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VISIBILITY FOR THE NEW SECONDARY EDUCATION IN BASIC EDUCATION: USE OF THE CONCEPTS OF ATOMIC MODELS AND THEIR PURPOSE FOR LEARNING IN THE ENGINEERING, TECHNOLOGY AND EXACT ITINERARY

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Abstract: This paper proposes the theme of atomic models in high school teaching materials to explain metal forming processes and structural defects that can occur in metallic materials. This theme is presented in classes of the Engineering, Technology and Exact Formative Itinerary, which students from a private institution located in the greater Belo Horizonte region, Brazil, are free to attend. In the classes, the ideas proposed proved to be attractive and innovative, in order to give meaning to the students' learning, with regard to the application of atomic modeling knowledge.
Keywords: metal forming, spheres, research, formative itinerary, atomic models.

INTRODUCTION

In traditional secondary education, it was common in classroom situations to question the importance of the subject of atomic models. In this sense, the New High School proposal, divided into General Education (GHE) and Formative Itineraries (FIs), allows for innovation and the creation of themes that differ from the traditional ones. In order to make this opportunity a reality, the author of this paper developed teaching material for the IF of Engineering, Technology and Exact Sciences for the 1st grade of a private educational institution in Belo Horizonte in 2022. The aim of this material was to deepen the subject of atomic models, specifically Dalton's model (sphere), in order to show students the importance and relevance of a simple atomic theory for explaining processes involving metals.

The Common National Curriculum Base (BNCC) establishes several objectives for secondary education in contemporary times, one of which is to "ensure that students take a leading role in their learning and develop their capacities for abstraction, reflection, interpretation, proposition and action, which are essential for their personal, professional, intellectual and political autonomy". In this sense, the FI proposal, in which the student can choose his or her further studies, gives them autonomy, protagonism and challenges that were not previously possible in basic education. What's more, young people who choose an engineering pathway are confronted with subjects that develop abstraction, reflection and interpretation skills. After all, the very existence of an atomic theory to explain phenomena requires imaginative skills to mentally understand the historically proposed representations of the atom.

Over the last few years, new generations seem to be more willing to find purpose in teaching certain content in the classroom. When teaching the atomic models of Dalton, Thomsom, Rutherford and Bohr, one plausible question is why several models should be taught, rather than just the right one. From this perspective, it is understood that all these atomic theories are correct, and we can use one of them according to the need to explain a phenomenon or understand processes. In this sense, teaching material whose atomic model by Dalton (spheres) is sufficient to explain problems in metal structures, as well as industrial processes common to engineering, opens up the possibility of demonstrating to students the applicability and meaning of learning these concepts related to modeling the atom.

METHODOLOGY

The methodology used in the production of this IF teaching material was inspired by the basic knowledge of atomic models in the FG and the skills of the Scientific Investigation structuring axis, which is in line with the references for the development of training itineraries. The theoretical construction of this material included an introduction to materials science and then a deeper understanding of metallic mixtures based on the sphere model of the atom. The ideas of the interstitial region were worked on, i.e. between iron atoms, where the carbon atom has a compatible radius, so carbon steel is formed.

