The State Of The Educational Reform In Chile In The Field Of Science Education: The Project On Inquiry-Based Science Teaching And Learning At Primary Schools

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Abstract

The knowledge requirements of scientific and technological revolution demand that educational systems provide new abilities for individuals and society in order to deal with a world in change. Science education plays a central role in this problem. Chile has started an educational reform that seeks a shift from academic science for the few to a basic scientific education for all, or scientific literacy. The skills this approach wants to provide are: questioning skills, inquiry and experimentation skills and the understanding of the relationship of science, technology and society. In this context, a milestone principle of action is to bring together the scientific community and teachers and students. A project, which implements the strategy of inquiry-based science education in poor urban schools of Santiago produces interesting preliminary evidence that support this principle of cooperation between first-line scientists and educators.

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There can be doubt about the significant impact of scientific and technological knowledge on the ongoing processes of transformation in contemporary societies. The revolution of information technology makes this even more noteworthy. Today, the life of people throughout the world is increasingly determined by the possibilities created by systems which are products of scientific research, as well as by their risks. In this context, the opportunities for development and well being increasingly lie on the abilities of individuals and societies to use knowledge creatively and to use the new tools in a positive way.

Moreover, the perspective of political and cultural integration of a democratic society, in which the resolution of conflicts and social and environmental problems is more complex and knowledge demanding, urges for a basic scientific education of all citizens.

That is why the goal of *Science for All*, or *scientific literacy*, is a milestone of our education reform, in order to satisfy the need of development of both our society and its members.

This objective represents an enormous curricular and pedagogic challenge.

The shift from academic science for the few to a basic scientific education for all

In the past, the science curriculum in Chile's schools was inspired by the framework of academic science. That is, considering the internal knowledge requirements of each discipline and the needs of the training of future scientists.

The result of this orientation was that only a very small group of students was actually able to acquire scientific knowledge. The current purpose of today's educational reform and of all policies throughout the last decade, is to achieve that all school pupils reach a scientific literacy that enables them to deal in a better way with a society in change. In this perspective, objectives and contents of this area must be redefined and a great and new challenge in science teaching must be addressed.

Scientific literacy is necessary for all students because of the intrinsic educational value of the enthusiasm, amazement and personal satisfaction that results from learning and understanding nature. Secondly, literacy is important because forms of reasoning belonging to scientific research are increasingly demanded in today's personal, work and socio-political contexts. Those who are not familiarized with this approach are likely to have an even higher propensity to be marginalised than today. Finally, this sort of science education contributes to create an attitude of respect and care towards nature, as a basic system for life that begins to evidence signs of global endangerment.

What are today's expectations as to what students should know and what they should be able to do after receiving a good scientific education?

An important scientific society, the *Association for the Advancement of Science*, in its project *Science for all Americans*, defined –in 1989- the essential components of scientific literacy:

"Science literacy—which encompasses mathematics and technology as well as the natural and social sciences—has many facets. These include being familiar with the natural world and respecting its unity; being aware of some of the important ways in which mathematics, technology, and the sciences depend upon one another; understanding some of the key concepts and principles of science; having a capacity for scientific ways of thinking; knowing that science, mathematics, and technology are human enterprises, and knowing what that implies about their strengths and limitations; and being able to use scientific knowledge and ways of thinking for personal and social purposes."[1]

Along these lines I would like to add some elements of our own curriculum reform, initiated in Chile in 1996. This reform defined its educational goal as to achieve that all students could acquire key skills for productive and personal life as well as citizens. These skills are those of criticism, vision and judgement on the relationship between science, technology and society.

Three Main Skills Science for all Should Develop

Inquiry and experimentation skills

- The ability to present a scientific research problem
- The development of criteria and skills for the collection of evidence, information management, its sources and its assessment
- To know and to use evidence analysis procedures and the derivation of conclusions
- To know and to use reporting procedures of results of scientific inquiry

Questioning skills

To acquire and to appreciate attitudes belonging to the activity of inquiry and experimentation, as curiosity, openness to new ideas, rigour, honesty, scepticism, objectivity, disposition to suspend a judgement and persistence.

- To develop abilities of critical analysis of one's own arguments and those of others, on the validity and veracity of science-related information published in the media

[1] American Association for the Advancement of Science, *Science for all Americans, Project 2061 Science for all Americans* proposes a definition of the abilities and contents American students should be able use after their school education. This document was an important reference for the Chilean reform

Science, technology and society

It is important that the school experience provides opportunities to identify, to describe examples of technological applications of a scientific idea and to inquire on its history. It is also important that students recognize science as a human endeavour and are familiarized with examples in which technology contributes to the development of scientific ideas. Students should have the opportunity to propose and discuss cases of ethical dilemma in different science areas.

