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CHAPTER 52

Pedagogical intervention using gemology in technical mining courses

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ABSTRACT

The present research aims to achieve the knowledge of a Pedagogical Intervention carried out in two Mining Courses in Professional and Technological Education (EPT), specifically in the discipline of Mineralogy, where the role of experimental activities in Geosciences can indicate whether the objectives indicated in the Curricular Pedagogical Proposal are fully achieved or not. Therefore, to give an emphasis to the incorporation of practical activities aimed at the development of procedural skills and the promotion of a comprehensive understanding of the specific principles of Gemology and its context. Therefore, in this research, through a Pedagogical Intervention Proposal, we tried to influence teaching through the development of experimental activities that were specified in the creation of a Manual of Gemological Minerals and the construction and distribution of Didactic Kits of these minerals for the realization of practical activities. In this way, improving the knowledge of the professors, as well as the students involved in the Mining Courses of the Mineralogy Discipline. After the Pedagogical Intervention, an advance in the knowledge of the area addressed was identified, as well as an institutional interest in the experimental activity in the teaching of Geosciences, as well as in the participating population due to the continuous training on the subject. In the same way, the potential of pedagogical interventions for the development of research in Geosciences was identified.

Keywords: Gemology, Mining, Geosciences.

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INTRODUCTION

First, in order to stay within the theme, we must know a little about what the word "intervention" involves, taking into account what several researchers have dealt with on the subject. Szymanski and Cury (2004) discussed the term "intervention" based on the writing of the Aurélio Dictionary (Ferreira, 1999). They indicate that the term relates to interference, and thus can be associated with absolutism, coercion. However, Becker (1993), with a view linked to the behaviorism of Psychology, understands the term as undemocratic.

In the context itself, Gil (2010) indicates that research on pedagogical intervention is applied, that is, it carries the purpose of contributing to the solution of practical problems. These interventions, according to the author, are opposed to basic research, which aims to expand knowledge, without the existence of concern with its possible practical incentives.

According to Coll (2002), aiming at a constructivist perspective, "the ultimate purpose of a pedagogical intervention is to contribute to the student's progress in the realization of meaningful learning". According to Damiani *et al* (2013), pedagogical interventions are characterized by pedagogical transformations or novelties, with the purpose of achieving improvements and advances in learning processes, with a subsequent evaluation of this path.

Taking into account the meaning of pedagogical intervention, researchers Agudelo and García (2010) emphasize that experimental activities in Geosciences are decisive tools to favor the learning process. Since the development of training spaces in Earth Sciences, in general, has not systematically incorporated procedural content as learning objectives, nor does it show a unification of criteria in the teaching network as to the type of experimental activities that can be implemented and generalized in the educational process. Considering that these spaces constitute a first approach for students of Professional and Technological Education, they should be motivating spaces that stimulate scientific thinking, however, they have traditionally been developed with a theoretical content orientation that limits their experimental nature.

According to Sierra and Barrios (2013), the disconnect between theory and practice can lead to the reinforcement of a misconception of Geosciences, giving them a stigma of theoretical knowledge of great difficulty and little motivation, also limiting the understanding of the application of the scientific method, fieldwork and its importance in the empirical sciences.

In Professional and Technological Education, several isolated efforts are known, carried out by small groups of teachers who have implemented experimental practices in their classrooms, making adaptations to the resources available in the network and to their own experiences, however, the lack of homogeneity in the different teaching centers has prevented the conciliation of standardized practices that could be replicated at the national level and meet the criteria of adequacy and sustainability necessary for its execution.

According to Bezzi (1999), geoscientists and educators involved in Earth Sciences have the great responsibility of transforming education in Geosciences into a process that must go beyond the mere teaching and learning of facts, laws and theories, it must involve the understanding of nature and its relations with society.

In this sense, the Proposal for Pedagogical Intervention on the agenda here aimed to sensitize teachers and students of two technical courses in Mining in Professional and Technological Education in the public network in the State of Minas Gerais in order to improve pedagogical practices in the classroom about Gemology. Thus, the following guiding question arose: How can students of the Technical Course in Mining, specifically of the discipline of Mineralogy, improve knowledge about Gemology?

