

## CHALLENGES AND OPPORTUNITIES OF SCIENCE & TECHNOLOGY EDUCATION IN KENYA

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### **Abstract**

*Kenya, like other African countries, is currently facing poverty, unemployment, poor infrastructure, destruction of the environment and many health issues. These challenges become more urgent than ever because of high population growth, climate change consequences and worldwide economic crisis. To combat these challenges Kenya will need its own engineers, constructors, biotechnology specialists as well as the public properly educated in science and technology. Kenyan schools usually struggle to get basic equipment and textbooks. There is an opportunity to teach hands-on science using simple and cheap equipment made of available materials. Especially renewable energy sources should be taught at primary and secondary schools. Hand made equipment using solar, water and wind energy can be used for simple laboratory investigations and measurements. It is necessary to increase awareness of importance of science and technology in daily life of Kenyan people.*

### **Keywords**

*Kenya, Africa, education, science, technology, curriculum, hands-on science*

## **1 INTRODUCTION**

Kenya has had compulsory school attendance since 2003. Government schools provide free primary education but there is deficiency of finances in the system. Usually there are about 100 pupils per one class. There are 8 grades of primary school, 4 grades of secondary and 4 grades of college. After completing eight years of primary education, pupils have to pass an examination of Kenya Certificate of Primary Education (KCPE). Secondary education is concluded by the Kenya Certificate of Secondary Education (KCSE) examinations, which are taken for a period of about 1 month. This certificate is used as the entrance requirement for Kenyan Universities. The British government provides financial supports to Kenya in order to keep the primary education free and to expand secondary education and universities<sup>[1]</sup>.

All students in Kenya learn three languages - English, Kiswahili and their native mother language. High importance is given to religious subjects mostly Christian, Islamic or Hindu. Mathematics is always part of compulsory education. Science in primary schools is integrated into one subject while secondary schools teach biology, physics and chemistry.

Although Kenyan education system passing through a radical reform has achieved a great success, there are many areas to be improved. The whole system is under-financed and science is one of the most affected sections. Not only textbooks but lots of equipment are needed to teach science properly. Because schools cannot afford to buy professionally made educational utilities they often teach science just theoretically. In fact there is a potential for simple and cheap hands-on experiments and laboratories. Education should always reflect present needs of society. Currently Kenya is facing energy crises and destruction of the Environment. High demand for firewood as the main energy source and low efficiency of its use causes devastating deforestation. In order to combat these challenges renewable sources of energy should be widely promoted starting with primary and secondary schools. Simple hand made devices utilizing solar, wind and water energy can be used as an instrument to teach various scientific topics and environmental conservation.

Another great threat to Kenya is the climate change, which causes more severe floods and droughts. Also seasons, which used to be stable in time are becoming more and more unpredictable. This is a serious problem for the farmers practicing rain-fed agriculture because they do not know when to start planting crops. Adaptation to these changes is difficult. To better understand the pattern of changing climate farmers should be trained in weather observations. After several decades of land use leading to depletion of soil in many areas of Kenya farmers need to become familiar with sustainable ways of farming and soil management. Kenyan population needs to become aware of the consequences of bad soil management and deforestation and learn new ways of farming (agroforestry). Because most of the poor people living in rural areas will never reach secondary education level, these new farming methods and technologies should be taught at primary schools.

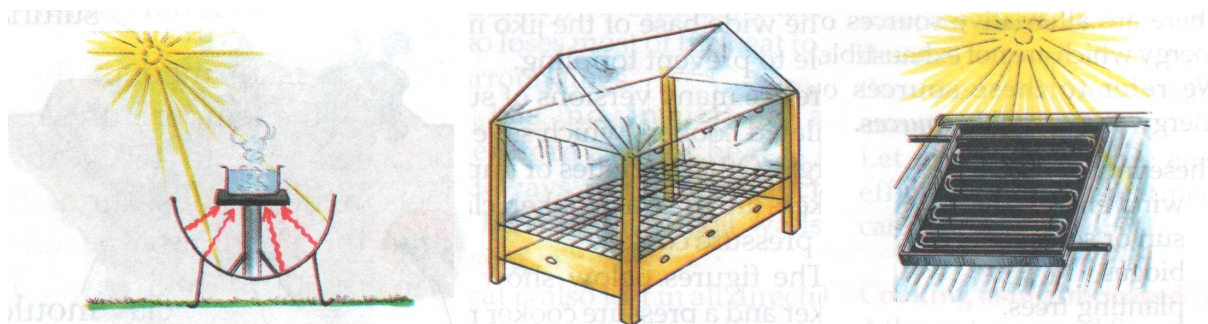
## **2 SCIENCE AND TECHNOLOGY EDUCATION**

