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Adolescents and Scientific Careers. Interests, Scholastic Experiences and the Opinions of Italian Students

Abstract: This study investigates students' views of science and technology, taking into consideration both internal and external factors. The article reports on the perceptions of 3,503 Italian students, focussing mainly on individual interests, scholastic experiences and their opinions concerning science and technology. A further analysis deals with the degree to which young people may consider following a career in scientific sectors. Findings show that although wider interests would tend to support future decisions, students appear to nurture ambivalent attitudes towards scientific careers. It is suggested that with respect to different levels of personal achievement in scientific careers various factors may have influenced the initial orientation. Such factors include the academic qualifications held by the students' parents and the presence of science laboratories at the schools they have attended. These variables moreover only appear to affect a student's intention to seek admission to a science faculty. In the presence of an intention to embark on a scientific career following graduation certain significant elements come into play, such as their participation in scientific events, the chance to come into direct contact with researchers and their confidence in scientific studies. If a student presents a desire to become a scientist, the degree of confidence that is felt with respect to this particular sphere also becomes significant. The pleasure in studying science subjects is the most influential variable, but its effect is reduced over the three stages of the envisaged or planned path.
Keywords: science, technology, STEM, education, motivation, scientists, careers.

Introduction

What do adolescents think about science and technology? What are their interests?

The relationship between adolescents and science has been studied for several years. Numerous studies have investigated motivations, skills and the most favourable didactic strategies. Among these we may mention the OECD PISA survey devoted to the study of competences [OECD, 2012], NAEP [IEP, 2013], TIMSS & PIRL [Loveless, 2013], the

ROSE survey on students' attitudes [Sjoberg & Schreiner, 2005] and the ASPIRE survey on students' intentions to study science and undertake a scientific career [Archer et al., 2010].

The attention dedicated to adolescents' interests with respect to science derives from the need expressed in various countries of the world to have an adequate number of scientists and researchers given the increasingly important influence of science and technology in economic and social development. Considering the inadequate number of students who attend scientific-oriented courses, in this regard it is possible to refer to a 'leaky pipeline', indicating the loss of students at the higher levels of study and thus a lower number of individuals who will embark on scientific careers. Beside this need, in several surveys a low propensity on the part of adolescents to pursue a career in science has been detected in various studies, this being a phenomenon that has stimulated reflection on the general interest in and on the teaching of science or STEM subjects, considering motivations, gender differences, family influence, school experiences, friendship groups and the connection with scientific careers [Carlone & Johnson, 2007; Holmegaard et al., 2012; Campbell et al., 2012; Harackiewicz et al., 2012; Robnett & Campbell, 2012; Hernandez et al., 2013].

The decision-making process that encourages young people to choose a career in science is rather complex and comprises numerous factors: interest, the perception of the usefulness of science, the relationship between science studied at school and its social relevance, scholastic education and relationships with teachers, the level of confidence in scientific institutions and scientists and gender differences. In many studies these factors have been considered in a negative way, identifying critical elements which normally discourage young people to embark on scientific careers [Eccles, 2009; Hyde & Lynn 2009; McRone, Morris & Walker 2005].

In this study we will investigate the interests of students, their school experiences and opinions concerning science and technology. Besides these three dimensions we will also take into consideration the variable of confidence in science and scientists and we will evaluate which factors influence these five dimensions. Finally, we will verify whether a relationship exists between these different dimensions and the orientation present in adolescents who feel they should undertake scientific studies or work in the field of research and in those who have a desire to become scientists.

Background

The 'Adolescents, Science and Technology' survey was carried out using various questions of the international ROSE (the Relevance of Science Education) survey dedicated to the study of the orientation of adolescents with respect to science and technology [Schreiner & Sjoberg, 2005].

The concept of a 'scientific attitude' that was considered refers to the distinction proposed by Klopfer as a set of affective behaviours in science education [Klopfer, 1971]. The distinction concerns "the feelings, beliefs and values held about an object that may be the enterprise of science, school science, the impact of science on society or scientists themselves" [Osborne, 2003]. In our study we considered these elements, identifying certain significant factors that relate to the following dimensions: interests, attitudes towards school experiences, attitudes towards science and scientists, pleasure derived from scholastic education and the intention to pursue a scientific career [Osborne et al., 2009].

Many studies have pointed out that an interest in science and technology is formed during adolescence [Osborne & Tytler, 2009]. When referring to a 'scientific interest' we mean primarily the 'domain interest' that focusses on scientific content covered during school lessons in line with the distinction suggested by research carried out by Haeussler & Hoffman [Haeussler & Hoffman, 2000], given that the questions proposed elements concerning the context of everyday life, the effects of scientific activity and the usefulness of science. On the other hand, elements concerning a 'subject interest', referring to the 'modality of learning', were analyzed within the sphere of school experiences, considering the evaluation of scientific content offered in the classroom.

