

In- and out-of-school activities and their influence on attitudes and expectations regarding science and technology

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Abstract

Introduction. Interest in understanding the decline in positive attitudes to science and technology (S&T) among children and young people has led to numerous studies in recent years. Some research has focused on how personal characteristics of children and young people and other demographic and sociocultural factors influence the development of these attitudes, while other studies have centred on activities in which they participate that provide learning opportunities. In both cases, further research is required to determine how children and adolescents perceive S&T, and how this perception is associated with their expectations of working in science in the future. In this context, the aim of this study was to examine whether student's preference for taking part in S&T-related activities in- and out-of-school was related to their attitudes towards science and scientists and their future professional aspirations.

Method. We administered a survey to 1,336 students aged 10, 13 and 16 years. The frequencies and corresponding percentages were calculated with respect to the total for the sample, and according to the factors (regional location, socioeconomic status, age and gender) that were considered. The Pearson's chi-squared test was used to seek significant differences among the two populations of each factor.

Results. The results showed that the greater the students' preference for participating in S&T-related activities, the more value they attributed to science work to improve people's quality of life. Future professional expectations were associated to a greater extent with a preference for taking S&T-related subjects at school than with participation in S&T-related activities outside school.

Discussion and Conclusion. We discuss the need to analyse in depth the characteristics of these activities and what children and young people learn from participating in them, in order to define strategies that increase motivation and interest in learning about S&T and improving its teaching.

Keywords: attitudes, learning activities, science and technology, formal learning contexts, non-formal learning context.

Resumen

Introducción. El interés por comprender el progresivo declive de las actitudes favorables de los niños y jóvenes hacia la Ciencia y la Tecnología (CyT) ha impulsado en las últimas décadas la realización de un buen número de investigaciones. Algunas de estas investigaciones se centran en la influencia de las características personales de los niños y jóvenes y otros factores demográficos y socioculturales en el desarrollo de estas actitudes, mientras que otras lo hacen en las actividades en las que participan y que les ofrecen oportunidades para aprender. En uno y otro caso se destaca la necesidad de seguir investigando cómo los niños y adolescentes perciben la CyT y cómo esta percepción se relaciona con sus expectativas sobre una eventual dedicación profesional a la ciencia en el futuro. En este marco, la finalidad del presente trabajo es estudiar la relación entre la preferencia de los niños y jóvenes por realizar actividades vinculadas con la CyT dentro y fuera del contexto escolar y las actitudes que manifiestan hacia la ciencia y los científicos, así como la relación con sus aspiraciones profesionales futuras.

Método. Se administró una encuesta a 1,336 estudiantes de 10, 13 y 16 años. Se calcularon frecuencias y porcentajes con respecto al total de la muestra y en función de los factores considerados (ubicación territorial, nivel socioeconómico, edad y sexo). La prueba de chi-cuadrado de Pearson se utilizó para buscar diferencias significativas entre las poblaciones de cada factor.

Resultados. Los resultados muestran que cuanto mayor es la preferencia de los alumnos por participar en actividades relacionadas con la CyT, mayor es también el valor que atribuyen al quehacer científico para la mejora de la calidad de vida de las personas. Con todo, las expectativas profesionales futuras se vinculan en mayor medida a la preferencia por realizar asignaturas escolares relacionadas con la CyT que a la participación en actividades relacionadas con estos contenidos fuera de la escuela.

Discusión y Conclusión. En las conclusiones se discute la necesidad de analizar en detalle las características de estas actividades y los aprendizajes que los niños y jóvenes realizan participando en las mismas, con el fin de definir estrategias que promuevan la motivación y el interés por el aprendizaje de la CyT y mejorar su enseñanza.

Palabras clave: actitudes, actividades de aprendizaje, ciencia y tecnología, contextos formales de aprendizaje, contextos no formales de aprendizaje

Introduction

In recent decades, an alarming drop has been observed in the number of young people choosing higher education courses related to science and technology (S&T). This situation is widespread in the most developed parts of the world, such as Europe, Canada, New Zealand, Japan and Korea (Bøe, Henriksen, Lyons, & Schreiner, 2011). Some recent studies predict that a lack of science and technology professionals will leave a considerable number of jobs vacant in Europe in coming years (European Commission, 2013). Consequently, some countries have incorporated the promotion of science and technology careers into their political agenda as a priority (Eurydice, 2011). Some studies also note that the development of S&T-related skills is essential among the citizens of the future, as the demand for skilled labour in the research and technology sectors is and will remain high, and because citizens will only be able to meet the challenges of contemporary society if they have these kinds of skills (European Commission, 2012; Osborne and Dillon, 2008). The inclusion of an evaluation of attitudes to science, technology and the environment in the “Programme for International Student Assessment” (PISA) tests of 2006 and 2015 illustrates the concern with young people’s interest in science (OCED, 2007, 2016).

Interest in understanding this indifference to S&T in advanced societies has led to numerous studies being undertaken that have focused on young people’s attitudes as one of the key factors. Attitude can be defined as a person’s disposition to make a positive or negative evaluation of objects, actions, situations or ideas that they encounter. This evaluative judgement precedes their behaviour and guides their decisions and choices (Regan & DeWitt, 2015). In the area of S&T, the distinction that Gardner (1975) made between “attitudes towards science” and “scientific attitudes” is now classic. Here, we are interested in studies that have focused on “attitudes towards science” that highlight the more affective, emotional aspect of attitudes, rather than centring on the more cognitive nature of “scientific attitudes”, which are associated with ways of thinking and doing related to scientific method (Acevedo, 2007; Osborne, Simon, & Collins, 2003; Vázquez & Manassero, 1995). In this regard, Gardner stresses that “attitudes towards science” are complex and multifaceted, and he defines three elements or main components of them: feelings, beliefs and values towards i) science content, ii) scientists and their work and iii) scientific achievements and their social impact.

In relation to the first component of attitudes towards science indicated by Gardner, a literature review shows that most studies have focused on children's and young people's attitudes to science at school and whether they are related to various demographic, social or cultural factors. Few studies have analysed attitudes towards the science content of out-of-school activities (Bennett & Hogarth, 2009).

With respect to attitudes towards science content at school, there is broad agreement among researchers that at the start of adolescence, a time that coincides with the transition between primary and secondary stages of education, there is a decline in positive attitudes of students towards S&T-related subjects (see, for example, Barmby, Kind, & Jones, 2008; de Pro & Pérez, 2014; Osborne, Simon, & Collins, 2003; Potvin & Hasni, 2014; Tytler & Osborne, 2012; Vázquez & Manassero, 2011). Some studies highlight a more marked drop in positive attitudes among young people aged between 11 and 14 years, and draw attention to the key role of the first few years of secondary education (Bennett & Hogarth, 2009; Galton et al., 2003). Generally, these studies concluded that children and young people perceive S&T classes as difficult and boring, and consider that the contents bear no relation to their own interests and are not very relevant to most people's daily lives. Some studies also found that attitudes towards science-related subjects worsened more quickly with age among girls than among boys (Barmby, Kind, & Jones, 2008; Bennett & Hogart, 2009; de Pro & Pérez, 2014; Manassero & Vázquez, 2002).

