

# “Scientists for a day” a program to encourage young people to science

*Gustavo Horacio Marin(1,2), Daniela Sbattella (1), María Isabel Ponzinibbio (1), Guillermo Garaventa (1), Pablo Ixtaina (1),*

(1)Comisión de Investigaciones Científicas, Calle 526 entre 10 y 11 – La Plata, Argentina.

(2)Secretaría General de la Gobernación, Expertos en Gestión Pública, Buenos Aires, Argentina. E-mail: [gmarin2009@gmail.com](mailto:gmarin2009@gmail.com)

## Abstract

In Latin America number of people choosing science and technology (S&T) as a job severely decreased. To solve this problem we launched a program that shows young students, “life models” to be followed in order to encourage them to remain in the educational system and study careers related to S&T. This work shows the results of the experience.

Methods: study: descriptive, analytic with an intervention stage; unit of analysis: young students aged 12-15. Period of analysis: August 2012 to July 2014. Variables: Age, sex, type of school; scientific vocation (willingness to be a scientist, intention to study science, willingness to work in the science field); attitude towards science; marks for school subjects. Intervention consists in all day long interaction of student/researcher, in the research schedule programmed.

Results: 6750 students (5.78% of 12 years old the students and 18.5% of those considered at risk of dropping out school), were included in the program. 96.8% of them felt that the experience was highly positive; 89.7% still remember the experience after 3 months as a factor that had a positive impact on your training; and 68.9% showed an increased interest and a better attitude towards science-related subjects at school according to their science teachers. 93.2% of researchers considered that the activity brought them closer to the community, 89.5% were highly pleased with activity, 72% said that after the experience they found more meaning in their research and 77.6% postulated themselves to repeat the experience.

Conclusions - the program reached the goals previously set like: student motivation, increased interest in science, and social inclusion of vulnerable teenagers. Positive externalities were also seen such as increased school attendance, reduced in dropout school rate, as well as a positive assessment and high degree of satisfaction with the experience among the researchers.

**Key Words:** Science, Technology, vocation, school, motivation

## 1. Introducción

Career or profession choice is a consequence of the individuals' vocation, their personal expectations and the representation they have of themselves and the carrier. (Fouad, 2007)

Traditionally, professional vocation has been associated with moral and ethical values of society (Antolinez & Gadna 1997; Cortina, 1997). Vocation is developed in response to the idea one has of oneself in the context of the global process of socialization and individual development of human beings, this is why professional stereotypes go beyond relevant aspects of personality (Rivas y Martínez, 2003).

The environment influences, the individuals' representations and their vocation, as revealed by the analysis of the statistics on careers and professions which exhibits an uneven proportion among the diverse groups according to sex, ethnicity or social class . (Fouad, 2007).

Recent data show that men have chosen professions leading to higher socio-economic status and political power (Pérez, 1993).. Along with this tendency many professions have become more feminized (e.g., Medical Sciences); while scientific and technological careers and professions (physics, maths, geology and technical careers) have traditionally been chosen by men, whereas those related to social services and humanities (teaching, pedagogy, psychology) are more frequently chosen by women, explaining the occurrence of careers, which are stereotypically for men or women . (Pérez, 1993). Men's career choice is related to antifeminine attitudes (perception of difficulty and absence of affectivity), whereas men's non-traditional choices are related to more liberal attitudes (Davey, 2001; Whitehead, 1996). In choosing engineering, men make an earlier decision than women, and they referred to their vocational interests, whereas women make a more reasoned choice after looking for information and advice or refusing other alternatives; women consider social reasons or altruistic help to people.

However, the XXI century have brought new tendencies towards equality, and, even if men and women stereotypes still remain, current statistical studies (Pérez, 1993; Zamora, 2004) demonstrate that gender variable is not so strong as it was.

Far from being ideal, equality has led to a general crisis concerning science vocation, which is revealed in the decline in the number of students (boys and girls) pursuing scientific and technological careers

worldwide. This phenomenon has had greater effects in the developed and developing countries due to their need for qualified and sufficient labor force to support their productive systems, basis of their welfare and social progress (Convert y Gugenheim, 2005; OECD, 1997).

It is well known that the development of the countries is closely related on its scientific and technological capacity (Khan, 2004).

