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Response of Teachers Related to Experimental Activities in a New Science Curriculum in Sao Paulo Municipality Schools

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ABSTRACT *There has been a growing belief that science and technology are related to the understanding of natural world and the changes introduced to it by deliberate human action. Education plays an important role in preparing future generations to be conscious of the complexity involved in scientific enquiry as well as in the judgment of planned changes. For many years, the main educational problem in Brazil was purely the access to schools. Nowadays, basic education was almost fully extended to the whole population, which has actually reached 98% of our children aged 7-14. However, while attendance in schools is guaranteed to the great majority of children, the main problems in Brazilian schools are efficiency, quality, and equity. Teachers' profiles show clearly the roots of such problems. In order to design proper science activities, there is need for supplementary programs in terms of didactic-pedagogical materials and in-service preparation of science teachers. This paper analyzes a case with experimental activities, for a new science curriculum. After several pilot field tests that were carried out in 15 public schools of Sao Paulo municipality, in the outskirts of the city and in very poor areas, the project was designed. Primary teachers involved in the project were asked questions about it. After having collected and analyzed their answers, we came to some conclusions about the challenges science education has to meet in order to improve science literacy standards in public schools, especially in disadvantaged areas. The results of this research reflect important data about the way primary teachers react to the idea of improving science and technology teaching in 21st century.*

KEY WORDS: *Brazilian education, science education, quality education, in-service preparation.*

Introduction

Children's Learning in Science and Technology (CLST) has been a fertile field of research and practice in the last 30 years. Contrary to strict Piagetian perspectives, which advocated the impossibility of formal reasoning before 13-14 years of age, there has been a great deal of research showing that children aged 7-10 can deal with hypotheses and judge evidence, if presented in proper ways. Research indicated that primary teachers usually avoid the subject for many reasons. Some of them have a high background in science and use traditional justifications based on the grounds of psychological approaches to education. "They are too young and therefore they cannot understand" is a phrase that can be pronounced in a number of ways, but their meaning is summarized by it. Other teachers admit that they have no proper background to teach science and technology, and, therefore, they lack

the essentials to deal with the questions raised in classrooms. A third group uses as justification the fact that there is no proper means in schools and classrooms to develop science and technology.

There is a general consensus that science and technology are related to the understanding of the natural world and the changes introduced to it by deliberate human action. We all agree that education plays an important role in preparing future generations to be conscious of the complexity involved in scientific enquiry, as well as in the judgment of planned changes. Many teachers recognize nowadays that societies throughout the world are becoming increasingly diverse and complex. Citizens live in a technologically dominated world, where equity in social relationships, respect of the environment, and sustainable development are yet to be achieved throughout the world. Science and technology education, therefore, have a very significant role to play in the socio-economic development of communities in a global environment.

Education in science and technology is an essential process, which has to take into consideration the diversity that prevails in societies, and is directly related to sustainable development. Students have to be able to judge evidence and draw conclusions from the scientific point of view. They must be able to critically grasp the extent to which scientific uncertainty allows predictions. As citizens, they should be able to evaluate possible technological solutions based on the knowledge of the natural world and its complexity.

A number of articles indicate how critical teacher education is for science education (i.e., Abd-El-Kalick & Lederman, 2000). Some consensus can be discerned in authors who study the views of knowledge and thinking shared by teachers, and how they impact students' learning (Putman & Borko, 2000). Despite their importance, these issues seem too abstract in places like big Bazilian cities, where children hardly reached schools. In fact, for many years, the main educational problem in Brazil was the access to schools. Few people could reach basic school and acquire literacy and numeracy. Much attention has been placed on "Education for All," and there has been a widespread acknowledgement that Brazil has a proper coverage of basic schools for the majority of the population, even in poor areas. Now, there is a general concern that children go to school, but they learn less than expected. Teachers and administrators recognize that is needed to go further and offer a relevant science education for those, who are looking for a deep understanding of the possible roles played by science and technology education in providing a relevant education for all citizens.

