MAURITIUS RESEARCH COUNCIL

Science Education

An Action Plan

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1. Background

The Mauritius Research Council commissioned a number of investigations and studies that were conducted with a view to assessing the status of science in Mauritius in general, and more specifically, in the schools.

In short, the studies have allowed identifying several weaknesses in science education. Our current lacking in science could have implications on the quality of our human resource, particularly within the context of the vision of transforming the country into a Cyber island. *A fundamental realisation is that one cannot develop competent IT skills without a sound knowledge of science and mathematics.* The major recommendation of the consultants is a complete review of the teaching and learning of science in our primary and secondary schools. The consultants are of the view that the current state of affairs is already leading to pupils and students shying away from science for many reasons varying from science being perceived as a difficult subject to the lack of career opportunities for those opting for scientific subjects.

The present status of science in Mauritius is **not an isolated finding**, since many other countries in the world are facing more or less the same problem. In a recent report commissioned by the House of Commons in the U.K, Dr Ian Gibson, Chairman of the Science and Technology Committee, commenting on GCSE Science, quoted the following:

"Science should be the most exciting subject on the school curriculum: scientific controversies and breakthroughs hit the headlines every day. But school science can be so boring it puts young people ***off science for life****. GCSE science students have to cram in so many facts that they have no time to explore interesting ideas, and slog through practical exercise, which are completely pointless.* ***This is a disaster****: we need to encourage a new generation of young scientists and to ensure that the rest of the population has a sound understanding of scientific principles."*

The above quote applies equally to the status of science in our schools, as we tend to follow closely the British model. Other countries have and are already taking bold steps to reverse the negative trend. In most countries science is compulsory to the age of 16 and in some to the age of eighteen. These countries realise that, nowadays, science literacy is a must to become a productive citizen. Mauritius cannot afford to stay aloof or else we stand to miss the boat!

This brief summarises the findings of an audit on science and technology in Mauritius and lays down some of the issues and measures that need urgent attention to redress the situation in order to maintain our competitive edge. To that end an **action plan** that mainly focuses on the education sector is presented.

2. Summary of Issues

2.1 For the Primary Sector:

- At what age should science be introduced?
- Science curriculum to be reviewed to be locally relevant.
- Science taught in an abstract form.
- Are teachers adequately qualified, trained and motivated to teach science?
- Total lack of practical work.
- Introduction of group learning (for practicals).
- Use of multimedia to teach practical (Virtual Laboratories).
- Use of local low-cost equipment for practicals.
- Introduction of Mobile Science Laboratories.
- Science should be fun and attractive.

2.2 For the Secondary sector:

- Science perceived as difficult.
- Lack of career opportunities.
- Less than 25% of pupils opt for science at O level.
- About 10% of pupils take computer studies at O level.
- Less than 3% of pupils take computer studies at A level.
- Extremely few girls are attracted to physics.
- Lack of infrastructure for practicals.
- Review of practical and field work.
- Training and recruitment of Laboratory Assistants.
- Science not an option in some schools.
- Science curriculum to be locally relevant.
- Curriculum should not be a “Puzzle”.
- Recommend some form of integrated science to be compulsory up to Form V.
- Phase out and eventually ban “Alternative to Practical Exams”.

2.3 For the general public:

- Public awareness of science in Mauritius is low and steps, through the media and other means, should be taken urgently.

3. Steering Committee on S&T Education

A Steering Committee under the chairmanship of the Mauritius Research Council has been set up to address the above issues and to recommend to the Ministry ways and means to revert the negative trend in science in the educational sector. The committee will be facilitated by the MRC and will consist of senior representatives of the various institutions.

The committee will, inter-alia, focus on the issues raised above and through consultative meetings and discussions with all stakeholders, assist the Ministry of Education and Scientific Research to implement the reforms that would be necessary to re-orient the teaching and learning of science in the schools. The Mauritius Research Council will assist in the funding and commissioning of any further studies that may be required.

3.1 Two Task Forces

Two Task Forces have been set up with a view to assisting the Steering Committee and working out the technicalities. The first Task force will examine the issues raised at the level of the **primary sector**, while the second will deal with the **secondary sector**. The two Task Forces will include representatives of all stakeholders and will also be facilitated by the MRC. The Task Forces will make their recommendations to the Steering Committee. The Terms of Reference of the two Task Forces are found at Annexes II and III.

