INTERNATIONAL COUNCIL FOR SCIENCE ICSU

Proceedings of

INTERNATIONAL CONFERENCE ON PRIMARY SCHOOL SCIENCE AND MATHEMATICS EDUCATION

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Organised by:

Committee on Capacity Building (CCBS)
International Council for Science (ICSU)
Ministry of Education, China
Chinese National Committee for UNESCO
China Association for Science and Technology (CAST)
Beijing Normal University

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I. Acknowledgements

We would like to acknowledge the efforts of all those who worked so tirelessly to make the Beijing conference a success.

First, we would like to note the extraordinary leadership and efforts of our CCBS colleague, Professor Wei Yu. Beginning with her invitation to CCBS to bring such an international conference to Beijing,her team of staff and participating organizations worked unceasingly to manage all of the logistics involved in accommodating the needs of participants from around the world. She was also able to attract high level attention and publicity for this international conference within China and for the issues that it set out to present.

We note the contribution of our CCBS members,speakers, discussion leaders and recorders who provided the essential substantive contributions for this conference and its proceedings and the attendees who shared their insights and experiences.

We acknowledge the support of our funders and the work of the ICSU staff in helping to disseminate information about this conference and in assisting in preparing the draft proceedings. We appreciate access and use of official photos from the conference as well as informal ones contributed by Dr. Otto Hammes.

Dr. Leon Lederman
Dr. Shirley M. Malcom
Co-chairs, CCBS

Travel for developing country's participants and support for publication and dissemination of the report were provided by UNESCO.

II. Background

Educators, scientists and officials from over 20 nations met in Beijing, November 1- 4,2000,for the first International Conference on Primary School Science and Mathematics Education. In addition to over 100 international representatives, over 70 participants from cities and provinces across China took part in the gathering. The conference was held at the Harbour Plaza Hotel and included site visits to school programs and to the China Science and Technology Museum.

The conference, organized by the International Council for Science (ICSU) and its Committee on Capacity Building in Science (CCBS), was invited to convene in China by CCBS member and Vice Minister of Education,Professor Wei Yu. In China the conference was co-hosted by the Ministry of Education,China; Chinese National Committee for UNESCO, China Association for Science and Technology (CAST),and Beijing Normal University.

The conference reflects the continuing interest of CCBS in primary school education in science and mathematics as a basic tool for capacity building around the world.

CCBS member and Vice Minister of Education, Professor Wei Yu addresses the conference.

Speakers and organizational leaders meet Education Minister Chen Zhi Li

In addition the conference was an extension and direct follow-up to a CCBS sponsored workshop held coincident to the World Conference on Science (WCS) held in Budapest,Hungary in June 1999 and co-sponsored by UNESCO and ICSU. One of the key recommendations from the WCS stressed that "There is an urgent need to renew, expand and diversify basic science education for all,…"(Science Agenda-Framework for Action/ Section 2.4, Paragraph 22).

The aim of this International Conference was to provide a forum to discuss strategies to accomplish this end. It was organized to focus less on presentations and submitted papers and more on networking, providing opportunities for discussion, and developing specific action plans to guide future work of individuals,donors,NGO's,higher education institutions and governments. The emphasis was placed on sharing practices,ideas, research and strategies to address common concerns in primary school science and mathematics education while acknowledging,honoring and incorporating differences in approaches based on geography, history, culture and/or language. Technology's potential was also recognized as a mechanism to enable cooperation,networking and exchange of ideas now and into the future, using the power of the Internet and growing world connectivity. These efforts would build on earlier work of the CCBS to develop a capacity building "portal," *www.teachscience.org* and other similar initiatives.

The choice of China as a conference venue had the added value of supporting countrywide initiatives underway to reform curriculum for science and mathematics in primary education.

III. Introduction

The opening plenary was highlighted by messages and remarks from representatives of the collaborating groups. A choral presentation was given by students of the primary school attached to Beijing Normal University. It served not only as entertainment and welcome to Beijing.It also served as a reminder of the hundreds of millions of primary age children in China and around the world.Children requiring quality education in science and mathematics to meet the challenges of the future—and the subject and objective of the discussion and deliberations at the Conference.

Following opening remarks by CCBS member and Vice Minister for Education,Professor Wei Yu, a welcoming address by the Minister of Education, Chen Zhi Li,noted the historic occasion of the meeting and its importance to curriculum reform efforts currently underway in China. She and the subsequent speakers, the presidents of CAST and Beijing Normal University, noted the immense changes underway in China and around the world by virtue of advances in science and technology (Internet,information and communication technologies,genetic technologies). How then to provide an education for children that prepares them adequately to live and work in that world?

A choral presentation by students of the primary school attached to Beijing Normal University

Speakers acknowledged the need to consider what is taught,how it is taught and how teachers would be prepared to teach the new curriculum. These themes previewed issues that were discussed throughout the four days of the conference.

Dr. Larry R. Kohler, Executive Director of ICSU, described the makeup of the Council,its work and its long term interests in issues of capacity building. He then read a letter of greetings from Professor H.Yoshikawa, President of ICSU, which further underscored the need for increased attention to the primary years, not only in capacity building, but also in the preparation and recruitment of young people to science and the promotion of the public understanding of science.

CCBS Co-Chair and Nobel Laureate Professor Leon Lederman,in his opening remarks and introduction to the conference, briefly recounted the history of CCBS and its interest in primary school education in science and mathematics. He described some of the common challenges faced in providing such education in developing and developed countries alike. Professor Lederman charged the conferees to develop an action plan that might focus on organization building, mobilizing donors,using the World Wide Web to network and share information,and developing and deploying a cadre of science education technical co-operation providers.