A comparative analysis of secondary school students (15/16 years) from over 40 countries who participated in the "Relevance of Science Education: ROSE" project (Schreiner & Sjøberg, 2004; Sjøberg & Schreiner, 2010; Vázquez & Manassero, 2007) supports the idea that cultural and social factors are variables that modulate students' attitudes to science. The results of the study indicated that science at school is seen by students as less interesting than most of the other subjects. Moreover, it was found that the greater a country's level of development, the more negative its students' attitudes towards science at school. In comparison, the conclusions of an analysis of PISA 2006 (OECD, 2007) report that 15-year-old students from the countries with the highest level of socioeconomic development tend to show greater general interest in S&T subjects at school, and tend to state that they enjoy learning sciences with greater frequency than students from countries with a lower level of socioeconomic development. However, this relationship was not mentioned in the results of PISA 2015, in which it was noted that students from socioeconomically disadvantaged schools have fewer opportunities to attend science

classes than students from privileged schools (OECD, 2016).

Far fewer studies have explored the attitudes of children and young people towards S&T-related activities out of school. Studies that have been undertaken on this topic tackle it from noticeably different approaches to the definition and identification of these activities. For example, the ROSE study defines out-of-school experiences as very specific actions such as making a bow and arrow or a slingshot, using a mobile phone, trying to find constellations in the sky, using a camera or seeing an animal suckle its young. In contrast, other studies include a broader range of learning experiences in the category of informal activities, such as going to museums, aquariums or zoos, participating in out-of-school programmes, festivals or science camps, attending talks and conferences, participating in online forums or communities, watching TV programmes or reading magazines on S&T (Bell, Bricker, Reeve, Zimmerman & Tzou, 2013). In general, many of the studies note that S&T-related activities out of school attract only a small minority of students on a regular basis (OECD, 2007, 2016; de Pro & Pérez, 2014; Vázquez & Manassero, 2007). However, in the recent results of PISA 2015, students stated that they participate in science-related activities to a greater extent than their counterparts in 2006. For example, in 2006 a total of 5% of students claimed that they participated regularly in a science club, whilst in 2015 this figure stood at 8% (OECD, 2016).

Some studies found that attitudes to S&T-related activities out of school are more positive than towards science subjects at school. However, the same trend is followed in both cases: attitudes become less positive as age increases, particularly at the end of secondary education (de Pro & Pérez, 2014; Bennett & Hogart, 2009). In general, these studies also highlight that the range of S&T-related experiences clearly differs among boys and girls: both quantitatively, as boys show greater preference for these activities; and qualitatively, as the type of activities varies depending on the gender (Bennett & Hogart, 2009; Jenkins & Pell, 2006; OECD, 2007, 2016; Vázquez & Manassero, 2007). The results of PISA 2006 also indicate that students' socioeconomic background is strongly associated with their involvement in these activities. Students from more disadvantaged socioeconomic backgrounds participate regularly in fewer activities in most countries (OECD, 2007). However, the results of PISA 2015 do not highlight any relationship between participation in S&T-related activities out of school and students' socioeconomic status (OECD, 2016).

In relation to the second component of attitudes towards science proposed by Gardner, feelings, beliefs and values held about scientists and their work, Bennett and Hogarth (2008) concluded that almost half of students surveyed agree that scientists were trustworthy, and there were no notable differences by age or gender. De Pro, Tárraga and Pérez (2009) considered that students' views of scientists' characteristics seemed to fit with reality, and students valued scientists' contributions to daily life.

Attitudes towards scientific achievements and their social impact, the third component defined by Gardner, are generally positive. Students consider that S&T are important to society and contribute to the progress of nations. In fact, on average in all OECD countries, 92% of students stated that advances in S&T normally improve people's living conditions, and 87% considered that sciences are valuable to society (OECD, 2007). Other studies found equally positive results, but with some variability depending on the level of development in the country of origin (Sjøberg & Schreiner, 2010); age, with a slight tendency for older students to have more positive attitudes; and gender, with boys having significantly more optimistic views of science's beneficial role for society (Bennett & Hogarth, 2009).

Despite students' positive attitudes to these last two components of science work and the social impact of science, when they were asked about their expectations of working in science in the future they did not seem so enthusiastic about this profession: between 70% and 80% clearly stated that they did not want to be scientists or they were not sure, and girls always showed less inclination to work in this profession (Bennett & Hogarth, 2008; de Pro, Tárraga & Pérez, 2009; OECD, 2016; Sjøberg & Schreiner, 2010). As indicated by Jenkins and Nelson (2005), the message students transmitted, clearly and resoundingly, was: "important but not for me". It is difficult to determine what factors influence this disjunction between general attitudes towards science and future aspirations. Some studies explore the potential influence of factors such as social class, gender, ethnicity or academic self-concept in sciences, as well as attitudes of parents or peers towards science (Archer et al., 2010; DeWitt et al., 2013; DeWitt & Archer, 2015). In accordance with other authors (Bell et al., 2009; Bennet, Braund, & Sharpe, 2013), we consider that students' attitudes are closely associated with the practices and activities in which they participate, which provide them with learning opportunities and resources, and that students' attitudes are defined and develop through this participation.

One of the features of the current information society is that learning is no longer almost exclusively associated with the school environment as in past decades. Instead, children and young people participate in a wide range of activities that take place in many, diverse contexts that also provide opportunities and resources for learning (Barron, 2006). Children and young people from all eras have always had access to different contexts (family, cultural associations, sports clubs, the community that they belong to, among others) that have enabled them to gain different kinds of knowledge in a range of areas, including S&T. However, with the ubiquity of digital information and communication technologies and the increase in number and widespread use of mobile devices with wireless connection, the contexts that provide learning opportunities and resources have increased exponentially (social networks, online games, communities of interest or practice and online forums, among others). Consequently, students' learning beyond the walls of formal education institutions and schools (Coll, 2009, 2013) is increasingly important.

Aims and hypothesis

To sum up, the literature review showed that students' attitudes to S&T learning content are not generally very positive. However, their attitudes to scientists, S&T achievements and the social impact of science are positive. Therefore, one fundamental question emerges from these studies: what is the relationship between these attitudes and students' expectations of working professionally in S&T in the future, and their decisions about whether or not to take higher studies relating to S&T? Taking this issue as a starting point, we administered a survey to students aged 10, 13 and 16 years to investigate the following questions:

1) What degree of preference do students show for participating in S&T-related subjects at school and S&T-related activities out of school? How do factors such as place of residence, socioeconomic status, age or gender affect this preference?

2) What relationships can be established between students' preference for participating in S&T-related activities in- and out-of-school and the value they attribute to science work?

3) What relationships can be established between students' preference for participating in S&T-related activities in- and out-of-school and their expectations of working professionally in S&T in the future?

Method

Participants

Participants in this study were 1,336 students of three ages (10 years plus/minus 6 months, 13 years plus/minus 6 months, and 16 years plus/minus 6 months) from families with different socioeconomic status who attended one of 24 public schools (12 primary and 12 secondary) in Catalonia (Spain). The basic sampling unit was the schools, selected according to the following criteria: education level (primary or secondary education); regional location (urban area: towns with over 10,000 inhabitants; rural area: towns with fewer than 10,000 inhabitants); and socioeconomic status (high or medium-high; low or medium-low). The secondary sampling unit was the class groups, selected according to the criteria of age and availability. In most cases, the surveys were completed by the entire class (4th year of primary education and 2nd and 4th years of compulsory secondary education). Surveys filled in by students who were not of the ages considered in the study were excluded from the analyses.

