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# EXPERIENCES IN MEXICO IN THE USE OF HANDS-ON, INQUIRY SCIENCE EDUCATION SYSTEMS IN PRIMARY SCHOOLS

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## *Introduction*

Since 1995, different activities have been undertaken in Mexico to explore the application of Hands-On Inquiry Centered Systems (HOICS) for Primary Schools with the support of the Mexican Academy of Sciences and in close collaboration with the National Academy of Sciences of the United States.

Twelve Units of the Science and Technology for Children (STC) curricula developed by the National Science Resources Center have been translated and adapted to Mexican conditions. Close collaboration has been established with several groups in the United States including school districts, universities and research institutions that have been working with HOICS in the United States.

As a result of the series of research activities, national and international conferences as well as pilot programs in different Mexican States, there is now wide interest in these systems and in the ways to insure their adequate application in Mexico.

A brief account of these experiences will be introduced in this presentation, considering their implications for other countries with conditions similar to Mexico.

An outline of possible international collaboration schemes will also be given based on the results of the International Conference on Research related to Science Education held in Monterrey, Mexico, in September 2001.

*Adaptation of STC units to Mexican programs and schools*

After the analysis, translation and modification of the initial 6 STC units that were selected for the pilot programs in Mexico in 1995, a research project was made applying one unit per grade of the STC in 8 schools in Mexico City.

In this research project, special care was given to the analysis of:

– The pedagogical strategies of teachers and the support they need to improve them.

– Techniques to use children's interest to cover several areas of the education programs.

– The evaluation of children's results.

There was great concern that the teachers would not be able to apply these systems in the classroom. Would it be possible for the teachers to feel confident teaching hands on, inquiry science? Would they be able to apply the pedagogical strategies needed to work with these systems? The main findings of this research are the following:

1) Teachers already have a good background in the pedagogical theories involved and are able to work effectively with these systems if they have adequate preliminary training in the details of the pedagogical objectives and scientific contents of each unit as well as continuous support during the application.

2) Teachers could easily relate important themes from other subjects like language, mathematics, geography and history with the work that the children were doing in each unit. It became particularly interesting to see that the notebooks with the written description of the children's experiences and ideas were a very good way to help them to improve their writing and communications abilities. In other cases, the use of measurements, comparisons, tables and graphs facilitated the introduction and use of mathematical concepts.

3) The evaluation of the children was seen as a very significant challenge. There was the need to go beyond the evaluation of the answers that the children could give to questions on the scientific content of the units. It was necessary to evaluate if the children had gained the thinking skills and developed the scientific attitudes that each STC unit had within its objectives.

4) Teachers require special professional development to be able to use the assessment methodologies and techniques that are appropriate for these types of science education. This is especially the case in the assess-

ment with the observation of the children in the classroom and with the tests which the children are requested to solve problems using the knowledge and skills that they have gained.

5) There was much interest to find which ways the teachers can use the pupil's interest in the STC units to deal with other subjects that are also important in the education programs.

A support system for STC applications was derived from the research results, including:

– Training workshops.

– In classroom support of a science assistant, in the first application of a Unit, to prepare and distribute materials and also to help the teacher in the review of the scientific content of the unit.

– Pedagogical advisory support to the teacher by an advisor who every two weeks visits the classroom, reviews with the teacher the work of the students and the teacher's pedagogical strategies.

– Complementary guides to facilitate the broadest possible coverage of the objectives and subjects of the official programs, linking them with the content of the STC units and the interest of the children.

The use of these support systems were found to be very important in reducing the fears of the teachers about teaching science or being exposed to questions that they could not answer properly. These support systems were also very important in facilitating the improvement of teacher pedagogical skills, especially through interaction with the pedagogical advisors, through cooperation among teachers and through additional courses and lectures that the teachers might require.

*Application of the STC in Mexico*

After the initial pilot applications were made in Mexico City in 1995, pilot programs were established in the states of Queretaro and Veracruz using the methodologies derived from the research project. In these cases, the local school for teachers participated in the preparation of the pedagogical advisors and in the follow up to the results in the classrooms. The science assistants were students of the last semesters of the science programs in the local universities. These assistants received training on the system, on the specific STC units that they were going to use and on the environment in the school to insure that they interacted properly with the school support system.

In the five years after 1995, STC has been applied by more than 2500 teachers in 210 schools. This has been done with the support of the local state governments and in some cases of Mexican business companies, like Resistol, Bacardi and PEMEX.

Some of the main results that have been observed are the following:

– The STC work in the classroom is curiosity driven and can be guided by the teacher to be really effective in the development of cognitive skills and scientific attitudes

– Children become enthusiastic about science and technology by exploring, discovering and making things work.

– Science taught in this way is a good support for teacher in helping students to write, to read, to deal with essential mathematics concepts and to learn about geography, history and other subjects in the general curriculum.

– Children and teacher share the need to explore, investigate and to build on previous knowledge and new experiences

– Children modify their previous schemes and enrich their possibilities to build new doubts and new knowledge that launch them to new challenges.

The STC has been used in rural areas with the same type of results and even with street children, 'CHAVOS'.

*Work with Street Children*

It is important to mention that in the work with street children it has been found that:

– These types of systems help the children to recognize that the knowledge that they have already developed during their childhood and their street experiences is valuable and can be the basis for them to learn more and to be better.