CCBS Co-Chair and Nobel Laureate Professor Leon Lederman

ICSU Executive Director, Dr. Larry Kohler leading a discussion group of ICSU family with Dr. Due Yue, Director, National Commission for UNESCO of China

IV. Key Program Themes

A New Approach to Teaching Science and Mathematics

Noting the trend of curricula in many countries emphasizing rote memorization of the facts of science, examples were provided of "hands on"approaches to teaching that had been developed and implemented in diverse regions of the world—in hundreds of schools in Chicago, Illinois in the United States; in Paris,France;and in Ceara and San Palo in Brazil.

Professor Pierre Léna,speaker

The Chicago TAMS group (Teachers Academy for Math and Science) described the challenge they faced to make new instructional strategies for science and mathematics available to teachers in primary schools in impoverished areas of Chicago. Teaching mostly American minority children of African American and Hispanic origin,the major concern was in making teachers more confident, comfortable and knowledgeable about the content they were expected to provide to children. The

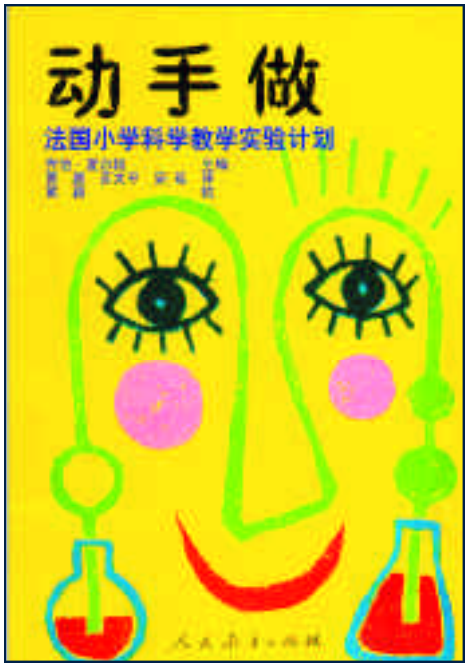
Professor Yves Quéré,CCBS member and speaker

challenges were described not only as educational and intellectual but also political —how to influence the incentives that affect the way schools are organized and run. TAMS Founder Leon Lederman and Director Lourdes Monteagudo emphasized the need to provide not only training but also ongoing support to teachers within schools for a sustained period of time.

A similar hands on initiative in France, La Main à la Pâte Program, was described by Professor Pierre Lena and Professor Yves Quere. Professor Lena noted the emphasis of the program on teacher training and teachers'connections to scientists. A program Internet site promotes exchanges among teachers, provides classroom materials, Internet-based science resources,and consultation by scientists and educators. In addition to its implementation in France, La Main à la Pâte Program has generated considerable interest in many other countries of the world. A major publication of the project was translated into Chinese (see right) and made available to participants in the conference. Wider circulation of the translated material is planned. An agreement of cooperation was signed between China and the French Academy for support of the project's diffusion in China.

Similarly, programs in Brazil described by Professor Dietrich Schiel and science teacher Domingos Pereira Viana Filho emphasized hands on,integrative approaches to science teaching based on locally available material and locally meaningful themes. The challenge for Brazil (as well as for the other sites) stems from the need to provide appropriate instructional preparation and professional development for a very large numbers of teachers, geographically dispersed over great distances,in ways that are educationally sound. All groups acknowledged a role for technology in disseminating exemplary materials and potentially adaptable instructional strategies.

A message from Professor George Charpak, Nobel Laureate in Physics and a driving force behind the introduction and adoption of La Main à la Pâte Program in France, was shared with the participants.



La Main à la Pâte for China

The picture that emerged from the panel focused on:

- The need to have clear goals for science and mathematics education
- The value of targeting the primary years
- The challenge of providing adequate preparation for non-specialist teachers to deliver science and mathematics instruction using more active, "hands on" approaches.
- The interaction of science instruction and literacy goals
- The need for greater involvement of scientists with teachers and curriculum for the primary grades
- The development of mechanisms for outreach and information sharing

Dr. Ella Yulaelawati exchanging information with participants on programs in the Asia/Pacific region

Science and Mathematics Education in the Asia/Pacific Region

Professor Wei Yu moderated a panel of country representatives from the region who briefly described the current state of primary education in science and mathematics as well as the critical issues being faced.

Despite representing countries as diverse as Sri Lanka, Indonesia, Malaysia, Viet Nam, India and the Phillipines there was strong similarity among major themes expressed by the presenters.

Goals for primary school education in science and mathematics extended beyond cognitive and skills development to include social, cultural, and moral development.

There was universal recognition of the value of active learning and hands on approaches to teaching science and mathematics. There was general acknowledgement of the science skills that were valued, underscoring the common language that science and mathematics represent among all the subject areas.

There was amazing similarity across the current problems outlined by the presenters. Beyond the key issue of universal access to education for girls and boys there were concerns about mechanistic (rote) approaches to teaching and learning; learning experiences not connected to local situations; and inadequate participation of the science community in efforts to improve science and mathematics education.

Facing the challenge of providing basic education to all girls and boys, at least through the level of compulsory education, the issue then becomes one of developing a curriculum that builds on young children's natural curiosity — a curriculum that promotes creativity and initiative. And what kind of programme is required to prepare teachers who can teach a new curriculum using more active methods?