The aim was not to obtain a representative sample of Catalan primary and secondary schools, but to ensure the participation of a sample of children and adolescents that included different combinations of the three variables mentioned above (educational level, regional location, and socioeconomic status of the family). These variables may have a considerable impact on the variety and characteristics of contexts of S&T activities in which children and young people participate. The three ages selected for the study correspond to three points in life at which we can reasonably assume that there are significant changes in students' activities and in the contexts of the activities in which they participate. Furthermore, the fact that entire class groups completed the survey ensured that there were similar numbers of male and female participants. As mentioned above, previous studies found that gender had a considerable influence on the aspects analysed.

Students were assured that their responses would be anonymous, and would only be used for the purposes of the research. Table 1 shows the main characteristics of the sample of students whose responses to the survey were the object of the analysis.

Table 1. Demographic characteristics of the sample

	Regional location				Socioeconomic status				Sex				Total	
	Rural		Urban		Medium low		Medium high		Girl		Boy		f	%
Age	f	%	f	%	f	%	f	%	f	%	f	%	f	%
10 years	191	47.99	207	52.01	252	63.32	146	36.68	207	52.01	191	47.99	398	100.00
13 years	235	54.40	197	45.60	298	68.98	134	31.02	207	47.92	225	52.08	432	100.00
16 years	238	47.04	268	52.96	329	65.02	177	34.98	269	53.16	237	46.84	506	100.00
Total sample	664	49.70	672	50.30	879	65.79	457	34.21	683	51.12	653	48.88	1.336	100.00

As shown in Table 1, in the three age groups, the final sample was fairly well-balanced with respect to the area in which the schools were situated and the gender of participants, but slightly biased in terms of the third variable studied, the families' socioeconomic status, in which a medium-low level was predominant.

Instrument

So as not to add to the already large number of instruments used to explore attitudes towards science, and to align our study with the specialized scientific literature in the field, we applied an instrument which has been used in previous research and which has the same focus as our study. We used an adapted version of the "Attitudes to School Science and Science" survey, an instrument developed by Bennett and Hogarth (2008) based on a previous study by Aikenhead and Ryan (1992).

The survey was subjected to a rigorous validation process by the authors (Bennett & Hogarth, 2008), and its usefulness for exploring students' predispositions to participate in S&T-related activities and for eliciting their opinions regarding the influence of S&T in society has been noted in various studies (e.g., Oliver & Venville, 2011). Consequently, in addition to guaranteeing the adequacy of the instrument to explore our study focus, the use of this survey strengthens the comparison between our results and the results of previous research.

The survey's development and validation are described in detail in Bennett and Hogarth (2008). Due to the geographical and cultural proximity between the original context of the instrument and the context of our research, and also to the similarity in the ages of the participants in both studies, few modifications were necessary for our study. The changes included the differentiation between two versions: one for the ten year olds children and the other for the 13

and 16 year olds, with slight variations in the way the questions were written. This is why, in addition to the original validation, we carried out a dual translation process, an expert validation and a pilot study with the adaptation of the survey in its two versions.

Regarding the translation of the instrument, two independent translations were made from English to Catalan, and a third translator reviewed them and produced the final version after merging and fitting the two proposals. For the content validation of the survey we asked seven experts in the field (three from the University of Girona and four from the University of Barcelona) to evaluate the relevance of each item and the information they provide. Finally, a pilot study was carried out with a first version of the two surveys. The surveys were administered to groups of students of 10, 13 and 16 years old. On the basis of the information obtained, some of the statements and response options were revised and a second, definitive version of the surveys was drawn up. The result of the whole process is a survey with two statements referring to students' preferences for taking S&T-related subjects at school, one statement on the usefulness of these subjects, five on S&T out of school, and three on the value attributed to S&T in society and the likelihood of their working in science in the future (see Table 2). In response to each of these statements, students had to choose between three options: "*I agree*", "*I neither agree nor disagree*" or "*I disagree*". Participants also answered some questions on personal data such as gender and age.

Table 2. Statements in the survey, adapted from Bennett and Hogarth (2008)

<p>Science at school</p> <ol style="list-style-type: none"> 1. <i>Science classes are my favourite (10 years). Science and/or technology classes are my favourite (13 and 16 years).</i> 2. <i>When I can choose, I'm going to select subjects related with science and/or technology.</i> 3. <i>What we do in science and/or technology classes is useful, whatever you do when you leave school.</i> <p>Science outside school</p> <ol style="list-style-type: none"> 4. <i>I like to watch documentaries, and read magazines or books on science and/or technology.</i> 5. <i>I like to fix machines like bicycles or open up devices to see how they work.</i> 6. <i>I like science and technology games (games about chemistry, optics and electricity).</i> 7. <i>I like to visit science museums (such as CosmoCaixa), the zoo or the aquarium.</i> 8. <i>I like to look after houseplants or work in the vegetable garden.</i> <p>Science and society</p> <ol style="list-style-type: none"> 9. <i>I would trust something a scientist said.</i> 10. <i>I would like to work as a scientist.</i> 11. <i>Science and/or technology have a positive influence on society.</i>
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With regard to reliability, Cronbach's alpha scores were .612 for the 10-year questionnaire and .590 for the 13 and 16-year questionnaires. According to Taber (2017), several studies in the field of science education consider values of this kind to be satisfactory. In agreement with Griethuijsen et al. (2014), we consider the low values of the indices obtained may be due to the small number of items in the instrument.

Procedure

The survey was completed online during academic year 2014-2015 by entire class groups from 4th year of primary education (10 year olds) and 2nd and 4th years of compulsory secondary education (13 and 16 year olds respectively), under the supervision of the form tutors and a pair of researchers.

Data Analysis

The tabulation and analysis of the data was carried out with the help of the SPSS statistics package. The frequencies and corresponding percentages were calculated with respect to the total for the sample, and according to the factors (regional location, socioeconomic status, age and gender) that were considered. The Pearson's chi-squared test was used to seek significant differences among the two populations of each factor.

Results

Below we present the results organised according to the three questions that the study was designed to answer. First, we describe results that define students' patterns of preference for participating in S&T-related activities in- and out-of-school, and the distribution of these patterns according to the sociodemographic factors that were considered (regional location, socioeconomic status, age and gender). Secondly, we present results on the two questions that explore the value students attribute to science work: the extent to which they consider that S&T has a positive influence on society, and how trustworthy they consider scientists to be. Finally, we show the results on the relationships between students' patterns of preference and their expectations of working professionally in S&T in the future.

Patterns of preference for participating in S&T related-activities in- and out-of-school

We analysed students' answers to survey items on preference for S&T related activities. On the basis of this analysis, we established three patterns with different degrees of preference for S&T-related subjects at school: i) high preference, when students agreed with two of the three statements about science at school; ii) medium preference, when students agreed with one of these statements; and iii) no preference, when they stated that they neither agreed nor disagreed or that they clearly disagreed with these statements. Likewise, we established three patterns with different degrees of preference for S&T-related activities outside school: i) high preference, when students agreed with three or more of the five statements on out-of-school activities; ii) medium preference when they agreed with one or two of the statements; and iii) no preference, when they neither agreed nor disagreed, or clearly disagreed, with the five statements.

