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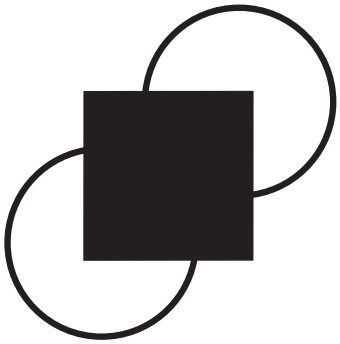

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INTERACTION BETWEEN COURSE UNITS: AN EXPERIENCE IN HIGHER EDUCATION

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Abstract

Given the specificity of the Higher Professional Technical Courses (CTeSP) of Portuguese Polytechnic Institutes, it is important that in the course units related to these courses is promoted, whenever possible, a more contextualized learning environment, less theoretical and more connected to practice. In order to respond to this approach, in the Safety and Environment course unit, integrated in the CTeSP in Mechanical Technology and Vehicles, was followed a methodology that involved the interconnection of this course unit with the one of Automotive Materials Processing I of the same course. It should be noted that, in recent years, it is common for students to carry out a practical group work in the area of Safety and hygiene at work, where they analyse, in a real context, the hazards and risks associated with working with machine tools of the Mechanical Technology laboratory of the institution where they attend the course. As in the 2nd semester, students still attend the Automotive Materials Processing I course unit, where they produce a metal piece using industrial machines, also in the same laboratory, it was considered relevant to take advantage of the work they were developing in that course unit and make a connection with the Safety work. In this sense, in the 2020/2021 school year, it was proposed that students identify hazards and risks associated with the production of the metal piece they were developing, as well as establish preventive and control measures associated with its production (engineering, collective protection and safety signs measures; personal protective equipment; work organization and administrative control; training and information). From the analysis performed, the students created a PowerPoint® presentation to show their productions and present their conclusions to the class. In general, students easily adhered to the proposed task, having committed themselves to its implementation, which was visible in the final assessment, since all those who participated in the work were approved in the course unit. In the student's opinion, the connection between the two course units, motivated them more to carry out the group work, facilitated their learning and helped them to better understand the application of Safety concepts to the practice of mechanics (79.2%, 75% and 83.3% agree or totally agree, respectively). Carrying out the group work, allowed them to know their difficulties, overcome some of them and improve their arguments (79.2%, 83.3% and 95.8% agree or totally agree, respectively). It is considered that the learning resulting from this contextualized work can be useful, in order to promote a greater exchange between course units, and a greater awareness for the application of the course contents in a real context. The experience carried out can be easily replicated to other CTeSP and can significantly contribute as a learning factor for the internship that integrates the study plan of these courses.

Keywords: Higher education, learning in context, interconnection, safety, laboratories.

1 INTRODUCTION

The Higher Professional Technical Courses (CTeSP) are two-year, four academic semesters courses, taught by the Portuguese Polytechnic Institutes. These study cycles have the following components: (i) general and scientific training; (ii) technical training and (iii) training in a work context, which takes place through an internship in the last semester of the course [1].

Due to the particularity of CTeSP, it is important that, whenever possible, in the classes of its course units, more student-centred learning is promoted, with a greater connection to practice and to the respective course. As pointed out by Cabral and Batista [2] it is urgent that teaching and learning contexts enhance the active involvement of students in their own learning process. Not only are students' agents of their own transformation, but also higher education institutions and teachers have a fundamental role in mediating these processes, facilitating and moderating learning contexts that are intended to be in constant evolution, transmutation, and transformation.

It should be noted that the collaboration between teachers from different areas and with different backgrounds, who have been working as a team for some time [3], [4], [5], [6], [7], [8], [9], has contributed to the debate on teaching and assessment practices, leading to the implementation of some more student-centred practices, with results considered favourable from a motivational and learning point of view. For example, Silva, Barros, and Ribeiro [3], [4], [8], [9] concluded, based on their experiences with CTeSP students, that learning is promoted with a strong connection to practice, namely in the laboratory context, there is evidence of a positive impact on students learning. They also verified that the knowledge acquired in the performance of tasks can be useful for other course units.

