SMALL IS BEAUTIFUL

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ABSTRACT

When UNESCO first launched its global microscience project 15 years ago, many countries still took a purely theoretical approach to science teaching, not out of choice but of necessity. They simply could not afford the exorbitant cost of equipping schools and universities with laboratories. The miniature kits proposed by UNESCO offered a low-cost, safe alternative for experimentation. Given their multiple advantages, it was not long before the miniature kits caught on. Cameroon, Tanzania and South Africa have invested massively in them, as have Russia and the UK. Angola, Ethiopia, Namibia, Malaysia, Sudan, The Gambia and the Palestinian Authority have all held workshops to adapt the kits to the national curriculum, while other countries are still at the stage of demonstration workshops. Today, there is a growing demand for UNESCO's assistance in customizing the miniature kits for national use – nowhere more so than in Africa. *[AJCE, 2(1), January 2012: Special Issue]*

Teachers on Rodrigues Island in Mauritius using a microscience kit to oxidate ferrous sulphate at a workshop in August 2008 ©UNESCO/Maria Liouliou

INTRODUCTION

If there is little or no experimentation in many classrooms and university laboratories in developing countries today, one also finds virtual substitutes for laboratory experimentation in the developed countries, such as computer-based simulations and video sequences. This can hamper learning, as even the most practical notions will appear abstract to a student who cannot put theory into practice. 'Nothing compensates for the solid grounding in physics, chemistry and biology which experimentation provides,' observes Alex Pokrovsky, a chemist who retired from UNESCO several years ago but still keeps an active interest in the project. 'How can any country train scientists, let alone promote the national research which is indispensable to development, without experimentation?' he wonders.

The first microscience kits were designed in the 1990s by the Research and Development in Mathematics, Science and Technology Education (RADMASTE) Centre at the University of the Witwatersrand in Johannesburg (South Africa) in the 1990s. Veritable mini-laboratories, the kits replace the traditional glass test-tubes, beakers, flasks and measuring cylinders with miniature plastic alternatives. The kits are inexpensive, compact, re-usable and difficult to break. In addition, the small quantities of chemicals employed make the kits environment-friendly and safe, with low operating costs.

In 1996, UNESCO and the International Union for Pure and Applied Chemistry (IUPAC) were searching for a means of proposing low-cost experimental equipment at a price that any country could afford. They found the answer in South Africa. Initially, RADMASTE focused on experiments in chemistry. However, the basic concept can be adapted to experimentation in many other areas of science, including physics, material sciences, geology, hydrology, biochemistry, biotechnology and agriculture. Over the years, RADMASTE has added other kits

to its repertoire, including the Basic and Advanced Microchemistry Kits, the Microburette Kit, the Bar LED Microconductivity Kit, Microbiology Kit, Microelectricity Kit and Microchem Water Field Kit. Most recently, it designed the International Year of Chemistry Global Experiment Kits for UNESCO and IUPAC (*see box*).

Cameroon was one of the first countries to see the kits' potential for strengthening science and technical education. By December 2000, more than 7000 kits were being used in secondary schools across the country. As the pilot project developed, it became urgent to provide a structure for the introduction and monitoring of microscience in the country's primary and secondary schools. UNESCO suggested setting up a Centre of Excellence in Microscience Experiments. The General Leclerc High School in Yaoundé, with a roll of almost 5000, was chosen to host the centre. It trains teachers and organizes sub-regional seminars for teachers and education specialists for Cameroon and the four other countries belonging to the Economic Community of Central Africa, namely the Central African Republic, Chad, Republic of Congo and Gabon.

Teachers using the microelectricity kit at the Mauritius workshop in August 2008
©UNESCO/Maria Liouliou

BIG BUSINESS

Today, the project is implemented within UNESCO's International Basic Sciences Programme, in collaboration with the teacher education section of UNESCO's Division of Higher Education. RADMASTE remains a key partner, as does the Islamic Educational, Scientific and Cultural Organization (ISESCO) for participating countries from the Muslim world. ISESCO was a key partner, for instance, in the introduction of the microscience kits into Jordan, Lebanon, the occupied Palestinian territory and Syria in 2006 via a series of workshops. UNESCO's Ramallah office recently signed a contract with the Ministry of Education and Higher Education to provide 15 kits to18 Palestinian schools for grades 1–9, for a total of 270 kits. The Ministry now plans to buy bulk quantities of the kits.