Table 3 shows the distribution of students in the sample according to these patterns of preference. As can be seen, there is a statistically significant difference in the distribution of patterns of preference for in- and out-of-school activities ($p=0.001$). In fact, 49.33% of students show a pattern of high or medium preference for S&T subjects at school, and 50.67% no preference. In contrast, 83.53% of students show a pattern of high or medium preference for S&T activities outside school, and only 16.47% no preference.

Table 3. Distribution of students according to the patterns of preference for S&T related activities

Patterns	S&T subjects	A&T activities outside school	<i>p</i>
High preference	24.93%	39.07%	0.001*
Medium preference	24.40%	44.46%	
No preference	50.67%	16.47%	
Total	100.00%	100.00%	

* $p \leq 0.01$

The patterns of preference for S&T-related activities in- and out-of-school were distributed in a very similar way in the urban and rural environment, and in the high/medium-high and low/medium-low socioeconomic levels, with no significant differences between these factors. In contrast, the distribution of patterns of preference for S&T-related activities in- and out-of-school varied significantly by the age of students and the gender.

If we look at age (see Table 4) in relation to preference for S&T subjects at school, the most common pattern among students aged 10 years was medium preference. In contrast, most students aged 13 and 16 years showed no preference for S&T subjects, although students aged 16 years generally showed more positive attitudes towards S&T subjects than students aged 13 years. The differences in the distribution of patterns of preference between the three age groups were statistically significant, according to the results of the chi-squared calculation ($p < 0.01$). In terms of preference for S&T activities outside school, the distribution of patterns varied significantly with age ($p < 0.01$). Thus, most students aged 10 years showed a high preference for these kinds of activities, whilst the most frequent pattern in 13 and 16 year olds was that of medium preference. In this case, we did not observe a sharp decline in preference for this kind of activities in students aged 13 years, but a gradual decrease in preference as age increased.

Table 4. Distribution of patterns of preference by age

Patterns	S&T subjects			<i>p</i>	S&T activities outside the school			<i>p</i>
	10 years	13 years	16 years		10 years	13 years	16 years	
High preference	28.39%	13.19%	32.21%	.001*	61.81%	36.11%	23.72%	.001*
Medium preference	39.95%	22.22%	14.08%	.001*	32.66%	46.53%	51.98%	.001*
No preference	31.66%	64.58%	53.75%	.001*	5.53%	17.36%	24.31%	.001*
Total	100.00%	100.00%	100.00%		100.00%	100.00%	100.00%	

* $p \leq 0.01$

The differences in distribution of patterns of preference depending on the gender of students were also pronounced (see Table 5). Over half of the girls stated that they had no preference for S&T subjects at school. Although this was also the most common pattern among boys, its prevalence was significantly lower. There was a greater difference between boys and girls who had no preference for S&T-related activities outside school. In this case, and in the case of patterns of high preference in and outside school, the differences between boys and girls were statistically significant ($p=0.001$). In contrast, we did not find any statistically significant differences between boys and girls who had average preference for in- and out-of-school activities.

Table 5. Distribution of patterns of preference by gender

Patterns	Subjects S&T			S&T activities outside school		
	Girl	Boy	<i>p</i>	Girl	Boy	<i>p</i>
High preference	21.08%	28.94%	.001*	32.50%	45.94%	.001*
Medium preference	22.40%	26.49%	.082	43.92%	45.02%	.686
No preference	56.52%	44.56%	.001*	23.57%	9.04%	.001*
Total	100.00%	100.00%		100.00%	100.00%	

* $p \leq 0.01$

It is particularly interesting to interpret the distribution of patterns of preference for S&T-related activities by age and gender (see Figure 1). Among the 10 year olds, we did not find any statistically significant differences between patterns of preference for school subjects by gender ($p=0.613$). However, at 13 and 16 years old, boys had more positive attitudes than girls to S&T-related school subjects, and these differences were statistically significant (p between 0.001 and 0.004). Despite these differences, the trend followed by girls and boys was similar, with a considerable decline in positive attitudes at 13 years and a certain upturn at 16 years.

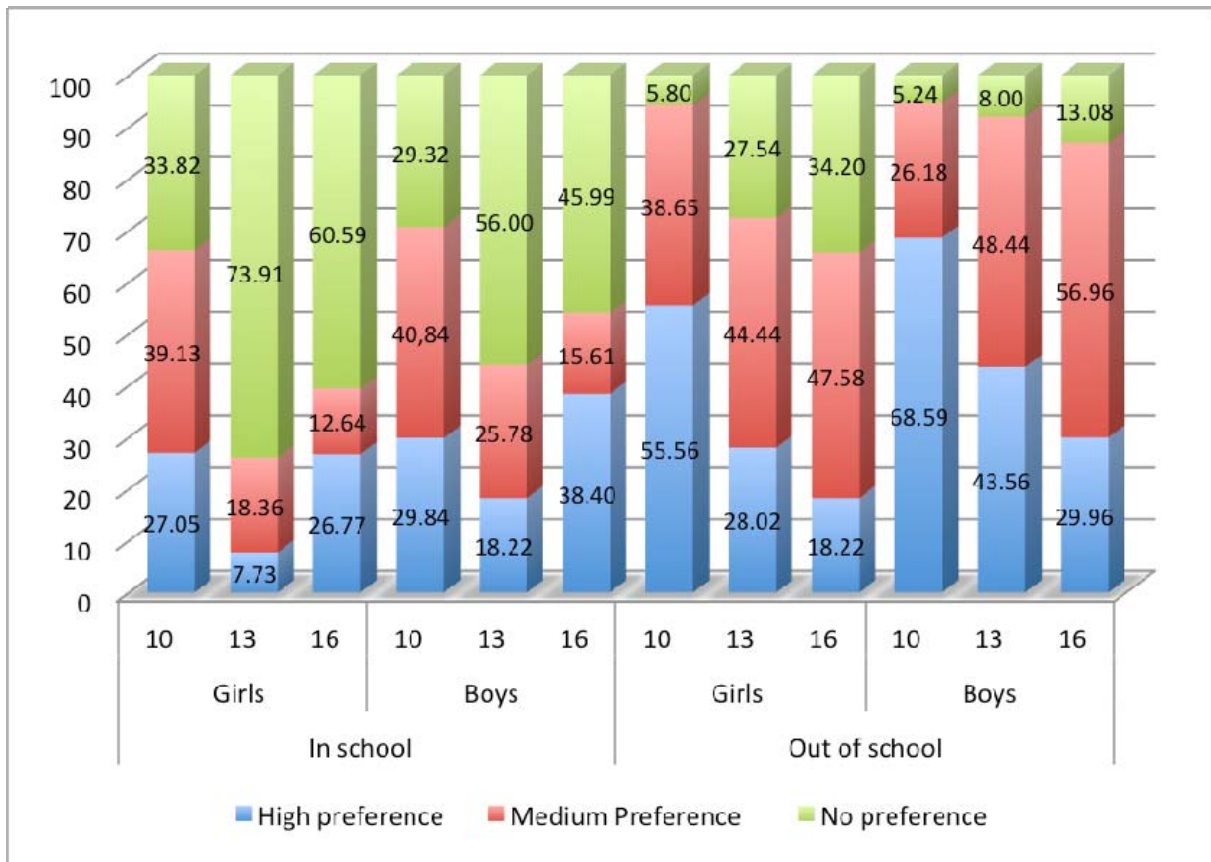


Figure 1. Distribution of patterns of preference by age and gender

POR FAVOR, LIBEREN EL TEXTO DE TABULADORES DE ESPACIOS QUE IMPIDEN LOS AJUSTES

Boys showed greater preference for S&T-related activities outside school than girls at the three ages, and this difference was statistically significant ($p=0.023$, 0.001 and 0.001 at 10, 13 and 16 years respectively). However, the trend was similar in both genders: with increasing age, there was a progressive rise in the number of students who showed no preference for carrying out S&T-related activities outside school.

