

MENDIVE



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Original article

Safety and health at work of Mining Engineering students

La seguridad y salud en el trabajo en estudiantes de la carrera Ingeniería de Minas

Segurança e saúde no trabalho em estudantes da carreira de Engenharia de Minas

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ABSTRACT

The education of engineers in carrying out actions for the prevention of occupational risks, accidents and incidents and professional diseases is part of the integral training to which Cuban higher education contributes. For this reason, a study of the theoretical basis was made, it allowed to determine the main aspects of the subject that converge in its development with the help of the teaching tasks. This justifies, the use of methods such as: dialectical-materialist, historical-logical, analytical-synthetic, inductive-deductive, pedagogical observation, interview, survey and mathematical-statistical methods. That is why the aim is: to elaborate teaching tasks that promote Education on Safety and Health at Work of Mining Engineering major students, in the University of Moa, Dr. Antonio Núñez Jiménez. The result showed that the insufficiencies presented by the students require alternatives that favor the transformation of the current reality in several scope of action, and fostering their education as part of the country's economic and social development project.

Keywords: occupational accidents; occupational diseases; Safety and Health at Work; teaching tasks; Mining Engineering.

RESUMEN

La educación de los ingenieros en la realización de acciones para la prevención de riesgos laborales, accidentes e incidentes y enfermedades profesionales forma parte de la formación integral a la que contribuye la Educación Superior cubana. Por esta razón, se realizó un estudio del basamento teórico, que permitió conocer los principales aspectos de la temática que convergen en su desarrollo con el auxilio de tareas docentes. Ello justifica la utilización de métodos tales como: dialéctico-materialista, histórico-lógico, analítico-sintético, inductivo-deductivo, la observación a clases, la entrevista, encuesta y métodos

matemáticos-estadísticos. Por ello se persiguió como objetivo: elaborar tareas docentes que propician la Educación de la Seguridad y Salud en el Trabajo en estudiantes de primer año de la carrera Ingeniería de Minas, de la Universidad de Moa "Dr. Antonio Núñez Jiménez". El resultado evidenció que las insuficiencias presentadas por los estudiantes precisan de alternativas que favorezcan transformar la realidad existente en las diversas esferas de actuación, y que propicien su educación como parte del proyecto de desarrollo económico y social del país.

Palabras clave: accidentes de trabajo; enfermedades profesionales; Seguridad y Salud en el Trabajo; tareas docentes; Ingeniería de Minas.

RESUMO

A formação de engenheiros na realização de ações de prevenção de riscos, acidentes e incidentes ocupacionais e doenças ocupacionais faz parte da formação integral para a qual contribui o Ensino Superior cubano. Por esse motivo, foi realizado um estudo de fundamentação teórica, que permitiu conhecer os principais aspectos do assunto que convergem no seu desenvolvimento com o auxílio de tarefas de ensino. Isso justifica a utilização de métodos como: dialético-materialista, histórico-lógico, analítico-sintético, indutivo-dedutivo, observação de aula, entrevista, levantamento e matemático-estatístico. Por esta razão, perseguiu-se o objetivo: desenvolver tarefas pedagógicas que promovam a Educação para a Segurança e Saúde no Trabalho em alunos do primeiro ano da carreira de Engenharia de Minas, da Universidade de Moa "Dr. Antonio Nunes Jiménez. O resultado mostrou que as insuficiências apresentadas pelos alunos exigem alternativas que favoreçam a transformação da realidade existente nas diversas esferas de atuação, e que promovam sua formação como parte do

projeto de desenvolvimento econômico e social do país.

Palavras-chave: acidentes de trabalho; doenças ocupacionais; Segurança e saúde no trabalho; tarefas de ensino; Engenharia de minas.

INTRODUCTION

The concept of Safety and Health at Work evolves to the same extent as man. Since primitive times, he felt the need to protect himself, first of all, from the inclement weather and from the attack of animals; after the industrial revolution, with the invention of machinery for work, of the risks generated by development itself. Therefore, it was at that time that the first studies for its prevention, the first legislation and the inspection mechanism originated.