Brazil apparently lacks a tradition of rewarding academic excellence in science education. However, access to public university can show how those who do not drop-out and develop deep learning in a number of areas, especially science, can be rewarded. Public universities of high standard of teaching, which offer free education, select the best academic performances, so that only few students can really take advantage of what they have learned in basic education. Teacher preparation has to face what have been called "Post-modern perspectives," which can seduce many people, creating an apparent alternative to a so called "new knowledge." The main result of this approach seems to be driving out of the scientific field many

teachers, who could possibly never understand properly the real contribution science and technology can bring to their students, especially to the youngest.

How is it possible to provide a proper science and technology background for children, although just a few will pursue these subjects to a higher level, and, yet, at the same time, provide an appropriate and rewarding science and technology experience for all students? In other words, how to give more attention to popularizing science and increasing public awareness for future citizens, and encourage student participation in problem-solving and decision-making activities, rather than portray science and technology as knowledge subjects, where success is largely measured by memorization of facts? In addition, how is it possible to show teachers that an alternative to these biased approaches to science, book and memory-based, can be found in the knowledge provided by traditional science? How to show that a supposedly short-cut to a "new knowledge," generally presented as "holistic" or "interdisciplinary," cannot deny the disciplinary knowledge in science? These questions had to be adequately addressed when designing a science program for young students in public schools, in poor neighborhoods in a large city as Sao Paulo, Brazil.

Education in Brazil

The Brazilian educational system is impressive for its numbers. Recent data (2002) show that pre-school is attended by 4.97 million children, basic education ("ensino fundamental") is provided to some 35.23 million students, 91% of whom attend some 200,000 public schools. In these schools, students stay 667 hours in the classroom per academic year, and this is considered very low. A survey carried out by an international agent showed that countries of low income offer students a mean of 870 hours a year. European countries typically offer around 1300 to 1500 hours, where the school year is from 190 to 250 working days. As a rule, Brazilian elementary schools work with three populations of students a day. Elementary education is offered in the morning and afternoon, and night classes are given for older students who normally work during the day.

There are 8,78 million students attending high school and 2.7 million students attending higher education courses. This means that school seats are used by 50 million students every day; therefore, almost one-third of the Brazilian population attends school regularly. In other words, the school population is three times as much it was in 1970 in absolute numbers, or twice as much in relative terms. There is a clear tendency towards universal coverage with basic education, which has reached 98% of children. However, while attendance in schools is guaranteed to the great majority of children, the main problems in Brazilian schools are efficiency, quality, and equity. Teacher profiles show clearly the roots of these problems.

In the first eight grades of basic education ("ensino fundamental"), there are 1,6 million teachers, but just near half of them have a higher education degree. As shown in Table 1, there are 86,070 teachers with no professional degree, including high-school level.This percentage varies greatly from one region to another. In the southeast, the most industrialized area, there are 9% of these teachers, a low figure compared with the northeast region, where 60% of these teachers can be found.

Table 1
Distribution of Teachers with no Professional Degree per Region in Brazil

	Teachers with no Professional Degree				
Regions	Fundamental Education	Pre-School	Kindergarten	EJA	TOTAL
Brazil (total)	52.751	17.604	11.349	4.366	86.070
North	11.561	2.129	499	1.310	15.499
Northeast	33.977	11.854	3.463	2.741	52.035
Southeast	2.330	1.574	3.670	119	7.693
South	2.106	1.334	3.356	120	6.916
West-Centre	2.777	713	361	76	3.927

Source: MEC/NEP/SEEC. Censo, 2001 (job places) (EJA=adult education)

Illiteracy in the country has shown a clear change since 1995. In 1970, illiteracy reached 33.6%, which meant almost 16 million people. This percentage dropped gradually despite continuing growth in absolute numbers. However, in 1995 there was a clear inflexion, as relative and absolute numbers decreased. In fact, numbers for the 1996 census showed that there were 14.7% illiterate people, a total of 15.5 million people. In 1991, there had been 19.2 million (20.1%). These numbers reflect three major factors. First, there is more efficiency in the school system, which means a reduction in dropout numbers; second, there are important demographic phenomena taking place as an inflexion of increasing population rates; and, third, there have been several campaigns for adult literacy.