In order to achieve the proposed objective, the theoretical concepts about the theme in question were presented to the students, previously in a dialogued lecture. Subsequently, they were invited to participate in a complementary teaching activity, which was the sample of several cut gemstones and raw minerals, which had as its main focus the recognition of a large number of gems in order to improve and deepen the knowledge and understanding of the points addressed a priori in the expository class. This was followed by the construction of a Gemological Kit, with its respective Manual of Gemological Minerals, and finally, as a complementary activity, a field excursion was carried out, where the "*in situ*" observation of gem producing sites was conducted, with a long content on the formation and production of these minerals.

Finally, it is intended to facilitate the reading and understanding of the content of this Final Course Work and, in general, to describe the distribution of the research work developed. Starting with the presentation of the introduction to the theme, encompassing the objective of the study, guiding question and a brief description of the methodology used. The theoretical framework of the subject is presented below. Subsequently, the methodology applied in detail. The results obtained are presented below. Finally, we will conclude with the final considerations of the research.

PROFESSIONAL AND TECHNOLOGICAL EDUCATION (EPT) IN BRAZIL

In Brazil, Professional and Technological Education (EPT) can be considered as one of the most challenging and complex specialties of education in existence. According to Rosa Júnior, Rosa and Mata (2017), Professional and Technological Education concentrates the functions of forming citizens (the main function of all types of education) and also training labor for the market (the unique function of EFA). All of this requires great effort from teachers and students in order for the teaching and learning process to be built in a convincing way.

In this way, the Law of Guidelines and Bases of National Education (LDB), Law No. 9,394/96, regulates that the EFA student must receive a comprehensive education that prepares him

for life in all senses. In this sense, according to Góes *et al* (2015), the contents addressed must be linked to the socio-political reality of the student, whose education must develop their critical vision, the understanding of society's contradictions and the construction of a committed, ethical and competent professional practice. For Aguiar (2016), observing the economic-social-political situation experienced in Brazil, the challenge of EFA is expressive, given the diversity of realities of students in Brazilian educational institutions.

TECHNICAL COURSES IN MINING

The Mining Courses in Professional and Technological Education generally aim to train mid-level technical professionals-citizens in the mining area, with technical and ethical competence, with a high degree of social responsibility and that contemplates a new profile to know, know how to do and manage activities specific to the area such as prospecting, research, planning, mining and treatment of mineral assets.

These courses are usually based on pedagogical practices that support the integration of theory and practice, aiming to train the graduate professional for the adequate performance of the professional activities inherent to the mining sector.

In this way, the disciplines deal with issues related to the environment in a permanent, continuous and transversal way, providing the individual and the community with the construction of social values, knowledge, skills, attitudes and competencies aimed at the conservation of the environment, a good for the common use of the people, essential to a healthy quality of life and its sustainability, according to Law 9.795 of April 27, 1999. which provides for environmental education, and institutes the National Policy for Environmental Education and makes other provisions.

TEACHING OF EARTH SCIENCES

Since the end of the twentieth century, teaching difficulties have arisen for teachers of Earth Sciences. According to Groves (1996), many teachers are unfamiliar with rocks and minerals, they have limited knowledge and few resources of reference materials, needing help from experts who share their knowledge and experience.

According to Pedrinaci (2013), there is an international consensus on certain guidelines or methodologies that can be useful to promote literacy in Earth Sciences, which involves offering a wide range of activities, such as map handling, laboratory activities such as the identification of rocks and minerals, as well as field activities, among others.

On the other hand, García Aguilar (1998) raises the difficulty involved in the selection and organization of practical activities, necessary in some disciplines of Earth Sciences, and that this is due to:

Problems with laboratory supplies (need for equipment and items that are rarely found in a teaching center). In addition to the scarcity or even absence of proposals for truly operational practical activities.

We know that the reality of each country influences the teaching tools used by teachers, since as Chakour *et al*. (2019), suggest that in technical education, less than 30% of teachers use models, rocks or thin sections, and topographic or geological maps. This is mainly due to the absence of Earth Science Laboratories and the inability of teachers to use certain geological tools.

The lack of Earth Sciences laboratories and the lack of teacher training with difficulties in the use of certain materials are crucial aspects in the teaching of these sciences, as Chakour *et al*. (2019), state that teacher training should be based on what is practical and applicable, including planning, field visits, and practical work, so that teachers take ownership of geological concepts and phenomena, which will undoubtedly result in the necessary conceptual changes.

