A PROPOSAL FOR SCIENCE TEACHING IN MEXICO THROUGH HISTORY AND PHILOSOPHY OF SCIENCE

(Abstract)

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This paper presents a research project on science teaching that is being developed at the National Autonomous University of Mexico (UNAM). The research on science teaching in Mexico has traditionally taken two main directions. On the one hand, there has been a specialized approach from several disciplines like Physics, Chemistry, Biology, Mathematics for a better training of their respective students. On the other, various psychological approaches have been interested in understanding the processes and mechanisms in science learning as well as in creating strategies for science teaching.

In the context of the alarming situation of education in general and in most of the scientific disciplines in our country, we have created a research project that from a psychological perspective intends to contribute to knowing more and showing the importance of science teaching under the premiss of its comprehension through history and philosophy of science and of the specific subject.

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In January, 2006 a group of scholars initiated a research project in the Faculty of Psychology at the National Autonomous University of Mexico (UNAM) with the participation of undergraduate and graduate students, as well as the collaboration of researchers and scholars of other universities from Argentina, Brazil and Spain. Science teaching is the axis of our project. The research on science teaching in Mexico has traditionally taken two main directions. On the one hand, there has been a specialized approach from several disciplines like Physics, Chemistry, Biology, Mathematics for a better training of their respective students. On the other, various psychological approaches have been interested in understanding the processes and mechanisms in science learning as well as in creating strategies for science teaching.

We know now from the experience of countries like the United States, Canada, Australia and Great Britain, that not only wealthy budgets or human resources are necessary to improve science literacy in students through different educational levels. Investments have been made in this area and yet changes have not been as impressive as they should.

In the context of the alarming situation of education in general and in most of the scientific disciplines in Mexico, we have created a research project that from a psychological perspective intends to contribute to knowing more and showing the importance of science teaching under the premiss of its comprehension through history and philosophy of science and of the specific subject.
Antecedents of our project

Psychology is a discipline whose scientific nature has been challenged since its inauguration as an independent science in the nineteenth century. Recently, all these questionings have reemerged and psychologists, either during their studies or while in professional practice, usually lack the elements to accept or refute them. The main problem may be that many psychologists have lost the sense of what it means to be a scientific discipline due to the positivist excess, the benefits of a pragmatic discipline and the criticism from hermeneutics.

For this reason, in a previous project our goal was to bring in philosophy and history science for the education of our undergraduate and postgraduate students. Also, we promoted the development of research works on history and philosophy of psychology in the participating scholars. Under this general frame we have produced theses, papers, articles, chapters and books where these disciplines have become protagonists. Simultaneously, we started developing a research line on bioethics and another on epistemology and science teaching.

Two essential facts made us decide that science teaching should be the axis of a new project. Firstly, through Mauro C. B. de Moura we became aware of the Graduate Programme (then for Masters and now also Doctoral) in History, Philosophy and Science Teaching in Brazil. This programme is carried on jointly by the Federal University of Bahia [UFBa] and the State University of Feira de Santana [UEFS], in Brazil. Their programme awoke our interest for several reasons among which we point out: 1) their critical but well founded stance on the nature, production, diffusion and teaching of science; 2) a declared and effective interdisciplinary approach and 3) in order to attain 1) and 2), the programme finds its support on the contributions of philosophy and history of science.

The second essential fact is closely related to the former one. It refers to the great contribution of Michael Matthews, whose works have not only approached science teaching, history and philosophy of science, but created an indispensable link between them. My first contact with Matthews’ works was through a book published by the Brazilian group, *Epistemologia e Ensino de*
Ciências (Epistemology and Science Teaching) in an edition prepared by the industrious Waldomiro J. da Silva Filho.  

Besides these facts we must add the circumstance that some participants and collaborators of the previous project had been developing research in cognitive psychology, especially on learning, child development and conceptual change.  

Given the conjunction of these facts and circumstance, we persevered in opening a research line in science teaching with the convergence, first of all, of philosophy and history of science, but including also sociology, anthropology and psychology.  

In this manner, we have set a double purpose: 1) promoting better knowledge and research on science teaching with philosophy and history of science and 2) supporting the development of research on the processes and specific notions that will allow us to know more about science learning and, eventually, will lead to proposing better strategies for science teaching.

Science teaching with philosophy and history  

One of our main concerns emerges from the results of recent evaluations. The 2006 Annual Report of the National Institute for Evaluation on Education (INEE), Quality of basic education in Mexico (La calidad de la educación básica en México), according to Axel Didriksson, presents repeated evidences of the disastrous state of education in Mexico. In this report we find that:

The level of competence of 15 year old Mexican students are in average quite low to those in more developed countries and a large proportion of these students (half in reading and two thirds in mathematics) does not reach level 2 in the tests, which is considered the minimum required to manage oneself suitably in a democracy and a developed economy.