Context

The Adolescents Science and Technology survey was conducted in Italian schools, in which the compulsory courses provided for by the Italian State are held.

The eligible population from which participants would be acquired for the study consisted of all students between the ages of 12–14 regularly attending the second year of secondary school. At the time of the survey the eligible population of subjects consisted of 545,624 students [MIUR, 2014]. The Italian scholastic system includes educational institutes characterised by different orientations, in which science education may range from a few to several hours, and usually from 1 to 3 hours. The study involved adolescents enrolled in the second year of a hundred randomly selected schools and was carried out between March and June 2014. In each school two classes were involved. The selection of schools from the available list occurred on a random basis, respecting the total numbers of students within the five geographical regions of the country: North West, North East, Central, South and the Mediterranean islands.

The students of the selected classes completed a hard-copy questionnaire with the assistance of teachers. The survey involved a sample of 3,503 students (52 % female).

Method

This article will try to highlight the relationship between 8 independent variables and some dependent variables which we will refer to as 'dimensions'. The study of this relationship was carried out with a view to comprehending the orientation of adolescents with respect to science and technology. The independent variables, which were identified following a verification of their significance, comprise gender, geographical area of residence, the level of education of the parents, the number of books available to students, the number of hours dedicated to science subjects at school, the use of a laboratory at school, the level of exposure to science in the media and participation in events having a scientific nature. In all of the regression models which we will present both the dependent and independent variables were subjected to normalization and assume values between 0 and 1. To analyse any multicollinearity issues a correlation table was compiled for each regression model and in all cases none of the correlation coefficients assumes values that may be considered as too high.

The dimensions selected as the subject of study for regression analysis are interests, school experiences, opinions on science and technology and confidence in science and

scientists. After analysing the relationship between the 8 independent variables and these dimensions we studied the relationship between the independent variables, the dimensions and three significant factors that concern scientific careers in order to ascertain which factors are capable of explaining the orientation of adolescents towards three characteristic aspects of a commitment to a possible career in science: the intention to enrol in a science-based degree course, the desire to work in the world of science and technology and the desire to become a scientist.

Interest in Science and Technology

In line with the objectives of the study and with the methodological approach adopted in the main international research, the first area of study examined is the level of interest in a significant set of scientific and technological aspects.

Students are primarily interested in practical aspects related to daily activities and which have an immediate affect at the personal level — as in the case of health — and, secondarily, they tend to focus on more general and theoretical knowledge. Drawing up a list of main interests, there is an evident preference for health in terms of knowledge and the possibility to treat those in need of medical assistance. These interests are followed by the meaning of dreams, scientific discoveries that have changed the course of history and environmental issues. Less evident were views relating to the meaning of life and phenomena not yet described and explained in a scientific manner. Comparing the data with the Rose survey conducted in Italy in 2009, an interest in understanding diseases remains a stable variable, while increasing attention is paid to first-aid intervention within the medical sphere, the meaning of dreams, inventions and environmental issues.

The interest of adolescents in science and technology was examined in a more analytical manner by studying the articulation of preferences within the list of 26 proposed items. This strategy was adopted in order to assess the areas that attract the younger generation and the relative degree of interest presented with respect to them within a context of significant transformation of the image of science and technology. A principal component analysis through successive trials allowed for the identification of 7 dimensions[1] (Table 1). The items that saturated each component were grouped together by means of summation indexes.

The interests of male students are mostly related to the exploration of outer space, the environment, agriculture and food and above all the use of technology. Female interests on the other hand tend to focus on issues relating to health, medical treatment and the psyche.

The main territorial differences concern the subjects of agriculture and food issues, the environment, health and medical treatment and issues more generally related to the generation of scientific knowledge, which adolescents in the South are more interested in with respect to the other participants.

Relationships between parents' qualifications and an interest in technology, the environment, agriculture and food, health and medical care are negative, while a larger numbers of books available in the home corresponds to a greater interest in environmental topics, issues relating to space exploration and the life and work of scientists.

[1] The use of the orthogonal varimax rotation exemplified the choice of the limited number of variables that saturate each component and made it possible to obtain a distinct separation between the various components (Di Franco, Marradi 2003, Osborne 2015).