Relationship between patterns of preference and attitudes to science work

In terms of students' attitudes to whether science work improves people's quality of life and solves social and environmental problems, 65.19% of students agreed that science has a positive influence, while only 7.34% disagreed, and 27.47% were not sure. In response to the statement regarding trust in scientists and their work, just over half of students (55.31%) con-

sidered that scientists were trustworthy, 10.18% considered that they were not trustworthy, and 34.51% were not sure.

Below we present the results of analysing the relationship between patterns of preference for activities in- and out-of-school and attitudes to science work. Figures 2 and 3 show students' level of agreement with the statement about the positive influence of S&T in society, according to the patterns of preference for carrying out S&T-related activities in school and outside school respectively. Figures 4 and 5 show students' level of trust in scientists and their work, according to the patterns of preference.

In both cases, the trend was the same and the percentages of responses to these two statements were very similar for all patterns of preference relating to subjects or activities outside school. The percentage of students who agreed that S&T has a positive influence on society or that scientists are trustworthy clearly declined as the degree of preference for carrying out S&T-related activities in- or out-of-school dropped. For example, the percentage of students who had a pattern of high preference and agreed with the statements was 84.98% (subjects in school) and 75.86% (activities outside school) respectively; whilst for students with a pattern of medium preference, the percentage stood at 63.5% and 62.79%, and for those with no preference the figures were 56.28% and 46.36% respectively. Pearson's chi-squared test showed that in both cases the differences were statistically significant ($p=0.001$).

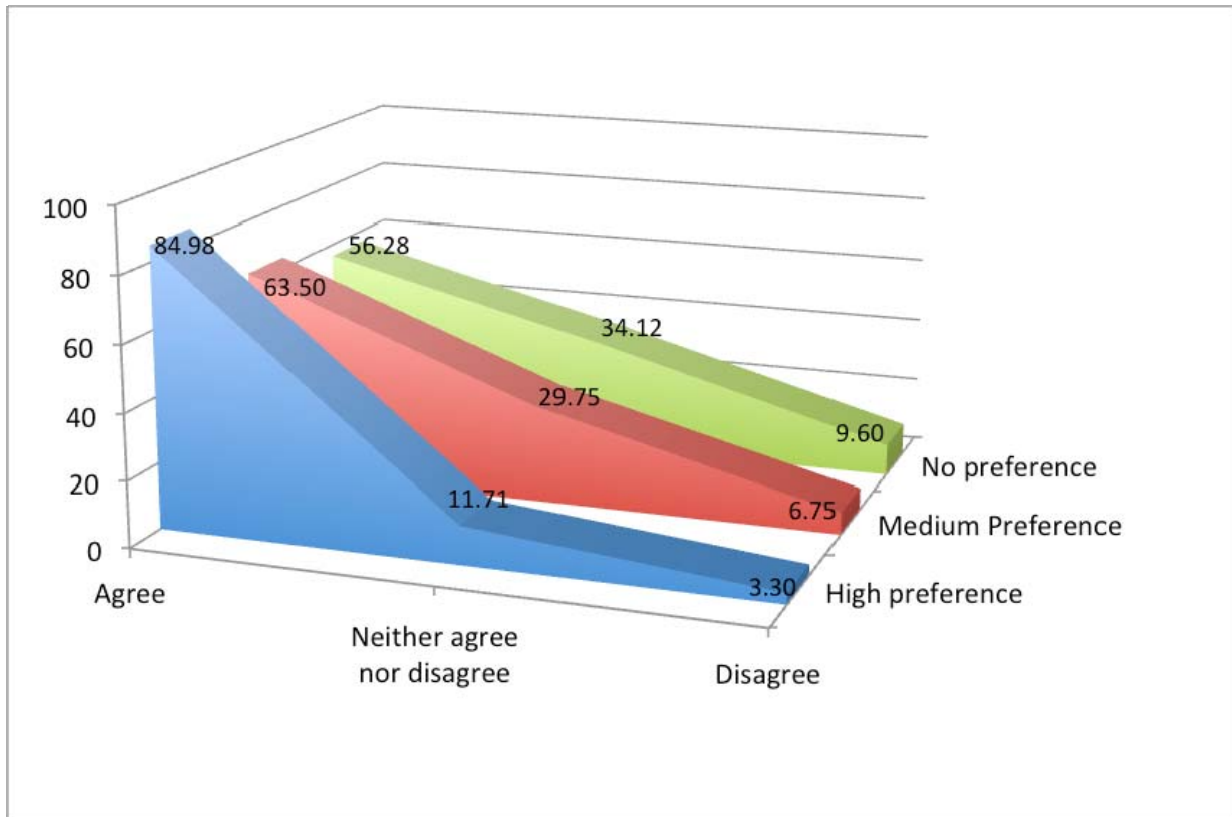


Figure 2. Students' level of agreement with the statement about the positive influence of S&T in society, according to patterns of preference for S&T-related activities in school

