

Project Words: Which words identify science nowadays?

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Abstract

This research was inspired by the project "Shaping Science Education in Just 100 words- 100 parole per la scienza", an initiative carried out from a science seminar conducted in Italy and published on Nature in 2008. In that project, a group of young people between

ages 16 and 18 were challenged to choose 100 words that in their opinion represent crucial factors and concepts that influence trends in science today. Similarly, this research study aimed at collecting the words related to the world of science that are identified by high school teachers and students from the program Pre-Scientific Initiation developed by the Provost's office for Research from USP (University of São Paulo), Department of Education of the State of São Paulo, CNPq and Santander bank, during the year 2012. From a methodological standpoint, a questionnaire was drafted to students and teachers requesting them to list fifty words about factors and concepts that, in their opinion, influence science today. The data analysis was done following a qualitative and quantitative format, splitting them into two groups - teachers and students - and in two separate moments.

We present the data related to the second moment, where the words of both groups were analyzed based on three categories: a) attributes related to science's external aspects b) attributes related to science's internal aspects and c) attributes related to historic and philosophic aspects. For both groups, category B was the most present followed by A, showing quantitative differences between groups of students and teachers. Category C was very little present in both groups.

Introduction

One cannot deny today's strong presence of science and technology in the day-to-day lives of citizens, either through products we consume or through its impact and its effect on our everyday lives. It would, thus, be easy to argue the importance of the control on scientific and technological knowledge by citizens as an instrument for ensuring better life for all. Without ruling out such importance, we can, however problematize it. There has been discussions related to the way in which scientific knowledge is to be acquired by the population, as to not only accumulate information but effectively be able to apply them to make decisions at work (KRASILCHIK E MARANDINO, 2007).

We consider, as Sasseron (2008), that scientific literacy means understanding terms, basic concepts and knowledge about science, knowing the nature of science and the ethical and political factors that surround its practice and understanding the

relationships among science, technology, society and environment. Such process is continuous and goes beyond school hours, requiring ongoing acquisition of new knowledge. Schools, museums, radio and television shows, print magazines and newspapers, the media in general should stand as partners in this endeavor to socialize scientific knowledge, in a critical manner, to the population.

It is, thus relevant to understand what the audience and, in particular, the school audience knows about science and its relationship with society. Today the word science is present in the vocabulary list of the average citizen, even though we might not be fully aware of that. However, even present, science can have different meanings to individuals: set of knowledge and hard facts accumulated by scientists; process of obtaining knowledge arising from research conducted with methodological rigor; and, more recently, the structuring and development of institutions that are responsible for promoting, subsidizing, organizing and evaluating scientific activities. Thus, knowing what students think and what words and expressions on science are used among teachers and young high school students become an important demand for mapping, assessing actions and organizing scientific literacy activities.

Along this line, we found the “Shaping Science Education Project in just 100 words” - '*100 per la parole scienza*' - (PRUNOTTO, 2008), an initiative undertaken from a workshop held in Venice, Italy where a group of young people between ages 16 and 18 were challenged to choose 100 words “that in their collective opinion represent key factors and concepts that influence trends in science today.” The results indicate that young people, in addition to their more traditional vocabulary, include terms related to ethical problems in medicine and biology, evolution theory among others.

Inspired by the aforementioned project, this study aimed at collecting the words related to the world of science raised by teachers and high school students who participate in the *Programa Pré-Iniciação Científica* - Pré-IC (Pre-Scientific-Initiation Program) conducted by the Provost's office for Research of *Universidade de São Paulo – USP* (University of São Paulo). This program started to be developed in 2009 by USP in partnership with the São Paulo State Department of Education (ESS / SP) and with the participation of the *Conselho Nacional de Pesquisa - CNPq* (National Research Council), *Fundação de Apoio à Universidade de São Paulo- FUSP* (Foundation for the Support of

the University of São Paulo) and Banco Santander S/A for the purpose of promoting the participation of high school students from public schools in the investigation processes carried out from the University through these individuals' experience in laboratories and research centers and with researchers.

In the research conducted, the focus was to map words related to the world of science, that, when analyzed, can indicate crucial factors and concepts that influence trends in science today. The goal is to be able, through the words raised, to identify not only what teachers and students think about science today, but also raise guiding elements for the improvement of teaching and communication of the sciences with regard to a proposal for contextualized scientific literacy.

Methodology

This research is part of a set of studies that consider the selection of topics that are meaningful to citizens and that work as the basis and guidance for their personal and social decisions. Examples of such initiatives are being developed by fostering entities as the Brazilian Ministry of Science and Technology (MCT, 2007), among others.

It was applied, as investigation procedure, an instrument of data collection with students and teachers from the program Pre-IC in the second half of 2012. They were requested to list fifty words that refer to factors and concepts that, in their opinion, influence science today. Data from 20 teachers and 109 students were collected altogether. Each participant signed a consent form to participate in the research study, thus contemplating ethical research procedures.

The data analysis was conducted following qualitative and quantitative format, splitting them into two groups - teachers and students - and in two moments. At first, focusing on general quantitative analysis of words selected by the subjects, a program developed by two fellows of the program from USP *Ensinar com Pesquisa* (Teaching with Research) was applied as tool. The program examined the words of the questionnaires to disclose the most used ones and to learn how many times they were repeated in each subgroup. Moreover, still in the first moment of the study, a general qualitative analysis was processed where the words were sorted into empirical categories identified from the data. This analysis will not be presented here.