While the general curricular outline was clear the details differed for each country. In Sri Lanka the subjects taught at the primary level were listed as mathematics, religion and environment related activities. Environment then becomes the basis for teaching other disciplines, including science. In Malaysia science is core and compulsory at primary and lower secondary levels. At the lower primary level, science is integrated across the curriculum. At upper primary (grades 4,5 & 6) science is taught as a separate subject organized around five areas of study:

- The Living World
- The Physical World
- The Material World
- Earth and the Universe
- The World of Technology

In addition extra curricular science experiences are provided for students during years 4-6. Science curriculum for Grades 3 to 6 in Indonesia follows similar themes: Life and Living; Materials; Energy and change; Earth and beyond; and Technology. The common challenges to implementation included:

- Teachers to deliver the new curriculum
- Providing locally relevant experiences
- Modifying assessments to incorporate hands on approaches that are valued in instruction

The presentation and discussions about the current status of primary science and mathematics education led participants to recognize the potential and power of coming together to explore common issues. A planning session was held later during the conference for the Asia Pacific Region. This session produced the following recommendations:

- Convening an Annual Meeting for the Asia Pacific Region
- Such a conference should include representatives from ministries of education and local universities.

The meeting might focus on topics such as:

- Content of curriculum

  —how does each country incorporate its own culture in the curriculum

  —use of local cultural techniques for science teaching and learning
- Update on recent education developments of different countries
- Teacher training successes and failures
- Teaching materials, such as textbooks,learning modules,equipment and workbooks

Establishment of a network to exchange information and ideas concerning science teaching and learning. This might be done by means of :

- Internet
- Newsletter
- Exchange programme
- Participation in and reporting at the second ICSU International Conference in Brazil on progress made in the Asia Pacific Region.

What Science and Mathematics Should be Learned

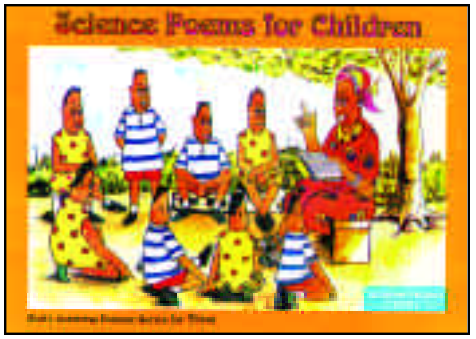
Overall goals for education are translated within ministries, departments and agencies into detailed curriculum. A panel of scientists and educators discussed the processes and outcomes of these deliberations in different countries illustrating:

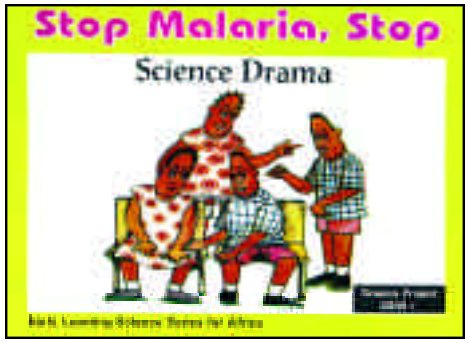
- Development of curriculum in science and mathematics specifically designed to address national issues and concerns, building on local traditions and incorporating cultural components;
- Adaptation of curriculum goals for primary science and mathematics developed outside of the country with incorporation of local context;and
- Adoption of a kit-based program for science.

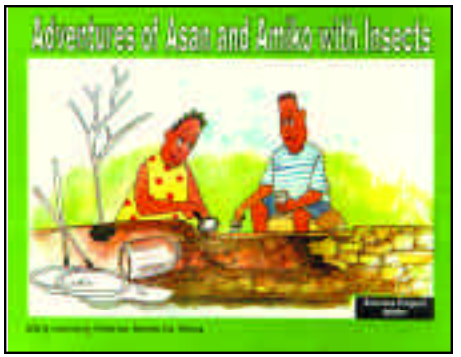
Extending a quality basic education in science and mathematics at the primary school level for girls as well as boys was the central story that Professor Sam Bajah presented as he described the programmes being implemented in Nigeria. The goals for science necessarily were directed toward providing students basic education needed to manage their lives and their health. Themes that were incorporated within specially prepared teaching resource materials included such topics as malaria and HIV/AIDS.

Policies regarding what is taught are developed nationally, and science and mathematics are core subjects within the national curriculum. The objectives of primary school science in Nigeria mirrored very closely those described in presentations from Asia Pacific region countries, including:

- A focus on observing,exploring,appreciating and protecting the environment;
- Developing functional knowledge of basic science concepts and principles as well as basic science process skills;







Cirriculum materials from Nigeria

- Developing basic understanding of natural phenomena;
- Developing scientific attitudes (habits of mind) including curiosity, objectivity, critical reflection;
- Being able to apply knowledge and skills gained to solve everyday problems;
- Developing self-confidence and self-reliance through problem-solving.

Grade by grade expectations for learning are articulated that range across the life sciences (the human body, plants and animals,agriculture),physical sciences,(e.g.,properties of water, air, light, energy),earth sciences (rocks, weather, earth and sky),mathematics (grouping,ordering, measurement),and environment (nature discovery, plants and animals,soils,pollution). Activities and topics appropriate to the age and developmental level of students characterize the national curriculum. Professor Bajah pointed to a number of issues which had also been raised in the Asia Pacific region presentations.

While governments may be involved in the development of goals,frameworks and curriculum for science and mathematics education this does not ensure that these will be implemented. Implementation depends on additional factors including the knowledge, skills and confidence of the teachers;the presence of supportive classroom environments and teaching resources, including books and equipment.