In the literature consulted about Occupational Safety and Health, the following stand out: Céspedes and Martínez (2016); Rooster and Beak (2017); Roman (2017a, 2017b, 2019); Fields and others (2018); Orozco (2018); Guerrero (2019) and the Constitution of the Republic of Cuba (2019). In these investigations, questionnaires have traditionally been offered to evaluate working conditions, teacher occupational health, preventive strategies, and article 69 of the Constitution establishes the right to Safety and Health at Work.

The research contributions of the referenced authors are aimed at primary education, for the design and implementation of a safety and health management system at work and postgraduate; however, a treatment from the pedagogical sciences aimed at Safety and Health at Work is necessary, for the

comprehensive training of the students of the Mining Engineering career.

On the other hand, the National Office for Standardization (2005) defined it as the activity aimed at creating conditions, skills and culture so that the worker and his organization can carry out a work activity efficiently and avoid events that may cause work-related damage. In other words, to guarantee an adequate environment with the aim of preventing and impeding the appearance of occupational diseases.

Therefore, Occupational Health and Safety encourages the worker to carry out their work efficiently and without risk, prevents events from occurring that affect their health and integrity, the assets of the entity and the work environment.

In this regard, Rodríguez (2007) defined it as the systematic application of policies, procedures and management practices to analyze, assess, evaluate and prevent the different types of risks faced by the company.

Regarding its scope, the concepts of Safety and Health at Work are applied to any work environment, which includes mining. This encloses the journey and the time spent as part of the working day, therefore, safe travel constitutes one of the areas that contains the subject in question.

Mining has been, since ancient times, one of the fundamental activities for the economic and technical progress of man. Almost all of the material goods that man uses come from the transformation of natural products, which is why mining resources occupy a prominent place. This indicates the need for students to know the risks to which they are exposed in their jobs and to develop safe habits that tend to protect their safety, their health and that of their colleagues.

In this effort, the professional pedagogical approach of all the training activities developed and the change that is required in the theoretical and methodological conceptions on Safety and Health at Work are aspects of research interest.

Cuban Higher Education aims to contribute to the comprehensive training of professionals prepared to carry out actions that promote their education and the use of natural resources in a harmonious way, as part of the country's economic and social development project.

Consequently, Occupational Health and Safety must be disseminated among the subjects involved. In this sense, the teacher and the students need to be aware of the commitment and the policy that is developed in terms of prevention. In this way, it is known that the risks are part of the daily action and that they will continue to exist. But, the fact that they are present does not imply that they materialize in accidents.

Based on the foregoing, the Mining Engineering career at Moa University "Dr. Antonio Núñez Jiménez" must promote the education of Occupational Health and Safety in students, expressing themselves in a practical, professional and comprehensive way, which implies not only observing and executing alternative solutions, but also contributing to transform the existing reality in the various spheres of action.

For this, a factual diagnosis was made to the students of the aforementioned career, in the 2019-2020 academic year, through which it was possible to verify that in the training process of the mining profile professional is insufficient in the treatment from didactics to Safety and Health at Work.

The foregoing made it possible to specify the existing problematic situation, evidenced in the insufficient perception of risk by the students, the insufficient actions in favor of

Safety and Health at Work for their training and the incorrect formulation and orientation of the objectives related to Health and Safety at Work, from the point of view of knowledge, skills and actions.

For these reasons, in the present investigation the objective is to present teaching tasks that promote Safety and Health at Work in the students of the Mining Engineering career.

MATERIALS AND METHODS

This study was conducted in the 2019-2020 academic year. The following were selected as a sample: 10 professors from the Department of Mines, five assistants from the companies "Ernesto Che Guevara" and "Pedro Soto Alba" and the 17 first-year students of the career with the first-year students of the Mining Engineering career from Moa University "Dr. Antonio Nunez Jimenez. The research is predominantly qualitative, non-experimental, with an emphasis on the theory of the science being studied.

With the purpose of fulfilling the proposed objective, the dialectical-materialist method was assumed as the general method of science, which allowed the analysis of the object of study and facilitated the orientation of the teaching tasks in terms of promoting Safety and Health at Work in the students of the Mining Engineering career.

