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Schematic models of wood for optic mineralogy and geosciences teaching

Modelos esquemáticos em madeira para o ensino de mineralogia óptica e de geociências

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ABSTRACT

Optical physics applied to mineralogy becomes a complex concept, since it is based on concepts of refractoriness of isotropic and anisotropic materials, dependent on crystallographic parameters. The work aims to materialize these concepts in three-dimensional schematic models in wood, such as optical indicatrix and figures of interferences, generated when the plane polarized or polarized light interacts with several transparent minerals. The pieces were applied in the classes of Mineralogy II of the Geology course of the Federal University of Espírito Santo in the years 2017 and 2018, presenting great receptivity by the dissenting body and ease in the profusion of the knowledge of the group of monitors and teachers. The geometric representations were also shown in workshops at the Natural History Museum of Southern Espírito Santo State with the objective of disseminating the geosciences. As a result, the classes obtained satisfactory results of approval and learning

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Keywords - Optic Mineralogy, Schematic wood models, Didactic

RESUMO

A física óptica aplicada à mineralogia torna-se um conceito complexo, visto que, é fundamentando em conceitos de refratividade de materiais isotrópicos e anisotrópicos, dependentes de parâmetros cristalográficos. O trabalho objetiva a materialização destes conceitos em modelos esquemáticos tridimensionais em madeira, como indicatrizes ópticas e figuras de interferências, geradas quando a luz plano-polarizada ou polarizada interage com diversos minerais transparentes. As peças foram aplicadas nas turmas de Mineralogia II do curso de Geologia da Universidade Federal do Espírito Santo nos anos de 2017 e 2018, apresentando ótima receptividades pelo corpo discente e facilidade na profusão do conhecimento do grupo de monitores e docentes. As representações geométricas também foram mostradas em oficinas no Museu de História Natural do Sul do Estado do Espírito Santo com o objetivo de divulgar as geociências. Como resultados as turmas obtiveram resultados satisfatórios de aprovação e aprendizado.

Palavras-chave - Mineralogia ótica, Modelos esquemáticos, Didática.

1 INTRODUCTION

Considered as one of the basic and important disciplines of the curriculum of Geology courses throughout Brazil, tactile techniques were developed that stimulated the student of practical and theoretical content.

According to Andrade and Del Lama (2007), the importance of the study is obtained by a basic content that supports most of the subsequent disciplines of the Geology curriculum. From schematizations on tactile materials, graphic schematizations facilitate knowledge, since discipline is only dependent on the sense of vision and the capacity for abstraction of three-dimensional figures.

Several authors, such as Libarkin and Brick (2002), Constante and Vasconcelos (2010), Garcia, Imbernon and Lacerda (2014), Silva (2013) and Silva et al. (2009), portray the importance of spatial representations of two-dimensional figures and three-dimensional models which are essential for the elucidation of didactic models in geosciences.

The three-dimensional representations may be relevant in Optical Mineralogy, since they represent the behavior of light emanating from the minerals (diffraction) and the representation of the Interference figures in the conoscopic system, from analyzes of the petrographic microscope of transmitted light, for description and identification of minerals in thin sections.

According to Chvátal (2007), the optical properties of the minerals are the result of the interaction of light with the crystal, depending strongly on the symmetry and considering that

the isotropic, uniaxial and biaxial anisotropic minerals are characterized by one, two and three different refractive indices respectively.

Nardy and Machado (2002) define from theoretical concepts that optical indicatrix is the result of the variation of refractive index of a crystal for the light waves in their directions of vibration, represented by three-dimensional geometric figures, that simulate a surface limiting the rate of propagation of rays. They generate spheres in isotropic minerals (minerals with a refractive index) and ellipses. For minerals with two different indexes of refraction, the indications will be uniaxial and for minerals with three different refraction indices, they will be denominated biaxial.

When analyzing anisotropic minerals under a petrographic microscope, it is possible to observe interference figures in the conoscopic system. Klein and Dutrow (2012) define that such phenomena are the result of particular situations of light interference, observable only when sections of the crystals are oriented correctly.

The didactic activity presented in this work was developed during the Mineralogy II course, taught by the Department of Geology, for the students of the UFES Geology Course and at the History Museum of Southern Espírito Santo State. The objective is the implementation of the use of tactile resources, such as wooden models of interference figures and optical indicatrixes, in the teaching of optical mineralogy in undergraduate courses mainly geology, geological engineering and gemology. The work also has the purpose of showing the material made in workshops and traveling exhibitions at the Museum of Natural History of the Southern Espírito Santo State (MUSES) for students of all levels of schooling and form blind people or low vision to presenting the representations of the geometric figures and their relations with the geosciences.

2 MATERIALS E METHODS

As didactic material complementary to the classes of optical Mineralogy and presented in didactic exhibitions at the MUSES, models were made in wood representing the optical indicatrixes for greater explanation of technical concepts such as light transmission in isotropic and anisotropic minerals as well as concepts related to basic geometry (spheres and ellipsoids).