Table 1

The items concerning interests and the 7 identified dimensions

	Things I want to know
Health and medical care	How to find cures for epidemics and diseases
	Cancer: what we know and how to treat the disease
	Understanding and how to find a cure for diseases such as HIV and AIDS
	Emergency Medical Services
	What we know about HIV/AIDS and how to keep it under control
	How alcohol and tobacco can harm the body
	Learning about sexuality and reproduction
	Using medicinal herbs or curing myself with alternative medicine treatments (acupuncture, homeopathy etc.)
Environment	What we do to maintain the purity of the air and drinking water
	How to improve crops in gardens and fields
Agriculture and food	The benefits and possible risks of modern farming methods
	The use of biotechnology to produce new foods
Outer space	Black holes, supernovas and other spectacular objects in space
	Missiles, satellites and space travel
The psyche	Life, death and the human soul
	Telepathy, mind reading, the sixth sense, intuition etc.
	The possible meanings of dreams
Technology	The use of laser technology (CD players, barcode readers, etc.)
	How devices such as television or radio operate
	How mobile phones send and receive messages
	How computers work
Scientific Knowledge	Famous scientists and their lives
	The biggest mistakes committed in scientific research and inventions
	How scientific ideas sometimes challenge religion, authority and tradition
	Inventions and discoveries that have changed the world
	Phenomena that scientists still can not explain

A greater number of hours dedicated to scientific subjects at school positively influences the interest in technology and negatively influences the dimension we have indicated as referring to the psyche, moreover having a school laboratory where science lessons are held and experiments are carried out positively influences solely interests in the dimension that concerns the production of scientific knowledge.

Finally, it should be noted that an increasing exposure to technical and scientific content through television, newspapers or the web corresponds to a growth in all of the identified dimensions of interest, while participation in exhibitions or science festivals has a positive relationship only with the dimensions of agriculture and food, technology and scientific knowledge (in general) (cf. Table 2).

Table 2

Regression models to explain the interest in science and technology

	Health and medical care			**Environment**			**Agriculture and food**			**Outer space**			**The psyche**			**Technology**			**Construction of scientific knowledge**		
	B	E.S.	Sig.	B	E.S.	Sig.	B	E.S.	Sig.	B	E.S.	Sig.	B	E.S.	Sig.	B	E.S.	Sig.	B	E.S.	Sig.
Constant	0.598	0.013	0.000	0.554	0.026	0.000	0.322	0.021	0.000	0.328	0.027	0.000	0.535	0.023	0.000	0.483	0.022	0.000	0.247	0.018	0.000
Female=1 Male=0	0.047	0.006	**0.000**	-0.051	0.011	**0.000**	-0.067	0.009	**0.000**	-0.094	0.011	**0.000**	0.141	0.009	**0.000**	-0.130	0.009	**0.000**	-0.009	0.007	0.229
North=1 Other=0	-0.008	0.008	0.282	-0.019	0.016	0.216	0.013	0.012	0.308	-0.014	0.016	0.386	0.011	0.013	0.397	-0.021	0.013	0.115	0.016	0.011	0.138
South and Islands=1 Other=0	0.023	0.008	**0.005**	0.045	0.016	**0.005**	0.050	0.013	**0.000**	-0.003	0.017	0.871	0.028	0.014	0.044	0.022	0.014	0.107	0.027	0.011	**0.014**
Parents' cultural level	-0.023	0.009	**0.009**	-0.046	0.018	**0.008**	-0.041	0.014	**0.003**	0.019	0.018	0.300	0.011	0.015	0.490	-0.034	0.015	**0.025**	0.019	0.012	0.113
Number of books at home	0.004	0.011	0.696	0.053	0.022	**0.016**	0.016	0.017	0.370	0.104	0.023	**0.000**	0.028	0.019	0.136	-0.027	0.019	0.146	0.093	0.015	**0.000**
Science-class hours	-0.004	0.011	0.728	0.047	0.022	0.036	0.008	0.018	0.663	0.029	0.023	0.219	-0.053	0.019	**0.007**	0.043	0.019	**0.025**	-0.014	0.015	0.373
School laboratory	-0.007	0.007	0.324	-0.008	0.014	0.570	-0.021	0.011	0.071	0.022	0.015	0.143	0.008	0.012	0.522	-0.007	0.012	0.571	0.025	00:01	**0.011**
Media exposure to science	0.105	0.014	**0.000**	0.169	0.028	**0.000**	0.175	0.022	**0.000**	0.370	0.029	**0.000**	0.066	0.024	**0.007**	0.238	0.024	**0.000**	0.367	0.019	**0.000**
Attend public meetings about science and technology	0.018	0.017	0.275	-0.008	0.033	0.813	0.143	0.026	**0.000**	0.041	0.034	0.234	-0.025	0.028	0.383	0.067	0.028	**0.016**	0.104	0.022	**0.000**
	R2=0.049			R2=0.038			R2=0.075			R2=0.107			R2=0.075			R2=0.124			R2=0.169		