Major actions since 1995 included the approval of the constitutional amendment (FUNDEF) to redistribute resources according to the number of students, who actually attend compulsory school. Another has to do with didactic materials for schools, a major program of distribution of textbooks for all eight grades throughout the country (PNLD). Another was the establishment of national parameters for compulsory education (PCN, 1996/1997), for pre-school (RCN-EF, 1998), and high school (PCN-EM, 1999) in all content areas, and in what was called "transversal themes," that is, important issues that could be included in different disciplines throughout the curriculum. Another important and controversial action was a major program of national evaluations of schools and faculties, which caused some concern about how efficient national tests could possibly be, especially in a huge country such as Brazil.

It was clear, just after approval of the 1996 law, that the main problem regarding financing of public education was not the exact amount of resources devoted to education, but rather the flexible way in which money was spent at the local level. In some rich municipalities, there were plenty of resources for education, following constitutional constraints, but no way to spend the whole amount prescribed. There was no way out other than to provide schools with non-essential materials, and sometimes expenditures were not directed to strict educational ends. Folk shows and asphalting roads were some items that could be found among what was called public expenditure on education. Rich municipalities could not objectively

spend on education as much as the Constitution determined, and, as a consequence, some of these municipalities established municipal universities in cities where there was lack of basic education, arguing that the state, and not the municipality, should provide free primary and secondary education.

Regional differences were also very significant, as some municipalities had plenty of resources and others lacked essential items even following constitutional regulations. Teachers' wages are evidence of these regional differences, as well as municipalities' expenditures on students. Data from 1997 show that public expenditure per student on basic education in municipalities of the state of Sao Paulo, the richest in the country, was US$ 618. This amount is more than ten times as much as that of the municipalities of Maranhao. This state is located between the Amazonian forest and the poor and dry northeast region.

Most students (68%) receive basic education in municipal schools, which spend some US$ 60 a year per student. It was clear that funding was a major problem. Equity could not be matched without a redistribution of resources, so that taxes raised in rich regions could be transferred to poor ones. This could be done in the same state, and/or rich municipalities were to transfer to the state resources to provide basic education in places where there was a need.

Brazilian Constitution states that the "ensino fundamental" is compulsory, and the state has to provide supplementary programs for didactic-pedagogical materials, transport, food, and health (Art 208, VII). Combining the picture of pre-service teacher preparation and the picture of financing of compulsory education, a clear image of perversity emerges. On one hand, poor places cannot afford supplementary programs for didactic-pedagogical materials, among other items. On the other hand, teachers do not have enough pre-service preparation as to overcome problems they face in everyday work in classrooms. There is an urgent need to face both problems simultaneously. Teachers' in-service preparation has to be done at the same time that students are offered relevant ways to learn science and technology. This double-approach (DA) was considered for the designing of science activities.

Just Science?

A frequent question that administrators and also teachers ask is why to offer new ways of learning science and not all subjects. The answer is not straightforward but can be summarized as follows:

- Recent data shows that students who perform experiments in school have not only a better understanding of science, but also of math and language. PISA data, available on the web, shows clearly that Brazilian students who have access to science experiments perform better in other subjects, and that the same happens in OECD countries;
- Traditional ways to learn science, using book and memory-based methods, do not encourage learning in other areas. Written texts can delimitate in a very strict manner tasks in which students can engage, avoiding other subjects and content areas. Performing experiments, on the contrary, is an alternative to these strict delimitations, and students need other content areas, namely, language and math;

