Science image in Portugal: Studying high school students

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Abstract

In the development of activities for the dissemination of science and scientific work there are difficulties and challenges. People get in touch with science in different contexts, as in their workplace or their social life. However, it is in school that the largest number of interaction activities occurs, through communication and education practices. And high school is probably a key context to the promotion of science among young people.

We have conducted an exploratory study on the image of science within Portuguese high school students, in order to collect useful data for communicating and attracting them to higher education. For this purpose, we have gathered a research team that includes two researchers of Basic Sciences (responsible for bringing to the project their vision and experience on science communication activities over the years) and two researchers of Communication Sciences (in charge of designing the study and its conceptual framework). This interdisciplinary team has been crossing experiences and knowledges gathered from their contact with communication science practices and their research in strategic communication. Within this context, we have developed a pilot survey that analyses the image of science and scientists hold by high school students within University of Minho's area of influence (north of Portugal).

Keywords: communication sciences, science communication and strategic communication.

INTRODUCTION

In the development of activities for the dissemination of science and scientific work there are difficulties and challenges. Many communication activities fail to engage their target audiences. In Portugal, some studies have been made on that matter and the results suggest that the relationship between Portuguese people and science can be evaluated in different perspectives: some researchers highlight proximity and awareness, while others emphasize the lack of interest.

People get in touch with science in different contexts, as in their workplace or their social life. However, it is in school that the largest number of interaction activities occurs, through communication and education practices. And high school is probably a key context to the promotion of science among young people.

High school in Portugal is a stage of learning on general themes, but also a moment of choices on the preparation for university and profession. Students contact with science and scientific activities within class

projects, conferences or promotional programs and all those channels seem to be potentially useful in generating a positive environment that overcomes resistance and enhances a scientific culture.

Science communication is, therefore, an important strategic tool to develop science literacy, to attract students to universities and to promote the cultural level of a country. It requires scientific expertise, but also communication skills to catch the attention of audiences, to produce a more effective spreading of the message and to develop a comprehensive version of the complex themes proposed by science. That is, science communication demands a permanent "conversation" between scientists and experts in human and strategic communication.

In 2002, a study on the publics of science in Portugal has shown that improving the training and updating scientific knowledge are two important factors in increasing the involvement with science (Costa *et al.*, 2000). And the practice of promoting science in high school responds to this purpose, providing the public (students) a close contact to scientific knowledge in different fields, reinforcing scientific citizenship and culture as basic elements for scientific literacy. In the University of Minho (Braga, Portugal) there has been an increasing interest in the activities of communicating science to non specialized publics. However, this is a difficult task mainly because of the lack of interest of the audiences, including visiting high school students. These students come to the university looking for information on its graduate programmes and the institution uses this opportunity to engage them in promotional activities oriented towards a *client-institution* relationship. These activities have been intensified since the 1990s, because by then Portuguese universities have entered the market context. As a consequence science communication expanded its meaning, by including in its sense activities oriented to the promotion of science with the purpose of attracting students to graduate and pos-graduate programmes. We refer to conferences, lab experiences, brochures or personal contacts with the work of science and researchers.

Responding to this internal issue we have decided to conduct an exploratory study on the image of science within Portuguese high school students, in order to collect useful data for communicating and attracting them to higher education. For this purpose, we have gathered a research team that includes two researchers of Basic Sciences (responsible for bringing to the project their vision and experience on science communication activities over the years) and two researchers of Communication Sciences (in charge of designing the study and its conceptual framework). This interdisciplinary team has been crossing experiences and knowledges gathered from their contact with communication science practices and their research in strategic communication. Within this context, we have developed an *exploratory study* that analysis the image of science and scientists hold by high school students within University of Minho's area of influence (north of Portugal). This paper presents the results of the study.

SCIENCE COMMUNICATION

Science communication is an established area of research whose borders are delineated by the very concept of science. In this paper we use the word "science" to describe the wide and complex phenomenon of knowledge development, including all kinds of human knowledge scientifically achieved. Although the tradition of science communication research is to consider only "pure science" (as mathematics, statistics, engineering, technology, medicine, and related fields; Burns *et al.*, 2003)**,** we have decided to take the concept on a much boarder contemporary meaning in order to include humanities and social sciences. We believe that a wider vision can enrich the concept and promote the growing of this academic field.