While active hands on approaches to teaching science are highly valued pedagogically, assessments that focus on recalling memorized materials are still in place and actively work against the movement towards hands on strategies.

Generalist teachers predominate in primary school education; strategies are needed to bring more knowledge of science into the preparation and continuing education of teachers. Alternatively, there is a need to consider use of science and math specialists in teaching and/or to explore partnerships that involve scientists as resources to generalists.

Professor Bajah described several curriculum projects undertaken in Nigeria and other parts of Africa. One specific project ELSSA (Early Learning Science Series for Africa) supports literacy goals as well as hands on science, involves culturally important activities such as plays and skits,songs and poems. He described the goals as "Think Science;Act Science;Sing Science."

Dr. Gonzalo Córdoba of SENACYT in Panama (Secretaria Nacional de Ciencia, Technologia e Innovación) described a different approach to primary science and mathematics reform undertaken in his country. Rather than undertake a process of curriculum development from the beginning,they instead sought to identify existing efforts that might be adapted for use in Panama. This research led them to the materials, approaches and training offered by Project 2061 of the American Association for the Advancement of Science in the United States. The major publications of the project were available in Spanish *CIENCIA: Conocimiento Para Todos* and *AVANCES En El Conocimiento* Científico) as well as the training that was provided to teacher leaders. The focus of the training was on understanding how to move from the conceptual goal for students and age specific learning goals,to standards based curriculum models for the classroom. This also focused on the ways to align goals and activities and the need to monitor progress toward student achievement.

Professor Samuel Bajah,speaker

Since Project 2061 materials are not prescriptive they thus provided a flexible framework for local adaptation. The products from AAAS were originally developed through yearslong interactions of scientists,science education faculty and teachers.

Dr. Otto Hammes described a kit based project developed in Germany that was being implemented in Indonesia. With a focus on improving the quality of science education in primary grades the components of SE QIP (Science Education Quality Improvement Project) included:

- a training system
- support system for teachers
- equipment system
- maintenance system for equipment
- written materials,and
- reform of examinations

In the implementation of the program there was the opportunity for local "interpretation"to meet district needs and conditions.

Critical Role of Teachers

Throughout the presentations and discussion there were repeated references to the critical role of teachers: their knowledge of the subject matter, their skills in teaching and their confidence and attitudes. Both the panel on curriculum and the panel on the preparation of teachers raised the following issues:

- the low levels of preparation of teachers in science and mathematics content;
- the need for specific training that relates learning goals to classroom practice;
- the need for a support system for teachers to support regular employment of newly acquired skills;
- the measurement of results of implementation with feedback into the teaching process and modification of classroom practice as needed and;
- The opportunity to observe each other, to learn together and to share experience.

Participants enjoy a visit with students

Dr. Ella Yulaelawati described efforts to improve the preparation of teachers of primary school science in schools in Indonesia. Earlier in the session Dr. Boediono had described the critical issues facing reform efforts in the country. Dr. Yulaelawati provided survey data indicating the differences in attitudes among instructors prepared in the Primary Training College (a specialized secondary school program),a two year updated teacher training college involving a post secondary program and pre-service students enrolled in the two year Diploma program. Eighty one percent of instructors perceived science as a body of knowledge with the resultant expectation that such knowledge was shared through "telling." Teachers who graduated from diploma programs (60%) and pre-service students of such programs (53%) were more likely to see science as "observations,investigations, verifications and inventions to solve problems and increase the quality of life." The diploma programs focus not only on increased understanding of subject matter but also on the skills needed to promote student learning. In-service training needed to upgrade preparation of teachers coming from the old program was described as inadequate. Such programs have focused on content transfer rather than content plus pedagogic skills,have been decontextualized from the reality of the classroom and/or have not taken in account local needs.

Dr.Yulaelawati emphasized the need to consider gender issues in the discussion of primary school education reform.Although there are more female teachers in primary schools the training opportunities for them may be limited. Fewer females are appointed to leadership positions in schools in spite of the fact that they greatly outnumber males among primary school teachers.The failure to address cultural barriers to training and opportunities for women thus can serve to limit the effectiveness of primary school science and mathematics reform initiatives.

Reforms should take into account the needs of those who teach for continuing professional support within schools as well as at district and provincial levels. She proposed that much of the work of in-service training needs to be done at the school level in work within teacher groups,led and supported by fellow teachers,head teachers and inspectors. The challenge resides in building sufficient capacity within the system to create a leadership group needed to sustain and extend such an effort.

The unique role that scientists can play was aptly demonstrated by Professor Julieta Fierro of Mexico and representative of the International Astronomical Union,assisted by Professor Isobe of Japan. Dr. Fierro's demonstration illustrated how complex ideas can be taught to teachers and even conveyed to young children by means of hands on activities and use of manipulatives.

The discussion that ensued about the preparation of teachers, facilitated by Dr. Karen Worth of the United States,led to an expanded view of the jobs that teachers are expected to do. This leads directly to an expanded vision of what preparation is needed for primary level teachers of science and mathematics. These needs extend beyond content knowledge to include:

- strategies for effective teaching;

- understanding the developmental level of children;
- knowledge of research on how children learn;
- understanding of how to select and adapt materials to meet local classroom needs;
- knowledge of effective assessment and questioning techniques.

Teaching was described as an extremely complex skill. And most approaches put in place to affect it are ineffective since they neither address the range of specific skills needed nor provide sufficient time, feedback and assistance to develop and support these approaches.

