Notes on science teaching in initial school years

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The necessity for improvement of education in general

EDUCATION is a key element that needs to be improved in order to ensure Brazil's social and economic progress. In spite of the enormous educational advance in recent decades finally resulting in nearly all children going to school, it is commonly felt that much remains lacking before an acceptable level is reached. Before talking about the teaching of the sciences it is necessary to speak about the general problems of education.

The national and regional exams, known as the Evaluation System for Elementary School, Brazil Test (SAEB); the National Middle School Exam (ENEM); the National Students Performance Exam for a University Degree (*Provão*/ENADE); the São Paulo State Student Improvement Evaluation System (SARESP) etc., given in all schools in recent years, show that the majority of students perform unsatisfactorily in the Portuguese language and in Mathematics. Literacy is only achieved later in the first levels.

International exams such as the Program for International Student Assessment (PISA) from the Organization for Economic Cooperation and Development (www.pisa.oecd.org), that are given to fifteen-year-old students, show greatly inferior performance to nearly all countries considered to be developed or developing, confirming both statistics and the national exams cited.

There is still a strong correlation between income level and educational quality in the country.[1]

Management of the school system

Multiple aspects of the educational system need to be improved.

Management of the school system is deficient and, even worse, impedes innovations and improvements:

- low salaries tend to inhibit dedication on the part of teachers and staff;
- a lack of qualified teachers, particularly in the sciences;
- teacher and director turnover, who remain only a few years at the same school;
- high work absence rate, leaving students without class;
- insufficient investment for building schools, resulting in up to four shifts

of students each with fewer than four classes per day;
- inadequate classroom materials;
- lack of study materials, libraries and laboratories;
- excessive bureaucracy, even for minor matters;
- political and corporate interests that put themselves above the requirements for good education;
- hours away from the classroom reserved for the teacher's pedagogical work are taken up with administrative matters or simply not made available;
- lack of evaluation and of the career of the teacher in public activity, such that the good, dedicated teacher earns the same as the colleague who performs inadequately, etc.

We will not be treating these management problems here, which are serious, the solution of which depends on the efficacy of the pedagogical measures to be treated in what follows.

In order to appreciate the magnitude of the problem, it must be remembered that a State School Board tends to be the largest institutional employer in the state (and in the large municipalities); in São Paulo there are around 300 thousand active workers (primarily teachers) and 130 thousand inactive.[2] No business comes close to these numbers.

Teacher education

Education of the teachers is the key pedagogical element for the improvement of education, though not in itself being sufficient to guarantee success.

For the first series known as the old "*Grupo Escolar*", the teachers, generally women, graduated from Teacher Schools. They had little preparation in the Sciences and few teach this material. However, they met the requirements for that time in literacy and arithmetic.

I recall that, in 1951, when I began as a student in the College of Philosophy, Sciences and Letters of the University of São Paulo, the Regional Center of Educational Research building was still being constructed, under Fernando de Azevedo's direction and dedicated to the improvement of the elementary school, particularly literacy. It received teachers with scholarships from all of Brazil and Latin America for research and improvement courses. A library was installed and also, new for the period, an educational technology center, an Audio-Visual Resource Service, SRAV, where we could check out educational films that included Physics.[3]

In 1961 the first Law of Directives and Basis of National Education, LDB, was approved and shortly thereafter the "minimum curriculum" for certificate courses, which prepared teachers for the 5th to 8th series and for the Middle School was established by the Federal Educational Council. There were consultations with universities and we could emphasize experimental activities in teaching future physics teachers, including a newly required subject,

"Instrumentation for the teaching of Physics," especially for teaching how to conduct experiments for the basic and middle level students. The existence of the course prompted teachers throughout Brazil to invent or adapt new teaching experiments.

In 1965 I was responsible for the basic teaching of Physics for freshmen in the Physics and Mathematics course. We quickly constructed a large number of instruments for experiments, allowing a connection to be made between laboratory and theory classes. Physics is a science in which theory and practice are interrelated, forming only one body of knowledge. For students with difficulties following complex and abstract reasoning, a common condition among those entering the university, the laboratory classes help in the comprehension of theory; for other students, with little prior activity with tools and equipment, these classes could make clear how a theory describes a sampling from reality.[4]

It is essential that the students, future teachers, and also future researchers and technicians, learn how to conduct their own experiments and observations.

