New Perspectives in Science Education
International Conference
NEW PERSPECTIVES in SCIENCE EDUCATION


Concept of Atoms in Future Brazilians Chemistry Teachers

Mateus Carneiro Guimarães dos Santos[1], Jhenifer Micheline Cortez dos Reis
Neide Maria Michellan Kiouranis[2]

Abstract

With the establishment of history and philosophy of chemistry the future teacher can use another apparatus of ideas to teach the atomic hypothesis. Subject that can bring several misinterpretations and is generally seen as very abstract by high school students. Based on this problem this study had as its focus an interference concerning the theme of what is real and the concept of what is the atom in a course of undergraduate in chemistry for future teachers. It was possible to note that interference in undergraduate classes was considered important by future teachers so that they could have a broader view of the nature of science and the importance of studying the history of chemistry to teach atomic hypothesis.

Keywords: *Chemistry, Teacher, Atom, Philosophy, History;*

1. Introduction

To know what science really is we have to consider it as an institution formed by a scientific community that clarifies and produces scientific knowledge about natural phenomena. It is, therefore, a human interpretation influenced by other social, economic, political, and cultural ideological dimensions determined in each historical period [1]

From the ideas proposed by Kuhn a science is only considered mature when it follows a paradigm (or disciplinary matrix) and it is he who establishes all norms of legitimization of the work within this science, as well as it coordinates the activities of problem solving of the normal scientists that belong to this group.[2]

Kuhn describes normal science as the solution of problems that are guided by the rules of a paradigm, being of theoretical or experimental nature, it must assume that the paradigm presents the enough means to solve the problems that arise. If failures occur in this resolution, the same is attributed to the researcher rather than the paradigm itself, although Kuhn admits that paradigms always have some anomalies.

Scientists develop several speculative theories but not all are part of the dominant paradigm, some are prior to or are developed during the crises suffered by him. It is these theories that can possibly point out the lines of research seeking the discoveries. It is only when theories are able to present a logical articulation with experiments as well as this encounter between theory and experimentation that discovery arises and so the theory is inserted into the paradigm.[2]

As soon as a new discovery emerges, explanations of phenomena on the part of scientists begin to widen as it becomes more precise or even makes possible the explanation of a greater range of phenomena. Therefore, as a direct response to a crisis the new theory emerges and with it several versions. This crisis is only resolved when a completely new paradigm conquers most of the scientific community until the original paradigm is abandoned with seemingly insolvable problems. This transition from one paradigm to another is a transitional period called the Scientific Revolution. In this way, the new paradigm still free of difficulties forceful distortions and will guide a new period of Normal Science until new problems arise with a new crisis which will give rise to the other revolution, and so on.[2]

According to Thomas Kuhn (1982) "perhaps the most complete example of a scientific revolution" was John Dalton's initial work on atomic theory, published in 1808 in his book "*A New System of Chemical Philosophy.*" Dalton states in his work that it is necessary to differentiate the corpuscles or atoms from gases not only by their size or shape, but also by their weight. Using Proust's Law as the basis of his atomic hypothesis the scientist suggests that combinations are effected by units of atoms in which atoms of the same element are identical. So the English scientist completes his theory by the Law of multiple proportions. He adds in his work that without the atoms these laws become too mysterious to be understood, such as Kepler's laws before Isaac Newton. [3]

[1] State University of Maringá, Brazil
[2] State University of Maringá, Brazil

The new world interpretation pioneered by John Dalton gave rise to a new way of understanding chemical reactions, a new apparatus of laws interpretations and reactions was guided by the paradigm of the atomic hypothesis. Thus conferring chemical science a quantitative character and an exact science status.[4]

So with the advent of atomic theories, the history of chemistry and science, a new apparatus of ideas can be used as a tool for the future teachers of chemistry to teach the content of atomic models, structure of the periodic table, laws and implications. But the idea of an atomic model brings with it some interpretations that can be brought by future teachers as alternative conceptions, and thus create a distorted idea of what the atomic hypothesis really is. Thinking about this problem this research had as objective to constitute data referring to the conceptions of what is real and conceptions of what is the atom in two distinct moments of the discipline of Supervised Internship in a Chemistry Course at a public university in south of Brazil with focus on: the history of atomic models to teach the atomic hypothesis to high school students

2. Methodology

This qualitative study was developed with six students of the 4th year of the Chemistry course, within the scope of supervised internship II. During the classes, the students should plan a didactic sequence focused on the discipline Chemistry and develop in public High Schools. The subject worked by the students was the history of the atomic models and the atomic hypothesis with a view to the discussion of important aspects about the nature of science. During the development of the subject the graduates students expressed some possible doubts that the high school students could present on the atom.

Based on the students' doubts, an intervention was planned, totalling 8 hours, which began with the question "Does the atom exist?"Among the answers of the trainees, the arguments about the reality of the atom were described by the existence of the objects and by the spectroscopic techniques which were problematized through the perspective of images and by Louis De Broglie wave-particle duality, with the objective of indicate that the scientific "reality" is perceived by the current theories that act as “glasses” indicating what is to be seen.