- Experimental work in science education has communication as a compulsory step. This means that students have necessarily to use language in proper ways as to understand what has to be done, what is the objective to be reached, and then to report what was done. It is important to make sure teachers recognize that science is directly linked to language;
- Performing experiments in the classroom normally allows students to develop group work abilities, creating a stimulating atmosphere, which can rarely be created in traditional book-blackboard-notebook activities.
- Experimental work demands better preparation of the teacher. It is common that teachers take lessons of a given textbook as something that does not require previous preparation, especially if the same book has been used in previous years. Experiments, on the contrary, are normally taken as challenges every time they are performed, and teachers know they have to be properly prepared to face unseen situations, even in well-known practical science activities. This has a direct impact on the professional profile of the teacher and can possibly be transferred to other lessons, especially in primary teachers who teach different contents;
- Traditional teaching methods constraint teachers to look for *repetition* as the major evidence of learning in students. Learning in science certainly brings other outputs, especially when considering application of knowledge to other situations. These new outputs usually can be recognized by teachers and applied to other content areas as new learning objectives. There is no doubt that *originality* is the main target in science, and it certainly impacts intrinsic student motivation towards learning.

Designing and Implementing Science Activities

The science and technology program was designed to offer a constructivist approach with activities characterized by experiments in every class. It is divided into grades, on a two-monthly basis, as to fit the schools calendar. Students have to face a new theme (unit) in science four times a year (a different theme every two months). The program provides 16 experimental classes, which means two science classes a week and four units a year.

The teacher begins each unit by identifying the previous knowledge or ideas of the students that are related to the theme of the unit. Then, with a series of oriented experiments, students test their own ideas with the teacher's support. In this process, teachers also take into account other content areas while exploring the subject studied, such as mathematics or communication skills.

This methodology has been tested in almost 30 schools in many different regions in Brazil in the last eight years (Bizzo & Othero, 2000), and the model, now implemented in Sao Paulo public schools, is its final configuration, resulting from some changes in the original model. The science and technology program presents three main guidelines:

1. *Constructivist methodology:* As it has been explained, the program uses the preliminary knowledge of the students in each unit, which will be changed or not, based on the data obtained from the experiments, as well as from the teacher's

orientation. The teacher also changes radically the traditional approach for teaching. The students now work in groups, the activities are developed in groups, in every classroom (it is not necessary a special environment). The teacher is responsible for coordinating the dynamics of this process including many discussions at the end of the class, integration of other disciplines, and orientation for additional research depending on each group development. The students, on their turn, easily accept and appreciate a lot this approach. Some of them say "now the school got interesting, I feel like teaching my parents what I learned." This fact may also explain why one of the most common fears teachers have before the program starts, never happens. They usually say, "with all these experiments and equipment, the kids will make a lot of noise and disturb the class." After the program starts, they say, "it is amazing, the kids are so focused and interested..."

2. *Teacher's preparation:* But to achieve the real success, this methodology requires a lot of preparation from the teacher. Our experience shows that some teachers, for example, although having already approved the methodology proposed, having learned about the experiments and having the complete set of didactical equipment, never open the boxes to use the material. In some cases, this happens only when there is proper technical support in the classroom. Another important point is the difficulty in preparing the teacher for extra-classes activities. This happens because not all the teachers will be available at that time and/or the school will have problems to pay for their extra time. Considering that, we designed a teachers' preparation program in-service, what means they will be prepared during the time they are in class, while the students are having classes with another teacher (one trainer that executes the activity prepared by the teacher of that class). This is a weekly and continuous system. The trainers are specialists in science areas (Biology, Chemistry, and Physics), with teaching experience. Their main function is to do all the experiments with the teachers before the classes, to explore all the didactical material and to prepare them for the constructivist methodology. Teachers frequently declare that they love this preparation program and the opportunity of having specialists to assist them every week.
3. *Didactical equipment:* To make a program like that successful, with experimentation in the classroom, in every public schools and in poor areas, we really need a great and efficiently integrated set of didactical material and equipment. For the experimentation, we need to provide safe, simple, but very effective equipment, appropriate to the students' age. The complete set must be provided because, in some areas, sometimes the student and the teacher will not be able to provide even materials considered cheap or easy to obtain. The program also requires the use of a teacher's and a student's book. The first has a great portion of content (for the subject studied), tips for the teacher, and a more detailed approach of the methodology. The latter is basically a guide for the experiments with some content. The updated design of the program puts all these equipment and materials stored in a still cabinet, locked by the teacher, in each classroom. This is to prevent losing pieces and to make the material ready to be prepared and used.