Various companies around the world manufacture the kits for microscience experiments. Prices vary but the kits can come with a price tag of as little as US$10–15 each. The sales price for bulk deliveries is negotiated directly by the country concerned and its chosen supplier.

UNESCO works primarily with three suppliers: Somerset Educational and Radmaste in South Africa and Edulab in the UK[1]. However, UNESCO encourages countries to develop their own kits from locally available materials. For those countries which prefer to purchase the kits from abroad, it might help to generalize use of the kits in schools if donors were to propose debt swaps in exchange for bulk purchases.

[1] Somerset International: microscience@isat.co.za; Radmaste: joseph.mungarulire@wits.ac.za; Edulab: enquiries@edulab.co.uk

A STRONG DEMAND FROM AFRICA: THE EXAMPLE OF SUDAN

Once a country expresses interest in the project, the first step is to organize a workshop in order to demonstrate how the kits work. In Sudan, for example, this workshop took place on 9 July 2010 at the International Academy School in Khartoum attached to the Ministry of Foreign Affairs. UNESCO and the National Commission for UNESCO then organized a second workshop on 31 January this year to adapt the standard kits and UNESCO's teaching materials to the Sudanese curriculum and local conditions.

For two and a half days, Alex Pokrovsky and Hassan Elfatih, the national microscience project coordinator and Dean of the College of Science of the Sudan University of Science and Technology, guided 50 curriculum planners, trainers, policy planners and teachers in creating their own teaching materials and kits for physics, chemistry and biology for children aged 14–16 years. The participants then appealed to the Ministry of Education to introduce the new Sudanese kits into the country's schools.

Six months on, a Sudanese version of the kits has been developed which is currently being tested in 30 pilot schools for a period of four months, with funding from the Ministry of Education. Two schools have been selected in each of the country's 15 states. In parallel, the National Microscience Team is training teachers how to use the kits in the classroom.

Once the kits have been evaluated and modified as necessary, Education Minister Ustaza Suad plans to supply the kits to 3500 schools. Sudan is currently negotiating a loan with the Islamic Development Bank to purchase the kits in bulk.

ETHIOPIA: HOME TO ONE OF AFRICA'S LARGEST STUDENT POPULATIONS

With 14 million school pupils and university students, Ethiopia counts one of the biggest student populations in Africa. In March this year, Ethiopia opted for a combined demonstration and adaptation workshop at the Ethiopian Management Institute east of the capital. Run jointly by UNESCO and the Ministry of Education over three days, the workshop attracted more than 40 secondary school teachers, university professors, curriculum planners and policy-makers eager to see the kits being used in conjunction with the accompanying teaching materials. Three professors from the RADMASTE Centre demonstrated the kits, an exercise that has since been captured in a brochure distributed to universities and schools.

Alexandros Makarigakis from UNESCO's Addis Ababa office helped to organize the March workshop. 'Ethiopia began developing its own microscience kits in June,' he explains. 'The Ministry of Education plans to focus on secondary and tertiary education and is developing kits in biology, chemistry and physics.'

'The Ministry has set up a steering committee to guide the process of adapting and testing the kits in pilot schools between September and March next year,' he adds. 'It also plans to set up a national microscience centre by September this year, with UNESCO's assistance.'

TEACHER TRAINING IN TANZANIA AND THE GAMBIA

Meanwhile, in the United Republic of Tanzania, UNESCO has been working within the United Nations Development Assistance framework to supply microscience kits and provide teacher training for 180 schools, at a cost of US$1.4 million. Tanzania is one of the eight pilot countries of the One UN Programme established in 2007[2].

[2] The others are Cape Verde, Rwanda, Albania, Cape Verde, Mozambique, Pakistan, Rwanda,Uruguay and Vietnam.

In The Gambia, a consultative workshop for the introduction of microscience kits was run on 10–13 January this year at the request by the President. For lack of funding, most senior secondary schools lack functional science laboratories. The meeting report observed that even 'the small number of schools equipped with laboratories fail to utilize their facilities effectively due to the absence of a maintenance strategy and in-service training on how to integrate practical work into lessons.'