The science subject of primary education is divided into twelve units: The human body, Animals, Plants, Foods and nutrition, Health education, Weather and the sky, Environment, Water, Soil, Energy, Properties of matter, Making work easier. Teachers follow these topics contained in the science textbooks. For example the unit “Energy” contains the following topics numbered by grades 1 – 8 respectively<sup>[2]</sup>.

Unit: Energy

1. Light, Sound, Animals make different sounds, Other things that make sound.
2. Light and sound, Making shadows, Producing sounds by plucking and hitting things.
3. Reflection of light, Direction of sound, Meaning of special sounds.
4. Uses of light, Ways of lighting a house, Sources of heat, Uses of heat.
5. Pollution from sound (noise), Effect of sound pollution on animals, Heat transfer, Good and poor conductors of heat.
6. How light travels, Effect of different materials on light.
7. Electricity, A simple circuit, Good and bad conductors of electricity, Electrical appliance at home and their uses, Safety when dealing with electricity, Lighting and safety measures.
8. Meaning of energy, Different types of energy, Transformation of energy, Methods of conserving energy.

As you can see except of the grade 7 focused on electricity they always investigate light, heat or energy. The devices using solar energy (solar cooker, solar dryer, solar collector) are introduced at the last year of primary education. In fact most of the people who finished primary school attendance have never seen these devices in reality; even teachers do not know how it looks like. They know only pictures from the textbook but have no idea how it works. This renewable energy equipment would be very useful at every household of rural areas if people knew the technology. A simple solar cooker can be made of aluminum foil, carton boxes and glue. All the material is available in Kenyan supermarkets. The cost of one hand-made solar cooker is about \$6 USD and in arid areas can save 2 tons of firewood annually. If pupils at primary school learned how to make a solar cooker, they would learn also about light, heat and energy. Solar dryers can be also easily made from local materials. Kenyan people have lost their traditional knowledge of preserving food and solar dryer can help them to overcome a period of hunger before harvest. Children need to learn that sun energy is free, abundant and can significantly fulfill their energy demand.



Pic. 1 – Solar cooker (left), solar grain dryer (middle) and solar thermal collector (right).  
These pictures were taken from the textbook Understanding science<sup>[2]</sup>.

There is a rain-fed agriculture in Kenya where weather used to be very reliable decades ago but it is not the case any more due to the climate change. Kenyan farmers still have to rely on weather because they cannot afford irrigation systems. If the farmers continuously monitored their local weather for several years or decades they should be able to predict seasons from the observed cycles.

Units Weather and the sky in the science textbooks are present at grades 1 to 5. At grades 6 to 8 it is replaced by units Water and Environment.

Unit: Weather and the sky

1. Weather changes, Clouds, Rain, Wind
2. Weather conditions, Weather symbols, Weather changes and the clothes we wear
3. Weather changes, Effect of weather changes on farming activities
4. The sky, The sky at different times of day and night, Types of clouds
5. Weather instruments, Different weather instruments and their uses, Making and using different weather instruments