For this pilot implementation in the municipality, which consisted in the second

semester (the pilot was developed for only 6 months) of the science end technology program, we had employed 2 units for each series, from the first to the fourth grade of the elementary school, as it follows in Table 2.

Table 2
Units Used in CTC Program

Grade	August/September units	October/November units
1st	Liquids and solids	Living beings
2nd	Transformations	Life cycle of a butterfly
3rd	Chemical Analysis	Plants growing and development
4th	Electrical circuits	Animals' study

Program Assessment with Teachers

We have developed an assessment of the science program using interviews with the teachers. These interviews were registered in statements they wrote and in a video, where we taped their opinion about many subjects concerning the program implementation. In the written interview, they were asked a single question: What is your opinion about the science and technology program? They were free to take the necessary time to answer, and our researchers prevented from giving any influence in this process. The aim in here was to analyze their answers to a very open question.

We had 335 teachers using the program of science and technology, and 170 out of them were interviewed. By the time of the interview, they had been using the new science and technology methodology for about 2 months. As a result, their statements were mostly positive when mentioning various aspects of the project. All documents were read and our researches could identify five categories that were frequently mentioned in the teachers' answers: 1. Program methodology; 2. Learning Improvement; 3. Training quality; 4. Equipment adequacy; 5. Others.

We have judged the statements according to positive and negative aspects of those categories defined. The final balance of this methodology is shown below, in Figures 1 and 2. Figure 1 relates to the positive aspect of the categories and Figure 2 to the negative. It is important to notice that, sometimes, the same teacher refers to a positive and also to a negative aspect of the same category in his/her statement; that is why, in some aspects, the sum of the positive and the negative numeric results overpasses the total number of teachers involved.

For the video taping, we collected responses of 6 teachers, 4 students, and 2 parents. In fact, it could be characterized as a chat session, since the conversation unfolded freely between the interviewer and the interviewee. The focus was to relate the experience of the implementation of the Science and Technology Program, with its ups and downs.

In the beginning of the new program implementation, the teachers showed some resistance to use the methodology. As we can notice in the following statements:

> *"(...) I'm afraid I won't be able to completely achieve the experiment objective. This fear doesn't relate to the material, which is very complete, but to the class*