The second moment of analysis sought to classify words into 2 subgroups - students and teachers separately - from categories created and based on literature related to discussions of scientific literacy and on the movement science, technology, society and environment (STSE) belonging to the field of science education. In particular, we used as reference the research study developed by Contier (2009) in which the author proposes attributes and characteristics related to aspects such as: concepts / scientific content, methods / procedures, relations between science, technology and society, ethical and controversial issues. The applied attributes can be seen in the following table:

A - attributes related to science's external aspects	B - attributes related to science's internal aspects	C - Attributes related to historical and philosophical aspects
A1. Negative social impact of the development of S & T	B1. Reference to terms and concepts of science (scientific terminology)	C1. Concerning the historical context of the construction of scientific concepts.
A2. Resolution of social, practical and everyday problems	B2. Reference to methodological procedures related to Science and Technology	C2. Scientific and Historical facts.
A3. Issues of environmental nature	B3. Personal characteristics of scientists	C3. Nature of science.
A4. Ethical and controversial issues	B4. Collectivization of scientific work	
A5. Issues of economic, political, social and cultural context in their relationship with S & T	B5. Procedures to consensus	
A6. State participation in issues related to S & T	B6 Social responsibility of the scientific community	

Figure 1

In this paper, we present the second moment of analysis. The captured data provide relevant information on what teachers think and what students involved in the project Pré-IC/USP think about science and its relationship with society. Thus, they become important contributions to draft course planning of curriculum for teacher education and science teaching in high schools, as well as for the action planning of the communication of science.

Results

In the second moment of analysis, we sorted 100 words that appear the most in both groups, and classified them from the attributes of science and its relations with society as previously mentioned. The synthesis of this data is summarized in the following table:

Teachers		Students	
Category	Number of Words	Category	Number of Words
A1	05	A1	03
A2	04	A2	07
A3	09	A3	04
A4	07	A4	02
A5	10	A5	11
A6	06	A6	03
Total Category A	41	Total Category A	30
B1	31	B1	33
B2	16	B2	21
B3	04	B3	10
B4	03	B4	00
B5	00	B5	00
B6	01	B6	02

Total Category B	55	Total Category B	66
C1	00	C1	00
C2	00	C2	00
C3	04	C3	04
Total Category C	04	Total Category C	04
Overall Total	100	Overall Total	100

Figure 2

Discussion

We can note a greater concentration of attributes related to science's internal aspects – 55% and 66% words are in these groups, respectively between teachers and students. Among these, we noticed strong presence of terms and concepts related to science (scientific terminology) - 31% and 33%. For students, this result can be explained by the influence of school culture in relating science to a repertoire of terms and concepts. This inference can be identified among teachers as well.

Some studies of scientific literacy, particularly in the field of Biology, indicate four stages that this process may go through: nominal, functional, structural and multidimensional (BSCS, 1993 apud, KRASILCHIK AND MARANDINO, 2004). Considering such studies, this given research study has identified higher concentration of words at nominal level - when the individual "recognizes specific terms of scientific vocabulary" (KRASILCHIK AND MARANDINO, 2004:19). This result among students could be explained by the influence of school culture itself and among teachers by the influence of their specific knowledge in teaching science. We must highlight that in the student universe there is strong presence of words related to procedures of doing science, concentrated in 21% of them.

On the one hand it was interesting to note the presence of words that refer to science's external aspects (category A), both among students and teachers. Despite having this category coming up in second place compared to category B, the data indicate - as the Italian research that inspired this research - that young people recognize social,

environmental, ethical and political aspects related to science. However, the fact that category A comes up less often than B shows a low awareness of issues, still present, related to science in its relation to society reinforcing the strong presence of the aforementioned nominal scientific literacy among the subjects of this research study.

Comparing the two groups, we find that teachers raise more words belonging to category A than students. The presence of 41% of words related to science's external aspects among teachers compared with 30% of students indicated that the former holds a larger repertoire of terms for the relations between science, technology and society which does assist teachers in their practice and allows students to also expand such repertoire.

Finally, category C comes up at a much lesser degree with very low representativeness among both teachers and students. It, thus, seems that in the surveyed group, the historical and philosophical dimensions of science are aspects poorly identified by them.

Conclusion

The results presented here are still partial, as it will be necessary to combine the data obtained from the first moment of analysis with those of the second. In any case, the analysis of this second moment reveals interesting aspects on the conceptions of science and its nature from surveyed subjects. It is noteworthy that the analyzed group takes part in research projects associated to the Pre-IC Program, which may explain the greater presence of words related to science's internal aspects and also the presence of words related to external aspects. The experience acquired by students and teachers attending laboratories and research groups may aid in the perception of the political and social dimensions, besides the human perception, when it comes to the production process of science. On the one hand, we do note the strong influence of school culture from the emphasis on the nominal dimension of scientific literacy among the words. Finally the low presence of category C points to the need for work geared towards teaching and communication of science as to emphasize its historical and philosophical aspects as part of the understanding of scientific culture.

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