

# The students' view about what it is a scientist



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## Abstract

Recent researches point to the lack of connection and engagement of students in relation to science study. One reason pointed out is the very stereotypical conception of science presented in the students. In general, a dehumanized view of scientific knowledge, in which its epistemological, historical and social dimensions are not shown, the student would not consider this knowledge as part of "their world", losing interest in it. In order to provide elements for discussion, this paper presents an analysis of how a group of students understand what being a scientist is. The activity was developed with students in 2nd year of high school (15 and 16 years) from a Brazilian school. In the first lesson (on a thematic group on "particle accelerator"), students participated in a debate about "scientists and research laboratories," and were asked to produce a short text in response to the question: "What is to be a scientist?" For the analysis of the responses, we took as reference the methodology of Discourse Textual Analysis (DTA) - Qualitative analysis - considering the following: unitarization, themes and communication. From the DTA, the students' responses were organized in three categories, not exclusive: (1) Scientists as knowledge producers: 100% of students describe the scientist as a person who produces knowledge through experiments, formulating hypotheses and theories, (2) Scientists as professionals: 45% of students indicate the scientist as a professional who needs funding, works in laboratories and makes group projects, (3) Scientists as people who seek solutions to social problems: 15% of students believe that knowledge produced by the scientist meets social demands, the development of drugs or cures for diseases. It is noticed that few students relate the production of scientific knowledge on issues considered relevant to society. The only examples given in this context refers only to the health area. Thus, this study highlights the need to reflect on the social role of science so that scientific knowledge is at least recognized by the students as part of their own world.

**Keywords:** Science Teaching, Understanding of Scientists, Discourse Textual Analysis.

## Resumen

Investigaciones recientes apuntan a la falta de conexión y el compromiso de los estudiantes para el estudio de la ciencia. Una de las razones destacar es la concepción estereotipada de la ciencia presenta a los estudiantes. En general, una visión deshumanizada del conocimiento científico en sus dimensiones epistemológica, histórico y social no se muestran, el estudiante no se considera este conocimiento como parte "Su mundo", perdiendo el interés en él. Con el fin de aportar elementos para la discusión, este documento presenta un análisis de cómo un grupo de los estudiantes a entender lo que significa ser un científico. La actividad se desarrolló con los estudiantes de segundo año en la preparatoria Medianas (15 a 16 años) de una escuela brasileña. En la primera lección (en un grupo temático sobre "Los aceleradores de partículas"), los estudiantes participaron en un debate sobre "los científicos y los laboratorios de investigación", y fueron invitados a producir un texto breve en respuesta a la pregunta: "¿Qué es ser científico?". Para el análisis de las respuestas, se tomó como referencia la metodología de Análisis del discurso textual (DTA) - análisis cualitativo - teniendo en cuenta lo siguiente: unitarización, temas y comunicación. De la DTA, las respuestas de los estudiantes se organizaron en tres categorías, no exclusivo: (1) los científicos como productores de conocimiento: el 100% de los alumnos que describan el científico como los que producen conocimiento a través de experimentos, formulación de hipótesis y teorías, (2) Científicos como profesionales: el 45% de los estudiantes indican que el científico como un profesional que necesita financiamiento, de trabajo en los laboratorios y hacer proyectos en grupo, (3) los científicos como personas que buscan soluciones a los problemas sociales: El 15% de los estudiantes creen que el conocimiento producido por científico cumple con las demandas sociales, el desarrollo de medicamentos o la curación de enfermedades. Se puede observar que algunos estudiantes se refieren a la producción de conocimiento científico sobre cuestiones consideradas relevante para la sociedad. Los ejemplos sólo se da en este contexto se refiere sólo a la esfera de la salud. En consecuencia, este estudio apunta a la necesidad de reflexionar sobre el papel social de la ciencia con el fin de que el conocimiento científico es por lo menos reconocido por los estudiantes como parte de su mundo.

**Palabras clave:** Enseñanza de las Ciencias, Comprensión de los Científicos y Análisis Textual de Discurso.

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## I. INTRODUCTION

Researchers and groups for the curricular reform have sought to reframe the science teaching, setting new goals for different educational disciplines that consist this area. This movement has been occurring with great intensity since the early nineties, a period in that countries like the United States, Australia, Brazil and others from the European continent started to carry out wide reforms in their education systems [1].