Science at School

Very often criticisms of various kinds are formulated with respect to science courses. Some studies in fact show that school lessons are rather theoretical and do not facilitate on the part of students a closer contact with scientific practice, while maintaining a separation between explanations and experiments[2]. For this reason, at European level the so-called IBSE (Inquiry Based Science Education) approach was introduced with numerous educational programs in order to encourage the active involvement of students in practical activities in science subjects, allowing for the development of the analytical and investigative skills typical of research[3]. The Italian Government also pointed out in a recent policy paper the importance of "re-thinking the idea of a science laboratory as a place where 'demonstrations' occur and a place solely associated with a technological dimension 'to promote' a consideration of science laboratories as facilities where innovation may be contemplated and which may be related to the stimulation of creative and 'problem solving' skills in students"[4].

But what do adolescents think about science and technology lessons? To what extent do they appreciate the usefulness of the subjects they learn about? Analysing preferences indicated with respect to a group of items concerning scholastic experiences, we first of all note that students positively evaluate time spent on science subjects, recognizing the importance of the knowledge and the usefulness of science subjects. The study of science is equally relevant for everyday life and future employment. The items most often preferred are the usefulness of knowledge of scientific subjects and its possible advantages in both professional and daily life. A comparison with the Rose 2009 survey data highlights a growing emphasis on various factors: the need for a scientific education for everyone and the perception of the usefulness of studying scientific subjects for everyday life and future careers. The consideration that science generates a form of curiosity for unknown things remains stable.

All items relating to scholastic experience were combined in a summation index, which, as in the case of all the other variables, was then normalized[5].

The multiple regression analysis carried out shows that female students evaluate their scholastic experience more positively than male students. The appreciation also depends on the geographical area of residence and is higher in the north of the country, while it is not correlated with family background.

[2] P. E. Childs, *From Ser to Stl: translating science education research into science teaching and learning,* in Ciesla P. et al., *Chemistry Education in the Light of the Research*, Pedagogical University of Krakow, 2014, pp. 28–29.

[3] The IBSE (Inquiry Based Science Education) is the pedagogical approach promoted by the European Commission with the 2007 Rocard Report based on investigation report that will stimulate questions and action which may lead to an understanding of phenomena and a problem-solving approach.

[4] Presidency of the Council of Ministers, Ministry of Education, Universities and Research, *La Buona Scuola,* 2014, p. 111.

[5] The items used to evaluate school science lessons were: a) I think everyone should study science subjects at school; b) What I learn during science lessons will be useful in everyday life; c) I think that the scientific knowledge acquired at school will be an asset in my future professional career; d) The science lessons have increased my curiosity about things we can not explain yet; e) Science subjects have made me more appreciative of nature; f) I would like to have more hours dedicated to science at school; g) Science classes have taught me to take better care of my health.

An increase in a positive evaluation with respect to science lessons at school corresponds to an increase in the number of hours dedicated to science subjects and is higher among those who have the opportunity to attend lessons in a laboratory.

Finally, the variables that have the greatest positive influence on pleasure in studying science subjects at school are students' participation in scientific events and, above all, exposure to science through the media and, first and foremost, an interest in science and technology. The estimated value of the parameter relating to variable exposure to science in the media remains high but decreases if the variable which comprises all of the interests in science and technology is added to the regression model. We have previously noted that interests are primarily related to exposure to science in the media; with this regression model we see that the relationship between exposure and pleasure in studying science subjects at school is mediated by interests, this being the most influential variable (Table 3).

Table 3

Regression models to explain the pleasure in studying science subjects in the classroom

	Pleasure in studying science subjects								
	Model 1			Model 2			Model 3		
	B	E.S.	Sig.	B	E.S.	Sig.	B	E.S.	Sig.
Constant	0.147	0.017	0.000	-0.102	0.020	0.000	-0.084	0.019	0.000
Female=1 Male=0	0.020	0.007	**0.005**	0.025	0.007	0.000	0.023	0.007	0.000
North=1 Other=0	0.054	0.010	**0.000**	0.055	0.010	0.000	0.056	0.010	0.000
South and Islands=1 Other=0	0.065	0.010	**0.000**	0.052	0.010	0.000	0.049	0.010	0.000
Parents' cultural level	0.024	0.011	0.034	0.033	0.011	0.002			
Number of books at home	0.022	0.014	0.117	0.007	0.014	0.605			
Science-class hours	0.055	0.014	**0.000**	0.060	0.014	0.000	0.057	0.014	0.000
School laboratory	0.024	0.009	**0.008**	0.026	0.009	0.003	0.029	0.009	0.001
Media exposure to science	0.462	0.018	**0.000**	0.354	0.018	0.000	0.355	0.018	0.000
Attend public meetings about science and technology	0.148	0.021	**0.000**	0.119	0.021	0.000	0.122	0.020	0.000
Interest in science and technology				0.529	0.026	**0.000**	0.535	0.026	**0.000**
	R 2=0.249			R 2=0.344			R 2=0.342		

