.* (1989) that their working conditions are better in the Western universities than their countries. They can find more opportunities and particularly their salaries are better than in their own countries.

As is well known, UK, US, West Germany, France and Soviet Union have major publishers of scientific books and journals. Their large numbers of patents, discoveries and innovations result in important power over the world, as developing countries depend on "imported knowledge".

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 can not benefit from them (Altbach *et. al.*, 1989).

The participation of girls in science education is varies in different developing countries. In Sub-Saharan Africa the difference between male and female school enrolments is not very much at primary level but at secondary level only 34 % of girls enrol science, in Asia 39 %, in Latin America 50 % (World Bank, 1988). Particularly girls prefer to take biology lessons rather than chemistry and physics. Lewin (1992) has determined that in Kenya 2 % of girls take physics and 3 % of them take chemistry, while 50 % take biology.

This difference can be seen all over the world. The factors that affect **gender disparity** have been described by Duncan (1989) as cited in Lewin (1992) as:
The countries' level of economic development,

- The availability, accessibility,
- The type of school,
- Cultural norms,
- Expectations concerning women's roles,
- Socio-economic factors: family backgrounds, social class and the level of urbanisation,
- Residence in urban areas,
- Family-related factors (perceived marriage prospectus),
- Labour maker opportunities, lower aspirations for science based careers,
- Lack of self confidence for laboratory work,
- School environment, staff structure of schools,
- Gender stereotyping; Teaching materials and textbooks of science rarely include female characters.

According to Heyneman & Loxley (1983), **school effects** are important in determining achievement in science education. They have researched in 16 developing and 13 industrialised countries about school effectiveness and achievement of science education. Their report shows that;

- In India, 27 % of achievement had been effected by school quality, 3 % by social class,
- In Thailand, 25 % by school quality, 6 % by social class.

Hanushek (1986) has mentioned that "...attitudes and drop-out rates and reduced class sizes and more trained teachers were also unlikely to make much difference to achievement."

In addition, textbooks' quality and contents are influenced on achievement in science education because sometimes understanding of some textbooks' is very difficult for students. Fuller & Heyneman (1989) as cited in Lewin (1992: 60-62) indicated some effective and ineffective factors on school achievement (Tables 1 and 2)

Effective parameters	Percent of studies showing positive effects (%)
Length of instructional programme	86
Pupil feeding programmes	85
School library activity	83
Years of teacher training	71
Textbooks and instructional materials	67

Table 1. Some effective factors on school achievement

Ineffective parameters	Percent of studies showing positive effects (%)
Pupil grade repetition	20
Reduces class size	24
Teachers salaries	36
Science laboratories	36

Table 2. Some ineffective factors on school achievement

The type of school especially teaching methods, private schools, teacher salaries, length of time spent on instruction, students' attitudes towards science, teachers' attitude towards laboratory activities and convenient laboratory materials, pre-service and in-service teacher education are other agents for achieving success in science education.

Mulupo & Fowler's research as cited in Lewin (1992: 65) in Zambia shows the discovery method of teaching is more effective than traditional methods for understanding science. Besides this, according to Tuppen (1981) as cited in Lewin (1992: 65), "...parental education levels and interest in schooling are important in explaining variation in examination scores."

Although socio-economic factors effect students' achievement in science education, Moundu (1988) as cited in Lewin (1992: 65-66) suggested that socio-economic factors can be reinforced by teaching and learning resources.

As has been mentioned above, teacher education is one of the important factors for achievement in science education. Otewa (1983) as cited in Lewin (1992, p.137) indicated that "...the more professionally qualified the teacher in a given school the better the performance of student in that school and less difficulty the teacher has with the curriculum material."

5. Suggestions

In Lewis & Kelly's opinions (1987), understanding of science is needed, science should be for all of the school levels; primary, secondary, university vocational, adult continuing and further education, science programmes should be useful for social needs, new teaching methods should help the teachers.

Elstgeest as cited in Lewis & Kelly (1987) suggested that an education system, as well as some basic standards of numeracy and literacy, should provide simple science and technology as related to home and environment.

Teachers and educators from all over the world, they should share their experiences and take some decisions by co-operation. (UNESCO Congress 1983 as cited in Lewis & Kelly 1987: 11). Rugumaya as cited in Lewis & Kelly (1987: 81) noted that developing countries should establish democratic institutions in which scientists should carry out innovations and develop their own home produced approaches. They should make science relevant practical and problem-oriented. Creativity, competence, curiosity, compassion should be essential issues. He believes that science education should contribute directly to fighting against drought, famine and fragile economies but the success of science education directly depends on the elimination of political instability.

> "*Science education must be learner-centred and teacher assisted, action-oriented, project-based and topical, deriving its material nourishment from the immediate environment. Methodologies would involve interdisciplinarity, team teaching,*

interaction with the community and use of the media. It would be necessary to integrate the ideas into pre-service and in-service programmes for all science educators through a well-worked programme spread over several years."(Rugumaya as cited in Lewis & Kelly 1987: 86)

In addition, for African countries he has suggested that;

"Support by government, industry or the society at large for any enterprise, be it the much needed mobile laboratories science and mathematics education resource centres or any other venture, does not come readily. It comes with a lot of consultation, pressure, persuasion and propaganda."

- Science education programmes should include the total community and integrated scope, encompassing social, economical, political, psychological and cultural aspects.
- Science education should provide students self-reliance.
- Science should contribute to people and to the society.
- Science education should be practical, relevant and appropriate. It should promote adaptability to change.
- Students should acquire a frame of mind associated with inquiry and discovery rather than for them to memorise facts whose value may be transitory.
- Science should inform the public and foster their interests.
- Some technical knowledge should be taken from industrialised countries but it must be suitable to the society and their needs.
- An indigenous education system should be provided.

6. Conclusion

As it has been emphasised above, Science and Technology Education are very crucial to the development of countries. Some countries spend a lot of money on development although there are various problems that affect the development of science education. Recently people have realised the importance of science and there is greater emphasis on science education than that before. The developing countries firstly must realise their problems and the aspects which cause those problems. It would seem clear that all of the developing countries and particularly Turkey should accelerate the development of science education as learner-centred, teacher-assisted, action-oriented, project-based education programmes. Pre-service and in-service teacher training programmes must be improved. For the rapid development of science education, government, society and industry should be in a co-operation and work together.

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