In this context, the movement called scientific literacy has become predominant in science field. In general, it is considered only the presentation to students of theoretical-conceptual content and its operation, in the case of physics, in the form of numerical exercises are not enough to grow up a citizen that deal with issues of our time.

Initially, scientific literacy was defined as the ability or habits of thought, necessary to build scientific knowledge [1]. In this perspective, aspects related to use of scientific language, that is, codes related to science concepts such as formulas, tables and graphs etc, would be the main focus of learning.

However, today a new understanding of scientific literacy has been developed (this new conception is often called the second generation of scientific literacy and extended scientific literacy). Several authors note that the notion of the literacy individual involves considering that he can engage in social problems and make a critical reading of the reality around him [2]. This involves going beyond the ability to encode / decode elements of science, but being able to use the developed skills to position himself on issues that involve different ways of scientific knowledge and socially controversial.

Although a social / humanistic science education meets the skills expected of a citizen of the century XXI, many questions still remain opened. Between them we can indicate: Scientific knowledge conveyed in schools is sufficient to discuss social issues? Teachers are trained to deal with such goals? Students recognize the role of scientific knowledge in social problems.

In the middle of this universe of issues, the aim of this paper is to understand how students understand the work of a scientist and, more specifically, we try to verify that they attribute a significant role for scientists in solving social problems.

## II. THE NATURE OF SCIENCE AND THE PROBLEM OF STUDENTS IDENTITY

One of the problems found in the science teaching-learning process and specified as one of the more serious specialized literature refers to the conception of science by teachers and students [3]. Several surveys indicate that, in most cases, an underlying view is positivist educational practice. In general, science is seen as a knowledge that is obtained through the "scientific method" that guarantees a universal validity to itself, that is, truth value and limitless in its

application. In this reasoning, scientific research is neutral, independent of social values and devoid of institutional pressures. These elements that would guarantee the status of irrefutable scientific knowledge [4].

This conception of science is extended to the own image of the scientist. Roslynn Haynes [5] conducted a study that was discussed the main stereotypes of scientists conveyed in the social imaginings (his work has analyzed the image of a scientist in the media, film and literature). As a summary of their study, the author considers seven main images to represent the vision of scientist and that are widely present in society.

1 - The wicked Alchemist, as a kind of wizard who looks for some secret formula in his lab isolate.

2 - The noble scientist, like a hero, who makes a big discovery that could "save" people from a harm that exists.

3 - The fool scientist that can be easily fooled and manipulated by others.

4 - The inhuman researcher, unemotional, fanatical about his work.

5 - The adventurer scientist that is part of major expeditions.

6 - The dangerous scientist that projects "wepons" to do wickedness.

7 -The helpless scientist, that loses control of his creation.

Although the vision of scientist can be more or less positive, the most interesting in the author's analysis is that in all cases, the researcher is seen in isolation and without interest for problems that affect the daily lives or which are recognized as socially relevant. Only extreme cases, the presence of an epidemic may require the presence of a scientist in society.

According to the same study, the relationship between the scientist and society is disturbed, caused exactly by their social isolation. Haynes also shows that the vision of "Inhuman researcher" is the most persist in the society. In addition to his deliberate isolation, this kind of scientist would believe that knowledge does, inevitably, the good, and he was responsible for discovering it. In this perspective, it is not necessary to question whether the knowledge produced is relevant to society or if it should turn the same need to society. The intrinsic value that is assigned to knowledge would not be necessary to consider in establishing relationships with society.

From an educational standpoint, it is necessary to question the naive visions of science and scientist. The so-called learning aspects about the "nature of science" are seen today as one of the main dimensions of scientific literacy [4]. Among the different motives, understanding the nature of science is seen as a necessary element for the student can understand the role of science on questions that are socially relevant.

The stereotypical image of science as something produced by "different people" and "able to uncover the truth" can make students do not identify themselves as someone capable of "carrying scientific knowledge". One of the reasons that students do not engage in learning

science would, in this perspective, the image he does of himself - his identity - and the image he sees who he should be for learning science [6]. Thus, for the students engages in science learning and take this knowledge as his, that is, as part of his worldview, it is necessary that he create identity bonds with this knowledge. Propose that working on the images of science that students build on their experience, so they consider the knowledge as a set of truths produced by geniuses and learning to consider science as an integral social reality.