Opinions regarding science and technology

Generally, male and female students express positive views with respect to science and technology. In particular, general confidence is noted with respect to the activities of researchers and scientific institutions. Consistent with the interests that were expressed, also in this area students once again present an interest in work carried out to defeat serious diseases, showing that science and technology may contribute towards identifying opportune remedies for human health.

The expressed confidence, however, is not unconditional. In fact it is possible to recognise some critical elements which indicate the need to think about new models of development in which special attention is paid to the environment and human health with a rapidity of intervention deemed adequate from both the social and economic points of view.

A principal component analysis of orientations allows for the identification of four distinct thematic areas. The first area concerns the role of scientists in terms of knowledge[6]. In this area females reveal greater scepticism in their ability to provide reliable data and to be objective, while males show greater confidence in all aspects considered. The major concerns are also present especially among students residing in northern Italy.

The second area includes views on the capacity of science and technology to address important issues such as poverty and hunger[7]. In this regard the orientation of females is more critical as is that of students living in the southern regions.

Examining more closely the critical aspects related to scientific activity, a third area is identified; the elements taken into account concern the topic of values, the impact of scientific activities on the environment and the pace of change[8]. These data may be compared with the orientation of Italian public opinion and the findings of the Osservatorio Scienza Tecnologia e Società (*Science Technology and Society Observatory*) in 2014 (Bucchi, Saracino 2015). Adolescents generally have a more positive attitude. Considering in particular the rate of change affecting lifestyles brought about by science and technology, the average Italian believes that this is the element of greatest concern, while for the students who were interviewed this element is placed in third position following two positive considerations concerning the treatment of diseases and opportunities for development for the younger generations. Females in particular express doubts concerning the effects of environmental innovations, their effect within the social sphere and an acceleration of change in lifestyles. The analysis carried out in relation to geographical areas also indicates that the greatest concerns regarding the aspects considered are present among students living in the South of the country.

The last thematic area comprises expectations concerning the treatment of diseases and the development of advantages generated by scientific discoveries[9]. During a phase of life in which numerous expectations may be conjured up when considering the future, males reveal greater expectations with respect to the success of science in the health-care field and the possibility to exploit opportunities generated by technical and scientific innovations. Adolescents living in families presenting a higher cultural level state they are confident in the positive effects of science in these areas.

[6] The items that saturate the component *Neutrality and objectivity of scientists* are: a) Applying the scientific method, scientists always find the right answer; b) Scientists are neutral and objective.

[7] The component *Aid provided to eradicate poverty* is saturated by item a) Science and technology will help the poor and item b) Science and technology will help to eliminate poverty and hunger around the world.

[8] The component *Negative implications of research* is saturated by item a) Contemporary science threatens fundamental values, such as human life and the family, item b) Science and technology change our lifestyle too rapidly and item c) Science and technology are responsible for most of the environmental problems.

[9] The items that saturate the component *Future opportunities offered by science* are: a) Science and technology will find cures for diseases such as AIDS, cancer etc, and b) Thanks to science and technology there will be great opportunities for future generations.

For the regression analysis the items included in the questionnaire used to collect opinions concerning science and technology were grouped together by means of summation indices in two dimensions: confidence in science and technology in general and confidence in scientists.

With regard to the first dimension, the analysis highlights a significant correlation with gender, exposure to science in the media and pleasure derived from the study of scientific subjects (Table 4).

However, the variables relating to geographical area of residence and family background that were considered in a multivariate model lose their significance, both in this case and also when the dependent variable is confidence in scientists. Moreover, nor is it possible in both cases to establish a level of significance with respect to the variables relating to the number of hours dedicated to science subjects at school and the presence of a science laboratory at school.

On the other hand, as far as the dimension that comprises opinions with respect to scientists is concerned, once again female students show greater confidence than male students and the confidence increases in a manner parallel with an increase in exposure to science in the media and pleasure derived from studying science at school; an interest in science and technology and participation in scientific events also become significant elements (Table 5).