Scientific research methods of the theoretical and empirical levels were used, as well as the following mathematical-statistical ones:

The historical-logical method: it was used to assess the evolution and development of the object of the investigation, its development and the fundamental historical connections, the essence of the phenomenon investigated at the fact-perceptual level.

The analytical-synthetic: made it possible to process information, determine the main theoretical and methodological references of Occupational Health and Safety Education in the Mining Engineering career and the development of teaching tasks.

The inductive-deductive: allowed to determine the state of the investigated problem, its possible causes and assess the educational practice with the application of teaching tasks. In addition, it was used to know the essential characteristics of the research object, as well as its initial and final state.

To verify what was stated, methods of the empirical level were applied, such as: observation of classes, surveys and interviews with students and teachers.

The observation to classes: made possible the verification of information, directed to the detailed perception of the actions of the students of the Mining Engineering career, of the University of Moa "Dr. Antonio Núñez Jiménez", in its spheres of action.

The interviews with students and professors: were used to collect information offered by the first-year students of the Mining Engineering career, in relation to the knowledge they have about Safety and Health at Work, their potentialities, deficiencies and limitations, as well as in the consensus among teachers about the feasibility of the conceived teaching tasks.

The surveys, applied to the first-year students of the Mining Engineering career and to the professors who teach the subject in said career, to check the level of knowledge they have about Safety and Health at Work.

In addition, mathematical-statistical methods were used, with emphasis on percentage calculation for data processing, with the help of descriptive statistics.

The analysis of the results of the methods and techniques applied to search for information about Safety and Health at Work, in a general sense, allowed us to verify that:

- There are insufficiencies in the methodological design of the Ergo-environmental Training Curriculum Strategy.
- The Curriculum Strategy only exists at the career level and is implemented through the Ergo environmental Protection discipline.
- The actions related to the Curriculum Strategy are only reflected in the teaching-methodological work plan of the groups of academic years.

Therefore, the application Ergo-environmental Training Curriculum Strategy implies not only observe and execute alternative solutions, but rather rebuild, reformulate and transform the existing reality in the various contexts and spheres of action from an interdisciplinary point of view.

RESULTS

From the application of the empirical methods used (observation to classes, interviews, surveys of students and teachers), the insufficiencies present in the teaching-learning process on Safety and Health at Work were determined in the students of the Mining Engineering course. Therefore, it considers a didactic response necessary to solve the limitations through teaching tasks.

Six controls were carried out in classes to the professors of the Mining Engineering career who teach in the different subjects. From the analysis carried out with the observation of classes, an insufficient treatment of the objectives oriented to Safety and Health at

Work was corroborated, in order to achieve an integral formation in the students and create an awareness related to accidents, incidents and professional illnesses.

One aspect contributed by the observation was the high level of motivation shown by the students in their attention and participation during the teaching-learning process. However, this motivation is affected by the fact that their real professional activities are not represented in the didactic actions aimed at Safety and Health at Work, during work practice, in tasks and learning situations used in the educational context.

On the other hand, a survey was applied to 17 first-year students of the Mining Engineering career, with the objective of knowing the degree of difficulty of the same on the contents of Safety and Health at Work. Of the total number of respondents, the results show that 76.4% showed interest in the classes of the career disciplines; not so 23.6%, who showed lack of motivation on security issues.

53.0% expressed that conceiving the study of Safety and Health at Work outside the curriculum benefits their learning and 47.0% stated their preference for receiving the content of the subject within the curriculum. That is why 82.3% stated that there is ignorance on the subject, aspects considered in the investigative process.

In the interview conducted with 10 professors from the Department of Mines, five assistants from the companies "Ernesto Che Guevara" and "Pedro Soto Alba" and the 17 first-year students of the career, it was found that there are difficulties in the treatment of the theoretical and methodological fundamentals on Safety and Health at Work, through the different disciplines and subjects of the career. 90% of the interviewees agree that, despite recognizing its importance, there are no actions aimed at its implementation during

the teaching-learning process; only 10% state that some teachers in an interdisciplinary way introduce the importance of Safety in their classes.