Nevertheless, the conceptualization of science is a very complex process. As Morin (1994: 17) states "the question 'what is science?' is the one that still has no scientific answer". Well know scientists have proposed some very interesting definitions, as Einstein (2005) that suggested that science is the *refinement of the common thought* or Feynman (1998) who sees it as *an understanding of Nature*. The concept embodies experimental perspectives (Oppenheimer, 1954), social visions (Morin, 1994), methodological paradigms (Burns *et al.*, 2003) and free thinking trends. But in its very essence science is "the systematic enterprise of gathering knowledge about the world and organizing and condensing that knowledge into testable laws and theories" (American Association for the Advancement of Science, 1989).

For a long time science was "a peninsula on a cultural and social continent" (Morin, 1994: 48), an elite territory for elite people. Its methods, its rules, its rituals, its languages are hard to understand and deviate the average citizen of its world. However, states and opinion leaders argue today that science needs to break this isolation. Science is the materialization of human knowledge and it has a great impact in social life, so it must be increasingly present in citizens' culture (Costa *et al.*, 2000). "Scientific citizenship" then has emerged as a strong concept that incorporates the proposition of an open participation of the population in the scientific field.

This openness of science to society demands new communication strategies to engage all the participants and it raises questions on the scientific learning process. Recent research projects have shown that formal and informal learning contexts can enhance the development of positive attitudes towards science as well as the improvement of basic and fundamental skills to understand scientific concepts. Communication is, therefore, an important instrument to increase "public awareness of science" (a set of positive attitudes towards science) and "public understanding of science" (the understanding of scientific matters by non-experts) (Burns *et al.*, 2003).

Communication is the process of producing and negotiating meanings (Mumby, 1994), a practice which always takes place under specific social, cultural and political conditions. Science communication is, therefore, the process that allows the negotiation of meanings with different publics, through the creation

of understanding and awareness of the scientific work. It is the set of communication activities developed by journalists, public relations or scientists themselves in order to promote information and interaction with science.

Burns and his colleges (2003) have developed an interesting definition of this field by using the vowels metaphor: science communication is "the use of appropriate skills, media, activities, and dialogue to produce one or more of the flowing personal responses to science (the vowel analogy) - ***A****wareness*, including familiarity with new aspects of science; ***E****njoyment* or other affective responses, e.g. appreciating science as entertainment or art; ***I****nterest,* as evidenced by voluntary involvement with science or its communication; ***O****pinions*, the forming, reforming or confirming of science-related attitudes; (and) ***U****nderstanding* of science, its content, processes, and social factors" (191).

The promotion of awareness and understanding of science is particularly important in the engagement of young people. Scientific culture and literacy can only be enhanced by acting with new generations. This demands the deconstruction of stereotyped images of science and scientists hold by these publics. In some countries, research shows that students are uninformed about science and that they are very much influenced by mass media messages. This can explain the predominance of stereotyped visions of scientists documented as males, wearing lab coats, eyeglasses and facial hair (Jones *et al.,* 2000; Reis *et al.,* 2006).

In order to deepen our understanding of the Portuguese publics' perception on science, we have conducted a pilot survey to high school students. This empirical study will be presented in the next section.

THE EMPIRICAL STUDY

Studies on the perceptions of science and scientists hold by young people have been conducted in different countries for a long time (MacCorquodale, 1984; Furnham, 1992; Lee, 1998; Jones *et al.,* 2000; Sjoberg, 2000; and others). Looking for a better understanding of the Portuguese reality, we have carried out an exploratory study aiming to examine high school students' representations on science and scientists. The purpose of the research was to help those involved with science communication activities by giving them information about one key public, in order to understand failures in communication strategies prepared to attract students to higher education and research careers.

The study involved 354 students aged between 15 to 19 years and attending the last years of high school in two different institutions (within Braga's district). We have used a survey instrument, applied to a non probabilistic sample with the purpose of serving as a pilot test for the development of a boarder study.