Table 4

Regression models which explain confidence in science and technology

	Confidence in science and technology								
	Model 1			Model 2			Model 3		
	B	E.S.	Sig.	B	E.S.	Sig.	B	E.S.	Sig.
Constant	0.426	0.016	0.000	0.461	0.011	0.000	0.479	0.007	0.000
Female=1 Male=0	-0.022	0.005	**0.000**	-0.021	0.005	**0.000**	-0.024	0.005	**0.000**
North=1 Other=0	0.012	0.008	0.122						
South and Islands=1 Other=0	-0.004	0.008	0.622						
Parents' cultural level	0.011	0.009	0.198						
Number of books at home	0.030	0.011	**0.005**						
Science-class hours	-0.004	0.011	0.724						
School laboratory	0.014	0.007	0.053						
Media exposure to science	0.056	0.015	**0.000**	0.051	0.015	**0.001**	0.053	0.014	0.000
Attend public meetings about science and technology	-0.006	0.017	0.719	0.007	0.016	0.678			
Interest in science and technology	0.040	0.022	0.073	0.037	0.022	0.090			
Pleasure in studying science subjects	0.099	0.015	**0.000**	0.109	0.014	**0.000**	0.116	0.013	0.000
	R 2=0.075			R 2=0.064			R=0.062		

Table 5

Regression models which explain confidence in scientists

	Confidence in scientists								
	Model 1			Model 2			Model 3		
	B	E.S.	Sig.	B	E.S.	Sig.	B	E.S.	Sig.
Constant	0.241	0.022	0.000	0.216	0.017	0.000	0.185	0.016	0.000
Female=1 Male=0	-0.028	0.007	**0.000**	-0.027	0.007	0.000	-0.029	0.007	0.000
North=1 Other=0	-0.011	0.011	0.308						
South and Islands=1 Other=0	-0.001	0.011	0.892						
Parents' cultural level	-0.002	0.012	0.876	-0.001	0.012	0.927			
Number of books at home	-0.046	0.015	**0.002**	-0.053	0.014	0.000			
Science-class hours	-0.010	0.015	0.511						
School laboratory	-0.019	0.010	0.047						
Media exposure to science	0.048	0.021	**0.022**	0.046	0.021	0.028	0.042	0.020	0.036
Attend public meetings about science and technology	0.045	0.022	**0.046**	0.047	0.022	0.034	0.045	0.022	0.041
Interest in science and technology	0.176	0.030	**0.000**	0.183	00:03	0.000	0.182	0.030	0.000
Pleasure in studying science subjects	0.171	0.020	**0.000**	0.165	00:02	0.000	0.165	0.019	0.000
	R 2=0.102			R 2=0.999			R 2=0.999		

Scientific careers

Future vocational orientations are engendered at school. To identify the expectations nurtured by adolescents three questions were presented. A possible path was studied in which the initial stage would involve enrolling in a science faculty, the second stage a desire to work in research and the third stage would present the chance to become a scientist. The three variables proposed stimulated varying degrees of acceptance. For the first and second variables one individual out of four amongst those interviewed gave a favourable response, while only 14 % of the sample stated they agreed with the statement "I would like to become a scientist", and among these only one third of the subjects were female students. In this section we will attempt to highlight the variables that influence these three conditions.

To identify which elements are capable of explaining the propensity to undertake a scientific career each of the three dependent variables identified was related to the 8 initial independent variables and with the 4 dimensions described in the preceding paragraphs.

The intention to enrol in a science faculty is less frequent among male students and among residents in the north of the country. It correlates positively with the level of education of the parents and the number of books in the home and the intention increases with an increasing exposure to science through the media, a greater number of lessons dedicated to science and a positive attitude concerning the student's participation in the same. The intention is more frequent if science classes are held in a laboratory at school, while it decreases in the presence of an increase in other interests. This latter tendency shows that a dispersion of interests in various areas does not facilitate the engendering of a specific orientation towards scientific studies.

Like the intention to enrol in a scientific faculty, the desire to work in research is also more common among women. It increases with a concomitant increase in the number of

books in the home, exposure to science through the media, a greater number of lessons dedicated to science and a positive attitude concerning the student's participation in the same. However, it is also positively correlated with participation in scientific events and confidence in science.

Unlike the two previous stages of the proposed career path, an aspiration to become a scientist is more frequent among males. It is less frequent among those residing in the South of the country, and it is associated positively with the number of books in the home and the number of hours dedicated to science at school, exposure to science through the media or by visiting exhibitions and festivals. It tends to increase with a stronger presence of pleasure found in studying science, an interest in scientific topics and confidence in science and scientists.