3.2 Promotion of Science Teaching

With a view to promote the teaching of science and to keep teachers updated on new developments at the international level, it is proposed that an association of science teachers from, both the public and private sectors, be launched. The development of a web-site for science education with international linkage could be one of the initiatives of this association.

4. A Time-phased Action Plan

4.1 General Objectives

- Active participation of students through innovative/challenging activities
- Improved implementation of teaching and learning strategies
- Effective use of ICT within the science curriculum
- Increased teacher knowledge and understanding of science and technology
- Enhanced links to Numeracy and Literacy
- Effective use of assessment techniques.

4.2 Specific Objectives

4.2.1 For the primary schools:

- Teaching and learning of science and technology should meet intellectual, moral and social criteria.
- Actual system lays too much emphasis on preparation for exams instead of on learning *per se*, thus drawing on the energy of teachers, pupils and parents. More emphasis to be laid on learning for life.

- Lack of dedicated/specialised teachers and facilities for teaching of science and technology.
- Adequate human, logistic and financial resources to be made available to meet requirements.
- Teachers to be encouraged to enhance capacities.
- Based on the recommendations of the reports:
  - Development of a national project for science and technology education
  - Set up a steering committee "Science and Technology" with a representative composition
  - Work out the specific terms of reference
  - Propose one institution for operational steering

Review of curriculum

- Is the present curriculum adequate and does it comply with the needs and aspirations? Review is required to provide a science and technology programme, including practical, experiments and fieldwork to allow mind-developing, curiosity, objectiveness, imagination and reasoning of the child.
- Qualitative and quantitative evaluation of the current science programme to identify gaps and propose corrective measures.
- Identification of other drawbacks if any.
- How much science and how many hours per week will be required?
- How to balance teaching and learning of science and technology with other subjects?

Should science learning start at Standard IV or earlier?

- Since science is also about observing and understanding, then the age of the child is immaterial.
- Science familiarizes the child with a world governed by laws.
- The world today is more and more technology driven.
- Science will allow the child to understand the cause-effect relationships, properties, constants and functions of well-defined objects and the value of precise calculations and logical reasoning.
- Early introduction to basic principles of science through everyday life examples could prompt the thinking process of the child.
- Science education could use examples of various phenomena or activities and then slowly move to the principles and basics. "Visual instead of virtual".

How should science and technology be taught at school?

- Methods and pedagogy review
- Teaching of science and technology should allow pupils to participate in building their own knowledge
- Science and technology teaching should involve pupils in research and activities based on questioning
- Teaching method should include prompting and guidance by the teacher

- Teachers should not necessarily be extensively trained in science
- Hands-on learning projects and use of the local environment
- Science to be attractive and fun.

Teacher qualification and training

- Comprehensive review of teacher education
- S&T and ICT trained teachers
- Support of University and other institutions
- Support group made up of policy makers, inspectors, research staff, trainers for teachers (exchange, assistance, follow-up and monitoring).

Use of IT and Multimedia

- Provision of computers in schools
- Internet facility
- IT teachers
- Multimedia tools (products of the VCITL of UoM)

Other Resources

- Low-cost equipment and hands-on (la main à la pâte)
- Mobile and virtual labs
- Visits
- Co-operative learning
- Talks by scientists and researchers (substitute for school education or complementary tools?)
- Non-school resources for science and technology: RGSC, museums, industries, parks, gardens, school yard, etc.
- Networks among teachers and schools
- New technologies to stimulate teaching environment
- Internationally available resources (books, magazines, web-sites,etc)

4.2.2 For the secondary schools:

What kind of citizenship for tomorrow? (Societal benefits)

- Why should science be compulsory to Form V?
- Do students enjoy studying science?
- Is there sufficient flexibility in the science curriculum?
- Are there enough facilities?
- "Science literacy" and science for further studies
- Science curriculum should include recent developments and advances in the various fields of science and technology.