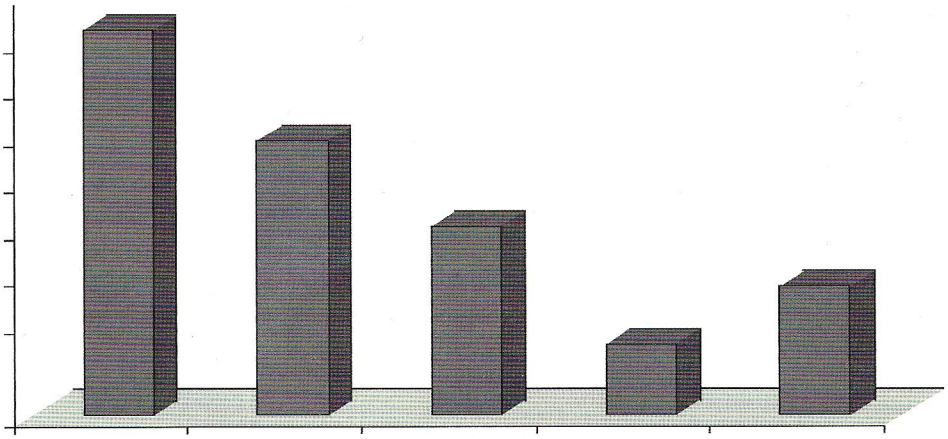

Figure 1. Balance of Positive Aspects as Identified by the Teachers

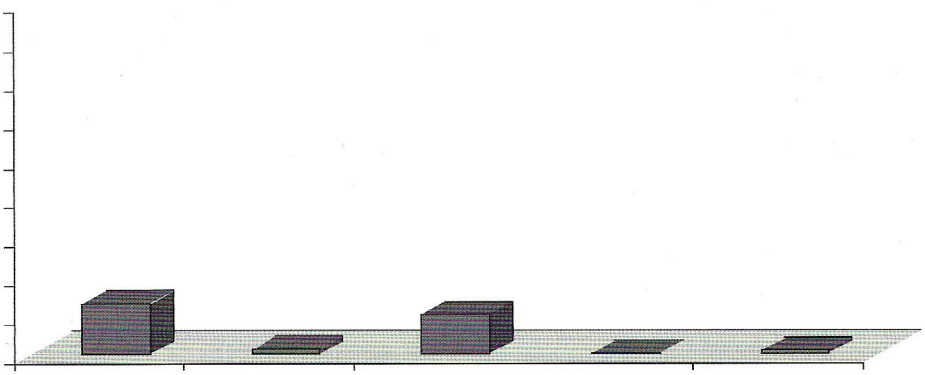

Figure 2. Balance of Negative Aspects as Identified by the Teachers

development. To make the (needed) observations also requires a deep study of the written material, because we can face observations (questions from students) to which we may not know the answer (...)" (Professor 1 - EMEF Heraldo Barbuy – Written statement).

"During the presentation of what we were supposed to use in class, we thought that it would be hardly feasible for the students. But after the first classes, we noticed that due to the richness of the content in the boxes that we received (it made) our concerns diminished substantially (...)"(Professors: 2, 3, 4, 5 – Written statement).

"We were a bit afraid; will we really be able to? What will really happen in the classroom? Will there be too much disturbance, because of the large number of students?" (Professor: 6 – EMEF Saturnino Pereira – Taped statement).

> *"In the beginning we were a bit afraid; would we be able to do it?"* (Professor: 7 – EMEF Saturnino Pereira– Taped statement).
>
> *"To face the new means not knowing the result, then you can get concerned. But enthusiasm is bigger and then you can do it."* (Principal: 8 – EMEF Saturnino Pereira – Taped statement).

The teachers usually referred to the following beliefs, as a justification to their initial reaction:

1. As the program has a lot of interactive experiments to be applied in the classroom, indiscipline could grow among the students;
2. Municipality schools have a lot of students per classroom, and this could make the experiment organization a very difficult issue;
3. Teachers could feel intimidated by such a new methodology.

After the beginning of the training program, these teachers experienced the weekly support of a science teaching specialist, who regularly visited the school and sometimes got into their classroom. Then, we could notice that their resistance decreased, considerably. Reading the statements, we noticed that some of the mentioned categories could be even subdivided, to provide us with a deeper analysis of answers. So, under *program methodology,* we defined two subcategories, with the aim of checking how involved and stimulated by the science program the teachers would be.