At this point it is interesting to note that the academic qualifications held by students' parents and the presence of science laboratories in schools appear to solely influence a student's intention to seek admission to a science faculty. The variable *Pleasure in studying science subjects* is the most significant in all three regression models but its effect is slightly reduced among the three stages of the outlined career path. In the presence of an intention to continue a scientific career following graduation significant elements come into play, such as participation in scientific events, the chance to come into direct contact with researchers and one's confidence in scientific studies. Finally, it should be noted that, in addition to the student's confidence in science, if the desire in question is to become a scientist, the confidence felt with respect to this professional category becomes positively significant.

Table 6

Regression models aimed at explaining an orientation towards a scientific career

	I would like to enrol in a science faculty			I would like to find a job in a scientific or technological field			I would like to become a scientist		
	B	E.S.	Sig.	B	E.S.	Sig.	B	E.S.	Sig.
Constant	-0.496	0.059	0.000	-0.359	0.056	0.000	-0.319	0.032	0.000
Female=1 Male=0	0.046	0.018	**0.010**	0.110	0.017	**0.000**	-0.027	0.009	**0.004**
North=1 Other=0	-0.061	0.025	**0.015**	0.047	0.024	0.052	-0.026	0.014	0.058
South and Islands=1 Other=0	-0.047	0.026	0.068	0.002	0.025	0.943	-0.037	0.014	**0.009**
Parents' educational qualification	0.122	0.028	**0.000**	0.035	0.027	0.186	0.024	0.015	0.105
Number of books at home	0.208	0.035	**0.000**	0.068	0.034	**0.045**	0.052	0.019	**0.006**
Science-class hours	0.209	0.037	**0.000**	0.072	0.034	**0.038**	0.103	0.019	**0.000**
School laboratory	0.120	0.023	**0.000**	0.026	0.022	0.241	0.016	0.013	0.210
Media exposure to science	0.258	0.051	**0.000**	0.204	0.048	**0.000**	0.162	0.027	**0.000**
Attend public meetings about science and technology	0.004	0.057	0.950	0.106	0.052	**0.042**	0.101	0.029	**0.001**
Interest in science and technology	-0.264	0.073	**0.000**	0.097	0.069	0.161	0.098	0.039	**0.012**
Pleasure in studying science subjects	0.837	0.048	**0.000**	0.452	0.046	**0.000**	0.427	0.026	**0.000**
Confidence in science	0.089	0.063	0.156	0.159	0.060	**0.008**	0.074	0.034	**0.028**
Confidence in scientists	0.004	0.046	0.935	-0.031	0.044	0.481	0.097	0.025	**0.000**
	R 2=0.349			R 2=0.125			R 2=0.281		

Discussion

The interest in science and technology on the part of adolescents is a multidimensional concept that has been studied with this work, taking numerous elements into account. The analysis carried out allows for the identification of those elements which may be considered the most significant.

Firstly, there are significant differences between males and females; males display a stronger orientation towards technology, the exploration of outer space and the environment, while females present a greater interest in health and want to understand the ultimate goals of scientific activity. Moreover, the students' experiences at school have a significant effect on their interests and laboratory activities tend to nurture their curiosity with respect to scientific knowledge. Again, gender differences are found and it is noted that females derive a greater sense of gratification from science subjects studied at school.

Another key factor is media exposure; for all interests there is a strong correlation in this respect, which indicates an important influence of the media on adolescents' preferences.

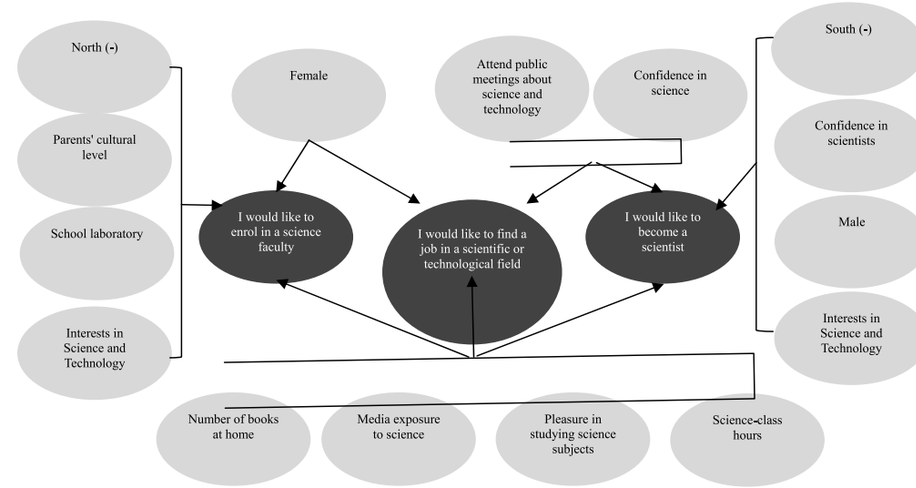
Students express positive opinions about scientific institutions and research activities, recognizing the progress that science has made in combating disease. Some doubts are detected however concerning the capacity to develop adequate responses to environmental problems and welfare issues in general. This type of concern shows that apart from scientific competence and expertise there is a need for intervention on the part of public institutions and policy-makers in the definition of a sustainable form of development. Students and especially girls do in fact manifest certain doubts in the ability of scientists to provide a secure response and objective data, this being an attitude particularly evident in students living in the north of the country, the area which is the most highly developed from the economic and industrial point of view.