The CTeSP in Mechanical Technology and Vehicles of the School of Technology and Management of the Polytechnic Institute of Bragança (Portugal) is part of the area of training in Technology and includes in its study plan the course units (UC) of Safety and Environment and of Automotive Materials Processing I, both taught in the 2nd semester of the 1st year. The latter includes the course contents: Machining; Non-conventional machining and Plastic forming. In the case of the Safety and Environment UC, it is intended that students know the principles of Prevention Management of Work Safety and Environmental Management System with main focus in the context of mechanical technology and vehicles. In order for students to consciously and responsibly deal with machine tools that they may have to use within the scope of Automotive Materials Processing I UC, it is necessary that they know the hazards and risks associated with their use and ensure their own safety, aspects that the Safety and Environment UC can make an important contribution. Additionally, the application in a laboratory context of theoretical knowledge acquired in Safety and Environment classes contributes to the perception of its practical usefulness and, consequently, to a deeper understanding of the concepts involved. Based on these perspectives, in the academic year 2020/2021, at the Safety and Environment UC, more specifically on the theme of Safety and hygiene at work, it was proposed to carry out a practical work interconnected with the laboratory task of manufacturing a piece, that students were developing in the Automotive Materials Processing I UC. This article aims to describe the experience carried out and reflect on its contribution to students learning.

2 METHODOLOGY

2.1 Study context and participants

In recent years, in the scope of the Safety and Environment UC, it has been common for students to carry out practical work related to the Safety and hygiene at work component, where they analyse, in a real context, the hazards and risks associated with working with machine-tools from the Mechanical Technology laboratory of the higher education institution where they attend. However, in the 2020/2021 academic year, it was found that in the same semester, in the Automotive Materials Processing I UC, students would use the machines in that laboratory to manufacture a metal piece. In this way, it was considered pertinent to take advantage of the work they were developing in that UC to make a connection with the work of Safety.

The experience was carried out with 24 students who attended the Safety and Environment UC. The students were all male, with ages between 18 and 24 years old, and expect of two students, one Cape Verdean and the other from São Tomé and Príncipe, all had Portuguese nationality.

In the first classes of the Safety and Environment UC, theoretical concepts related to the area of Safety and hygiene were addressed [10], [11], [12] and practical exercises on the subject were solved. Once it was considered that the students already had some information on the theme, it was proposed that they organize themselves into groups of four elements (were formed six groups) and discuss with them the type of practical work they would carry out. Thus, it was decided that they would identify hazards and risks associated with the production of the metal piece that they were developing within the scope of the Automotive Materials Processing I UC, as well as establish preventive and control measures associated with the production of the piece: (i) measures of engineering, collective protection, and safety signage; (ii) personal protective equipment; (iii) work organization and administrative control and (iv) training and information.

In the end, each group should prepare a *PowerPoint*® presentation to share the work done with the class. To promote the students' attention and make the debate about the work more fruitful, the teacher assigned each group the responsibility of asking questions to one of the other groups previously selected.

In terms of classification, it was stipulated that the work would weigh 75% in the final grade of the UC.

2.2 Methods of database collection and analysis

The evaluation and reflection on the experience carried out are based on the students' productions, field notes recorded by the teacher, and a questionnaire applied in the last class of the semester. This was made up of two parts. The first “General Information” asked for general information on a personal level and on the academic path. The second part “Information on the Safety and Environment course unit”, aimed to collect the students' opinions about the UC classes, namely the difficulties they felt in terms of contents, the attitude they had towards practical work, and the contribution to your learning.

In most closed-answer questions, students expressed their opinion on several items, based on a four-level Likert scale: 1 - Totally disagree; 2 - Disagree; 3 – Agree, and 4 - Totally agree. Some questions were opened.