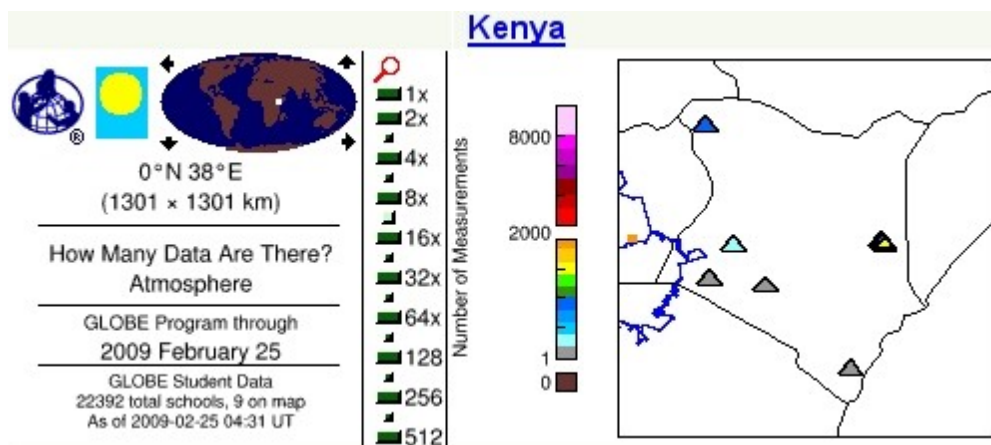
In Kenyan primary and secondary school curriculum the weather is discussed sufficiently. Unfortunately most of the pupils have no science textbook, they just write down into their exercise books what the teacher writes on the blackboard. There is a danger that pupils will memorize names of meteorological equipment without even seeing a model. Kenyan primary schools could have their own meteorological station and pupils should be responsible for taking daily measurements.

The first step towards more experimentally based education has been taken at the Kisumu Boys High School, a prestigious institution providing relatively good quality education to their students (Kisumu is the third biggest town in Kenya situated on the eastern banks of Lake Victoria). As a part of the science education they run a meteorological station containing Stevenson screen, rain gauge, anemometer and evaporation pan. Students learn how to measure basic meteorological variables such as air temperature, rainfall, wind speed, evaporation. By daily measurements they also learn responsibility, systematic and precise approach to laboratory measurements. Unfortunately school meteorological stations in Kenya are very rare.



Pic. 2 - Meteorological station at the Kisumu Boys High school

Currently there are 31 Kenyan primary and secondary schools registered in the Program GLOBE<sup>[3]</sup>. Only nine of them have provided any data (their location is marked on the map below). Unfortunately most of the data were obtained during period since 1999 to 2001. There are no current meteorological data from Kenyan schools available.



Pic. 3 – The map of Kenya displaying nine Kenyan schools participating in the international Program GLOBE.

There is a sufficient amount of good science textbooks in Kenya. The problem is that the poor schools cannot afford to buy them and photocopying part of the textbooks is not legal. There is an alternative to print and use extra materials available on the Internet. UNESCO has prepared very interesting handbooks for science and technology education in developing countries<sup>[4]</sup>. The two-part document „Low Cost Equipment for science and technology education“ contains 150 plans for simple and low-cost devices, all of them can be made from available materials. Other very useful documents prepared and provided on-line by UNESCO are: Resource Kit Science&Technology Education, Technology Education Guide, Scientific and Technological literacy for all. These books give a comprehensive overview of science and technology education in developing countries and can serve as a guide to the science educators.

There is another interesting project focused on education about energy. It is called NEED Project - National Energy Education Development Project. Many printable educational documents for primary schools are available at the project websites<sup>[5]</sup>. The documents are divided to pupil's books and teacher guides with solutions and all necessary instructions. All of them are free to download and use. The NEED materials were not primarily written for developing countries but they can be easily used in Kenya for teaching renewable energy sources. The textbook *Energy from the Sun* was successfully tested at the TMSC private primary school in Western Kenya during summer 2007 and 2008. The pupils loved to learn about solar energy utilization. Also their parents were taught about efficient energy use at the environmental seminars organized at the primary school<sup>[6]</sup>.



Pic. 4 - Children at Western Kenya drawing colours of rainbow and studying using the NEED Project textbook *Energy from the Sun*.

### 3 CONCLUSION

Urgent threats in Kenya are climate change, energy crises and destruction of the Environment. To educate population about these problems primary and secondary school curriculum of science and technology education should be extended. Kenyan educational system is underfinanced and most of the schools cannot afford proper equipment for science lessons. As a solution we suggest hands-on activities using renewable energy devices and laboratories based on weather observations. Additionally to official science textbooks can be used documents about science and technology education available on the Internet. Good source of such documents are websites of UNESCO, the NEED Program and others. All these strategies were successfully tested at the primary school in Western Kenya.

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