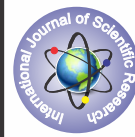


Scientific performances to improve science skills in students



Science

KEYWORDS: science; vocation; students.

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ABSTRACT

Science could be a difficult subject to learn by students. In order to motivate teenagers in science, we launch this study.

Methods: Volunteers researchers belonging from Scientific Research Commission (CIC) staff were included in this project. Socially vulnerable schools were invited to register their scholars in the program (6-12yrs). Students were invited to attend to theatre plays where head researchers became actors and actresses. The plays were based in 3 mayor topics of science (either math, physic, biology or chemistry topics). Each performance was interactive with the presence of students from the audience.

Results: 3600 underserved students were included in the program. After the play 97.4% considered the experience as highly positive; 80.3% still remember the contents of the play after 3 months; 77.6% showed an increased interest towards science-related subjects at school according to their science teachers. 96.1% of researchers considered that the activity brought them closer to the community.

Conclusions: teaching science in non-traditional way (through theatrical performances) achieved a greater interest among students from elementary school. When science's topics are teach to children in non-conventional ways; students are able to increased their attention, improving the willingness to learn, and increasing their interest in science's topics.

Introduction

Early vocational developmental theorists affirmed that childhood is a vital formative period for vocational development (Havighurst, 1972). Several factors are associated with children's vocational choice development. Among them are parents, social environment or the favorite subject at school. Elementary schools have a main role since from the way they expose each course, students can be stimulated to follow a given profession in the future.

Children's vocational aspiration starts as early as at preschool years. In those early years, parents play a critical role in motivating and encouraging their children to explore about various vocations (Seligman et al., 1988).

The goal of guidance is to make it possible for individuals to explore their unlimited endowed options. Many authors opined that the major service areas of counseling are educational guidance to encourage young students to choose and prepare to their real vocation and to become an active members of the society. Career or profession choice is a consequence of the individuals' vocation, their personal expectations and the representation they have of themselves since early youth. (Fouad, 2007).

In their daily life, children experience limited number of real representations of any vocational type. Although they are exposed to teachers daily, if they see a doctor or nurse when they need a health care, or if they see a traffic police when they travel, those experience are strong enough to stimulate their vocations. Thus, many of the vocations are underrepresented in their daily life and could be directed towards a unique lived experience. Media, particularly television, provides a bunch of vocations with good and bad examples and with traditional and non-traditional role models.

Though children reported that TV has a little influence on their vocational aspiration (McMahon et al., 2001), children probably absorb some information and develop perceptions implicitly.

Traditionally, professional vocation has been associated with moral and ethical values of society (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).

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).

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 (Perla, 2014).

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. (Dalton, 2008). Even a small percentage is still observed among the economically vulnerable children of which unfortunately drop out of school before they reach 15 years old (Binstock & Cerruti, 2005).

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 aim of the present study is to assess the impact of a state program developed to encourage vocations in Science and Technology in elementary school students from Buenos Aires, Argentina.

Methods

Type of Study: descriptive, analytic with an intervention stage

Subject population young students aged 6-12 from a sample representing public and private schools located in Buenos Aires state, Argentina. All of them were considered social vulnerable children since the private school were religious schools financially helped by the State.

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 January 1st of 2014 to November 30th of 2015.

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:

Students were transported in each theater play from their schools to the playhouse. Each group of students was hosted by CIC staff in the theater. The theater spectacle was prepared and executed by main researchers of the scientific system. The shows were based of math, physic, astronomy, biology, chemistry, or medical topics. The contents of the performance were prepared to be presented in an interactive and funny way. The students were invited to participate in the play as well as their teachers. After each performance, some basic concepts were reinforced by the researcher actor/actress. Each group of students was invited to three plays. After them, a certification of lived experience was given to each student as a reminder of events.

Tools for data collection

Survey to students: Before intervention (the first attendance to the theatre play) a coordinator conducted a survey among the students. Each student was provided of a personal code in order to respond to questionnaire, which after being answered was asked to be deposited in a survey box. The survey was repeated three months later in order to find out if the students can still remember the concepts and contents of the play, and some attitudinal and vocational elements.

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

3600 students were included in the program (table 1). According to the general data 97.4% of them felt that the experience was highly positive; 80.3% still remembered the experience after 3 months as a factor that had a positive impact on their training; and 77.6% showed an increased interest and a better attitude towards science-related subjects at school, according to their science teachers.

Table 1. General Data

N° of Students	Sex		Age (years old average)	Students according School management		Students according School location	
	F	M		Public	Private	Capital region	BA province
3600	1753	1847	8.94	2161	1439	2034	1566

Regarding the variable "Science vocation", willingness to be a scientist increased from 12.8% in the survey conducted before the experience to 84.5 in the survey conducted after the experience. The intention "to study as much science as possible at school" increased from 18.9% to 74.2%. (table 2).

Table 2. Impact of the experience on the students

Parameter assessed	Responses considered positive (%)		Statistical significance (p value)
	Before experience	After experience	
Willingness to become a scientist	12.8 (n461)	84.5 (n3042)	<0.01
Intention to study more science	18.9 (n680)	74.2 (n2671)	0.01
Willingness to get a science-related job	8.6 (n310)	59.3 (n2136)	<0.01
Interest and global attitude towards science	48,8 (n1757)	82,7 (n2977)	<0.01

Regarding the academic performance of the elementary school students that attend the program, 77.8% obtained better marks in the subjects related to S&T.

Results of the survey performed among the researchers revealed that 96.1% of the researchers considered that the activity brought them closer to the community, 86.7% were highly pleased with activity, 68.3% said that after the experience they found more meaning in their research and 79.1% 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 in 2016-2017 period.

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.

Comparison between public and private schools showed no differences, respect to the variables explored.

Conclusions

Attitudinal variables towards science topics have a high predictive capacity of the scientific vocation among boys and girls that carried out the program.

The significant predictors identified for S&T vocation suggest an innovative approach to science teaching contributes to the development those vocations.

A program focused in awaken the interest of young students in science was able to change original negative attitude towards the science and improved the students' performances in science related subjects.

The program reached the goals previously set like: student motivation, increased interest in science, and social inclusion of vulnerable scholars. A positive assessment and high degree of satisfaction with the experience was obtained among the researchers.

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