In addition, a survey was applied to the professors of the Mining Engineering career with the objective of determining the level of application of the contents of Safety and Health at Work through the different subjects of the curriculum to improve the teaching process. learning of the Mining Engineering career. The results of the same showed that 53.4% took into account Safety and Health at Work from the formulation and orientation of the objectives of the classes; the rest, 46.6%, only conceived its own content in their subject.

46.1% of the teachers surveyed used adequate and up-to-date methods and procedures during the classes taught; 53.9% expressed that they continued with the implementation of traditional methods during the teaching-learning process. Only 15.3% of the total number of respondents used teaching aids related to the teaching of Safety and Health at Work.

Regarding the evaluation, 46.1% considered that the evaluative forms they use allowed to obtain an evaluative, quantitative and qualitative criterion of the students, but not 53.9%, who expressed the need to improve this category through self-evaluation, heteroevaluation and coevaluation.

Teaching tasks are considered a fundamental part of the educational teaching process. They promote knowledge, skills and values to be formed, thus facilitating the student's instruction, development and education.

Hence it is conferring an important role to teaching tasks, in the appropriation of information and necessary knowledge in students, to achieve their cultural training and, consequently, a more effective learning. In this purpose, the foundation of the tasks

is constituted by the contradiction between what one has and what the subject wants to achieve; that is, it is precisely the contradiction of the problem posed in the tasks that advances thought on the path to its solution.

To achieve this, it is necessary that there be changes in the conception for the elaboration of teaching tasks, since these must encourage the teacher to pay attention to the individual differences of their students, based on an adequate diagnosis and depending on the levels of assimilation, which contributes to their integral formation.

For the conception and elaboration of the teaching tasks, the different classifications were considered according to the levels of assimilation.

1. Reproductive tasks: are those that require the student to repeat the content that has been reported, either in a declarative way or in solving problems that are the same or very similar to those already solved.

2. Productive tasks: require the student to be able to apply the content in new situations. In this way, when it solves problems whose situation is unknown to it and that requires to conceive the way of its solution.

3. Creative tasks: the student works in new conditions and situations. Here he has to make qualitatively novel contributions; for this, he uses the logic of research.

This classification highlights the role of teaching tasks in teacher-student interaction, to achieve the leading role of future professionals who are needed in current conditions. The activities that make up the proposed teaching tasks are differentiated based on the diagnosis and depending on the levels of assimilation.

The tasks are linked to different subjects of the curriculum, such as Notions of Mining,

General Geology, Open Pit Mining, Underground Mining, Mining Mechanization, Protection of Mining Work and Chemistry, with the aim of guaranteeing in students' knowledge, habits, skills basic and professional values to face socio-professional activities; as well as the development of awareness about the protection of the environment and of man, where the effects produced by mining activity and the proposals for measures to prevent occupational risks and mitigate environmental impacts are valued.

The tasks are motivating and are related to the study profile. They make it possible to minimize the risk caused by accidents, incidents and professional illnesses as a way of preparing for Occupational Health and Safety content and contributing to their comprehensive training.

For the elaboration and concretion of the teaching tasks, the role of the company and its specialists was considered as an essential educational context in the training of professionals in the Mining Engineering career.

Methods

Various methods were used for the application of the teaching tasks:

- According to the logical ways of obtaining knowledge: inductive, deductive and analytical-synthetic.
- According to the sources of obtaining knowledge or forms, by the form of perception: oral, visual and practical.
- According to the degree of participation of the subjects: exhibition, independent work and joint elaboration.
- According to the degree of mastery or level of assimilation of the teaching content: active or productive.

Media

It is important to explain that, in order to carry out teaching tasks, students must have the corresponding technical documentation (standards, manuals, general and specific instructions, etc.) and the regulations applicable to the situation to be verified; at the same time, they must have the opportunity to delve, through experts in the field, into some essential topics about the activity they carry out. The teacher must provide the basic bibliographic sources that correspond to each theme and the complementary means that will facilitate the performance of the teaching tasks.

Evaluation of teaching tasks

The student, once he advances in the development of the tasks, must be able to self-assess his work, so the evaluation does not focus on the final result, but rather it assesses his learning process from the moment he is able to work without the help of the teacher or another more capable colleague.