Phasing out of "Alternative to practical"

- Students to be given the opportunity to carry out varied experimental and investigative work. This will help develop understanding of science, acquire hands-on skills and ensure interest
- "Science for life" course
- "Science literacy"
- Suitably equipped laboratories
- Resource centres/regional science laboratories?

Continuous Assessment

- Evaluation and comparing students' educational results
- Monitoring the quality of learning and the success of implementation of new programme
- How to assess attitudes, inquiry spirit and curiosity?

The communication Strategy

- Public awareness
- Parents' participation
- Teachers unions
- Parent-teachers associations
- Films, slide shows and talks by scientists and researchers
- Attractive science magazines/journals for each age group
- National Science Day
- Best Science Awards (by schools, groups)

4.3 International Comparison

4.3.1 France

Even for those taking "Bac L" (literature), science and maths remain compulsory subjects and will continue to be taught until at least the lower sixth.

Efforts have been made to liven up school curriculum and make science teaching more "hands-on"; but criticism of theoretical bias persists.

At "collège" (11 - 15), all pupils study science.
For age group 12 –14, the principal aim is to equip pupils with an adequate scientific grounding ("culture scientifique").

For age group 15 –18 in the lycée, all pupils studying academic courses leading to the general baccalauréat will study a core science curriculum in "seconde": 3.5 hours per week of physics/chemistry and 2 hours per week of biology/environmental sciences.

For Bac Science, 16 hours per week are spent on maths and sciences combined, from a total timetable of 26 hours.

A fact-based, teacher-centred style of learning has taken precedence over discovery-based, pupil-centred style of learning.

4.3.2 Germany

Compulsory schooling commences at the age of six and terminates at 18. Nine (or ten) of these years have to be spent in full-time schooling: the following years either in full-time schooling or part-time vocational schools, e.g in connection with an apprenticeship.

14 to 16 year pupils: biology, chemistry and physics are taught as separate subjects and are part of the core curriculum. All students must study these subjects.

4.3.3 Japan

All pupils in Japan take science education at lower secondary schools (ages 12 – 15).

All pupils at lower secondary school follow the same curriculum. After a standardised first year, pupils at upper secondary schools can choose their study courses. Upper secondary school courses are classified into three categories: general, specialized and integrated courses. The specialized courses are further classified into agriculture, engineering (mechanical, electric, electronics and information technology) commerce, fishery, home economics, nursing, science-mathematics, physical education, music, art and English language. Curricula of upper secondary schools are based on the Course of Study, issued by MEXT.

The Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) has recently announced proposals to launch a "Science Literacy Enhancement Initiative" including a scheme to create "Super Science High Schools".

MEXT are designating 26 schools as "Super Science High Schools" ea ch of which will receive an additional subsidy this year of ¥25 million (about £136,000) out of a total allocation of ¥727 million (about £4 million) to run the scheme this financial year. The scheme will run for three years. It is not yet clear whether there will be additional subsidies in future years as this will depend on the budget available to MEXT.

The aim of the scheme is:

- to create elite pupils
- to develop a special curriculum particularly on science and mathematics
- to prepare lectures to be given by university professors
- to provide opportunities to have lectures at universities and research institutions

- to conduct research into education methods to improve logical thinking, creativity and originality, and assist the activities of science clubs
- to provide opportunities to meet top class scientists and engineers to learn about advanced technologies
- to provide the opportunity for exchanging students between super science schools

4.3.4 Sweden

All subjects in the Compulsory school [7-16] are mandatory. A total of 12% of the Compulsory school curriculum is devoted to Biology, Chemistry, Physics and Technology. All science subjects aim to describe and explain nature and living organisms from a scientific perspective. Developing pupils' curiosity about, and fascination for, nature in general terms as well as their interest in everyday phenomena is also an aim common to the science subjects at this level.

Annex I

Terms of Reference

Task Force I: Primary Education

A first activity would be to carry out an audit on the teaching and learning of science at school including: infrastructure, teaching qualities, laboratory facilities, science output.