Student Learning

Part of what teachers must take into account to support teaching of science and mathematics at the primary level,as well as the preparation of teachers, is the emerging body of research about how students learn. Drawing on a model developed by Harlen and Osborne (1985) Dr. Malcom and Professor Dong Qi,Vice President of Beijing Normal University, briefly discussed issues related to brain and cognitive research that need to inform work in curriculum development and classroom practice.

CCBS Co-Chair Dr. Shirley Malcom

Central to these findings is the importance of developmentally appropriate strategies. Providing sensory rich learning experiences that include interactive, hands on approaches to support learning of science and mathematics is supported by the emerging research.

V. Recommendations and Action Plans from Discussion Sessions

During the course of the meeting concurrent breakout-sessions provided the opportunity for participants to focus on selected themes critical to reform of primary science and mathematics education. Each session was asked to include a discussion of the similarities and differences among countries and regions of the world,opportunities to share promising practices, the role of scientists,the contributions of unions and interdisciplinary bodies and the interest and role of donors.

Provided below are the recommendations and action items that emerged from those sessions.

Curriculum Content and Assessment

- Need to collect and disseminate reform curricula, which embody content,process and building students'interest. Relevance and relationship to children's daily life are important;
- Need to have an international network to exchange information on assessment,which will focus beyond 'Paper and Pencil' tests, especially in the area of process skills,interests and attitudes;
- Need to find out how the above issue has been dealt with,including both external assessment and techno-generated data;
- There should be good opportunities for teachers to be competent in assessment of science and mathematics.The assessment should not be threatening—good relationship between pupils and teachers is essential when assessments take place;
- Collect information on teacher evaluation methods.Children should be involved in the evaluation of a class room;
- Create and disseminate a list to guide teachers in their practice;
- Need to gather information on computer use coordinated with science teaching,and to develop guidelines that will help make the use effective.

Recommendations of the Technology Group

GUIDELINES:

1.Technology is not a panacea: It is too often used inappropriately. However it has an important role in elementary math and science education

We recommend: developing guidelines for the effective and appropriate use of computers and networking in math and science education;

2.Small computers: Small handheld computers offer new opportunities for universal access to computers and networking,particularly in a few years when costs can be expected to be in the $10 range;

We recommend: ICSU sponsor international collaboration on small computer in-class experimentation and software sharing.

Professor Leon Lederman with a group of students at the museum

3.Resource sharing: There is a huge need to share best practices,materials,and software that can be applied to math and science education internationally.

We recommend:

- Sponsor a planning meeting to plan mechanisms and topics for sharing
- Develop a mechanism to share software. Consider sponsoring and advocating open source licenses
- Continue and expand www.teachscience.org consider an international decentralized staff overseen by an international board.

4.Student data sharing: Teachers and students can gather data and information locally and share it globally;learning good science, communication and environmental stewardship in the process.

We recommend: ICSU sponsor a portal that would support student sharing with shared databases,do-it-yourself facilities and resources.

5.Online Teacher Professional Development (TPD): Online courses offer huge potential for teacher professional development, but ICSU cannot deal directly with this.Instead, its role might be to provide guidance and share information.

We recommend:

- Develop guidelines for effective cost-effective online teacher professional development,with examples in math and science.
- Develop online seminars for TPD professionals and policy makers.

Teacher Training and Continuing Education

SUMMARY OF KEY POINTS:

1. Teachers Colleges: We need to be aware of and ready to incorporate latest development in cognition science research (cooperate with Universities and Planning and Research department.)

2. Teacher Recruitment:

- Raise social and economic status
- Connecting teaching to patriotic obligation of advancing education
- General conditions to enable high schools to perform their vital tasks
- Sound education policy and wide national consensus
- High priority for teaching training, pre-service, continuous professional development

3.A Coherent Curriculum: Spans pre-K through secondary schools

Criteria for success:

- Build on natural curiosity of children
- Encourage innovative and critical thinking
- Recognise practical connections in study of science and languages

Relevant to lives of children:

- Build systematically earliest ideas and science activities through more abstract concepts that support the core science disciplines
- Mathematics must be properly taught for its own power and its use in the sciences

High schools must produce graduates who are:

- Future citizens who can manage their lives and contribute to a world of bewildering changes-contributed by extraordinary changes in technology globalization and new economy
- Skilled in reading,basic algebra, computer facility
- Most important,high school graduates must have a positive attitude towards the mathematical and aesthetic values of science.
- The coherent curriculum described should serve to simplify the tasks of high schools

4. Teacher Training:

Declarations:

- Continuous and meaningful teacher development programs are critical to science and mathematics reform in primary school.
- The science and mathematics communities have a responsibility to work with educators in improving science and mathematics teaching and learning in primary school.
- Teacher development programs must address the needs of pre service, students,in service teachers and those who provide the development programs.

Action steps:

- Plan and implement communication networks to encourage dialogue and the exchange of resources among participants in professional programs including teachers,school district decision makers, higher education faculty, mathematicians and scientists.
- Through the network develop a compendium of program designs,professional development materials, curricula and other pedagogical material.

- Create a working group to collect,compare and analyze existing standards and criteria for quality professional development programs and evaluation and assessment strategies

5.Our comments are by no mean complete:

Other issues yet to be examined:

- Difference between science as pure knowledge and technology which is the application of knowledge to society
- Children should be eager to learn about environment,moral and ethical issues in the use of technology
- Assessment of students
- Decisions of students after high school

Out of School Science Education Opportunities

SUMMARY OF KEY POINTS:

Early Education-Preschool:

- Collect programs,strategies and materials for support of pre school science and math education,including learning at home, through media.Importance of values and culture.
- Develop booklets, web sites for dissemination through Early Childhood Resource Center for Science, Math and Technology, perhaps through cooperation of UNESCO, UNICEF and ICSU capacity building efforts.