Models were initially developed in computer programs, adobe illustrator®, and then made from reused wood. The optical indicatrixes were made of recycled hardwood of construction material. The spheres are 11.5 centimeters in diameter and the ellipses are 13x5x5 cm (Figure 1). For the study and

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understanding of interference figures, a circle of 12.5 cm in diameter (representing the field of vision) was produced, a cross with thick ends of 28.5 cm to represent the isogyres of the interphase figure of uniaxial anisotropic minerals, semicircles and wood strips of 28.5 and 27.5 cm, respectively, to represent the isogyres of the biaxial anisotropic minerals, as well as estimate of the angle 2V (Figure 2).

During the years of application of the technique in practical classes, weekly meetings were held with the monitors, led by a professor of the geology course and the technique responsible for the Microscopy Laboratory of the Geology Department of the Federal University of Espírito Santo.

Figura 1. Representations of optical indications produced of wood. Source: The authors.

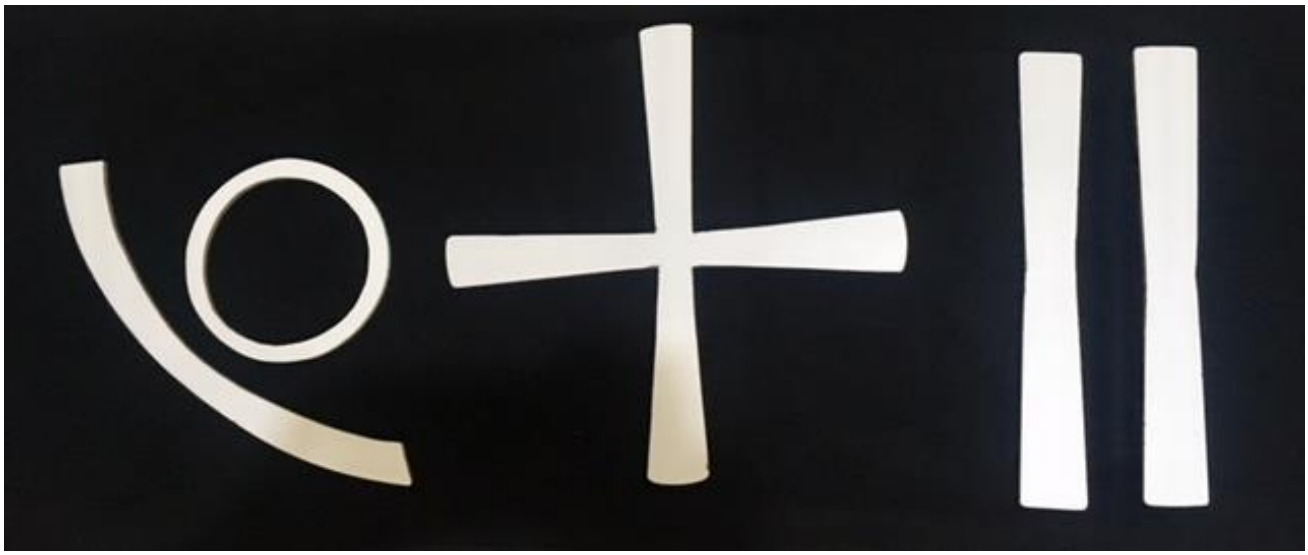

Figure 2. Representations produced of wood for schematizing Interference Figures. Source: The authors.

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3 RESULTS E DISCUSSIONS

The use of the technique was applied during the practical and theoretical classes of Mineralogy II of the UFES Geology course at the Alegre Campus between 2016 and 2018. The subject taught in the 4th period, with 60 total hours - 30 hours of theory and 30 practical concepts with the use of petrographic microscopes of polarized light. The laboratory classes were attended by two lecturers from the UFES Institutional Scholarship Program (PIBID-UFES) and 9 volunteer monitors from the UFES Geology course. In addition to helping learners it is to stimulate teaching from the profusion of scientific knowledge, showing innovative techniques with reuse of materials.

With the use of wood pieces, the monitors were trained to transmit the optical-crystallographic concepts in the most appropriate way (Figure 3).

The representations of the optical indications sections helped the students of mineralogy II course in the understanding of the phenomenon generated by the behavior of the light rays inside the crystalline structures of the minerals. Several real examples were used from observations made in thin section. In the isotropic crystals the rays vibrate with the same velocity in all directions, and thus were represented of the same size in the model of the sphere model. In the anisotropic minerals, the ellipses in wood allowed us to understand that there are two or three distinct refractive indexes due to differences in propagation velocities.

Figure 3. Use of materials in class by monitors. Source: The authors.

Handling and schematic drawings that were done with blackboard chalk on wooden pieces aided students in elucidating the representation of optical phenomena and better understanding of interference figures.

The schematic models allowed to simulate the movement of the interference figures, which often generates many difficulties, requiring a considerable level of abstraction, due to the understanding of the positions of the quadrants in uniaxial minerals when the section of the mineral generates a figure of non-centered optical axis. For the biaxial minerals, the movement of the models facilitated and understanding the path of the isogyres and the estimation for the determination of the 2V angle.