These are the subcategories illustrated with some of the teachers' statements:

1. The methodology and/or the material is motivational for teachers, students, or others;

> *"I am quite motivated by "Projeto Ciências." The class has acquired new dynamics, where the students can effectively live Science contents, in a contextualized and meaningful manner. That is, I realize the students' involvement with the matter and I see real learning possibilities, comparing (the program) to the boredom of "blackboard, notebooks and books". (Professor 9 – Written statement).*
>
> *"The project is great. We, 4th grade teachers, just love it for the classes became involving and creative. For the first time, we felt ourselves valued and supported, since we know we have commitment and will, but we do not usually have significant pedagogical support" (Professors 10, 11, 12, 13, 14 –EMEF Ezequiel Ramos Júnior– Written statement).*
>
> *"I love to work with the project in the two groups I teach (1st and 4th grades). The activities are rich and dynamic, through which the student gradually builds up his knowledge on the theme of the module. It has been gratifying to notice the students' involvement and interest while handling the material and discovering concepts and functionalities'"* (Professor 15 – EMEF Engenheiro José Amadei – Written statement).

2. The methodology and/ or the material is interesting for teachers, students, or others;

> *"The project "Ciência e Tecnologia para Crianças" awakened the students'*

> *enthusiasm and interest. They enjoy the moment of the class. (...)"* Professor 16 – EMEF Dr. Afrânio de Mello Franco – Written statement.
>
> *"(...) It is really gratifying when you teach and notice that your student enjoyed your class"* (Professor 6 – EMEF Saturnino Pereira – Taped statement).

From the 170 written statements, not considering the tape, we counted the numbers for both subcategories: Forty-seven answers affirmed that the methodology and/or the material is motivational for teachers, students or others; and forty-eight answers affirmed that the methodology and/or the material is interesting for teachers, students or others. Through these results, we found that 95 teachers (or 56%) considered the program effective to turn the classroom into a very positive and motivating environment for teachers, students and others.

Program Assessment with Students and Parents

The EMEF Alexandre Vannucchi Leme is one of the schools involved with the project. A research was conducted among their students and parents in order to check their opinion about it. The statements were written by 69 students, who were accompanied by one of their parents. They received a sheet of paper, divided into two fields: the upper part was for parents' statement and the lower one for the students' statement. They were asked the same question already responded by the teachers: "What is your opinion about the science project?" The following statements are very representative:

> "Well, I think this Project is a very interesting form of learning; the kids are going to learn in a more practical way, they will be more interested. I hope this Project continues and does not stop here" (Parent 1)
>
> "This is a very important Project. School used to be that routine, even monotonous for the children, and curiosity is a characteristic of children; "knowing," "discovering" involves and stimulates them. The enthusiasm I see in my son, makes me really believe in this change in education, about which everybody has talked a lot. I see this project as really important and very interesting" (Parent 2).
>
> "This Project has been really important for the students and it must be carried out. Sometimes, we do not pay attention to simple things, we overview interesting things. After my son has participated in this Project, I could notice how much his behavior and his interest have changed. Therefore, I think (the Project) is useful and should keep growing, with more investments in this idea"(Parent 3).
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> "I think the experience was really important and, through it, we could develop our knowledge and our minds. I also think the materials are really cool and (the Project) should continue in the schools. We learned things with the experiments, discovering what we didn't know. (...) *This,* in my opinion, should be permanent in the schools, for all the students" (Student 1).
>
> "I think the experiment is very important, because it is nice...I didn't know that sugar is a chemical substance. I enjoyed dealing with iodine, cabbage juice, vinegar and water" (Student 2).

"I think the experiment we are doing is really good and also very important to learn and develop our minds. We are learning things, we didn't know before (...) I think all of us loved the materials and we loved the name you chose and we loved the things you sent to us. I hope next year, or better, this year, you send us more material (...) I also liked the books, we are going to take good care of them, and we are going to love when you send more books and a lot of material to us" (Student 3).