There is another type of very useful teaching resource, the demonstration experiment, in which the teacher carries out and explains the experiment to the students in class. Conducted well, this type of demonstration can be highly instructive. For the teacher to be able to do demonstrations, the materials need to be assembled. We organized a Laboratory for Demonstrations, where the teacher could check out the equipment in order to do the demonstration in class. This lab is a small museum of physics demonstrations, remaining open for use by students, who can invent new experiments, and is a pedagogical instrument to familiarize future teachers with didactic experiments.

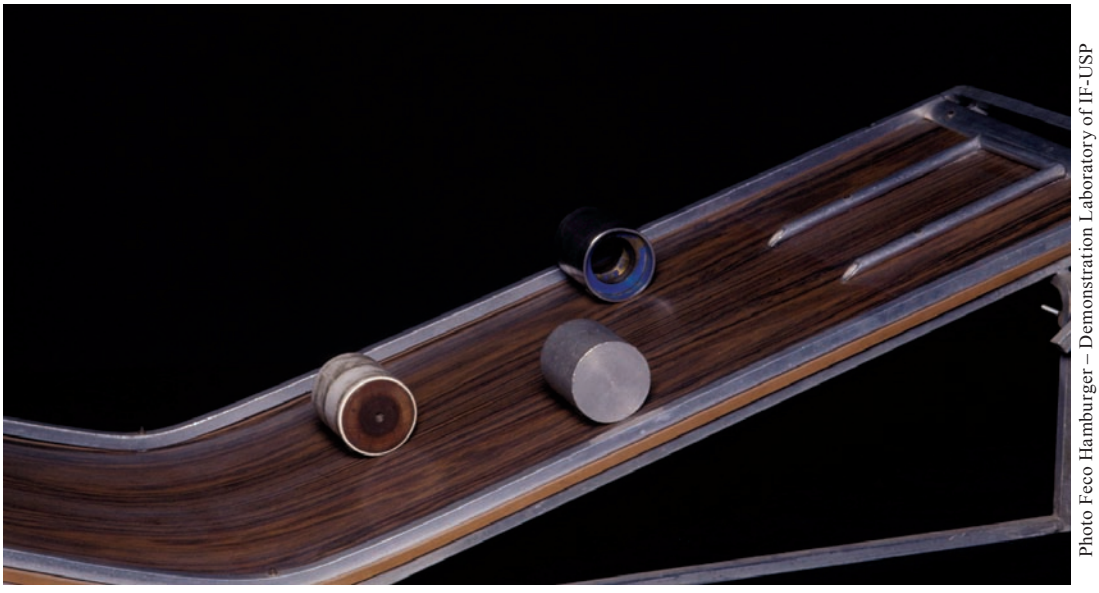

Photo Feco Hamburger – Demonstration Laboratory of IF-USP

Three cylinders of the same shape and weight but different distribution of mass, roll to the bottom. Which will arrive first? (Answer: the one with the mass concentrated close to the axis).

A preliminary estimate of the Ministry of Education observed that in the twelve years from 1990 to 2001 there were around 7300 graduating students who were licensed in Physics and 13,600 in Chemistry, when the national need was 55,000 for each of the fields.

In 1971, the new Law of Directives and Basis of Education was published and the traditional teacher preparation course for the 1st to 4th grade, "*Curso Normal,*" for primary school teaching was replaced by more professional teaching preparation for the regular middle school, resulting in a downgrading for the earlier grades. The third LDB of 1996 went on to require teachers with a university degree for all basic teaching from infant to middle level.

However, in place of the college course (*Curso Normal Superior*) envisioned by the law, the old pedagogy course was adapted, which was oriented more toward the preparation for school administration than teachers.[5] The result is that there is presently neither a legal structure nor adequate courses for good preparation for the beginning levels, perhaps the most important in children's education!

For the teaching of the Sciences the requirement of a university degree doesn't seem to have improved the situation; future teachers continue learning very little science and have difficulty treating scientific themes in class. They don't feel particularly well prepared to conduct experiments or observations with the students in class.

For the 5th to 8th grades and for middle school the legislation expects teachers to have licenses in the sciences or in a specific science - physics, chemistry, biology, mathematics. The number of licensees is greatly inferior to the needs of the country. A preliminary estimate of the Ministry of education observed that in the twelve years from 1990 to 2001 there were around 7300 licensed in physics and 13,600 in chemistry, when the national need was 55,000 for each of the fields. There is also a scarcity in mathematics, biology, and Portuguese.