In the analysis of the questionnaire data, in the case of closed-answer questions, descriptive statistical techniques were used, namely the calculation of frequencies organized in tables as a way of structuring and synthesizing the information. In the case of open answer questions, based on the students' answers, categories were defined, a posteriori.

3 RESULTS

3.1 Student Productions

Within the scope of the Automotive Materials Processing I UC, the students produced one metal piece per group, and its execution involved several phases in which several machine-tools present in the laboratory were used. During this process, students had to apply the knowledge of Safety and hygiene at work acquired in classes of the Safety and Environment UC, organizing the practical work as follows:

- Phase I: Frame and justify the topic within the Safety and hygiene area; Indicate the main objectives; Give a brief description of the metal piece; Identify the main machine-tools involved in the machining and welding operations necessary for the production of the piece; Proceed with the legal and regulatory framework applicable to the situation in question; Insert photos and, if possible, a short video regarding the production of the piece;
- Phase II: Identify hazards and risks associated with the machining and welding operations described in Phase I;
- Phase III: Establish preventive and control measures associated with the production of the piece; Present the main conclusions and list the consulted bibliography.

Based on the procedures and analysis performed, the students prepared a *PowerPoint*® presentation, in which they synthesized the main ideas of the work and made a presentation to the class. As an example, in Fig. 1, an extract of the presentation of the practical work carried out by one of the groups is presented. In this case, after some more specific research carried out by the students [13], they identified hazards, risks, and prevention and control measures, associated with one of the operations ("welding") involved in the metal piece production process "support to bottles".

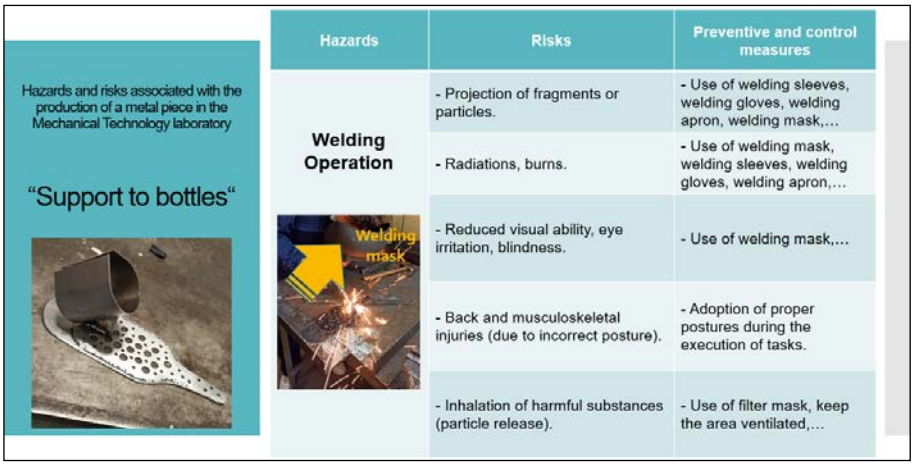

Figure 1. Extract from the presentation of the practical work of a group.

3.2 Perceptions about the contents and the experience carried out

Regarding the contents of the Safety and Environment UC, during classes, more than half of the students had no or few difficulties in identifying hazards (66.7%); identify risks (58.3%); identify the legislation applicable to the situation in question (58.3%) and suggest preventive and control measures (75%). Students easily adhered to the proposed task, having committed themselves to its implementation, which was visible in the final assessment, since all those who carried out the work were approved by the UC.

3.2.1 Students' opinion on the fact that there is a connection between UCs

In the students' opinion (Table 1), the articulation between the Safety and Environment and Automotive Materials Processing I UC, motivated them more to carry out group work, facilitated their learning, and helped them to better understand the application of the concepts of Safety and hygiene at work for the exercise of mechanics (79.2%, 75%, and 83.3% agree or totally agree, respectively).