One option for incorporating hands-on activities into the classroom is to make specialized science kits designed for the study of concepts in a particular area, especially in cases where there is no laboratory equipment or facilities. Reinforced in previous experiences.

According to Piltz and Gruver (1963), in this way, having knowledge of this topic with more accurate information helps to make better use of the kit material, since, ultimately, the teacher's decision about the use of a kit or other equipment in the science teaching-learning process is related to the purpose and type of activity involved.

In such a way that committing to the incorporation of experimental activities in the teaching of Earth Sciences and in the training of teachers who are dedicated to teaching them, is something that must be done to achieve the improvement of the educational quality in the teaching of Geosciences and to arouse interest among future generations.

METHODOLOGY

The methodology applied in this research was developed with two classes of the 1st year of the curricular matrix of the Technical Course in Mining in Professional and Technological Education in the State of Minas Gerais for one month. In total, 55 students took part in the research. According to the 4th edition of the National Catalog of Technical Courses, approved by CNE/CEB Resolution No. 2, of December 15, 2020, the graduate of the Technical Course in Mining will be qualified to:

- Carry out prospecting, technical and economic evaluation, planning, extraction and production activities related to natural resources;

- Provide technical assistance and advice to the study and development of technological projects and research or to the work of inspection, expertise, arbitration and consultancy;
- Prepare budgets, reports, opinions, reports and projects, including the incorporation of new technologies;
- Perform topographic surveying, remote sensing and geoprocessing, according to their professional training;
- Assist in the characterization of ores under the physical-chemical, mineralogical and granulometric aspects. Execute projects of dismantling, transportation and loading of ores;
- Monitor the stability of rocks in underground and open-pit mines. Assist in geological mapping and sampling on surface and subsurface.
- Supervise, coordinate and operate fragmentation, mineral separation, solid/liquid separation, hydrometallurgical and drying equipment;
- Supervise, coordinate and operate mineral extraction, drilling, drilling, sampling and transportation equipment;
- Guide and coordinate the execution of equipment maintenance services;
- Provide technical assistance in the purchase, sale and use of specialized equipment.

In this way, and to achieve some capacities, there are disciplines such as mineralogy that within its syllabus indicates the knowledge of "Basic notions about minerals and the processes that form minerals. Study of physical and chemical properties. Classification and identification of mineral groups: Native Elements, Sulfides, Sulphates, Oxides, Sulphosals, Haloids, Carbonates, Nitrates, Borates, Phosphates, Wolframates and Tungstates and Silicates. Genesis and stability of minerals and their practical applications. Basic Mineralogy of the Earth's Major Compartments". Not presenting a direct contact with Gemology.

DEVELOPMENT OF PEDAGOGICAL INTERVENTION

To carry out the research, a plan of activities was elaborated, as follows: (1) Application of a questionnaire to characterize the knowledge profile of the students with a duration of 30 minutes; (2) Presentation of theoretical content in the classroom, defined in three moments:

- **First:** exposition on the theme putting on the agenda the most diverse concepts about gemology. At this stage, the professor highlighted the importance of the various gemological varieties existing in nature, as well as the commercial value they represent within the mining production chain. With a duration of 90 minutes.

- **Second:** after the initial moment (videos and teacher's explanation) it was time to divide the students into groups, remembering that the number of students per group depends on the need and adequacy of the room. With a duration of 90 minutes.
- **Third:** in this stage, each group of students was given several types of minerals (raw) and cut gemstones, defined by the teacher and from this the mineral identification activity was developed effectively, culminating in an approximation in the recognition of these. With a duration of 120 minutes.

(3) Realization of a practical class in the preparation of a didactic kit of Gemological Minerals, and the elaboration of a Manual of Gemological Minerals, taking into account that there are approximately 3500 mineral species, and only about 70 of these have characteristics to be defined as GEMS, with a duration of 150 minutes. And (4) Carrying out a field practice in the city of São José da Safira (MG), where "*in situ*" gem producing sites were observed, with a long content on the formation and production of these minerals.

Bearing in mind that practical experiences, in the laboratory or field, are essential activities for students to experience the theories that are intended to be taught. For example, in Mining, Geology, and in general in Geosciences, field activities are indispensable. However, because these are activities that require considerable financial resources, they are sometimes minimized or neglected by those responsible.