Besides the lack of teachers with specific training, the quality of training leaves much to be desired. The large public universities graduate few licensees; their courses of study represent a major flight, given the possibilities of better remuneration from other careers. The majority of teachers in the public schools are taught in private colleges, many of which don't maintain good courses.[7] There is practically no training in laboratory experimentation and scientific investigation.

Curriculum and methodology

In the 1940s when I was a student, the teaching in the Primary Science Course was taught under the script of Lessons of Things. It was mainly descriptive and possible for students to learn by memory without experiments and without much comprehension of the concepts and scientific laws.

The principal subjects of the school were, as today, reading, writing and arithmetic.

I remember having to memorize the names of the cities between São Paulo and Rio along the length of the Central Brazil Railway as well as the tributaries of the Amazon River. I don't remember experimentation, demonstration or observation.

The Manifesto of the Pioneers of the New Education in 1932, by Fernando de Azevedo, Anísio Teixeira, among others, had already envisioned a different school:

> Beginning with a pre-school for 4 to 6 years up to University, with a scale for primary education (7 to 12 years) and for secondary (12 to 18 years), "uninterrupted continuation of creative forces" should raise the level of the student's whole personality and the development of his productive faculty and creative power, by the application, in the school, for the active acquisition of knowledge, by the same methods (observation, research, and experimentation), which the mature spirit follows, in scientific investigation […] favoring the expansion of creative energies of those being educated, seeking to stimulate their own strength as the most efficient element in their education and preparing them, with work in groups and in all the pedagogical and social activities, to swim in the current of material and spiritual progress of the society from which they come and in which they are going to live and struggle. (Azevedo et al., 1932)

The vertiginous growth of scientific knowledge during the twentieth century, as well as its applications in industry, in agriculture, medicine and in all aspects of daily life, reinforced the importance of science teaching for the whole population as part of contemporary culture. In spite of this, after 75 years and the efforts of many teachers, we still haven't reached the standards of 1932. When I was a student of the Middle School in the only state school in the city of São Paulo in 1948-1950, we practically never made use of the Laboratories of Physics and Chemistry that the school had.

After World War II, and notably after the launch of Sputnik, the first artificial satellite, by the Soviet Union in 1956, there was a strong science teaching reform movement in the United States which soon spread to other countries. The United States was afraid of remaining behind in technological, military and industrial development.

In Brazil there was already consciousness, in the academia métier, that teaching of science in school was unsatisfactory, considered amateurish and a return to memorization.

Since 1948 the journalist José Reis had written in favor of research and a renovation of the teaching of the sciences. José Leite Lopes and Jayme Tiomno, in Rio de Janeiro, translated, with the support of the Ministry of Education, the North American physics textbook by O. H. Blackwood, who emphasized the application and experiments of science. Oswaldo Frota Pessoa

was writing a new biology textbook, A little later the Brazilian Institute of Education, Science and Culture (Ibec) was founded (connected to the United Nations' UNESCO), and the Ministry of Foreign Relations in 1955 which advocated an educational renewal and teaching science from experiments and observations.

Starting in 1956 various new curricular projects in the United States sprang up for the teaching of the Sciences in High School (Middle School). The first was Physics, from the Physical Science Study Committee, later came the curricula of Chemistry, Biology and other Sciences, including some for basic Junior High School teaching, prior to High School. Another physics curriculum was (Harvard) Project Physics, with an emphasis on History and Philosophy of Science. In England Science and Physics curriculum arose, supported by the Nuffield Foundation.,

These curricula taught up-to-date science with scientific research results recent at the time, and besides this, gave value to experimentation, with measurements and the observations of major figures, concepts and modern theories. They were originally intended for the Middle School, later for the older Gymnasium, today Cycle II of the basic teaching (series 5th to 8th).[IBECC.9]

In São Paulo, The Brazilian Institute of Education, Science and Culture, directed by Isaias Raw, doctor and biochemist, professor of the College of Medicine of USP, made a translation and published the course of the Physical Science Study Committee as well as other new curricula, and organized updating courses for the teachers of the sciences in order to publicize them.

It was soon determined that these new curricula, though praised by scientific researchers, required knowledge and skills as much beyond the teachers as the students, in Brazil as in the United States. They were too difficult for the schools.