Students express varying degrees of interest in scientific careers. About a third state that they intend to work in the world of scientific and technological research; these are students who derive a sense of gratification from science lessons at school, are interested in the work of scientists and have a positive view of scientific activities. For these students it is thus crucial to have a direct relationship with the world of research and they are willing to become a part of this sector in the future assuming a professional role.

The desire to enrol in undergraduate science courses, however, is evident in male and female students who come from families characterised by a fairly high cultural level and have acquired significant 'scientific' experiences at school. The choice of going to university carries on a family tradition and is almost always sustained by a good secondary school education which will make it possible to choose quite demanding academic courses for which above-average scholastic achievements are required.

Finally, the group of subjects who intend to become scientists, formed mainly by males, is restricted and represents 14 % of the sample. The lack of interest in becoming a professional scientist is due to the fear of embracing an activity too demanding in terms of one's personal commitment, and with a reduction in important opportunities for self-realisation beyond the sphere of one's work as highlighted by the ASPIRE project (Archer et al., 2014). The male and female students in this group have various interests, but to a greater degree with respect to others reveal greater confidence in scientists. The students interested in scientific careers state that they have an interest in science in many respects but they differ depending on the commitment required. It is thus not possible to imagine the introduction of simple policies aimed at supporting an interest in science and technology and encouraging

Figure 1. Graphical representation of regression models to explain an orientation towards a scientific career



scientific careers that will in any case be chosen by a small proportion of students. Rather, it will be useful to support the students with the characteristics described in their intention to undertake the careers that have been described, reinforcing contextual factors and intrinsic motivations to foster the development of a life-project within the scientific field.

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Russian-French Scientific Collaboration: Approaches and Mutual Attitudes[1]

Abstract: This article presents the results of a survey of Russian and French scientists, which has been conducted via face-to-face interviews, to identify motivations, origins, and a pace of development for scientific collaborations between the two countries. Respondents had experience in different types of interactions, including participation in joint research projects, fellowships, and part-time work in partner's lab. The major obstacle for these collaborations is the lack of funding, some logistical problems, with other issues related to the specifics of organization and regulation of scientific research in Russia. Sanctions and the state of foreign affairs also affect collaborations, even if indirectly. However, despite the existing obstacles, both parties are willing to continue joint work. Most of the findings of this study, which appeared to be more specific to science disciplines than to Russian-French relations, are likely to be applicable to the understanding of collaborations between the Russian and EU scientists in general.

Keywords: international scientific cooperation, Russia, France, mutual perceptions, obstacles, prospects.

Most studies of international scientific cooperation can be classified into the three categories, which focus on bibliometrics, legal and political issues, and existing collaborative programs, respectively. Bibliometric analyses are typically used to measure the intensity and productivity of collaborations. These studies showed, for example, that researchers from the developed Western countries prefer to publish jointly with their colleagues from the same country group (e. g., Chinchilla-Rodríguez, Vargas-Quesada, Hassan-Montero, González-Molina, & Moya-Anegóna, 2009; Gazni, Sugimoto, & Didegah, 2012; Marshakova-Shaikevich, 1995; Mirskaya, 1999; Shaposhnik, 1999; Wagner & Leydesdorff, 2005; Wilson & Markusova, 2004). Wilson and Markusova (2004) used bibliometrics to demonstrate that some developing countries, such as Russia, are trying to "catch up" by widening their cooperation with Western European and North American countries. In yet another study of this type, Shaposhnik (1999) used data from the Science Citation Index to follow changes in the Soviet/Russian international scientific collaborations.

Studies dealing with legal and political aspects of international scientific cooperation can be exemplified using a recent work by Kiselev (2014), who discusses these issues for Russia. The author suggests that the improvement of international ties can help Russia to become more successful in attracting a young generation into science, increase publication outputs, improve its currently weak grant system, *etc*. In another study of this kind, Dezhina

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