This issue has been a matter of global concern since the beginning of the XXI century and governments from all over the world have devoted much effort to address this problem. Thus, the European Education Council proposed several work programs with the aim of making Europe “the world's most competitive knowledge-based society”, suggesting an increase of 15% in the number of graduates in Mathematics, Science and Technology (S&T). Unfortunately, ten years later, these attempts have become only manifestations of good will, with no achievements of the strategic goals set by the Lisbon European Council or Bologna (Keeling, 2006).

As mentioned above, vocations strongly depend on the whole social context, however, vocation in science and technology can be highly influenced by the orientation of science teaching and science curricula at school, which not only include teaching of knowledge and procedures but also personal and social attitudes such as appreciating science and technology or learning to participate in the modern knowledge-based societies (Gadd, 2004; Abraham & Leigha, 2012).

It should be noted that positive attitudes, such as curiosity, interest and liking for science can be developed with education (Gouthier, Manzoli y Ramani, 2008).

Traditional science education is based on teaching of knowledge and theoretical processes, which far from developing positive attitudes towards S&T have given place to negative attitudes towards school science, producing a decline in the number of students pursuing a S&T career (Fensham, 2004).

Thus, in Spain a systematic reduction of -5% per year in vocations in scientific careers is observed, with a decreased of more than 23% in the last decade (Asenjo 2012; Perla, 2014; Ríos Rodicio, 2012).

Latin-American in general and Argentina in particular are not the exception to this deficit, showing a reduction of 25% in scientific vocations in the last decades. (Molina & Pujol 2014; PEFI, 2012), and also a decrease in the number of young people choosing

science as a job (Faye Neathery, 1997).

Much effort is now being devoted to encourage (by means of scholarships or financial support) young people to choose a Scientific and Technological career, such as a career in Engineering or Exact Sciences, when deciding their future career. However, evidence shows that scientific vocation occurs earlier during secondary school (Farenga & Joyce 2000; Fensham, 2004, Stekolschik, 2010).

The Scientific Research Commission from Buenos Aires State, Argentina; in order to stimulate students in science and technology subjects, create in 2012 two programs "The Science goes to School" where a Researcher visits the State schools and "Scientific for a Day" that promotes close interaction of one student and one researcher, by visiting the Research Centers and accompanying the researcher in their daily tasks.

The aim of the present study is to assess the impact of the program "Scientific for a day" designed to encourage vocations in Science and Technology in young students from Buenos Aires state, Argentina.

## 2 Methods

Type of Study: descriptive, analytic with an intervention stage

Subject population young students aged 12-15 from a sample representing public and private schools located in Buenos Aires state, Argentina

Sample. The sample size was calculated with the following formula, considering the number of students from public and from private schools:

$$n = \frac{NZ^2PQ}{d^2(N-1) + Z^2PQ}$$

a minimum sample size of 1980 units of analysis was obtained from the formula

Units of analysis: each student constituted a unit of analysis

Period of study: The study was conducted from November 1 to June 30 2014

Variables:

Age, sex and school (public or private); scientific vocation (variable constructed by the willingness to be a scientist, intention to study science, willingness to work in the science field); attitude towards science; marks for school subjects related to Science and Technology or not.

Intervention:

Once the students arrived at the Research Centers, the group was hosted by CIC staff and each student was presented to "his/her" researcher with whom he/she would spend the whole day, including research experiences and even lunch and tea times. At the end of the day, students receive a certificate from the head director of the Research Center, souvenirs and finally they are all taken back to their school.

Tools for data collection

Survey to students: Before intervention (experience of the students at the research center) a coordinator conducted a survey among the students. Each student responded the questionnaire anonymously and deposited the form in a survey box. The survey was repeated three weeks later.

The survey consisted of two sections, the first section included general questions on sex (male, female), age, type of school (public, private) and academic year; and the second one, which was more specific, assessed the relationship of students to sciences. For this second part we modified the ROSE questionnaire (Schreiner and Sjoberg (2004), taking into account the four attitudinal scales towards S&T:

- Scale "My opinions on science and technology" composed of statements with contents related to the image the students have of S&T

- Scale "Science classes", includes statements showing several general aspects of school science, with no references to specific subjects

- Scale "Environmental challenges", statements focusing on the concern on the future of the environment and the role of S&T in this issue.