In Brazil in the 1970s national curricula based on similar pedagogical presuppositions arose in Brazil, but less demanding in content, including (citing Physics examples) the Physics Teaching Project. Published by the National Foundation of School Materials (FENAME), a department of the Ministry of Education and Culture, each volume was accompanied by simple devices to carry out the experiments. This was "Self-taught Physics" (in the form of programmed instruction – developed both by teachers and students of the Institute of Physics of USP, and the Brazilian Physics Teaching Project, from the Brazilian Foundation for the Development of Science Teaching /IBECC.[9]

The Brazilian Institute of Education, Science and Culture also made simple materials to carry out experiments in class, that were sold to schools and interested people. Much later in partnership with *Abril Publications* a series of pamphlets accompanied by *kits* was produced to do experiments known as "The Scientists;" the pamphlet/ kits came out monthly and were sold at newsstands with great success. Today various scientists recall the stimulus of these kits for their choice of career. Some of the ideas of the Pioneers of 1932 began to be incorporated in middle school, but took longer to realize in basic school.

Abolishing the Entrance Exam: eight years of schooling for everyone

In 1968 the admissions exam was abolished, first in São Paulo and later in the rest of the country. For decades this exam represented a socio-economic barrier. Mandatory school attendance was only for the Primary level (1st to 4th grades) even though this left many children out of school. After the 4th (or 5th, there was an additional year for admission) grades, students from 11-12 years would take a general exam. Only those approved would continue their studies at the Gymnasium - the 5th to 8th grades - and passing was more difficult for children from families with little education – many didn't even try the exam.

Beginning in 1969, required schooling came to be eight years from the 1st to the 8th grades. In spite of the large number of children out of school, the number of students in the 5th to 8th grades increased rapidly and consequently the number of schooling years within the population. In particular there came to be many more classes in the sciences. Only two decades later in the 1990s did school enrollment surpass 95% of the children, that is, nearly all seven year old children went to school. However, many of them remained behind in the initial grades and never reached the 8th grade.

Elimination of the admission exam and the obligation of eight years in school created a crisis in the 5th to 8th grades. The proficiency level and knowledge of the now numerous students of those grades declined to new lows.

The increase of students in the 5th to 8th grades was not accompanied by a teacher preparation program. There was an attempt to reduce the number of years of teacher instruction at the University, creating a "Short Licence"[10] that failed: the licensees knew too little. There was a lack of well trained teachers, particularly in the scientific fields. This lack continues to the present day.

The lack of teachers was aggravated by a flattening of the salaries that began around 1968. In order to reduce the cost of the great expansion of the public school system, the government reduced salaries, and the teaching profession, previously respected, suffered gradual devaluation – for example, by the suspension, during various years in the 1970s, of the hiring exams for permanent teachers.

Further evidence of the devaluing is that in public universities, like USP, licensing (the example is Physics) was, until 1968, more sought after than a degree, with which it was more difficult to find jobs. Beginning with that year, the annual number of licensees diminished until they were surpassed by degree holders.

The second great expansion of the number of students in the schools in the 1990s, when schooling reached more than 95% of the children, also took no account of the teacher's preparation, and the shortage that has lasted until the present is worse, because the numbers are greater as shown in the previously cited MEC estimate.

Sciences in the first series

The concerns of the last years of the 20th century were with the Middle School and Cycle II of the Primary. I don't know of science projects designed

for the first series. There are science books published for use in these classes, one of the pioneers being from Oswaldo Frota Pessoa and Rachel Gevertz.

Research into the teaching of Sciences in Brazil began around 1970 and was stimulated by curricular projects cited earlier, by specific symposia like the National Teaching of Physics Symposia that occurred regularly beginning in 1970, and by the implementation of a graduate level in the Teaching of the Sciences Programs (initially Physics Teaching at the Federal University of Rio Grande do Sul, and at the University of São Paulo, in 1973).

In the 1970s, there were influences from the behavioral teaching models along the line of B. F. Skinner and his collaborators. Already the 1980s and 1990s are characterized by the growth of the influence of Piaget, Vigotsky and of constructivism.

It is common to consider that children under ten years of age still lack the capacity for abstraction necessary for scientific investigation.

Research in the teaching of the sciences in the 1990s in the United States indicate that children of six years, who are reaching literacy, already can follow classes based on experimentation and observation. The series of books *Insights*, directed by K. Worth et al. (1997) from the Educational Development Center, in Newton, Massachusetts, puts these ideas into practice.

In the United States, curricula of this type, known as Teaching of Sciences Based on Investigation (in English - Inquiry Based science education) have been applied with success in various cities. Especially cited are schools in Chicago, Illinois (Ciotola et al., 2004) and San Diego, California (Amaral et al., 2002, p.213-39), particularly in poor and socially problematic neighborhoods. The National Academy of Sciences supported the method. The Chicago project was inspired by High Energy Physicist and Nobel Prize winner Leon Lederman.