In the next sections present the context and the survey data that sought understanding the scientists vision from a group of students from a Brazilian school.

### III. CONTEXT OF RESEARCH

The activity presented here was developed with the students of private schools of the State of São Paulo. Students who participated in the survey are young people who have direct contact with various means of dissemination of science, such as magazines, documentaries, internet, cinema etc. This implies that their understanding about science are not limited to knowledge promoted in school, but are heavily made up of diverse means of disseminating knowledge.

The survey took place from June/2010 to March/2010 in a course provided in the curricular schedule, entitled "Connections Natural Sciences". This course was an initiative from teachers of the school, aimed at bringing current issues from the perspectives of science in interdisciplinary studies. This experiment was started due to little curricular articulation, in school, between the compulsory subjects of Physics, Biology and Chemistry, which did not comprehend the context proposed by the National Curricular Parameters, which are documents that indicate the purpose of education for whole Brazil. These documents establish that the knowledge from these three areas should talk with each other, allowing, beyond other things, the inclusion of new topics to students from elementary school.

For this to occur, the faculty from Natural Sciences Block met in order to prepare lessons on a theme to work during a period of three months with one class per week. These classes are designed for students in 1st, 2nd and 3rd year of high school. However, for this research are presented only the results from the work with students in 2nd year (15 and 16 years).

The proposal for such a class was developed by a physics teacher with the title "Particle accelerators." This discipline had predicted 10 lessons that focused on the role of research laboratories for the development of science and its relationship with the scientific work. The first class of the course discusses the role of experiments and research laboratories in the development of different scientific areas. Finally, a discussion would be made about particle accelerators, emphasizing the social role of large investments in these technological devices in Brazil, such as maintenance of the Pelletron accelerator (particle accelerator that exists since the sixties at the University of

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São Paulo) and the construction of the Large Hadron Collider (LHC).

In the first lesson, students were asked to discuss what being a scientist and the role of research laboratories to develop their work. After discussions and a brief consideration of the teacher, explaining the subject content (block about the scientists, block about laboratories, block about the concept of atom and block about accelerators), students have produced a text answering the following question: "What is to be a scientist?"

These productions were analyzed and are presented in the next section.

### IV. ROUTING METHODOLOGIE

As already mentioned, the purpose of this research was to understand what are the views of scientists who provide students of 15/16 years through their experience inside and outside the school. To obtain data that allowed us to assess students understanding was asked them to prepare a text answering the question "What is to be a scientist?". As instruction for the preparation of the text indicated that students could have full freedom to express their opinions and that the answers would not be assessed right or wrong. For the analysis, that searched to evaluate how students understand the activity of scientists from how their working procedure until to its purpose, we took as reference the methodology of Discourse Textual Analysis (DTA) [7]. This methodology is adequate for the analysis of data and qualitative information, especially because it produces new understandings about the phenomena and discourse analysis. This occurs by the dialogue process and immersion in the text, in which the researcher is submitted. Thus, choosing this form of analysis is justified by its proposal to combine rigorous analysis and subsequent synthesis, allowing the reconstruction of the text / discourse of research participants, in order to enlarge their meaning, especially towards the reconstruction of implicit speech. Moreover, ATD provides an emerging categorization process, *i.e.*, the construction of categories throughout the process, through the analysis is performed.

Look that the ATD is a methodology that assumes reconstructive writing from authors/researchers considerations, explaining the subject in the social reconstruction of reality. Thus, as the authors evidence, involved in this perspective is to engage in collective processes of meaning reconstruction. From the reconstructive production written, the researcher incorporates and participates in ongoing dialogues of meaning of the communities to which it belongs [8].

### V. ANALYSIS AND RESULT

For the analysis of student writing, three procedures were performed to characterize the ATD. First, it was the unitarization, which consists the fragmentation of texts written by students, like meaning units. These units were

grouped into thematic categories, according to their semantic similarities and under a theoretical look. Finally, moved to the communication procedure, were designed descriptive and interpretative texts (metatexts) concerning the categories were found.

From the analysis of student responses include three categories, non-exclusive, namely: (1) Scientists as producers of knowledge, (2) Scientists as professionals, and (3) Scientists as people who search solutions to social problems. Then, we discuss some elements that make up those groups.