The challenge is in teaching

The results of the international TIMSS test of 1999 on elementary and early secondary school teachers' confidence to teach the science contents are eloquent. Thirty-eight percent of teachers of the countries taking part in the test declared that they have low confidence in their skills and knowledge to teach science to 14-year old students. In the case of Chile, the figures rise to 63%.

- Considering these facts, we regard teacher training and on-service policies as a strategic issue.

- In this context, I would like to share with you a principle of action in which we put high hopes regarding the renovation of the teaching skills of our country's teachers. The implementation of this principle will have direct influence in the implementation of scientific literacy for the majority of our people.

- This principle is based on the construction of alliances and networks between the scientific community and schools.

- In Chile, the new curriculum was designed with the cooperation of first-line scientists. It is ambitious and demanding. Its practical implementation in classrooms, laboratories and schoolyards requires a joint effort of scientists and educators. We believe that this strategic vision will contribute to perceptively diminish in the short-term the high proportion of teachers that declare not having enough confidence in their skills and their work.

- We think that it is necessary to work in a fruitful conjunction between top scientists and schools -two worlds that are normally separated and often distant to each other. In our recent experience, both in Chile and other countries, we have seen the gradual progress of a commitment of the scientific community with the education of the people and its fundamental protagonists, the teachers. In our view, this union has the highest potential in terms of growth of the teaching skills of our school systems.

The fertility of this cooperation can be witnessed in what we can call a *seed-project*. This project, that is part of Chile's educational policies, is orientated towards the experience of an inquiry-based methodology for science teaching in primary schools. The project is based on the cooperation of scientists and teachers of poor urban schools of Santiago.

The inquiry-based methodology "reproduces" in the class-room procedures scientists use to study the natural world, and proposes explanations using evidence obtained through their work. This methodology gives children the opportunity to be motivated by

scientifically formulated questions, to explore and experiment to obtain information, to establish explanations, to evaluate them considering new evidence and to report and justify their conclusions.

Parts of this project are: the Chilean Ministry of Education, the Chilean Academy of Sciences, with the support of the School of Medicine of the University of Chile. Also taking part are leading international institutions in science education: the Academy of Sciences of France, and the United States' National Academy of Sciences.

Presently we are exploring the advantages of the principles of this cooperation in the classrooms. Although it is too early to establish a global assessment, what we have seen so far, strengthens our hopes. It indicates us that it is a promising strategy to put science education at the height of the demands of the information- and knowledge-society towards our schools.

In this forum we can put this proposal of science education to a test. We will be able to assess the benefits and advantages, fears and difficulties that arise when a collaborative work between these two worlds starts. Each one of them talks in a different language, uses different methods, and works towards different goals. The challenge lies in discovering a formula that overcomes these barriers and helps to take advantage of the respective expertise of the representatives of these two areas of intellectual work.

Innovative projects and the process of science education reform face the huge problem of turning objectives that used to mean access to scientific knowledge for a minority, into quality science education for all. The development of mankind, the perspectives of science and technology advancement produce a world of constant and swift change. We have to be able today to understand the essence of these changes, in order to be a part of them tomorrow.

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1. Content of the Paper

1.1 The goals of the Chilean education reform are to develop quality-centred policies, grant opportunities to all young people, develop equity-centred policies, and intensify education of values. The science curriculum shifted from an academic science for the few to a basic scientific education for all.

1.2 The challenge in the reform is to change teaching practices. In the pilot of the Inquiry-Based Science Teaching and Learning Program for Children in Elementary Schools, scientists, teachers, curriculum experts, school principals, local authorities, parents, and pupils work collaboratively together. The program is relatively new but there is sufficient information to scale it to other schools and districts. By 2009, the Ministry of Education expects to include more than 20 percent of the country's schools in the program.

1.3 The collaborative work between scientists and educators has some international milestones, including the Transition to Sustainability Conference, Conference of the World's Scientific Academies, May 2000, Tokyo and the International Working Conference on Research Related to Science Education, September 2001, Mexico. There are also some national events to promote international cooperation such as the seminar on the Generation of Experimental Materials and Learning Units for Science Education, January 2002, Santiago.

1.4 The pilot project is implemented in the district of Cerro Navia, Santiago that has 150,000 inhabitants, where 25 percent of them are poor. The project is small but involves the whole community. One of its main characteristics is a systemic approach and five components, namely the curriculum, professional development, assessment, administrative and community support, and material support are addressed and developed simultaneously.

1.5 Different diagnosis tests are used to assess the impact of the "new science lessons" on children's learning in science and also language and mathematics. Research in the United States and Mexico, show that the use of inquiry-based methodology in the classroom creates important progress in language and mathematics.