Physicist Georges Charpak, of the Academy of Sciences of Paris, a colleague of Lederman and also a Nobel Prize winner, decided to apply the same proposal in his country in a project called "Hand in the Pâte." The French Minister of Education began pilot classes beginning in 1996, and since the year 2000 has recommended the methodology for the whole country. Here also there was special impetus in poor neighborhoods.

In Brazil, the team of Ana Maria Pessoa de Carvalho, from the College of Education of USP developed material along a similar line, used in São Paulo schools (Carvalho et al., 1998).

Starting in 2001 in a joint venture between the Academies of Science of Brazil and France put into practice the program "ABC in the Scientific Education – Hand in the Dough," in which "ABC" refers at the same time to "Reading and writing" and "Brazilian Academy of Sciences (Academia Brasileira de Ciências). In three cities – São Paulo, São Carlos and Rio de Janeiro – the in-service training of teachers of the methodology "Teaching of the Sciences Based on Investigation," began in a pilot program.

The organization Inter Academy Panel, which combines the Academies of Sciences of the entire world, recommended "Teaching of the Sciences Based on Investigation" in 2003 to all of its members. A work group named by the Inter Academy Panel which included a representative from the Brazilian Academy of Sciences, conducted a study to clearly define what constitutes the programs "Teaching of the Sciences Based on Investigation" and how they should be evaluated (Inter Academy Panel, 2006).

There are 31 countries applying the program "Teaching of the Sciences Based on Investigation" in pre-middle school education, including: Argentina, Chile, Colombia, Mexico, Venezuela, United States, Canada, China, India, Malaysia, France, Germany, Belgium, Spain, Hungary, Italy, Holland, Norway and Sweden.

A new report was published this year (2007) about the teaching of sciences in the first grades (Duschl et al., 2007) by the National Academy of Sciences/National Research Council of the United States, reinforcing the result of educational research showing that children beginning at 5-6 years of age, on entering school, already have the intellectual capacity to learn science and do experiments. The challenge of the educator is to awaken curiosity and this capacity. The greater challenge is to train the educator and provide the conditions which can attain success.

An important characteristic of the programs supported by the Academies is to always envision collaboration between the scientists of a Center of Sciences, university or research institutes, with the school system and with the community. There is no "ivory tower" for the university; it should also be partnered with improvement of the school teaching. In society's own present dynamic, in which scientific and technological theories can change radically in only a few years, regular school updating is required, which can only be done in partnership with the universities.

The conducting of the investigation of a scientific subject, with the students in class, requires general planning and preparation. The teachers can't feel secure doing it, there are various training sessions to make it feasible. The proposed general theme should be discussed in detail with the students until they know how to define, with the teacher, an experiment or proceeding in order to respond to a question. A teacher typically takes two or more years of training and accompaniment until this type of class is incorporated into his routine.[11]

If the teacher preparation institutions would already teach the investigative scientific method to licensees during the course, the in-service training could be easier and more rapid; however, French and American trainers estimate that even in this case the teacher needs support to implement the method in school. Presently the licensees conduct few or no scientific investigations during the course, whose focus in general is the knowledge of scientific content and pedagogical principles. Rarely do they learn to look for and find the necessary scientific information and instruments; to not only lead the class in free discussions, but also to arrive at conclusions.

Science Station, founded in 1987 in São Paulo by CNPq, has been managed by USP since 1990. Nearly 400,000 visits per year, the majority being basic school students.

Centers and museums of science and scientific dissemination

In the words of the Pioneers Manifesto of 1932, Brazil needs an Educational Reconstruction. School is the main institution necessary to achieve that, but it is not sufficient. Other institutions have important roles to play, such as communication businesses (newspapers, magazines, radio, television, internet) and cultural centers.

In the scientific area, the centers of science and museums can perform an important role, as they stand between the research of the universities and institutes, with the school system and the population in general. There are still few, and those recent, centers and museums in the country.[12] Science Station, in São Paulo, founded in 1987 by CNPq, has been managed by USP since 1990. It maintains interactive exhibitions about the geosciences, biology, physics, mathematics and other sciences. Nearly 400,000 visit per year, the majority being basic school students. It has nuclei of theatrical creation, of internet, of exhibitions, it puts on cultural events, presents courses and talks disseminating science, and courses and programs directed especially to basic level teachers. It is responsible in the city of São Paulo for the "ABC in Scientific Education –Hand in the Dough" program cited earlier.