Table 1. Advantages of linking UCs

	TD/D (%)	***A/TA (%)***
It made it more complicated to carry out group work	50.0	50.0
It made me more motivated to do group work	20.8	79.2
It increased my motivation to attend UC	37.5	62.5
It made my learning easier	25.0	75.0
It helped me to better understand the application of Safety concepts to the practice of mechanics	16.7	83.3
It helped me to better understand what is a hazard	8.3	91.7
It helped me to better understand what is a risk	4.2	95.8
It helped me to better understand the importance of preventive measures	12.5	87.5
It helped me to better understand the application of preventive measures	8.3	91.7
It helped me to better understand the legislation applicable to the situation in question	8.3	91.7

TD - Totally disagree; D - Disagree; A - Agree; TA - Totally Agree

Most students consider that the fact that group work is interconnected with the work of the Automotive Materials Processing I UC had positive aspects (75% A/TA), a perspective that is corroborated by some of them, through the comments they made:

- *“We became more aware of the hazards/risks present in the work environment”;*
- *“Greater contact with what was exposed in Safety and Environment”;*
- *“We came to improve theoretical concepts in practice”;*
- *"Easier to do the work";*
- *“Knowing how to keep ourselves safe while doing work”.*

3.2.2 Students' opinion about the group, the work developed and the presentations

Most students believe that in carrying out the group work on the theme of Safety, there was coordination between the elements of the group, they discussed in the group which aspects should be included in the work, discussed in the group the concepts in which they had the difficulties and the sharing of the knowledge in the group helped to improve the quality of work (83.3%, 83.3%, 87.5%, and 91.7% agree or totally agree, respectively).

Working in groups allowed them to know their difficulties, overcome some of them and improve their arguments (79.2%, 83.3%, and 95.8% agree or totally agree, respectively) (Table 2).

Table 2. Opinion on carrying out the group work

	TD/D (%)	A/TA (%)
Improve my ability to argue	4.2	95.8
Become aware of my difficulties	20.8	79.2
Overcome some of my difficulties	16.7	83.3
Learn to be more objective	20.8	79.2
Learn to be more organized	16.7	83.3
Know how to highlight relevant information	12.5	87.5
Being able to structure the information	8.3	91.7

TD - Totally disagree; D - Disagree; A - Agree; TA - Totally Agree

In the students' opinion, despite the difficulties they felt in exposing their work (58.3% A/TA) and in expressing themselves during the presentation (58.3% A/TA), this allowed them to improve their communication skills (91.7% A/TA) (Table 3).

Table 3. Opinion about the presentation of the group work

	TD/D (%)	A/TA (%)
It allowed me to improve my communication skills	8.3	91.7
We discuss as a group which are the most important aspects to mention in the presentation	25.0	75.0
We had some difficulties working with PowerPoint®	37.5	62.5
I had difficulty to expose the work	41.7	58.3
I had difficulty to answer the questions from colleagues	41.7	58.3
I had difficulty to express myself during the presentation	41.7	58.3
I spoke too fast during the presentation	41.7	58.3
I felt nervous during the presentation of the work	41.7	58.3

TD - Totally disagree; D - Disagree; A - Agree; TA - Totally Agree

Most students consider that the presentations of group work made by colleagues from other groups were explicit (70.8 A/TA), have participated actively in the presentations by asking questions to their peers (70.8% A/TA).

4 CONCLUSIONS

The experience developed had positive effects on students learning. The practical group work allowed them to have a greater connection with the reality of the course, learn in a contextualized way, increase their autonomy, not be so dependent on the teacher, and consolidate their knowledge on the theme of Safety and hygiene at work. With the proposed work, students had the opportunity to observe in a real context, the hazards, and risks inherent in the production of a metal piece, as well as suggest preventive and control measures that allowed them to significantly work on the contents inherent to the Safety and Environment course unit, as well as greater awareness of these aspects. Even the difficulties that arise can be understood as a source of learning and a positive factor in favour of this type of experience, as students end up having to overcome obstacles in scenarios close to the professional reality they will face in the future.

It is important to emphasize that the knowledge and skills acquired by students during the practical work can be useful for other course units, in addition to being an important internship assistant that is part of the course's study plans.

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