On the other hand, evaluation (co-evaluation, hetero-evaluation and self-evaluation) is present in the teaching tasks, considered as a frequent action, integrated in the teaching-learning process, in order to improve it and check the real state of student learning in carrying out teaching tasks.

Activity 1

Semester: first.

Subject: Notions of Mining.

Objective: to classify occupational risks in a company.

Content: occupational risks.

Procedure: students must select and classify the occupational risks that can originate in a company, which could result in an incident, accident or occupational disease, through the solution to a problem.

1. Based on the existing risks in the different mining fronts, make an inventory of them, taking into account everything that could result from an incident, accident or professional illness.

Classify these risks and make a list according to their causes (organizational, technical and behavioral).

a) Assess the plans that include prevention programs in a company selected by you.

b) Carry out an analysis of the qualitative and quantitative management indicators that are used in a company selected by you for the control of the Occupational Health and Safety Management Model (MGSST), which is applied in it.

c) Select the production process of the "Pedro Soto Alba" Mine and make a general checklist to identify dangerous situations.

d) Make as many specific checklists as you consider necessary to identify these situations.

Activity 2

Semester: second.

Subject: General Chemistry.

Objective: to evaluate the occupational risks that appear.

Content: occupational risks.

Procedure: students must evaluate occupational risks through the solution of a problem.

2. In the Chemistry Laboratory of the University of Moa "Dr. Antonio Núñez Jiménez" the following risk factors were discovered:

a) Lack of fume hood in the chemistry lab. The substances used are highly toxic, which can cause chronic diseases with continuous exposure and acute diseases in the event of a breakdown in the process. The possibility of constant damage.

b) Poor condition of the burner hoses. Light burns occur very frequently.

c) Electrical equipment does not have ground anchorage. Accidents of electrical origin can occur, so it is possible that they leave disabling sequels, although it is unusual for them to occur. Apply the risk assessment that appears in the Labor Code (2013), Law 116.

Activity 3

Semester: first.

Subject: General Geology.

Objective: to identify occupational risks in a company.

Content: occupational risks.

Procedure: students must mention the occupational risks that can originate in a company, which could result in an incident or accident, through a case study.

3. Geological risks are those that cause the greatest natural catastrophes. In order to be able to act preventively and minimize the impact of these dangers, both on people and goods, it is necessary to know their behavior and their distribution in the territory. From the point of view of security, mention examples in each of the cases listed below:

a) Those caused directly by the dynamics of internal geological processes.

b) Those derived directly from the dynamics of external geological processes.

c) The induced geological risks caused by the intervention and direct modification of the human being on the geological environment.

Activity 4

Semester: first.

Subject: Open pit mining.

Content: means of individual and collective protection.

Objective: to identify the means of individual and collective protection that mining personnel must use in the different places where they work.

Procedure: students must recognize the means of individual and collective protection that mining personnel must use in the different places where they work.

4. Knowing that open pit mining is the industrial activity that consists of the removal of large amounts of soil and subsoil to later be processed in the extraction of the mineral, answer the following:

a) What means of personal protection should be used by mining personnel who work in places such as offices and others?

b) What specific means of protection should workers who work on transportation machinery use?

Activity 5

Semester: second.

Subject: Underground mining.

Objective: to assess the impact of occupational risks that can originate in underground mining.

Content: occupational risks.

Procedure: students must assess the impact of occupational risks that can originate in underground mining.

5. Taking into account that underground mining is the work that is carried out below the ground:

a) What do you consider could be occupational risks in this modality?

b) Assess its impact in terms of risks to the health of workers.

Activity 6

Semester: second.

Subject: Rock Mechanics.

Objective: to identify the occupational risks that can originate from the use of the different machinery in the transportation of the mineral, in addition to the individual and collective means of protection that the drivers or operators of these machines must use.

Procedure: students must identify the occupational risks that can originate from the use of the different machinery in the transportation of the mineral, in addition to the means of individual and collective protection that drivers and operators must use.

Content: occupational risks.