The educational crisis can be considered in general, but formal, natural and social sciences represent a significant part in quantitative and qualitative terms of the curriculum. Despite all the years our children and young people spend in school since elementary, passing through junior high, high school and up to the university we observe a lack of a scientific culture among them. We know this is not privative of “endlessly developing countries” as Mexico. This also happens in
developed countries that some decades ago took the task of evaluating the results of their science teaching practices and have invested to grow. Nevertheless, posterior evaluations to these deliberate efforts to improve scientific illiteracy showed the persistence of the problem.

As this is well known among this audience we will only mention as a reminder the studies during the 80’s and 90’s of Jon. D. Miller in the United States. Miller studied, for instance, the ability to say something intelligible (not a full and proper definition) about concepts such as “molecule”, “atom”, “byte” and found that only three per cent of high school graduates, twelve per cent of college graduates and eighteen per cent of college doctoral graduates were scientifically literate.11

Faced with this panorama, a search for new and more effective approaches emerged during the 80’s with groups and projects that emphasized the importance and indispensability of science teaching with a historic and philosophical core. An institutional expression of this in the United States was issued by the American Association for the Advancement of Science while recognizing as a general contribution that:

Science courses should place science in its historical perspective. Liberally educated students — the science major and the non-major alike — should complete their science courses with an appreciation of science as part of an intellectual, social, and cultural tradition .... Science courses must convey these aspects of science by stressing its ethical, social, economic, and political dimensions.12

A major impulse to this field has come from the different enterprises carried out by the International History, Philosophy and Science Teaching Group. Though their achievements may not bring to an end the crisis on science education, it is certainly making decisive contributions towards a better understanding and the surmounting of condition.

Science teaching presents different challenges depending on the educational levels where it is situated. Science is taught from pre-school up to high school although most of these students will not follow a scientific profession. Nonetheless, as M. R. Matthews has pointed out, the objective is also to educate about science.13 This way our young people and future citizens may have a good
idea of what happens in the natural and social world, will be able to lead successfully with the technological advancement and will distinguish between well founded knowledge and the overwhelming antiscientific and illogical views that surround us. From this perspective we think that natural, social and formal sciences have a fundamental role for the development of our culture and for the understanding of our physical and social world.

Science teaching at college level may seem less problematic, specially in the case of those students being trained as future scientists. We are sure this is more of a preconception than a fact. Anyway, in the case of disciplines like Psychology the meaning and contents of science teaching is often unclear, despite research is a field of professional development for psychologists.

Now, we are convinced of the fundamental role of philosophy and history of science either for a general education about science as well as for a specialized education in science. Nevertheless, we recognize that differences in the educational purposes along with the cognitive processes and structures involved, particularly those concerning the development of intellectual capacities, must be considered.

Anyhow, philosophy and history of science may contribute, accordingly to age and level, to understanding the nature of the scientific enterprise and its study objects. Students memorize (and subsequently forget) huge amounts of contents of scientific disciplines. If the development of science, its theoretical problems and its subject matters, its failures and new attempts, remain meaningless and therefore unintelligible, none of these will become part of the culture of our students or our citizens.

It is worth mentioning that these difficulties to learn are not something the student will resolve alone. With the support of philosophy and history of science, teachers (in all educational stages) are more likely give a perdurable scientific education. But we must recognize that, in general, in Mexico those who become teachers from pre-school up to junior high, may master the psychopedagogical aspect but are not specialized in the contents of scientific disciplines. Coincidentally, those who have a scientific background and dedicate totally or
partially to teaching do not master psychopedagogy. Often, in high school and college, we learn to teach during the practice. Above all, it is unlikely that in either case teachers are prepared in history and or philosophy of science, of their own science or any science as a foundation for science teaching.

From a historical and philosophical perspective science teaching makes possible understanding and eventually defeat one of the most challenging problems for science learning and teaching: naive conceptions or intuitive knowledge. Also, misconceptions about science itself —such as that the first step in science is observation and therefore its method is exclusively inductive—, become “anchors”. To weigh anchors we require the counterweight or lever that those disciplines make available.

Philosophy and history of science allow to thwart the unavoidable effect of our intuitive knowledge. As Asunción López-Manjón points out, intuitive knowledge is a personal assembly generally determined by cultural and social experiences. Lately, some disciplines like Antropology, Sociology and Psychology have revaluated this kind of knowledge. Nonetheless, scientific knowledge preserves its status. We want to emphasize that research shows that when intuitive knowledge disagrees or more over, contradicts scientific knowledge, what usually happens is that the intuitive one is retained and the scientific one is disregarded.

This is consistent with the findings of cognitive psychology that reveal that humans search for information that coincides with our previous knowledge and ignore or adapt the information that contradicts it. As López-Manjón indicates, intuitive knowledge is incompatible with scientific knowledge both in its epistemological as in its ontological and conceptual dimensions. Being so, “it is hardly surprising that everyday knowledge is so resistant to change and, therefore, the acquisition of scientific knowledge results quite difficult as they are two distinct ways of conceiving reality.”