Final Remarks

The Science and Technology Program, applied in municipal schools of the outskirts of Sao Paulo, was a major chance for the whole school structure. Generally, changes mean resistance and difficulties. If we consider the precarious condition of those schools and the social context of very poor communities, the resistance and difficulties in the process could be more than expected. Through the final evaluation of the users, we understand that the positive aspects of this new methodology can easily exceed the negative ones, as long as we count on the necessary support from teachers, students, principals, and pedagogical coordinators. In this study, we found the inflection point of change acceptance in the classroom, when the resistance diminishes and the implementation of the new methodology, starts to find, real support among users. Based on the analysis of teachers', students' and parents' answers regarding this adaptation process, we can highlight some aspects to bring to reality the new teaching methodology on science:

1. The methodology and the support to the teachers are fundamental factors to increase motivation in the classroom. This is based on the result of the analysis of 170 written statements, which indicated that 56% of the teachers mentioned this point. This motivation made students more interested in scholar program, and the teachers more satisfied with the dynamics in the classroom, as we can see in this statement:

   "(...) It is really gratifying when you teach and notice that your student enjoyed your class"(Professor 6 – EMEF Saturnino Pereira – Taped statement).

2. Teachers' fears regarding the implementation of a new teaching methodology can be easily surpassed with the right and intense support, i.e., with training. The trainers visited each schools weekly, and this fact was crucial to gain teachers' support for the new program, as we can see in the statement below:

   "The project is great. We, 4th grade teachers, just love it for the classes became involving and creative. For the first time we felt ourselves valued and supported, since we know we have commitment and will, but we do not usually have significant pedagogical support" (Professors 10, 11, 12, 13, 14 – EMEF Ezequiel Ramos Júnior – Written statement).

3. Spontaneously, teachers mentioned the innovation and the adequacy of the program methodology and the learning improvement to their students, as the most positive aspects of the program.

4. As negative aspects, the most cited ones are the program methodology and the equipment adequacy. It is interesting to notice that the program

methodology is, at the same time, the most flattered and the most criticized item by the teachers. As the main negative comments of the teachers for this category, we have: (a) Too many students in the classroom (sometimes more than 40 in a class), (b) Too much content to be developed, (c). We had a few cases where they say "the activities are suggested and the teacher shall be completely free to make its own program." The negative points related to the material adequacy category, are in most cases, related to some missing material in the kit they received.

5. The students get more excited working in groups with experimentation. They also start to appreciate their classes, as the famous story among the teachers of the program that goes: "in the weekday for science, nobody misses the class."
6. Parents are also quite interested in the effect that this new methodology might have in the interest of their kids for the classroom. They usually say that now science has a real meaning to their kids.

We hope to extend the program of activities to a wider group of students in 2003 and to keep the methodology of follow-up and assessment.

Bibliography

ABD-EL-KALICK, F. AND N. LEDERMAN, (2000). Improving science teachers'conceptions of nature of science: a critical review of the iterature. *International Journal of Science Education, 22(7)*; 665-701.

BIZZO, N. (1998). Ciências: fácil ou difícil? Coleção palavra de professor. Editora Ática. São Paulo.

BIZZO, N. (2000). Falhas no ensino de ciências. Ciência Hoje 159:26-31.

BIZZO, N., & OTHERO F. (2000). *O "Método dos Projetos" no ensino de ciências: reflexes sobre seis anos de aplicação.* Atas do VII Encontro "Perspectivas do Ensino de Biologia": 807-9.

MEC/INEP, Brasil (2001). Sinopse estatística da Educação Superior – ano 2000. Brasília (DF).

PISA (2000). *Measuring Student Knowledge and Skills.* OECD, Paris.

POSNER, G. J., STRIKE, K. A., HEWSON, P. W., GERZOG, W.A. (1982). Accommodation of a scientific conception: toward a theory of conceptual change. *Science Education, 66(2),* 211-227.

PUTMAN, R. T. AND H. BORKO, (2000). What do new views of knowledge and thinking have to say about research in teacher learning? *Education Researcher, 29(1);* 4-15.

SCHÖN, D. A., (2000). Educando o Profissional Reflexivo: um nov design para o ensino e a aprendizagem. Porto Alegre, ARTMED.

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