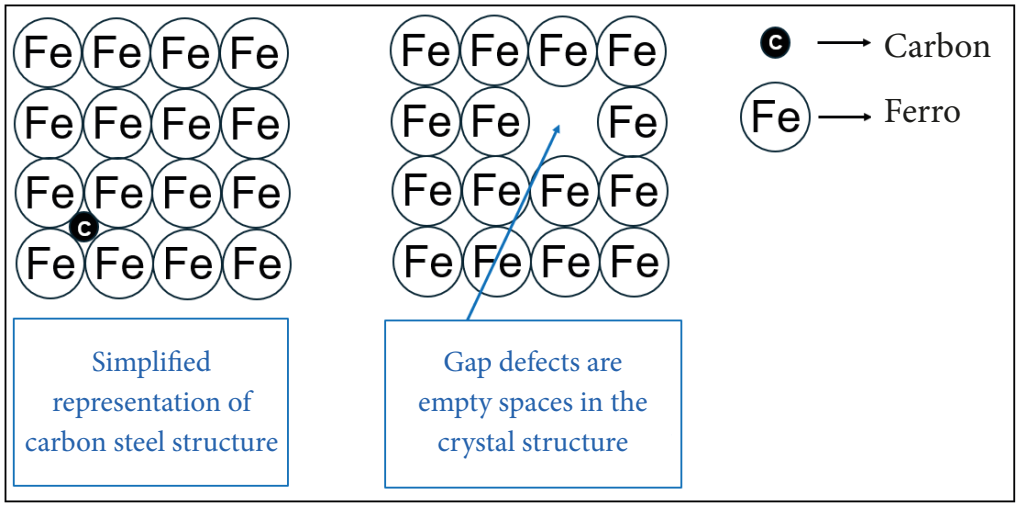

Figure 1 - Representation using a sphere model for an Iron/Carbon (carbon steel) mixture and a defect in a metal structure.

Source: Author's image

In addition, the plastic forming of metals through the sliding of atomic spheres in the rolling, drawing, extrusion and forging processes was explained. In addition, the presence of submicroscopic defects in the metal structure, such as gaps and interstitial impurities, which can cause problems in the applications of certain metal parts due to changes in properties, was addressed. Figure 1 exemplifies the sphere representations for the atom, its use in understanding the formation of carbon steel material, as well as the representation of submicroscopic structural defects, which can explain and help solve problems in metallic objects/materials.

RESULTS AND DISCUSSIONS

The didactic material related to the application of atomic models for the engineering pathway was worked on with students in the first year of high school, who opted for this FI, in the years 2022, 2023 and 2024, in the units of the aforementioned educational institution, located in the greater Belo Horizonte region. The third author of this paper, who taught this FI in one of these units, noticed that the students were more interested in the applicability of the concepts of atomic models, which were learned sequentially and historically in the FG, and the use of Dalton's model (spheres) in the engineering FI allowed the students to understand defects such as gaps, interstitial impurities, which metal parts can have, and what changes would be present in metal parts that had these defects.

In addition, this understanding allowed the teacher to relate the concepts of atomic models to the topics of periodic properties, such as the atomic radius, which explains the mixture of chemical elements in the formation of certain materials, such as carbon steel. In this sense, during the course of the lessons, the relationship between knowledge and the content of General Education was more comprehensive, especially when it came to pure substances and mixtures of substances, as in the case of carbon steel alloys.

In addition, the students were able to understand how metals are physically manipulated so that they can be transformed into wires, plates, swords and other objects, because the sphere model motivates them to understand that, by applying a mechanical force, the atoms can slide over each other, thus allowing them

to form. From this perspective, in one of the classes, an interesting question was raised by some students: if during the forming process, wouldn't the atom be crushed, instead of just sliding over each other? This question shows the students' interest, as well as the possibility of further clarification about the idea of models in science and the structure of matter.

The study of atomic models involves abstract concepts about the structure of matter, which can make it complex and, for some students, uninteresting because they don't identify its applicability in everyday life. However, during the school years mentioned above, by exploring atomic models in the classroom, especially Dalton's model applied to the study of metals and their conformation, it was possible to show how it remains current and relevant, being able to explain everyday phenomena, as well as its importance in studies related to scientific modeling.

FINAL CONSIDERATIONS

The proposal for teaching material involving the explanation of metal forming phenomena and the explanation of possible defects in the metal structure, based on the sphere model (Dalton), proved to be innovative and different from the traditional teaching of atomic modeling, which in many cases was considered demotivating because it did not arouse the student's interest. In addition, the didactic material made it possible to work with processes, making it more compatible with the activities of professions such as engineering and technology. After all, the study of metal defects is directly related to the performance of these professionals when it comes to solving problems in metal parts and components used in industry and construction in general. Thus, the young people who opted for this IF were able to test their affinity with this type of reasoning, favoring their protagonism and their professional and personal life project.

Therefore, the theme was satisfactory for demonstrating an understanding of phenomena related to the development of metal parts technologies, as well as emphasizing the importance of studying atomic theories in order to explain these processes today. In addition, the application of one of the atomic models to explain metal forming processes and problems in the structures of these materials can present a connection with STEAM (Science, Technology, Engineering, Art and Mathematics) learning in terms of meaningful and playful knowledge, since the use of an atomic model, proposed by John Dalton in the early 19th century, is current and applicable in materials engineering practices, favoring attractiveness, to give meaning to learning in high school chemistry classes.

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