The above mentioned allows a better understanding of the reasons for what Matthews calls the second–generation crisis in science literacy in Western countries. To illustrate this, Matthews refers to the longitudinal study carried out by Jon Miller (1983, 1987, 1992), in a representative sample where statements like: 1)
“the earliest human beings lived at the same time as the dinosaurs”, were correctly answered by thirty-seven per cent of the sample and 2) “Antibiotics kill viruses as well as bacteria”, only twenty-six per cent gave the correct answer. Miller concluded in 1992 that “between five and nine per cent of US citizens were scientifically literate” (1992, p. 14).  

In a closer example let us look at some answers from recent evaluations of students in Brasil whose aim is to be admitted in college:

1) Lavoisier was beheaded for inventing oxygen.
2) The optical nerve transmits luminous ideas to the brain.
3) The main function of the root is to dig itself.
4) The difference between romanticism and realism is that the romantics write romances and the realists show the situation of our country.
5) Greek democracy worked well because those who disagreed were poisoned.

These are not quick and dismissive answers to a survey. They are just a small sample of responses that students between seventeen and eighteen years of age are giving in an effort to pass an important exam.

We have no doubt about the urgency of changes in education. But not any change will serve the purpose. On the one hand, rethinking educational changes, as Edgar Morin affirms, requires a change in the main trends of what has been the predominant way of thinking. Instead of filling heads, what educators need to create are well put heads through the study of human condition, teaching how to live confronting uncertainties and transforming pupils into citizens.  

On the other hand, it is important to appreciate the value of the liberal tradition in education. This tradition aims to introduce our children and young people to the best that their culture can offer including, of course, the academic disciplines made available to their understanding. Not only the contents, assumptions, methodology, history, among other components are to be considered;
the ethical, cultural religious, political and economical context contribute to an integral view. In Matthews’ words:

Contributors to the liberal tradition believe that science taught from such a perspective, and informed by the history and philosophy of the subject, can engender understanding of nature, the appreciation of beauty in both nature and science, and the awareness of ethical issues unveiled by scientific knowledge and created by scientific practice.21

Concluding remarks

We share the ideals of the liberal tradition in education and we are convinced that science teaching, with the contribution of philosophy and history of sciences in general and of the specific disciplines, will improve the scientific literacy of our citizens and specially of our students.

We have mentioned studies that show that investing in science teaching through a number of years was not enough to improve science literacy. Thus, financial resources are necessary, they are not sufficient. Now, in terms of resources, we should mention that according to the Organisation for Economic Co-operation and Development (OECD), Mexico has the twenty-eighth place (out of thirty) concerning what is expended per student in elementary and junior high school.22 It is worth mentioning that education is placed as strategic for national development in government plans. With these resources, it is even more important for our project to launch bearing in mind previous experiences such as those presented by Matthews and other integrants of the IHPS group.

Hence, we found it necessary to follow two paths in order to achieve our goals. On the one side, we are promoting knowledge and research through history and philosophy of science and of specific subjects like psychology and education for science teaching. For this purpose, our undergraduate and graduate students are attending seminars on philosophy and history of science, epistemology, psychology and science teaching and most of them are developing their theses on at least one of these areas. Also, several members of our project contributed (and
fought an uphill battle) to create two new subjects for the undergraduate curriculum: History of Psychology (1st semester) and Philosophy of Psychology (4th semester). We have organized three conferences on education, history and philosophy of science and psychology with the noteworthy collaboration of Pablo Lorenzano from Argentina. Recently, we hosted a symposium that allowed us to gather specialists from our own university as well as from Argentina and Spain to let our academic community know more about their works and experiences and continue building a net of interrelation and possible collaboration with our group.

On the other side, we are also struggling for financial support to develop theoretical and empirical research on processes and specific domain notions to know more about science learning and to propose better strategies for science teaching. Although those two paths or approaches do not exclude each other, they do not come together either. Our challenge is to encourage their development and try to make them converge.

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NOTES

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2 Filosofía, historia y psicología (DGAPA-PAPIIT IN400502), from January, 2003 until December, 2005.
3 Cf. M. C.B. de Moura 2004: La psicología en el marco de la filosofía, la historia y la enseñanza de la ciencia, Working document for research project, Mexico: Facultad de Psicología and DGAPA, UNAM.


7 I. e. Rigoberto León, Asunción López-Manjón, Kirareset Barrera, Dení Stincer and Elena Calderón.

8Informe Anual 2006, Instituto Nacional para la Evaluación Educativa.


13 Matthews 1994, pp. 2-5.


16 Cf. ibid., pp. 73-74.


18 Cf. ibid., p. 77.


23 Zuraya Monroy-Nasr, Francisco Pérez-Cota and Germán Álvarez-Díaz de León, Jorge Molina-Avilés.

24 “Psicología del carácter en la Inglaterra victoriana”, given by María Luján Christiansen, who obtained her Ph. D. from the Institute of Philosophical Researches, UNAM; “El misterio de la herencia (o de cómo explica la ciencia: el caso de la genética clásica)” and “Teoría de la ciencia y psicoanálisis”, given by Pablo Lorenzano Ph. D. (Nacional University of Quilmes and CONICET, Argentina).

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