The survey design was prepared to answer the question: *what is the image of science and scientists hold by Portuguese high school students?* The survey test was applied in February and May 2010. The sample

included male (201) and female (153) students attending different areas of study: arts, humanities, economics, science and technologies. The questionnaire was applied in class and after a seminar on science. In class, the survey was given by the teachers and they were selected based on their willingness to help. The seminar experience was meant to perceive the effectiveness of this communication instrument. However the results did not expose any particular differences from the class context.

The survey instrument "*Images of Science and Scientists*" (table 1) was developed as a pilot test by our research team (with the purpose of helping to define a final study) and the questionnaire was inspired by other studies (Jones *et al.,* 2000). It included nine questions designed to assess students' perceptions on science, scientists, science communication activities and familiarity with scientists.

TABLE 1. QUESTIONNAIRE DESIGN
1. Gender
2. Age
3. School year attending
4. What do you think of science?
5. What do you think of scientists?
6. When do you contact with science?
7. Write a world scientist name:
8. Write a Portuguese scientist name:
9. Would you like to be a scientist in the future?

Questions 4 to 6 included statements and students were asked to place signs (*, a maximum of 3) in the phrases that best expressed their views on science and scientists. The data were treated to ascertain a simple average measure that would enlighten the results. These results are presented in the next section.

RESULTS AND DISCUSSION

Gender, age and school level did not show to be very significant in the reported results (table 2). There is a balance in the sample between male and female students and the students' age is consistent with the school year they are attending. However, the names of the scientists quoted (tables 6 and 7) seem to be related to the subjects taught in different school levels.

TABLE 2. CONTEXT VARIABLES	
Gender	Male 57% Female 43%
Age	15 – 18
School year attending	10th, 11th, 12th (final years)

Table 3 presents students' perceptions on the attributes of science. A significant number of students' answers (NA) point out science as "important to society" and as an "interesting" activity. These results suggest a positive image of science within our sample. However, science is still associated to laboratory experiments which exclude humanities and social sciences. 79 students also consider that science can create problems to mankind, although this perception needed further investigation. Moreover, the gender bias is not significant in our sample. Only 16 students consider that science is more suitable for man. To science communication is pertinent that only 68 students think that science is hard to understand.

TABLE 3. PERCEPTIONS ON SCIENCE

What do you think of science?	NA	PERC
▪ Science is important to society	342	33 %
▪ Science involves laboratory experiences	209	20 %
▪ Science creates problems to humanity	79	7,5 %
▪ Science is more appropriate for men than for woman	16	1,5 %
▪ Science is difficult to understand	68	6,5 %
▪ Science is interesting	326	31 %
Total number of answers	1040	

High school students within our sample also perceive scientists in a very positive way (table 4). Scientists "develop interesting activities", "help people" and "invent new things". These options convey an humanitarian vision of science as well as a more pragmatic perspective. Classical images on the scientific work – as being a "boring" activity developed in old libraries - seem to be disappearing. In fact the answers don't fit the traditional stereotype of the scientist as an isolated loner more interested in machines and technology than in helping people. Another interesting result was that the number of respondents that consider science as a well paid job is higher among economics students.

TABLE 4. PERCEPTIONS ON SCIENTISTS

What do you think of scientists?	NA	PERC
▪ Scientists have a boring job	52	2,4 %
▪ Scientists invent new things	290	28 %
▪ Scientists spend much time in libraries	48	5 %
▪ Scientists make a lot of money	84	8 %
▪ Scientists develop interesting activities	292	29 %
▪ Scientists help people	252	25 %
Total number of answers	1018	

Looking to understand the main channels that high school students perceive to put them in contact with science, we inserted a closed question with eleven answer possibilities (table 5). The results underline two trends: (a) they consider important the formal communication channels, as classes, seminars and school visits; and (b) they highlight mass media and internet as relevant scientific sources. But science seems to be distant from classical media as books and from family contexts. This last result is particularly important because, according to some studies, informal science experiences lay the critical foundations for deep conceptual understanding (Jones *et al.,* 2000).