- Scale "My out-of-school experiences": statements describing several activities related with S&T performed by students

- Scale "My future job" statements showing the interest the students may have in developing a future occupation or job related to S&T

Students were asked to make a closed evaluation of very short statements with a 1 to 4 Likert-type scale where 1 indicates "strongly disagree" and 4 means "strongly agree".

Among all the items included in the scales, 3 items highlight as main dependent variables in the study. These variables (complex variables composed by several questions of the survey) determined the scientific vocation of the students.

1. “Willingness to become a scientist”.
2. “Intention to study as much science as possible at school”
3. “Willingness to get a job related to science and technology”.

By analyzing the responses to these major components, “Vocation in S&T” was built as the addition of the three dependent variables mentioned above and the science teachers' opinions on each student's attitude towards S&T (which was considered as the fourth relevant variable). Analysis of the content of the four variables revealed two different aspects of vocation: the first aspect is job expectation or longing for a future job in S&T. (defined by items 1 and 3), described as the sum of both variables; the second one is the academic career in S&T, which was defined by variable 3 and the teacher's opinion (variable 4).

To determine differences between conditions before and after intervention, data from the dependent complex variables, were compared them in both periods of time, using statistical multivariate analysis.

Interview to teachers The teachers were asked about the changes in the students' attitude towards the S&T.

Academic marks: Academic performance was considered as the mark assigned by the teachers to 6 subjects: 3 were related to S&T (Mathematics, Physics and Chemistry) and 3 were unrelated (Language Arts, Social Studies and Civics). Marks obtained in the trimesters before and after intervention were taken as objective parameters.

Interview to researchers: The researchers were asked to give a general opinion on the experience and the positive and negative feelings they had towards their participation in the program

### Results

6750 students were included in the program (table 1). According to the general data 96.8% of them

felt that the experience was highly positive; 89.7% still remembered the experience after 3 months as a factor that had a positive impact on their training; and 68.9% showed an increased interest and a better attitude towards science-related subjects at school, according to their science teachers (figure 1).

Table 1. General Data

Nº of Students	Sex		Age (years old average)	Students according School management		Students according School location	
	F	M		Public	Private	Capital region	BA province
6750	3342	3408	13,86	3952	2798	4021	2729

Regarding the variable “Science vocation”, willingness to be a scientist increased from 21.81% in the survey conducted before the experience to 81.43 in the survey conducted after the experience. The intention “to study as much science as possible at school “increased from 30.87% to 69.26%. Also, willingness to get a job related to science and technology increased from 10.78% to 58.72% (table 2).

Figure 1. Students school interest in Science and Technology subjects according to teachers (scale 0 to 10)

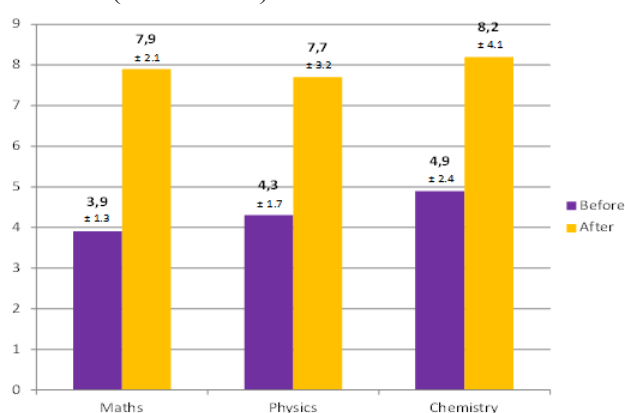


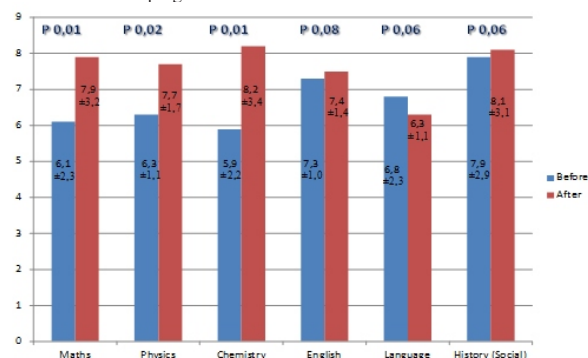
Fig.1 According to teacher's interview, students increased their interest and had a better attitude towards science-related subjects at school. Using a scale from 0 to 10, before de program teachers assigned in average 4,36 points to the interest of their students towards Math, Physics and Chemistry subjects; and according to their science teachers after de experience their performance was 7,93, increasing 1.8 times their basal levels.