(1) Scientists as producers of knowledge.

In this first category were classified the references that students made in their writings the internal procedures of "doing science", such as the choice of experiments and the role of experimentation, development and adjustment of hypotheses and models, the development of theories, processes data analysis and interpretation of results, etc.. In short, the scientist is seen as a researcher looking for an organized and systematic way to understand his subject object.

(2) Scientists as professional.

Aspects of the scientist role as a professional or the workings of science as an institution that make up the second category, such as the need for research funding ("sponsorship", "investment"), the work of this scientist (individually or in groups), the workplace ("labs", "indoor and open"), the development of projects and so on. The scientist is seen as a professional.

(3) Scientists as people who search solutions to social problem.

In this category were classified the placements made by students regarding the social science role. According to some students, the knowledge produced by the scientist meets social needs and aims to improve the quality of human life, or the development of drugs, the search for cures for diseases, etc.

In the following table, we present a summary table with copies of the "units of meaning" drawn from student writing, that is, statements of student writing that exemplify each of the categories of analysis developed. In the same table is indicated the percentage of students who expressed words in each category. Note that the categories are not mutually exclusive, the same student may have expressed more than an understanding of what is to be a scientist.

**TABLE I.** Categories and examples of "units of meaning" drawn from student writing.

Categ.	Units of meaning	%
(1)	"Is an investigator", "Phenomena of nature", "develop theories", "studies do experiments to prove", "elaborates hypotheses", "discovers and explains things unknown to man".	100
(2)	"Is a professional", "are paid by funding agencies", "receives money from other institutions", "not only carries out his studies in laboratories", "working alone or	45

	in groups", "need sponsorship".	
(3)	"Search improvement of life quality", "search creating a better world", "discovers drugs and reactions", "discovers the cure of diseases".	15

The results, we note that 100% of the students associate "being a scientist" to "being researcher." In student writing, it appears explicitly or by reference to the work of the scientist in an internalist view of scientific, for example, they explain that the scientist "conducts research, carries out experiments, formulate hypotheses, theories creates." In some texts, students delimit the areas of research scientists (mostly physics, chemistry and biology). The relationship between the scientist and the knowledge is also explored by students when they emphasize that the scientist "studies profoundly", "a master content" or "needs his thesis" and the novelty of that knowledge produced is also constant in texts ("search new knowledge", "discovering new things", "explains things unknown to man").

The identification of the scientist with a professional is made for 45% of students. The issue of funding for research, the collective nature of the work of scientists and the allusion to different research environments ("the scientists not only do their studies in laboratories") are some issues raised by students who bring up, though timidly, an externalist perspective of the scientist's work, which features a look at the science as a social institution.

Finally, the vision of the scientist as a person who searches solutions to social problems of the students expressed a look at the role played by the scientist in society. Only 15% of students in their writings emphasized the social implications of the development of scientific knowledge, which, in our sample are restricted to the field of health ("Scientists discover the cure of diseases", "discover remedies").

## VI. CONCLUSION

In this paper, we identify, through the written production of students of 2nd year of elementary school, their views on "what is to be a scientist." The texts produced could be extracted information concerning the activities of the scientist and his social role. The vision of the scientist as "researcher", as someone who researches to understand its object of investigation in a systematic way, makes up an internalist perspective of doing science, since it raises issues pertaining to this, like development and testing of hypotheses, design and realization experiments, creating theories, etc.

Already the vision of the scientist as a professional highlights aspects externalities associated with insertion of the scientist in a context that involves the research for funding, work in research groups (which is against to the vision of the socially isolated scientist whose work is performed individually) and so on. The initial discussion took place between students in the first class of the course

on the role of research laboratories for the development of scientific knowledge may have contributed to 45% of students to develop this perception for the collective work of scientists and the financing of research.

Regarding the recognition of the scientist role in solving social problems, we found that few students (15%) refer to the social implications of the development of scientific and technological knowledge, and when they are made, are restricted to the health field. This shows us that although we understand that there is some understanding by the students on the internal procedures of science and its functioning as a social institution, is still only beginning to understand the role of science in solving social problems.

As a result, this study demonstrates the need for reflection on the social role of science in their various fields of knowledge, were held in the school, so that students recognize this knowledge as part of their world.

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