STUDENTS' KNOWLEDGE PROFILE ABOUT GEMOLOGY

Initially, the students were invited to participate in the study, answering a questionnaire related to their previous knowledge about gemology, elaborated with the purpose of mapping their knowledge in the area. The questionnaire opened with a number of 10 questions. Of the 55 students in the two classes, 52 participated in the research. With the first stage of the questionnaire, it was possible to observe that 72.72% (40 students) had no knowledge of the area and the other 27.28% (12 students) had some knowledge about gemology.

RESULTS

The implementation of this Pedagogical Intervention allowed the improvement in the area of Gemology of a total of 04 teachers involved in the research. As a result of the analysis of the improvement and consultation sessions carried out during the study, the previous knowledge of the professors who teach in the technical courses in Mining in the discipline of Mineralogy was evaluated, and evidence of improvement in their understanding of the content on Gemology was identified.

In this context, the compendium of experimental activities and the elaboration of the Manual of Gemological Minerals, generated and validated by revision, constitute a concrete product that was condensed and improved during the course of the pedagogical intervention.

The content of the Gemological Minerals Manual was progressively organized for the acquisition of skills and procedural tasks specific to the training spaces, and includes two face-to-face moments, taking into account some specific characteristics, such as:

- Identification of minerals *in situ*;
- Physical and Chemical Properties of Minerals;
- Classification of igneous rocks;
- Classification of metamorphic rocks;
- Recognition of some important Geological Units and Structures in Brazil, such as the Pegmatitic Provinces.

The creation of a didactic kit with most of the gemological minerals was observed as a necessary instrument to carry out the following activity, which was a field reconnaissance and constitutes a second concrete result obtained in the research process.

The didactic kit built can be indicated as an important step in the process of teaching Gemology as an area of Geosciences, specifically Mineralogy, since, through research carried out, we identified that there are no local or national suppliers of this geological material that meet the scientific and pedagogical criteria necessary for its use in the execution of experimental practices of a formative nature. which, in this way, constitutes an important aspect in the research process.

In addition, a physical space was assigned and conditioned within the premises of the headquarters of the institutions contemplated with these activities so that they can develop experimental tasks that serve as a center for the production and testing of new didactic materials for the teaching of Geosciences.

On the other hand, the total number of participants in the Pedagogical Intervention (teachers, students, researchers and instructors' organization) openly expressed their interest in continuing training in the area of Geosciences specifically on Gemology, which indicates a good impact on the motivation of teachers in this area, as a result of the Pedagogical Intervention carried out in this study.

According to the comments of the teachers participating in the Pedagogical Intervention, the most frequent use they made of the Manual of Gemological Minerals and the didactic kit (either in the replication of practices or in their use as demonstration material) were for the identification and characterization of these minerals, highlighting as important achievements that:

1) The students carried out "collection and classification of different minerals and rocks in their communities."

2) They made a "field trip to see other pegmatite-related fields.
3) To make students relate Geosciences in the context where they develop their daily activities.

In addition to the above, it was identified that the professors who teach these spaces tend to be professionals who, for the most part, lack knowledge in the area of Gemology, which points to the need to implement processes of continuous training and spaces for pedagogical reflection, in search of improvement in the in-depth understanding of the subject and their professional performance.

In addition, it was also possible to identify the main reasons that prevent the content of the Pedagogical Intervention from being replicated in full, which according to the comments of the teachers surveyed correspond mainly to:

1) The lack of physical space within the facilities for the execution of laboratory and practical activities;
2) The reduced effective time for the execution of experimental practices.

Despite the above, it is interesting that many teachers stated that they have used both the Manual of Gemological Minerals and the didactic kit, as material in different disciplines such as General Geology, Petrography in Geology Courses, indirectly impacting the experimental activity in other pedagogical spaces.

Thus, the most replicated contents outside the Technical Course in Mining correspond to the units of: Identification of minerals *In Situ* and the Physical and Chemical Properties of Minerals, which indicated a good perception of the usefulness of the Manual of Gemological Minerals and the didactic kit, as well as the need to continue generating educational material adapted to the context of Professional and Technological Education.