Primary Schools:

- Connect science learning opportunities to other programmes focused on children, for example, nutrition and health programmes.
- Develop/collect and share examples of programmes that support and train parents on mechanisms and strategies for science and math learning.
- Interesting talk shows
- Children's science and math page in news papers
- Effective teaching toys and good books
- "Science Commercials"between children's programming on television
- Build linkages across different groups concerning children's health,education,science organizations,informal science institutions,etc.,to support science and math learning.
- Encourage government support for collaboration through funding of jointly developed, jointly submitted programmes.

Media:

- Develop and award international prizes for quality science media for children.
- Explore copyright issues or co-production arrangements in sharing science television for children and supporting its development.

Places for Science:

- Seek dialogue with science center groups around designs for 21st century science learning centers, closer connections to the science community, use of new technologies.
- Collect and share examples of co-located programs, such as hands on science programs in libraries,science play grounds.
- Develop and publish database of reviews, books and software for children in science and mathematics.
- Develop education events/communications around natural science phenomena (e.g.solar eclipses).Develop events to highlight science and technology for children,for example, science and technology week or month around the world.

VI. Proposed DRAFT-ICSU Statement of Principles for Natural Science in Primary Schools

During the final discussions in Beijing some of the participants put forward the following draft principles for the future consideration of ICSU as the possible basis to guide future ICSU activities in science education in primary schools:

- Consider that young children throughout the world share the same curiosity and average ability for science;
- Exploit the universality of science inside the multiple facets of local cultural and social life;
- Proceed from children's questions and observations to hypotheses and simple experiments on real objects and phenomena from their immediate proximity;
- Make sure that children argue and reason together, hence getting emotionally involved;

Dr. Larry Kohler, ICSU Executive Director with students at Museum

- Link tightly science teaching to language acquisition (oral and written as well as lexical and syntactic abilities);
- During science teaching, avoid the use of computer for children as well as that of 'black boxes';
- Rejuvenate teachers'training:practice of hands-on,unification of science beyond disciplines,use of computers for modeling;
- Involve the national scientific community, especially Academies of Sciences (through ICSU and IAP),in primary school issues and teacher's accompaniment;
- Delineate locally relevant processes and criteria to evaluate the building of capacities of both children and teachers,and exchange best practices;
- Aim at setting up a global internet network for exchanges, resources,data base consultation.

VII. Next Steps

Concluding sessions focused on input from donor groups and obtaining feedback from participants on the attached conference statement (See Section VII). This statement reaffirms the value of networking and collaboration to support the improvement of primary science education locally, nationally, regionally and worldwide.

The importance of sharing strategies,materials and programs was highlighted. The value of the international conference was reiterated,along with a commitment to convene a second such conference in Brazil in 2002 at the time of the ISCU General Assembly. The second conference would strive to increase the number of participating countries and regions represented, increase the emphasis on mathematics education within the meeting and presentations,expand the teams of country representatives to include policymakers and officials as well as scientists,mathematicians and educators and increase the presence and role of donor groups.

Concurrent sessions were held to focus on action plans. These included China representatives considering the role of reform initiatives in light of general conference discussions,and within the Asia-Pacific regional group and the "ICSU" family" group discussions. The action plan from the Asia Pacific group included proposals for sharing work on curriculum and teacher development, including strategies for incorporating local culture, a regional annual meeting focused on primary science and mathematics education, an information exchange network and participation as a region in the second International conference.

The "ICSU family"meeting, chaired by Dr. Larry R. Kohler, reaffirmed the need for ICSU to play a crucial role in linking primary school,secondary school and university programmes on science and mathematics education by forming direct links and partnerships between teachers,students and scientists and others. The "Science Corps," proposed by Professor Lederman as a future activity for ICSU, should be an initiative in close partnership with the education and technical co-operation communities—and efforts should begin to build these links.

The focus of the plan of action was on the following:

Outreach

ICSU should become more proactive in publicizing its interest in and capacity to support science and mathematics education. This could be accomplished through the publication of a newsletter on science education and the strengthening of the network of ICSU Scientific Unions and others in the ICSU family in the area of capacity building. ICSU can play a major role as a clearinghouse of quality materials and relevant information,perhaps building on the teachscience.org website with mirrored local websites translated into local languages.

Supporting and Networking with Existing Networks

More partnerships should be developed with additional countries and existing networks where improvement of primary science and mathematics education might appropriately be added to their ongoing collaboration.

Examples include networking through existing regional networks such as the "Latin American States Association" or through ICBA (Capacity Building in Africa).

Participants visit a pre-K classroom

Preparations for CCBS Conference (Brazil, 2002)

A specific proposal was made and accepted to support the idea of the 2nd International Conference to be held in Brazil in connection with the ICSU General Assembly in September 2002.It was also proposed that a symposium be incorporated into the program of the ICSU General Assembly focused on "Science Education: Opportunities and Problems."

The planning for these events would specifically address the need for the direct involvement of ministries of science and technology and education from the planning phase for the conference. In addition mechanisms must be found for the meaningful engagement of teachers of science and mathematics and those involved in curriculum and teacher training activities, especially from developing countries.