A feasibility study conducted in 2003 by the Ministry of Basic and Secondary Education, in collaboration with UNESCO's Regional Bureau for Education in Africa (BREDA) based in Dakar (Senegal), concluded that the kits would be very beneficial. The Gambia then applied to be one of the 22 countries selected for the UNESCO project, which was essentially funded by the Gaddafi International Foundation for Charity Associations at the time[3].

The 15 participants in the January workshop comprised heads of secondary schools, representatives of the Science Teachers' Association, science lecturers from Gambia Collage and the University of the Gambia, staff from the Curriculum Research and Development Directorate and the Standard and Quality Assurance Directorate, as well as staff from the Directorate of Science and Technology Education.

At the end of the four-day workshop, the participants recommended that the project be introduced simultaneously for all 12 years of schooling and that one kit be provided ideally for every three pupils, or a maximum ratio of one kit to five pupils. They recommended teacher training and observed that teachers would need more time than at present to prepare their classes. The participants recommended that Gambia College, responsible for teacher training in the country, incorporate the use of microscience kits in its training curriculum. It was also

[3] UNESCO ceased all co-operation with this foundation in February 2011 following the repression of civilian populations in the Libyan Arab Jamahiriya.

recommended that the kits be adapted to the national curriculum 'to suit the country's needs and aspirations.'

BETTER TEACHING OF SCIENCE AND MATHEMATICS

In April this year, the Pan-African Conference on Teaching in the Context of Education System Reform[4] recommended that microscience kits be used to improve science and mathematics teaching. The conference was organized in Lomé (Togo) by the African Union, BREDA, UNICEF and other partners within the framework of the action plan for the development of human resources adopted by the New Partnership for Africa's Development.

The microscience kits will next be demonstrated on World Teacher Day on 5 October at UNESCO Headquarters in Paris. Meanwhile, several workshops are planned for Haiti, Kazakhstan and Kyrgyzstan before the end of the year.

The Big Splash!

Schoolchildren of all ages are being invited by UNESCO and IUPAC to participate in what may turn out to be the biggest scientific experiment ever. With their teachers, children around the world are being asked to measure pH levels and salinity in water, to filter and purify water then desalinate it.

South African pupils measuring the pH of water during the Big Splash in Cape Town in March ©UNESCO/R.Sigamoney

[4] See www.teacherspacted.org

The United Nations' World Water Day on 22 March offered an ideal opportunity to use the microscience kits designed for conducting experiments on water chemistry. As this year's theme was Water for Cities: Responding to the Urban Challenge, the 1000 participating pupils from schools in different parts of Cape Town were first exposed to a key urban challenge: the difficulties Khayelitsha slum-dwellers face daily in obtaining clean water from a standpipe. The children were then transported to Ratanga Junction to watch a delightful play performed by the Jungle Theatre on the importance of conserving and preserving local water supplies.

The next day, the children were handed the microscience kits, so that they could conduct their own experiments, under the benevolent eye of Erica Steenberg from the RADMASTE Centre and three volunteers. The children first discovered the pH of a water sample taken from Intaka Island, a wetland in Cape Town, then filtered and purified the water. For most of the children, this was the first time they had ever conducted a chemistry experiment. Their excitement at completing the exercise successfully and the torrent of questions they asked were a pleasure to witness.

The kits were donated to the participating schools by the South African Department of Science and Technology and Sasol, a South African petrochemical company. The brief opening ceremony was presided over by UNESCO and by the Deputy Minister of Science and Technology, Derek Hanekom.

The Big Splash was part of a global experiment on Water: a Chemical Solution being run by UNESCO and IUPAC within the International Year of Chemistry. Since the Big Splash in March, a further 6303 students from 300 schools in 31 countries have registered the results of their own experiments in water chemistry at the dedicated website.

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To watch the video about the Big Splash:
www.youtube.com/watch?v=r4gS9bep8Tc&feature=player_embedded#at=77

For details of the global experiment: water.chemistry2011.org; r.sigamoney@unesco.org

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On the project in the Middle East, see also *A World of Science*, October 2007: http://unesdoc.unesco.org/images/0015/001537/153797e.pdf;

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