CONCLUSIONS

The development and implementation of experimental activities adapted to the reality of Professional and Technological Education and to the local context, such as those proposed in this Pedagogical Intervention, are an effective and accessible complement for the improvement of the teaching-learning processes of Geosciences, returning the experimental character to these disciplines such as Mineralogy, given the predominantly theoretical approach to which the teaching of Geosciences has been submitted in the formation of Education Professional and Technological.

The promotion of accessible didactic material with characteristics that allow its sustainability with local resources, as presented in the didactic kit produced in this study, favors experimentation in Geosciences and reduces the costs associated with the execution of experimental practices.

Finally, it should be noted that the Pedagogical Intervention carried out during this study managed to stimulate interest at the institutional level, around the importance that should be given to

experimental activity in the teaching of Geosciences and the constitution of interdisciplinary research teams, to contribute to the improvement of the teaching-learning process.

REFERENCES

1. Agudelo, J. D., & García, G. (2010). Aprendizaje significativo a partir de prácticas de laboratorio de precisión. Latin-American Journal of Physics Education, 4(1), 22. http://www.lajpe.org/jan10/22_Gabriela_Garcia.pdf

2. Aguiar, R. F. (2016). Docência na educação profissional e tecnológica: influência da formação no processo ensino-aprendizagem (Dissertação de mestrado). Universidade de Brasília, Brasília.

3. Becker, F. (1993). A Epistemologia do Professor: O cotidiano da escola. Petrópolis: Vozes.

4. Bezzi, A. (1999). What is this thing called geoscience? Epistemological dimensions elicited with the repertory grid and their implications for scientific literacy. Science Education, 83, 675-700.

5. Chakour, R., Alami, A., Selmaoui, S., Eddif, A., Zaki, M., & Boughanmi, Y. (2019). Earth Sciences Teaching Difficulties in Secondary School: A Teacher's Point of View. Education Sciences, 9(3), 243. https://doi.org/10.3390/educsci9030243

6. Coll, C. (2002). Aprendizagem escolar e construção do conhecimento. Porto Alegre: Artes Médicas.

7. Damiani, M. F., Rochefort, R. S., Castro, R. F., Dariz, M. R., & Pinheiro, S. S. (2013). Discutindo pesquisas do tipo intervenção pedagógica. Cadernos de Educação: FaE/PPGE/UFPel, 45, 57-67.

8. Ferreira, A. B. H. (1999). Novo Aurélio Dicionário da Língua Portuguesa Século XXI (3ª ed.). São Paulo: Nova Fronteira.

9. García Aguilar, J. (1998). Ideas sobre la realización de actividades prácticas en Ciencias de la Tierra y el Medio Ambiente. Enseñanza de las Ciencias de la Tierra, 74-75.

10. Groves, L. (1996). Considerations in stimulating students' and teachers' interest in geology and rockhounding. Oklahoma Geological Survey Special Publication 96-5, 103.

11. Gil, A. C. (2010). Como Elaborar Projetos de Pesquisa (5ª ed.). São Paulo: Atlas.

12. Góes, F. S. N., Côrrea, A. K., Camargo, R. A. A., & Hara, C. Y. N. Necessidades de aprendizagem de alunos da Educação Profissional de Nível Técnico em Enfermagem. Revista Brasileira de Enfermagem, 68(1), 20-25.

13. Pedrinaci, E. (2013). Alfabetización en Ciencias de la Tierra y competencia científica. Enseñanza de las Ciencias de la Tierra, 213. https://raco.cat/index.php/ECT/article/view/274153/362246

14. Piltz, A., & Gruver, W. (1963). Science Equipment and Materials: SCIENCE KITS. Bulletin.

15. Rosa Júnior, C. A., Rosa, V. C. M., & Mata, L. A. (2017). Anotações sobre o Processo Ensino-Aprendizagem na Educação Profissional e Tecnológica. Recuperado de http://www.esocite.org.br/eventos/tecsoc2011/cd-anais/arquivos/pdfs/artigos/gt014-anotacoessobre.pdf

16. Sierra, C. A. S., & Barrios, R. L. A. (2013). Las prácticas de laboratorio en las ciencias ambientales. Revista Virtual Universidad Católica del Norte, 3(40), 191-203.

17. Szymanski, H., & Cury, V. E. (2004). A pesquisa intervenção em psicologia da educação e clínica: pesquisa e prática psicológica. Estudos de Psicologia, 9(2), 355-364.