Meeting of the ICSU Scientific Unions (February 2001)

Science and mathematics education issues should be specifically addressed at the proposed meeting of Scientific Unions in Paris in February 2001. ICSU's Scientific Unions should be encouraged to become involved in the planning for the upcoming conference and to participate in relevant activities related to the improvement of science and mathematics education in primary and secondary schools.

VII. BEIJING CONFERENCE STATEMENT

Endorsed by the participants at the final session:

Scientists,educators,teachers,and representatives of government and the private sector from over 20 nations gathered in Beijing,China from 1-4 November 2000 to discuss problems and opportunities in the science and mathematics education of primary school children.

It was characteristic of the meeting that representatives of all regions raised problems that were common- the same in all regions of the world:north and south,east and west, rich and poor.

We recognized the common problem that primary school teachers are, in general, poorly trained in mathematics and science. In all regions there is a growing realization that any hope of building capacity to use science, mathematics and technology (SMT) to advance the human condition, world-wide will rest on our success in the education of children,especially in SMT. This has always been true in history but as we begin the 21st Century we become aware that access to the explosive developments in science and technology is becoming crucial to personal,national and international 'survival'.

The above assessments encourage us to propose a new action network to co-ordinate the efforts to achieve this common goal of worldwide advance of science knowledge and science thinking as a vital component of the education of young girls and boys.

We are aware of many organizations,national and international,that include primary school education,science and mathematics,and the welfare of young children as part of their mission.Our plan would include compilation of a complete list of those organizations in order to network all our efforts,minimizing unnecessary duplication and formulating a global strategy to bring every child in the world up to a level which would prepare them for education in schools,in informal settings and throughout life. We are all aware that early education shapes the attitudes of children and the expectations of parents and teachers for them,for their education; and for their futures as citizens, workers,scientists and engineers.An international network for primary science and mathematics education would encourage contacts among regions of the world,interchange of ideas and experiences,sharing of training methods and materials,exchanges of teachers and curriculum experts,and the organization of future meetings like this first Beijing Conference.
In designing future activities for this new action network,there is a clear need to take into account national, regional and global benefits that would arise from significantly enhanced collaboration to meet the challenge of creating a worldwide science literacy.

We are encouraged by the development of new, and the wider use of existing,educational technologies,as well as the rapidly increasing connectivity of the Internet. We have been inspired by the examples of international governmental and non-governmental institutions that could be networked with science and mathematics initiatives on primary school education. We recommend follow-up actions to the World Conference on Science, expanded partnership with major global initiatives like Quality Education for All,and collaboration with other international organizations such as ICSU, UNESCO, IAP, UNIFEM,UNICEF, and UNDP.

Too many nations have given inadequate priority to the education of young children,who must be prepared to live and work in the new millennium.In this new century, we recognize the challenge which will requires a much higher priority on the part of government,industry, NGOs,and society—the threat of ignorance, of illiteracy, of superstition and of a disengagement from the potentially huge advantages of these new technologies to support sustainable development.

A great value lies in the development and implementation of a consensus statement as to the usefulness of such a new action network,beginning with each of the individuals attending here signaling their support for the goals and recommendations of the meeting. To this end,ICSU is committed to convening a Second Conference on Primary School Science and Mathematics Education in September 2002 in Rio de Janeiro, in conjunction with the ICSU General Assembly. We will make every effort to ensure a greater number of nations and relevant organizations will participate in the Second Conference.

ICSU-BEIJING

PROGRAMME

INTERNATIONAL CONFERENCE ON PRIMARY SCHOOL SCIENCE AND MATHEMATICS EDUCATION

1-4 NOVEMBER 2000,Harbour Plaza,Beijing

Sponsored by the International Council for Science (ICSU) and its Committee on Capacity Building in Science (CCBS)

DAY 1 (1 NOVEMBER)

8:00 am Registration

9:00 am **Opening Plenary-**
Opening words by Dr.Wei Yu
Welcome Address by Minister of Education,China
Greetings by Professor Leon Lederman (CCBS)
Speech by Xu Shanyan,China Association for Science and Technology (CAST)
Greetings by Dr. Larry Kohler (ICSU)
Speech by Dr.Yuan,President,Beijing Normal University
Introduction to Programme, Dr. Shirley Malcom

10:00 Coffee Break

10 :30 Curriculum Reform in Primary Education in China, Li Lianning,Director General,Ministry of Education, China

11:00 **Reform of Science and Mathematics Education:Examples from the Field (Chair : Professor Leon Lederman)**
Teams of presenters,including scientist,educators, and participants,will describe programmes (and programme adaptations) to improve teaching and learning of science and mathematics at primary levels,using active, hands-on approaches.

Chicago, (USA) : Teachers Academy for Math and Science, Leon Lederman and Lourdes Monteagudo
http://www.tams.org

France : La Main à la Pâte :Yves,Quéré,Pierre Léna
http://wwwinrp.fr/lamap/

Brazil : Dietrich Schiel and Domingos Pereira Viana Filho
For information on China,see *http://www.sedu.org.cn*

13:00 Lunch

14:30 **Panel- Science and Mathematics Education in the Asia/Pacific Region**
Representatives from countries in the region will present a brief picture of issues in science and mathematics education,issues at the primary school level as well as implications of these for secondary school and preparation of science teachers.

16:00 Coffee Break

16:20-18:00 **Concurrent Breakout Sessions to discuss issues in light of earlier presentations**
Breakout sessions,organized around selected themes, would focus on key issues critical to reform of science and mathematics education.Every session would include a discussion of similarities and differences among countries and regions of the world, opportunities to share promising practices,the role of scientists,the contributions of unions and interdisciplinary bodies and the interest and role of donors.