– There is a cooperative and respectful environment that facilitates the sharing of ideas and the development of interpersonal skills.

– Children are stimulated to express themselves with confidence, both to express doubts and to communicate their ideas.

– The children assume a reflexive, critical, inquisitive and proactive attitude.

– They improve their thinking skills and their ability to use their previous knowledge as well as their resources and tools.

– Working with the Ecosystems unit, they identify themselves with other living beings and feel that they are part of an ecosystem.

The key element in obtaining these results were the 'facilitators', specially trained young professionals performing the role of the teacher and very committed to helping the street children to overcome this situation. The pilot work with street children was organized with specialized groups and with the support of the local Catholic Church programs.

There is the possibility to use these experiences with street children to design better programs. There is the pedagogical challenge to make the previous knowledge of the children and the knowledge gained with these programs a source of confidence, self-esteem and a basis for the Chavos to:

- Find new ways to live with young people and with the community
- Become responsible for guiding and building their own lives
- Have values to improve their life and to contribute to the community.

*Recent application of the STC in private and public schools*

Several private schools have started using the STC in a continuous way; however, most of the applications have been made in public schools as part of demonstration programs where the schools have worked with the STC only during one year. This has happened because there has not been a federal program to support the application of these systems and because of the limitations imposed by the existing education programs and working conditions.

In the last two years, with the participation of the United States-Mexico Foundation for Science and with the financial support of the Brystol Myer Squibb Foundation, several departments of education in Mexican States have become interested in setting up permanent HOICS programs and the federal education authorities have become interested in facilitating this process.

At the moment there are already continuous applications of the STC, including the operation of pilot Science Resources Centers, in the States of Tamaulipas, Quintana Roo and Querétaro and plans to establish more in the State of Nuevo Leon and in Mexico City.

Within the education research community in Mexico there is now better awareness of the importance of research in facilitating the work with these types of systems and to improve them according to the local conditions and experiences.

A Mexican Foundation, similar to the National Science Resources Center of the United States, has been proposed in order to facilitate the understanding and application of HOICS with support from the Federal Government, the Mexican Academies and several private foundations.

*Dissemination and outreach of science education improvement opportunities*

In order to facilitate the understanding of the essential elements and the benefits of the new HOICS, a series of meetings and lectures were organized with teachers, education officials, business leaders and other influential persons.

Two national conferences were organized, one in Queretaro in 1997 and the second one in Xalapa in 1999, to review the content, results and possibilities of HOICS where the U.S. experiences were also presented.

Especially important was the International Conference on Research Related to Science Education held in Monterrey, Nuevo León in September 2001. The Conference was organized by the Mexican Secretary of Public Education, together with the US-Mexico Foundation for Science, the Mexican Academy of Sciences and the Government of the State of Nuevo Leon. The support of the National Academy of Sciences and the National Science Resources Center of the United States were very important, as well as the collaboration with the Inter Academy Panel, and the Latin American Academy of Sciences.

The goals of the International Conference were to:

– Analyze and discuss cognitive research findings about how people learn and the implications of these findings for teaching science to students.

– Review and discuss research findings providing evidence of the impact of HOICS on student achievement.

– Recommend effective roles for the scientific and engineering communities in working with educators to improve science education.

– Identify strategies for international cooperation in research and implementing strategies for improving science education programs.

Some of the important conclusions derived from the conference are the following:

About research on 'How People Learn':

– There are very important practical consequences in the classroom of the research results about the relationships within mental structures, the way they evolve and function, and how they are applied to common problems.

– There are very important benefits for the students if the learning environments are centered on the development of learning capabilities.

– A well-structured curriculum emphasizes the children's acquisition of essential concepts (big ideas).

– It is essential to have evaluation methods that support learning.

On the results of the TIMSS Studies:

– A very significant factor in explaining the good performance of the students is that the curriculum should be presented with depth, rigor, coherence and should challenge the student to go beyond.

– International comparison is not important *per se*, but as a way to learn how to improve and to share experiences.

– Good science and mathematics education can be achieved with limited resources and has a very important role in the development of thinking skills and scientific attitudes essential for the future success of the student in the modern world.

– We all have the moral imperative to give the world's children the learning capabilities needed to build their future.

With respect to HOICS systems:

– They have an extremely important impact in the development of children's essential learning abilities.

– There is the need to have more comprehensive studies to assess the systems and to validate their success before the whole community.

– There are very good opportunities for international collaboration on these systems, both in research and in innovation projects.

On the role of science academies in the improvement of science education:

– They are a stable platform for the discussion and promotion of improvements.

– They provide continuity in science education research and innovation, which transcends political changes.

– They offer a direct and cordial link between scientists and educators.

– They symbolize a seal of excellence when they support research and development projects in science education.

Partnerships for science education improvements:

– The importance of linking both business and society in general with science education enhancement processes.

– Acknowledge the leadership role that the business community might have in science education innovation and reform.

*Final remarks*

The application of HOICS in the primary and secondary schools of Mexico is seen as a very important opportunity to develop the scientific attitudes and thinking skills of children as well as to help them construct essential scientific concepts and to be enthusiastic about science and technology.

It is not easy to introduce these types of systems. It is necessary to integrate them properly to the educational programs and to work with the education authorities, the teachers and the community to set up the systemic programs that are needed.

International collaboration is a very important support in facilitating the understanding, development and application of HOICS for children.