It was also verified that the performance of the groups from 2017 to 2018 were better than the previous ones (2011 to 2016). The classes contemplated by the proposal had the highest means in the evaluations of the last 8 years (Graph 1), with 100% approval in the discipline (Graph 2). In addition, there was an increase in interest in voluntary monitoring participation in Mineralogy II, as well as in research for this area.

The implementation of the didactic resource in MUSES took place during the XIV Science and Technology Week in 2018. The activity was of great importance because it allowed visitors to interact more with the monitors, handling the pieces of wood, creating sketches of the constituent layers of the planet Earth (Crust, Mantle and Core) in the pieces from the sphere and half sphere. The didactic resources were directed so that one could teach and work with people blind and of low vision. In addition, the spheres aided in the understanding of geometric and crystallographic relations.

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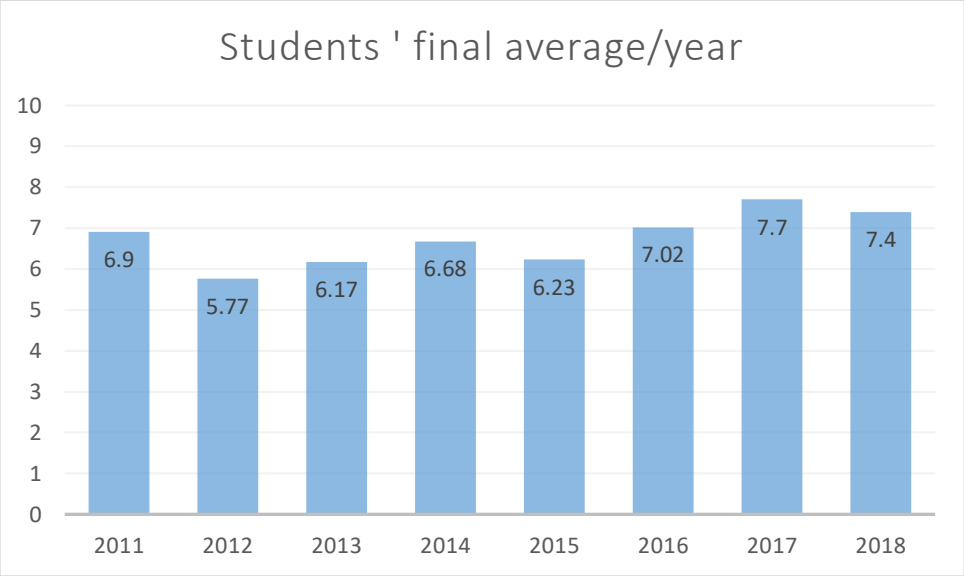
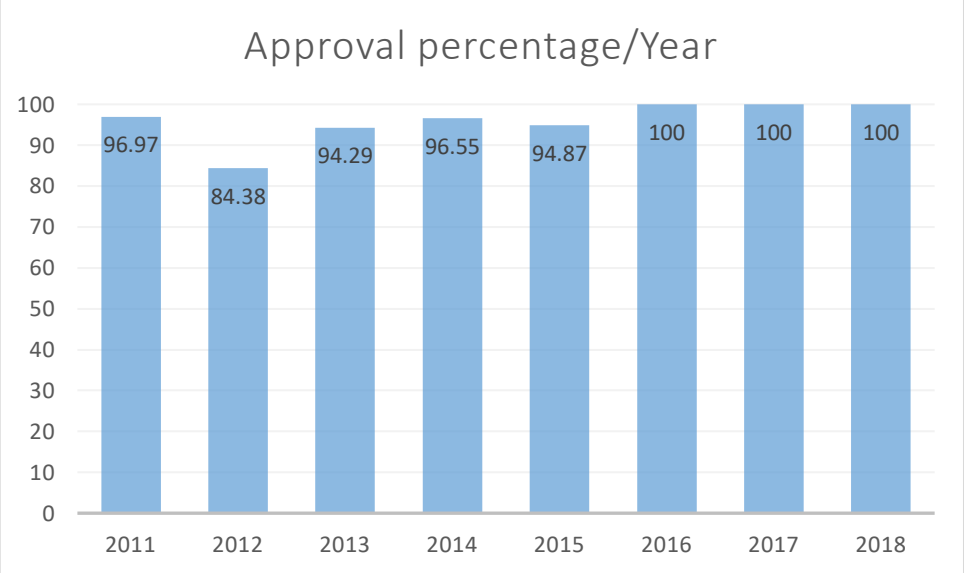


Graph 1. Averages of the last 8 classes of mineralogy II of the geology course of the UFES. Source: The authors.



Graph 2. Percentage of Approval in Mineralogy II of the Geology course at UFES. Source: The authors.

3 CONCLUSION

It is concluded that the material presents didactic potential, providing greater fixation and facilitating the assimilation of these fundamental aspects of optical mineralogy and geometric concepts for applications in the Museum of Natural History of the Southern Espírito Santo State. It also highlights the participation of monitors for profusion of knowledge, from the development of practical-theoretical activities, under the guidance of teaching staff, enabling the development of skills necessary for teaching in the areas of geosciences.

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