The existence of a center such as this, besides giving support to the teachers and to the schools, awakens people's curiosity, especially the young, attracting them to careers connected to the sciences. A popular ambience of interest for the sciences motivates children and helps their studies considerably. A recent study of the Ministry of Science and Technology[13] shows that the population both values and has interest in scientific knowledge. We have to now make this knowledge accessible by means of education and scientific popularization.

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Notes

1 See, for example, Simon Schwartzman, "Instituto de estudos do trabalho e sociedade: sumário do seminário sobre educação, Pobreza e desigualdade no Brasil," conducted in Rio de Janeiro, October 2006.

2 Dados Seade for 2003.

3 The Regional Center of educational Research (CRPe) building, reconstructed, today adjoins the College of Education of the University of São Paulo.

4 Differential and Integral Calculus to the present day is a major deficiency among the students who enter the Exact Sciences field of the University. By treating these subjects in a similarly less abstract manner, the Physics classes can help in the comprehension of Calculus. Students approved in Physics have a much greater chance of being approved in Calculus.

5 See Eunice R. Durham, "Um Passo atrás com as Novas Diretrizes Curriculares para o Curso de Pedagogia," *O Estado de s. Paulo*, 6 October.2006.

6 Preliminary estimate of the paper "Estatística dos professores no Brasil". MEC/Inep, Brasília, 2003, which should be supplanted by better data from "Sinopse do Censo dos Profissionais do Magistério da Educação Básica 2003," MEC/Inep, Brasília, 2006; this census, however, does not allow extraction of the necessary data.

7 Those trained in public universities tend to teach in private schools which pay better.

8 Since 2007 with the incorporation of the old Pre-school and the Fundamental school, they are the 6ª to 9ª grades.

9 Starting in 1982, the Center of Scientific and Cultural Dissemination (CDCC) of USP in São Carlos, has also developed material for scientific experiments, primarily for the 5ª a 8ª grades, in experiment boxes that are loaned to schools/ each one contains material about a scientific theme.

10 Resolution nº 30 of the Federal Council of Education from 1974. There was a campaign of the Scientific Societies– Brazilian Society for the Progress of Science (SBPC), Brazilian Mathematics Societies (SBM) and of Physics (SBF), among others – against the Resolution, which was repealed nearly fifteen years later. See Hamburger, E.W. *et al.*, *Ciência e Cultura*, v. 33, p.369, 1981.

11 Instructors in the USA and France cite three years as the typical time for teacher experience.

12 The Brazilian Association of Museums of Science brought these institutions together. (www.abcmc.org.br).

13 Cf. <http://www.mct.gov.br/index.php/content/view/50875.html>.

Bibliography

AMARAL, O. M. et al. *Bilingual Research Journal*, v.26, n.2, p.213-39, summer 2002.

AZEVEDO, F. de et al. *a reconstrução educacional no Brasil, ao povo e ao governo.* Manifesto dos Pioneiros da Educação Nova. São Paulo: Cia. editora nacional, 1932.

CARVALHO, a. M. P. et al. *Ciências no Ensino Fundamental* – o conhecimento físico. São Paulo: Scipione, 1998.

CIOTOLA, n. a. et al. *Teachers Academy for Mathematics and Science*. Chicago, Ill., USA, June 2004.

DUSCHL. R. a. et al. (ed.) *Taking Science to School*: Learning and Teaching Science in Grades K-8, publ. Washington, D. C.: The National Academies Press, 2007.

INTERACADEMY Panel on International Issues – Report on evaluation of Inquiry-Based Science Education (IBSE) Programs. ed. W. Harlen & J. E. Allende, Fundación para Estudos Avanzados de la Facultad de Medicina, Universidad de Chile, Santiago de Chile, 2006

WORTH, K. et al. *EDC-Center for science Education – Insights*: An Elementary Hands on Inquiry Science Curriculum. Kendall/Hunt Publ. Co., 1997.

Abstract – Science education and education in general, must be improved in Brazil. Management of school systems is deficient. Teacher training is inadequate and insufficient. Curricula and classroom methodology should be brought up to date. Science should be taught, based on inquiry, from the first school grades. Science popularization in museums and science centers and in the media can be an important teaching resource.

Keywords – Science Education, Teacher Training, Inquiry-Based Science Education, Science Popularization.

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