6. The following machines and equipment are used in mining tasks and works: excavators, backhoes, loaders, skid-steer loaders,

dumpers, bulldozers, motor graders and compactors. Of them say:

a) What types of risks could arise from the use of the different machinery?

b) What means or personal protection equipment should the drivers or operators of these machines use?

Activity 7

Semester: first.

Subject: Notions of Mining

Objective: to classify the type of fire that occurred in machinery

Content: fire classification.

Procedure: students must classify the type of fire that occurred in machinery and assess the type of risk that occurred, through the solution of a problem.

7. In the production process there are different machines and equipment that are used in mining works. In a loader, which circulated between 7:00 pm and 8:00 pm, a fire caused by a short circuit occurred, but this did not cause damage to the worker.

a) Classify the type of fire.

b) State the type of fire extinguisher being used in this case.

c) Assess whether the risk occurred is an incident or an accident.

Activity 8

Semester: first.

Subject: Protection of mining work.

Objective: to identify the Cuban legal norms that regulate Safety and Health at Work.

Content: legal norms.

Procedure: students must identify the Cuban legal norms that regulate Safety and Health at Work.

8. In Cuba there are different regulations that regulate the protection of mining work as a guarantee for the safety and health of those who perform these functions:

a) Could you mention what these legal norms are?

Activity 9

Semester: first.

Subject: Notions of Mining.

Objective: to identify the causes that originated the accidents.

Content: accidents at work.

Procedure: students must identify the causes that originated the accidents, through a case study.

9. In 2020, two work accidents occurred at the "Pedro Soto Alba" company that generated the loss of 145 days. So far this year, an occupational accident has occurred that is described below:

The mine uses a work system of 12 hours each (7:00 am to 7:00 pm and from 7:00 pm to 7:00 am). So far this year, the mining transportation trucks have not received maintenance, despite the fact that it was planned for the months of January and March; their technical condition is deficient, fundamentally due to their aging. On April 5, Pedro, who is a mining equipment operator and recently hired worker, had not received

safety instructions, nor had he operated any equipment; he was supposed to go to work at 7:00 pm, but for reasons unknown to the administration he arrived late, at 7:50 pm. As he was quite late, the first thing he did was go to the truck to transport the ore that was in the deposit, at that moment Pedro made a turn that overturned the dump, which caused damage to the worker, when maneuvering the equipment, a sprained his right foot, leaving him disabled for 21 days.

In this period, the company "Pedro Soto Alba" spent \$56.40 for the transfer of the injured person to a care center, \$6,970.63 for replacement of the injured person, \$2,059.00 for subsidy and other costs associated with human resources personnel, such as the time lost by his colleagues and managers at different levels, time spent by the service personnel of the entity of the injured and others, an amount of \$2944.41 CUP.

- a) Calculate and interpret the accident rates of the company in the year 2020, if it is known that the average number of workers was 600 and the hours in the year 2048.
- b) Determine, from the Ishikawa Diagram or Cause-Effect Diagram method, the causes that gave rise to the accident. Classify them.
- c) Classify the costs as direct and indirect and calculate the total costs.

DISCUSSION

In this research, contextualized teaching tasks aimed at the comprehensive training of students in the Mining Engineering career stand out as novel aspects, as an alternative to promote Safety and Health at Work.

As part of the analysis of the consulted literature, the author agrees with Álvarez

(1999), which provides theoretical elements on which this research is based. The analysis of the bibliography consulted showed the existence of a theoretical inconsistency centered on: the insufficient theoretical and methodological references related to Safety and Health at Work, aimed at the students of the Mining Engineering career, which ensures their education from a pedagogical perspective

On the other hand, there are various causes of the low risk perception of students, among them, those related to the methodology used in the teaching of Safety and Health at Work. That is why, during the work practice and as future professionals, the use of the means that are needed for their protection continues to be insisted on.

Hence the need to promote strategies and techniques that make it possible to educate students in aspects related to Safety and Health at Work. Teaching tasks, for example, constitute an ideal way to inculcate in the students of the Mining Engineering career the reduction of work accidents and professional illnesses.

The results obtained during the application of the teaching tasks bring with them the transformation of the educational practice in the formation of the students of the Mining Engineering career.

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The authors have participated in the writing of the work and analysis of the documents.



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