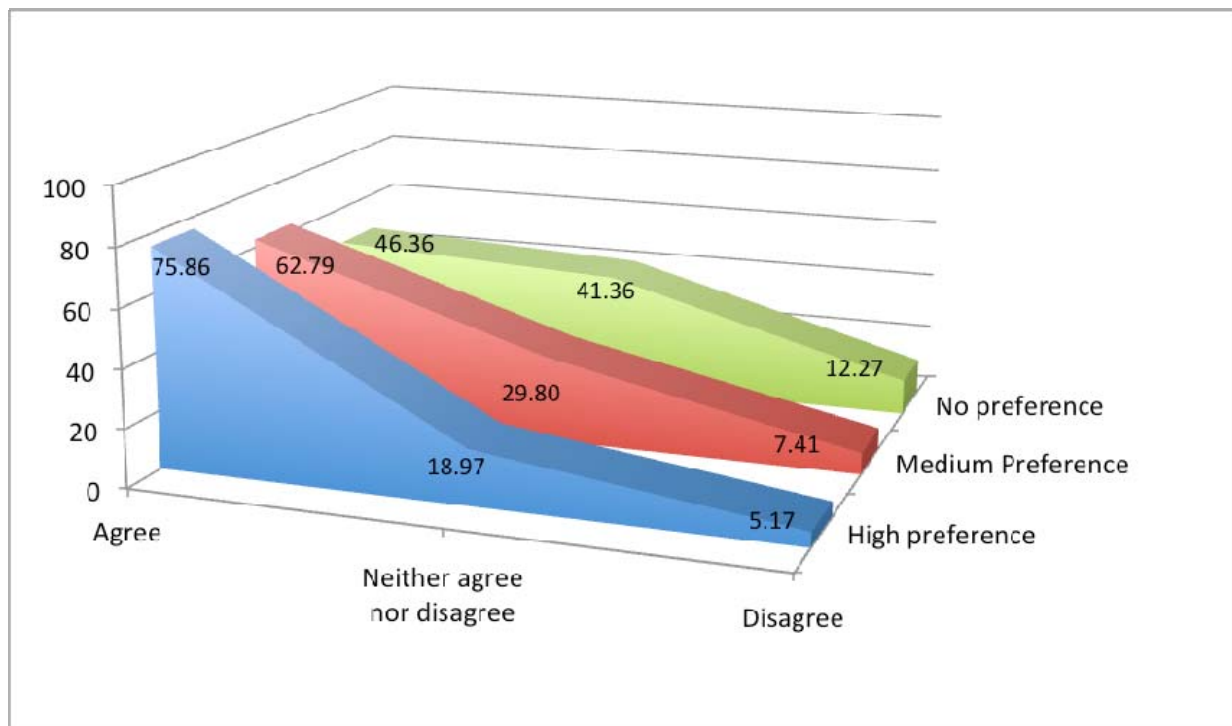


Figure 3. Students' level of agreement with the statement about the positive influence of S&T in society, according to patterns of preference for S&T-related activities outside school

A similar trend was observed in the relationship between patterns of preference and agreement with the statement about the trustworthiness of scientists and their work: the greater students' preference for science activities, the greater the percentage of students who recognised scientists and the work that they undertake. As shown in Figures 4 and 5, with respect to patterns of preference for S&T-related subjects at school, the percentage of students who stated that they trusted scientists was 68.77% (high preference), 55.21% (medium preference) and 48.74% (no preference). With respect to patterns of preference for S&T-related activities outside school, the figures were 64.75%, 50.17% and 46.82% respectively. In addition, with respect to patterns of preference for activities both in- and out-of-school, the percentage of subjects who stated that they disagreed or neither agreed nor disagreed with the statement about trusting scientists increased with the level of preference. Again, Pearson's chi-squared test showed that these results were significantly different ($p=0.001$).

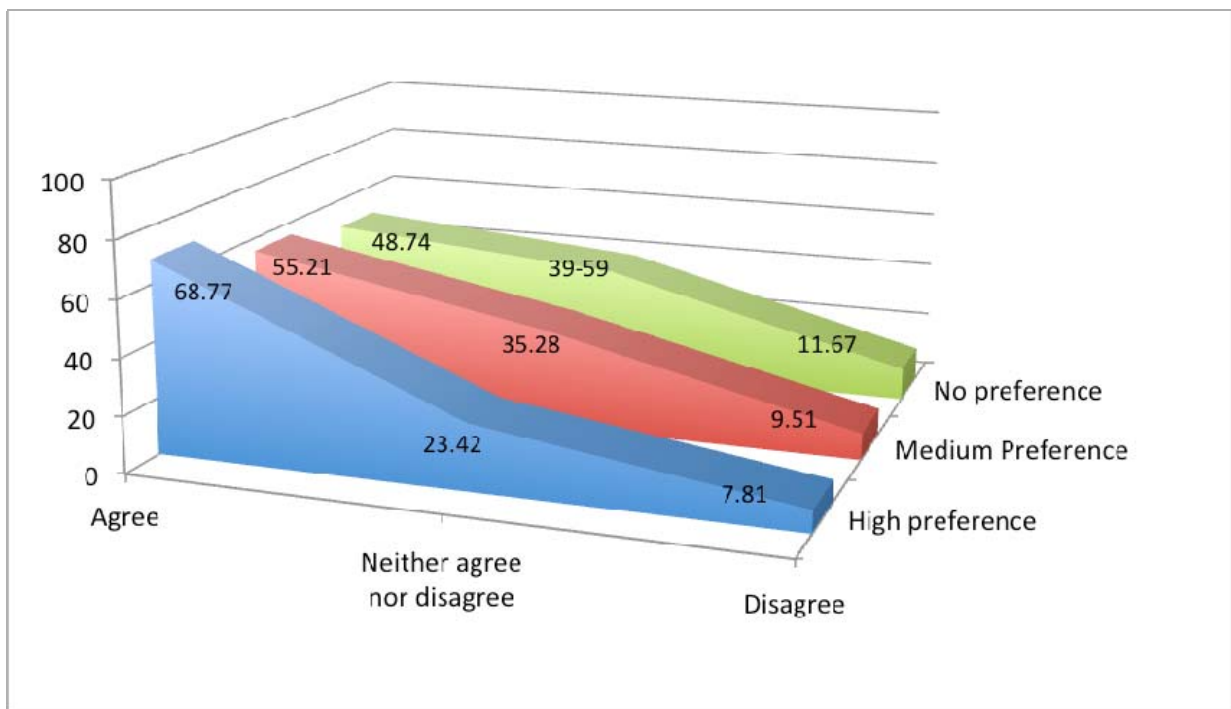


Figure 4. Students' level of agreement with the statement about scientists' trustworthiness, according to patterns of preference for carrying out S&T-related activities at school

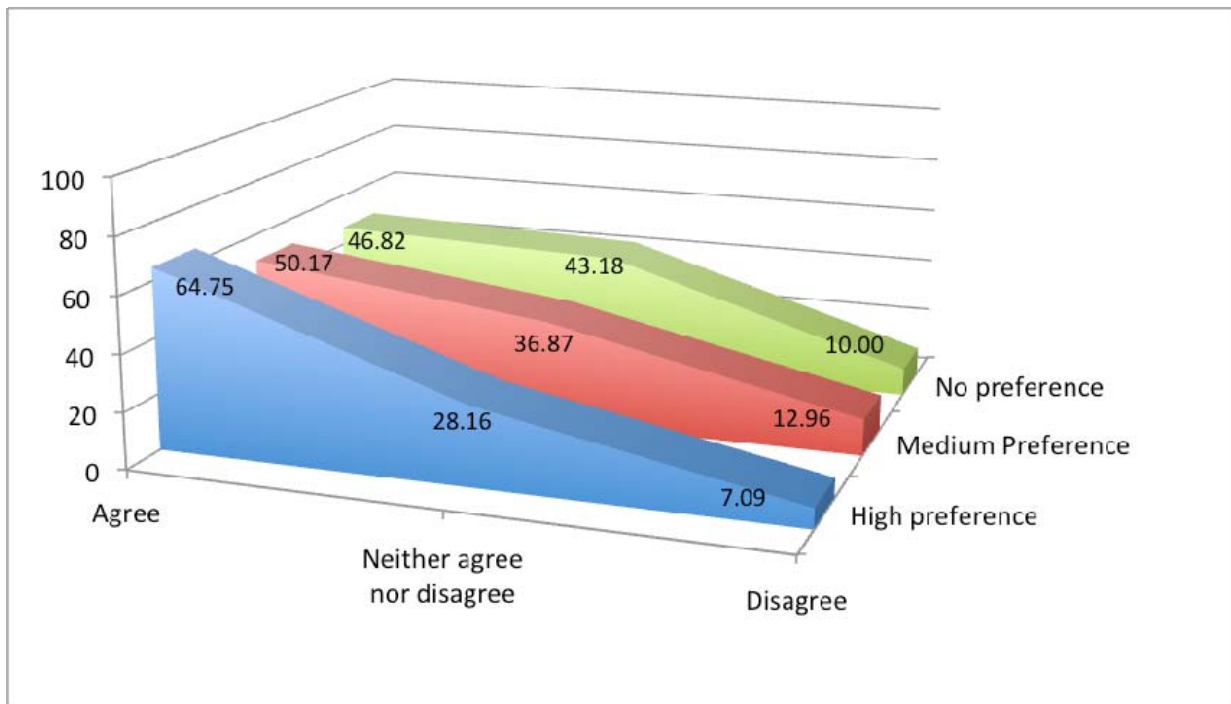


Figure 5. Students' level of agreement with the statement about scientists' trustworthiness, according to patterns of preference for carrying out S&T-related activities outside school