TABLE 5. SCIENCE COMMUNICATION CONTEXTS

When do you have contact with science?	NA	PERC
▪ In class	282	17 %
▪ In seminars	171	10 %
▪ In exhibitions	120	7 %
▪ In school visits	175	11%
▪ In official science day	76	5 %
▪ In newspapers and magazines	169	10 %
▪ In television	254	15 %
▪ In internet	221	13 %
▪ In books	134	8 %
▪ In family contexts	54	3 %
▪ Others	2	
Total number of answers	1658	

The best well known world scientists suggested by the participants in our study are classical names (table 6). Most of them work in "pure sciences" as Physics, Chemistry or Mathematics. Even among students of arts, humanities and economics the answers reveal a direct relationship to those scientific fields. However, within this group other names appeared as the philosophers Descartes or Rousseau. But Einstein was by far the most quoted world scientist.

TABLE 6. FAMILIARITY WITH WORLD SCIENTISTS

Write a world scientist name	NA
Albert Einstein (Physic)	165
Antoine Lavoisier (Chemistry)	12
Isaac Newton (Physics)	40
Marie Curie (Physics)	17
Others (quoted from 1 to 5 times)	25

Seeking to know Portuguese scientific references of high school students, we asked them to refer a Portuguese scientist they new (table 7). Within our sample Portuguese the best well known scientists are biologists, neurologists, physicists and doctors. Once again humanities and social sciences researchers were excluded. The national scientists quoted include an ancient Nobel Prize (Egas Moniz, Medicine 1949), but all the others are live and active researchers.

TABLE 7. FAMILIARITY WITH PORTUGUES SCIENTISTS

Write a Portuguese scientist name	NA
Alexandre Quintanilha (Biologia)	37
António Damásio (Neurology)	29
Pinto da Costa (Medicine)	62
António Egas Moniz (Medicine)	23
João Magueijo (Physics)	27
Others (quoted from 1 to 7 times)	15

The perceptions of real scientists are, therefore, leaded by historical and heroic references that place science as an exceptional work. Although to understand better the students' choices we would need further investigation.

To check image trends assessed in questions number 4 and 5, the questionnaire incorporated the issue "*Would you like to be a scientist in the future?".* 200 students said to feel attracted by the scientific field and this confirms the positive image of science revealed in our study.

TABLE 8. SCIENCE AS PROFESSION	**NA**
Would you like to be a scientist in the future?	Yes – 200 No - 154

CONCLUSION

The pilot survey described above has exposed the positive image of science and scientists hold by Portuguese high school students participating in our study. These results cannot be seen as the perceptions of high school students in Portugal, though its trends can be very useful to rethink a more boarder study.

Students within our sample consider science an interesting and valuable activity, and they believe scientists are helpful and creative persons. Their *awareness* level (positive attitude) is, therefore, high and this is an important piece of information for communicators because it can apparently facilitate their work and suggest new directions for communication programmes. In fact, if awareness is high communication should seek *understanding, enjoyment* or *interest* (Burns *et al.,* 2003) in order to bring the public to the next level: *action,* by entering graduate or postgraduate programmes (or others).

However, the final survey should look for a better understanding of their responses, by going deeper in the analysis of themes. We propose a more extensive questionnaire to assess the AEIOU vowel analogy suggested by Burns and his colleges (2003): *Awareness, Enjoyment, Interest, Opinion-forming and Understanding.* This would provide richer and more useful outcomes to the field of science communication in Portugal and it could develop the foundations for further research and evaluation.

These developments should include a study on the sender – science. Recent surveys indicate that the levels of interest in science are increasing in developing countries but these studies also show that there are continuing low levels of assessable understanding of science. This is in spite of extensive government-supported science promotion and education programmes (especially in the USA and UK). In addition, surveys suggest a more complex map of attitudes: the public does not know much about science and scientists don't know much about the public (Burns *et al,* 2003).

Science communication should be a *dialogue* to produce citizen responses to science. It is not simply encouraging scientists to talk more about their work. Its outcomes and responses may not be easy to study scientifically as they inevitably occur in the "real world" rather than in the controlled conditions of a

laboratory. And a deeper understanding of science communication requires skills from social rather than physical sciences. Nevertheless, our willingness to proceed can be essential to the development of this field.

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