ISSUES	ACTIVITIES	EXPECTED RESULTS
The most suitable age to introduce science	Interviews, review of relevant reports, documents	Recommendation and proposal(s) to the Steering Committee
Science curriculum to be reviewed to be locally relevant	Review of present curriculum and comparison with that of other countries	Recommendations based on success stories
Science is taught in an abstract form	Consider use of "lamap" methodology. Work out proposal for visual/practical science course	Integration of more practical, hands-on and field work in curriculum
Are teachers adequately qualified, trained and motivated to teach science?	Interviews, focus group discussions for identification of needs	Recommendations for enhancement of science teaching quality, training and facilities
The importance of practical work and field visits	Identify requirements and facilities for practical work	Proposals with estimates for number of hours and balance with other subjects
Introduction of group learning (for practical and fieldwork)	Review/assess international documentation and experience	Proposals for integration of group learning methodology within school programme
Use of multimedia to teach practical (Virtual laboratories)	Identify needs in terms of human resources and facilities	Proposal for use of multimedia tools at schools for science and technology
Use of local low-cost equipment for practical	Evaluate low-cost equipment pilot project and "la main à la pâte" (lamap).	Recommendations for modalities and application at national level
Introduction of Mobile Science Laboratories (Inventomobile)	Assess feasibility and evaluate suitability based on French experience	Recommendation on use of mobile labs as complementary facility for science teaching and learning
Analysis, evaluation and action plan for continuous assessment	Diagnosis of present evaluation system, review of current practices in other countries. Feasibility of continuous assessment	Recommendations and proposals for an active continuous assessment system
Science to be fun and attractive	Evaluate present teaching and learning methodology and materials. Review international documentation	Proposals for new pedagogy and materials, including capacity building, multimedia and films
Public awareness of science in Mauritius is low	Review policy and strategy for science awareness. Identify best practices at international level	Propose action plan for science and technology public awareness

Annex II

Terms of Reference

Task Force II: Secondary Education

A first activity would be to carry out an audit on the teaching and learning of science at school including: infrastructure, teaching qualities, laboratory facilities, science output.

ISSUES	ACTIVITIES	EXPECTED RESULTS
The perception that science is difficult	Review of available reports. Find out why this perception persists among students	Comprehensive brief of findings and recommendations for mitigation
Lack of career opportunities	Identification of needs in various sectors with forecasts for next 10 years	Summary of main findings for dissemination to student population Business world and colleges forum
Why less than 25% of students opt for science at O level?	Focus group discussions and interviews to identify causes	Recommendation as to age, level and type of science courses
Why only about 10% of students take computer studies at O level?	Review for relevance in the new context of forthcoming Cyber City/ICT Industry	Proposal for IT literacy courses for all and specialised programmes for IT "technacy"
Why less than 3% of students take computer studies at A level?	Review actual teaching methods and investigate on reasons	Proposal for adaptive courses and awareness programme for ICT sector
Why few girls are attracted to physics?	Carry out survey and identify reasons	Propose plan for Gender, Science and Technology

ISSUES	ACTIVITIES	EXPECTED RESULTS
Are facilities and infrastructure for practical work adequate?	Review state of laboratories and other facilities. Investigate other possibilities and carry out feasibility study	Propose plan for sharing of facilities/regional labs/resource centres/mobile labs
Science not an option in some schools	Carry out investigation and study reasons taking into account existing facilities	Propose recommendations for science and technology courses
Science curriculum to be locally relevant	Carry out audit of possibilities and methodology for use of locally available resources	Propose plan with identified resources and best practices
Curriculum should not be a "puzzle"	Review of present contents, requirements for exams and international experiences	Propose enhanced "practical" curriculum
Recommend some form of integrated science to be compulsory up to Form V	Diagnostic analysis of actual science courses and review of international practices	Propose science and technology courses for Form I to Form V in line with national policy and strategy for sustainable development
Analysis, evaluation and action plan for continuous assessment	Diagnosis of present evaluation system, review of current practices in other countries. Feasibility of continuous assessment	Recommendations and proposals for an active continuous assessment system
Training and recruitment of Laboratory Assistants	Prospective audit in relation to needs	Identification of number and quality for enhancement of lab facilities
Phase out and eventually ban "Alternative to Practical Exams"	Review of all relevant reports and identification of "cause and effect"	Propose plan for availability of practical courses to all
Public awareness of science in Mauritius is low	Review policy and strategy for science awareness. Identify best practices at international level	Propose action plan for science and technology public awareness