Relationship between patterns of preference and expectations of working professionally in S&T in the future

We turn now to the last question established in this study. Notably, 51.80% of students in the sample stated that they did not wish to work in S&T in the future, in contrast with only 25.60% who would consider it and the remaining 22.60% who were not sure.

Figures 6 and 7 clearly show that in this case the results were very different from those presented in relation to the two questions above. There were two types of differences. First, in the two previous questions, almost half of the students agreed with the statements presented, regardless of the pattern of preference for S&T-related activities in or out of school. Second, there were only small differences in the percentage of students who disagreed with the statement in each patterns of preference; and this difference was no greater than 10 percentage points in any case. In contrast (See Figure 6), when students were asked about their intention to work as scientists in the future, only 29.45% of students with medium patterns of preference and 10.19% of those with no preference for S&T-related subjects at school agreed with the statement. In contrast, over half of the students with a high pattern of preference (53.15%) agreed that they would work in S&T. There were considerable differences in the percentage of

students who disagreed with the statement in each pattern of preference for S&T-related subjects at school: 22.82% for high preference, 43.25% for medium preference and 70.16% for no preference. A similar trend was found in the patterns of preference for carrying out S&T-related activities outside school: 43.49% of students with a high pattern of preference stated that they would like to work as scientists in the future, compared to just 15.49% of students with an average pattern of preference and 10.45% of those with no preference for these kinds of activities. In addition, the percentage of students who disagreed with the statement varied considerably according to the pattern of preference: 34.10% in those with a high preference, compared to 60.94% in those with a medium preference and 69% in those with no preference.

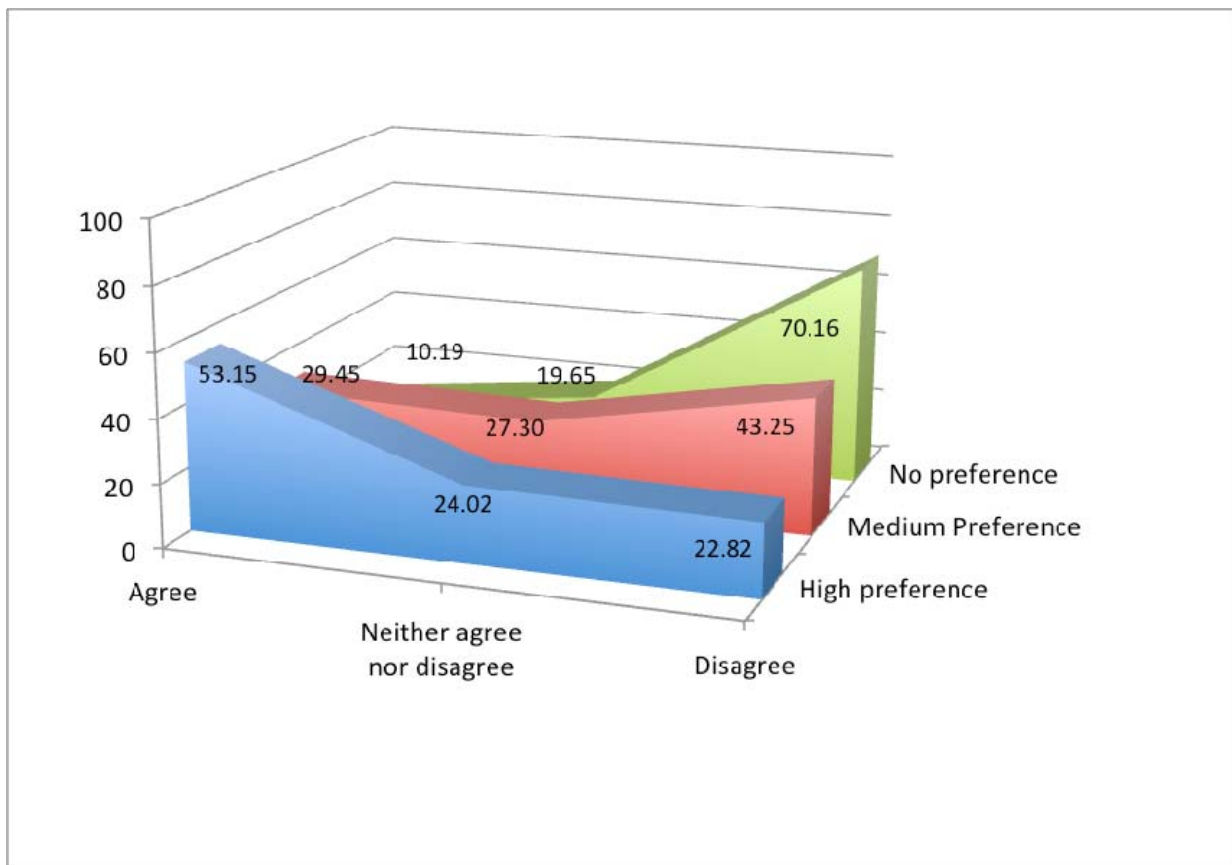


Figure 6. Students' level of agreement with the statement about expectations of working in S&T in the near future, according to patterns of preference for carrying out S&T-related activities at school