- Implications for high school science and mathematics teaching—Professor Leon Lederman
- Assessment of student learning—Dr. Jerome Pine
- A role for technology in supporting quality science and mathematics education—Dr. Robert Tinker
- Content (What Do Students Need to Learn)
- Learning science and mathematics before and outside of school Dr. Jayshree Mehta Ajitbhai
- Teacher training and continuing education—Dr. Dong Qi

19:00 Reception offered by Ministry of Education,China

DAY 2 (NOVEMBER 2)

9:00 am **What Science and Mathematics Should Be Learned (Chair :Yves Quéré)**
A panel of scientists and educators will discuss what science and mathematics content goals should be established,taking into account what science and mathematics students need and possible constraints related to different levels of economic and social development.

Dr. Samuel Bajah,Nigeria
Dr. Gonzalo cordoba, Panama
Dr. Otto Hammes,Indonesia
Dr. Wang Rongbn,China

10:30 Coffee Break

10:45 **Preparing Teachers Who Can Teach the New Curricul (Chair : Dr. Liu en-shan)**
A panel of scientists and educators will discuss their respective roles in the education and continuing professional development of teachers.

Dr. Ella Yulaelawatu,Indonesia
Professor Julietta Fierro, Mexico
Dr. Karen Worth,USA
Professor Ho Hing Jua,China

12:30 Lunch

14:00 Field visit : Kindergarten and Primary School attached to the Beijing Normal University

17:00 Visit to Summer Palace

19:00 Dinner at Summer Palace hosted by Beijing Normal University

DAY 3 (NOVEMBER 3)

9:00 **Student Learning of Science and Mathematics:What Does Cognitve Science Tell Us**
New findings on student learning should affect what and how science and mathematics are taught as well as how teachers are prepared.

10:00 Coffee Break

10:15-12:45 **Discussion sessions continued (preparation of proposals for action)**

12:45 Lunch

14:00 **Field Trip**-Meeting with primary school pupils and observing their activities at China Science and Technology Center

18:30 Dinner

DAY 4 (NOVEMBER 4)

8:30 **Plenary**- Reporting Back from Concurrent sessions

10:30 Coffee Break

11:00 **Discussion continued and donor perspectives**

12:00 **Lunch**

14 :00 Afternoon Planning Sessions for Implementation
China Primary Reform
Meetings of Representatives by Region
ICSU Union and Interdisciplinary bodies
Education representatives

Opportunities will be provided for participants to meet in planning sessions focused on next steps and their roles in implementing recommendations from the conference.

16 :00 Closing remarks

16 :30 End of Conference

Notes: English will be the official language of the conference. Products from the conference will include a proceedings volume and website as well as the planning documents.

OPENING STATEMENT

by Professor Leon M. Lederman

Co-Chairman, Committee on Capacity Building in Science (CCBS)
at the International Conference on Primary Science and Mathematics Education

1-4 November 2000, Harbour Plaza, Beijing

It is my honour and my pleasure to make some opening remarks at this important Conference. In June of 1994,I chaired a new ICSU group:the Committee on Capacity Building in Science (CCBS).It was soon evident that a crucial element in the capacity of any nation to do science for the advance of the society depended on the quality of the education it gives its children and,especially, the education in science and mathematics.

The CCBS Committee evolved and had a major role in the World Conference on Science (Budapest, 1999) where science education was an important topic. Thanks to the really outstanding efforts of Dr. Wei Yu,a member of the CCBS, this Beijing meeting was convened as a unique Conference devoted to the problems of science and mathematics education in primary school.

We selected primary schools because our experience indicated that the challenges in primary school science education are the same all over the world.Primarily, primary school teachers are not well trained in these subjects and you cannot teach what you don't understand.Other reasons for concentrating on primary schools have to do with the fact that all too often,in developing nations,it is the only education available and failure is especially serious for young women. Finally, young children belong to an international grouping which is not yet shaped by local cultural diversity so that common experiences are usefully exchanged and adapted as, for example, between Chicago, Nairobi and Calcutta.

Now a Conference as elegantly organized as this should easily produce an elegant conference report,which will be placed on a shelf of elegant reports of conferences down through the ages.This is not what we should do! I believe that the time has arrived for an action plan,i.e. a document clearly stating our objectives and the steps we need to take together to reach these objectives. I do no know what this plan will be but I would like to suggest some components of an action plan:

(1) The formation of an organization, representing the groups from the over 20 countries and which would eventually grow to include membership of groups from all the nations of the world.This would provide a mechanism for the exchange of ideas and experiences.

(2) The formation of a donors group so that every child will be able to benefit from a good education in which science and mathematics are important components.

(3) The use of the Web and other information transfer technologies to facilitate communication between members of the new organization.

(4) Inspired by International Red Cross, Peace Corps and Doctors without Borders, we can think of a "Teachers without Borders"organization ready to help where help is needed.

Clearly this is only an outline of a new organization that would have to network with other organizations which have some concern for the welfare of children.

I urge the members gathered here in Beijing to be bold. Political leaders,industrial managers all over the world are realizing the crucial importance of a science literate population.The 21st century promises to be characterized by an ever increasing pace of change as science and the technology based upon science change human behaviors and human possibilities. We enter this new century of science with a population that is ignorant of science and technology. This is a prescription for disaster. We, the scientists, educators, teachers have a moral obligation to do what we can to insure the most important aspect of science education,that of the children.

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