Table 2. Impact of the experience on the

Parameter assessed	Responses considered positive (%)		Statistical significance (p value)
	Before experience	After experience	
Willingness to become a scientist	21,81 (n1467)	81,43 (n5496)	<0,01
Intention to study more science	30,87 (n2084)	69,26 (n4677)	0,01
Willingness to get a science-related job	10,78 (n725)	58,72 (n3954)	<0,01
Interest and global attitude towards science	20,04 (n1353)	88,94 (n5392)	<0,01
Opinion that S&T play a major role in the environmental aspect	39,83 (n2688)	51,71 (n4031)	0,04

Regarding the academic performance of the students that attend the program, 78,56% obtained better marks in the subjects related to S&T, increasing 1.42 points in average the basal marks obtained before the experience. Figure 2 shows details of this data

Figure 2. School performance obtained by an objective variable like the different academic subjects obtained in the preceding and subsequent quarters in relation with the program



Some of the responses given by students in the “open opinion” option of the survey were:

“Science has enhanced my curiosity” “Science can provide solutions to environmental problems” “I like science better than most other subjects”; “I loved working with machines” “Science will make the world better and I want to help”; “Science has opened my eyes to new and exciting jobs “; “Science and technology make work more interesting”; “You should have shown this experience before and I would be interested earlier”

Results of the survey performed among the researchers revealed that 93.2% of the researchers considered that the activity brought them closer to the community, 89.5% were highly pleased with activity, 72% said that after the experience they found more meaning in their research and 77.6% postulated themselves to repeat the experience.

The authorities of the Ministry of Education formally agreed to officially incorporate the program to their schedule for all schools in the State of Buenos Aires. The Scientific Research Commission agreed to co-manage the program with the Ministry of Education for 2014-2015 periods.

The variable related to “Science vocation” was systematically low in the basal measurement for the related individual variables, which means that students do not show great interest in being a

scientist or looking for jobs related to S&T. The academic variable was basically close to the medium point in the scale, which shows that students' interest in studying more science at school, though low, is not absent, and that the experience significantly enhances their willingness.

No statistically differences were found between boys and girls except for the variables related to “Willingness to find a job related to science” that have a basal response similar to 10.35% in girls vs 10.96% in boys with a higher increase in boys (63.52% boys vs 52.84% in girls) p 0.03 after the experience.

Comparison between public and private schools showed only one difference, respect to the variable “Willingness to get a job related to science” and “become a scientist”, which had basal responses of 10.46% vs 10.92% and 19.3% vs 23.4% and 54.2% vs 60.1% after the experience for public and private schools, respectively (however it had no statistical relevance in either of the cases).

One variable not considered before the experience was dropout school rate by the end of the year, which was 10,1% in average for all the students from 12 to 15 yrs old in the educational system and 4,7% in those students included in the program (non statistical significance).

### Conclusions

In the last decades, scientific vocation substantially decreased in Latin America specially in Argentina. Efforts have been focused on providing scholarships for college end of those young people who opted for a career in engineering and other disciplines considered hard sciences.

However, there is strong evidence that scientific vocations wake up early at the age of 12-15 years. Therefore, it was designed a program to encourage scientific and technological vocations among young people. This work shows some interesting results extracted from this experience. Attitudinal variables towards S&T had a high predictive capacity of the scientific vocation among boys and girls that carried out the program.

The experience not only was able to change original negative attitude towards the science but awakened the interest S&T of the majority of the

program.

The experience not only was able to change original negative attitude towards the science but awakened the interest S&T of the majority of the young students that were included in the program.

Those students also showed changes in objectives variables like an improvement in the performance of school subjects related to science.

The program reached the goals previously set like: student motivation, increased interest in science, and social inclusion of vulnerable teenagers. Positive externalities were also seen such as increased school attendance, reduced in dropout school rate, as well as a positive assessment and high degree of satisfaction with the experience among the researchers.

The real impact of the experience will be determined within five years, at which time these students have to choose their college career and whether or not this will be related to science.

However, we believe that there is already an immediate benefit, showing young people in vulnerable socioeconomic situation, "life models" to be followed that may encourage them to remain in the educational system, studying careers related to science and technology that allows you to dream of a different future for themselves .

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