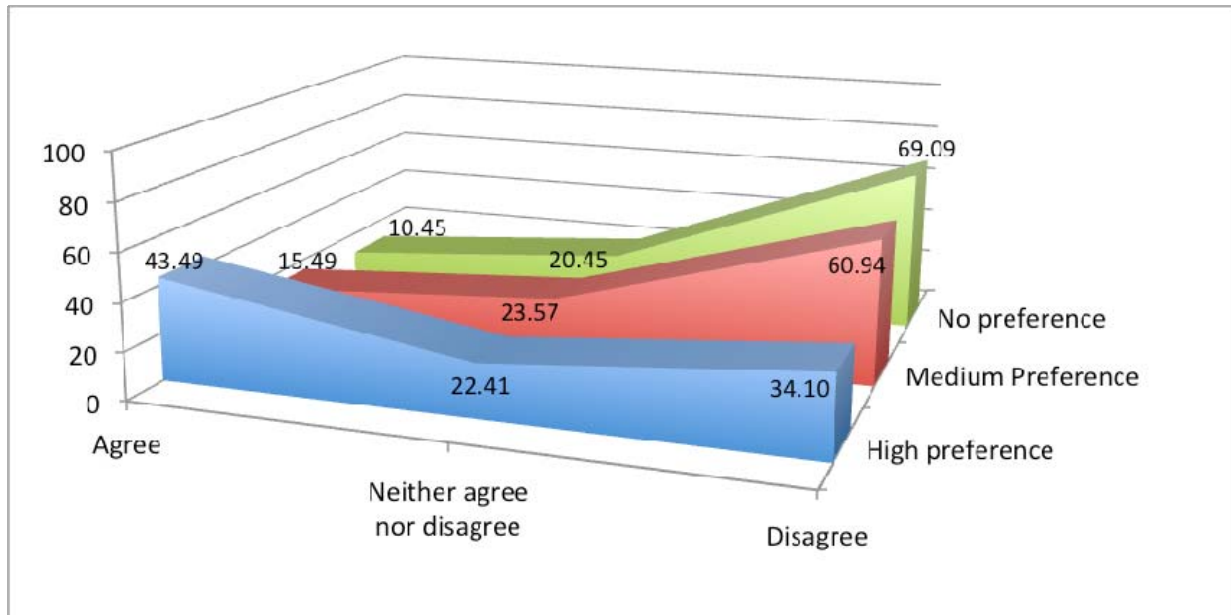


Figure 7. Students' level of agreement with the statement about expectations of working in S&T in the near future, according to patterns of preference for carrying out S&T-related activities outside school

Secondly, the responses of students with the same patterns of high and medium preference varied depending on whether the preference was for S&T-related subjects at school or S&T-related activities out of school. Thus, 53.15% of students who had a pattern of high preference for school subjects stated that they wished to work in S&T in the future, compared with 43.49% of students with a pattern of high preference for activities out of school who stated the same. In the first case, only 22.82% of the students disagreed with the statement, while in the second case the figure stood at 34.10%. Regarding the pattern of medium preference, 29.45% of students agreed and 43.25% disagreed that they would work as scientists in the future in the case of preference for S&T subjects at school, compared to 15.49% and 60.94% respectively, in the case of preference for participating in S&T-related activities outside the school. Finally, no notable differences were found in the percentages of students who agreed or disagreed that they would work as scientists in the future among those with a medium preference for S&T-related activities in- and out-of-school.

Discussion and Conclusions

The results enabled us to draw a series of conclusions that are presented below, organised according to the three questions that we aimed to answer.

Regarding the question about students' preferences for participating in S&T-related activities in- and out-of-school, the results led to the definition of three patterns representing different degrees of preference: high preference, medium preference and no preference. In the patterns that we identified, we found that the preference for carrying out S&T-related activities outside school was much higher among the students in the sample. In fact, most students (83.53%) showed some preference for carrying out S&T-related activities outside school, while only approximately half (49.33%) showed a preference for S&T-related school subjects. These results differ from those obtained in previous studies (e.g. OECD, 2007; Vázquez & Manassero, 2007) that showed a lack of participation of students in S&T activities in non-formal and informal contexts (museums, science centres, clubs, etc.). One explanation for this difference could be the increase in the number of S&T-related out-of-school activities and programmes in recent years in our environment (educational programmes in science museums, science fairs, programming workshops, robotics clubs, etc.). However, whether our results were exceptional or represent a change in trend is an open question that should be clarified in future research.

A second conclusion is the importance of age and gender as variables that modulate preference for participating in S&T-related activities. As in some previous research (de Pro & Pérez, 2014; Osborne, Simon, & Collins, 2003; Potvin & Hasni, 2014; Tytler & Osborne, 2012; Vázquez & Manassero, 2011), our results show a drop in preference for S&T with increasing age, both in relation to school subjects and out-of-school activities. Like Bennett and Hogarth (2009), we found that, with respect to school S&T subjects, this drop was much more pronounced at 13 years and was greater among girls than among boys. However, no significant differences were found in the distribution of patterns of preference according to the area of residence or the socioeconomic status of the students.

In terms of the second question, on relationships between patterns of preference for participating in S&T-related activities and the value attributed to science and science work, most students in the sample considered that S&T has a positive influence in society (65.19%) and that scientists are trustworthy (55.31%). However, these results are notably less positive than those obtained in the PISA 2006 survey (OECD, 2007), according to which most students recognised the value of science to improve living conditions in society. From our results, we can also conclude that there is a direct relationship between students' degree of preference for participating in S&T-related activities and the value they attribute to science work to improve people's quality of life and to solve social and environmental problems. The greater students' pref-

erence for participating in S&T-related activities, the greater the value they attribute to science work to improve society. In addition, this relationship was found in students who showed a high degree of preference for carrying out S&T-related activities in- and out-of-school. Our results support the conclusion made by various authors (Bell, Lewenstein, Shouse, & Feder, 2009; Bell, Bricker, Reeve, Zimmerman, & Tzou, 2013; Bennet, Braund, & Sharpe, 2013; Bevan, Bell, Steven & Razfar, 2013; Brossard, Lewenstein & Bonney, 2005) that the attitudes students develop towards S&T are closely associated with their participation in S&T projects in formal or informal contexts. The results also indicate that students who have no preference for carrying out S&T-related activities in- or out-of-school are more likely to be indecisive or doubtful about the degree of influence of S&T in society, or the trustworthiness of scientists. This difference may be due to the fact that students who do not participate in or do not like to participate in S&T activities have a low level of understanding of basic concepts of science and the nature of scientific research, and this makes it harder for them to form an opinion about these issues.

Finally, with respect to the third question on relationships between attitudes towards S&T and expectations of working in science in the future, we can conclude that expectations vary considerably depending on the degree of preference for carrying out S&T-related activities, and depending on whether this preference refers to school subjects or out-of-school activities. Our results support evidence provided by various authors (Bennett & Hogart, 2008; Jenkins & Nelson, 2005; de Pro, Tárraga & Pérez, 2009; Sjøberg & Schreiner, 2010) that few students consider working as scientists in the future (only 25.60% of the total number of students surveyed would like to work in science). However, our results enable us to further define and enrich this evidence by examining the relationship between the kinds of activities in which students prefer to participate and their future expectations. Thus, the number of students who associate science with a future life and professional project is considerably higher among those with a greater preference for S&T-related school subjects than among those who have a preference for S&T-related out-of-school activities. This finding opens up new questions about why children and young people participate in a certain kind of activities, and about the relationships between the learning experiences that these activities provide and young people's interests and life projects.

Our conclusions should be treated with caution due to the exploratory and descriptive nature of the study. One specific limitation of our work deserves special attention, and reveals

potential lines of future research. Our analysis was limited to exploring students' preference for S&T-related activities. Although our results confirm the interest of this approach, they also highlight the need to broaden and deepen the information obtained. One potential advance would be to analyse the characteristics of S&T-related activities that children and young people participate in- and out-of-school in terms of socio-institutional contexts, stakeholders, motives and the focus or content, as well as the learning that takes place and the importance that is attributed to it. Greater knowledge about these activities and the view of science that children and young people construct as a result seems to be essential to improve the teaching and learning of science in formal school contexts and in informal contexts such as museums, zoos, botanical gardens and aquariums.

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