In the second moment, a brief discussion about the paradigms of Thomas Kuhn and to illustrate the breakdown of paradigms in the history of science were discussed two historical episodes: The development of the concept of the Quasicristais by Dan Shechtman [5] and The red shift controversy by Halton Arp, both in the twentieth century. [6]

In the end students should write a text that answers the following question: "Do we see what is actually real, or do we see what our glasses (theories) show what we should see?" From the reading of the texts some questions about the nature of the science that were configured in the categories of analysis and established a posteriori were evidenced. [7]

3. Results and Discussions

The qualitative analysis of the data shows that the graduates were able to discuss important aspects about science and its construction. From the activities developed we identified and quantified the units of meanings that allowed us to establish five categories that are presented in figure 1 with some fragments of texts produced by the students and identified by the code “A”, followed by a random numbering.

Categories	Qty	Students Answers
Resistance in the Paradigm Shift	3	A1- "There is resistance when it comes to breaking paradigm" A3- "(...) with the passing of time new ideas arise that when recent cause serious aversions" A5- "(...) changing a paradigm is extremely difficult and time-consuming."
Influence of the organization of the Scientific Community.	5	A1- "(...) many see science as something immutable" A2- "(...) we are always influenced by society" A4- "(...) the scientific community is currently organized (or rather, as it has always been)" A5- "(...) science is complex and involves external factors such as political and social" A6- "(...) scientific community as a bourgeois community"
Vision of science by current theories.	3	A1- "(...) we see what our theories tell us." A3- "(...) we believe in temporary 'truths.' " A4- "(...) we see things the way the theories are shown"
Question about what is real.	3	A1- "Real is what can be perceived by the senses or is real what we believe?" A2- "It's hard to know what the theories show us is not really real." A5- "(...) sometimes we have the opportunity to know the 'real' but we are 'trapped' by the theories."
Adequacy of the anomalies by the current paradigm.	2	A4- "The results we get are interpreted in accordance with the theory" A6- "(...) bourgeois community, which adapts all that is new to its theories in order to indoctrinate."

Figure 1. Categories Analyzed

The category with the highest incidence is related to the organization of the scientific community as the influence of external factors in the construction of science. Possibly this is due to the historical episodes brought in the classroom that problematize the influence of economic, political and social issues in the establishment of scientific knowledge. These conceptions are in accordance with the aspects discussed by McComas (1998) in which science is part of social and cultural traditions.[8]

The second category refers to the process of paradigm shifting. The graduates students present the idea that it is a complex process and that it is under great resistance from the scientific community. This issue was discussed mainly through a documentary that shows how the groups of the scientific community seek to strengthen the argumentation of the current paradigm in their research according to criteria linked to their own conceptual framework [2]

The third and fourth categories discuss the strength of the paradigm and its current theories in the development of knowledge, as well as the question of what is real in scientific conceptions. This issue is addressed by Bachelard (2009) in pointing out that the mobility and the dynamics of science that generate the constant transformations of knowledge are attempts to approximate the real.[9] However, the notion of real discussed by the philosopher goes beyond naive realism, being assimilated to the rational in the sense that scientific "reality" is built on the basis of prevailing theories and paradigms.

Finally, the last category discusses the adequacy of the anomalies to the current paradigm. According to Kuhn paradigms always present some anomalies, however, when a paradigm is not satisfactory in explaining these anomalies, failure is attributed to the researcher rather than to the paradigm. This shows that even in the face of anomalies the paradigm presents a great force of acceptance on the part of the scientific community.

4. Conclusion

Through this study, it was possible to problematize the conceptions about the nature of science presented by students of Chemistry. It is considered that an adequate science vision is fundamental to the teaching of this science and, therefore, capable of providing the student of Basic Education an understanding of what is science and its construction in a more plausible way. Among the characteristics of the nature of the sciences addressed by the future teachers stand out the organization of the scientific community, the progress of science through the paradigms and the construction of the scientific real. It is considered that the interventions carried out were important in order to provide the reflections on these aspects evidenced in the texts produced by the future teachers.

References

[1] Maia, N, F. “A Ciência por dentro”. Petrópolis: Editora Vozes, 1998.
[2] Kuhn, T. “The Structure of Scientific Revolutions”, 12.ed, São Paulo, Debates, 1982.
[3] Vincent, B, B; Stengers, I. “Histoire de la chimie”, 4. ed, Lisbon, Institute Piaget, 1992.
[4] Oki, M, C, M. “Paradigmas, Crises e Revoluções: A História da Química na Pespectiva Kuhniana”, Química nova na Escola, 2004, p.32-37.
[5] Caracelli, I. “Nobel em Química 2011: Descoberta dos Quasicristais, uma Nova Classe de Sólidos” Química Nova Na Escola,2011,p.2-6.
[6] Neves, M, C, D.” Do Mundo Fechado da Astronomia à Cosmologia do Universo Fechado do BigBang: Revisitando novos dogmas da Ciência Astronômica In: Cibelle Celestino(org). Estudos de História e Filosofia das Ciências: Subsidios para aplicação no ensino.
[7] Bardin, L. “L’Analyse de Contenu”,3ªed, São Paulo, Edições 70, 2016.
[8] McComas, W, F; Almazroa, H. “The Nature of Science In Science Education: An Introduction” Science&Eduacation,1998, p.511-532.
[9] Bachelard, G. A formação do espírito científico: contribuição para uma psicanálise do conhecimento. Rio de Janeiro: Contraponto. 1996