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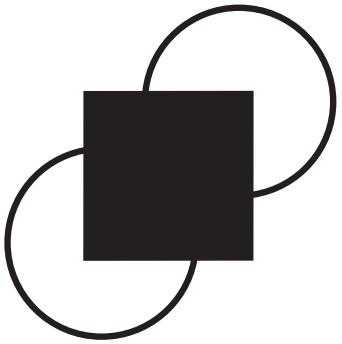

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LEARNING SCENARIOS IN SAFETY AT WORK IN THE SCOPE OF POLYTECHNIC HIGHER EDUCATION COURSES

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Abstract

The Higher Professional Technical Courses (CTeSPs) of the Portuguese Polytechnic Higher Institutes correspond to a cycle of higher education studies that does not confer an academic degree. They have a duration of 2 years and the successful conclusion leads to obtaining a higher professional technician diploma. Given the specificity of this type of courses, the course units of their study plan must promote, whenever possible, more student-centred learning with a greater connection to practice. This approach has been followed in the Safety and Environment course unit classes of the CTeSPs in Chemical and Biological Analysis and Mechanical Technology and Vehicles of a Higher Education Institution in the North of Portugal, between the academic years 2016/2017 and 2020/2021. In this sense, and in the Safety component, tasks were proposed that, depending on the academic year in which they were performed, involved different scenarios: (1) laboratory context and (2) business context (study visits). In both cases, it was proposed to the students to carry out a practical work in group that intended to analyse the hazards and risks associated with aspects of the context in question, applying in a specific situation the contents of the course unit. This type of work was oriented so that there was knowledge sharing (lectures and group interaction) among students attending: (i) the course unit; (ii) the course unit in another CTeSP and (iii) another course unit in degree courses. In some situations, connections were established with other course units, within the same course, or in different courses. In this paper we intend to explain the different approaches applied, reflecting on their advantages/disadvantages and possible perspectives of adaptation to the other component of the course unit (Environment) or other courses.

Keywords: Polytechnic higher education, higher professional technical courses, learning in context, safety at work.

1 INTRODUCTION

In Portugal, the Higher Professional Technical Courses (CTeSPs) are taught at the polytechnic higher education level, they do not confer an academic degree, and the successful completion of the respective study cycle grants the higher professional technician diploma. This cycle of studies has 120 credits ECTS (European Credit Transfer and Accumulation System). Its duration is four curricular semesters of students' work, composed of a set of course units (CUs) organized in general and scientific training components, technical training, and on-the-job training, which is accomplished through an internship that takes place in the last semester [1,2]. Given the specificity of the CTeSPs, it is crucial, from the perspective of student learning, to promote, whenever possible, more student-centered learning, less theoretical and more practice-oriented. It is worth mentioning that student-centered learning is characterized by innovative methods of teaching which aim to promote learning in communication with teachers and other learners and take students seriously as active participants in their own learning, fostering transferable skills such as problem-solving, critical thinking, and reflective thinking [3,4]. Concomitantly, students are at the center of learning and all the relevant parties work together in partnership to help students develop and acquire skills that are transferable [4]. This approach was followed in the classes of the Safety and Environment CU of the Chemical and Biological Analysis (CBAnalysis) and Mechanical Technology and Vehicles (MTVehicles) CTeSPs of a higher education Institution in the North of Portugal, between the academic years 2016/17 and 2020/21. Based on the experiences carried out in the mentioned CU, Silva, Barros, and Ribeiro [5-9] concluded that when learning with a strong connection to practice is promoted, either in a laboratory or business context, there is evidence of a positive impact on student's motivation and learning. In this way, this paper aims to explain the approach applied in different academic years, reflecting

on their advantages/disadvantages and possible perspectives of adaptation to the other component of the CU (Environment) or other courses.

2 METHODOLOGY

In the CTeSPs in CBAnalysis and in MTVehicles, the CU of Safety and Environment is taught in the 2nd semester of the 1st year. The programmatic contents cover the themes of Safety and hygiene at work and Environment, with greater incidence on the first theme. In general terms, the CU includes the following contents: Legislation, normative framework, regulations, and standards on safety, hygiene, and health at work; Prevention management; Assessment of occupational risks; Control of occupational risks; Occupational hygiene; Occupational safety and environmental management. Thus, it is intended that at the end of the CU the students will know the principles of prevention management of the occupational safety system and environmental management with the main focus on the context of chemical and biological analysis and mechanical technology and vehicles. The classes are theoretical-practical (2 hours per week), where, usually, the teacher exposes the theoretical concepts and the students solve application exercises and do practical work. The CU assessment covers mainly the Safety subject. In this sense, and in the Safety component, tasks were proposed that, depending on the academic year in which they were performed, involved different scenarios (Tab. 1). In both cases, it was proposed to the students the completion of a practical group work in which it was intended that they analyse the hazards and risks associated to aspects of the context in question, applying in a concrete situation the contents of the CU.

Table 1. Context and logistics of the tasks performed.

Scenarios	*Academic years*	*Courses*	*Participants*	*Assessment*		
				Practical work on the theme of Safety	*Practical work on the theme of Environment*	*Assessment test*
Laboratory context	2016/17	CBAnalysis	12	80%	20%	-
		MTVehicles	18			
	2017/18	CBAnalysis	3	70%	15%	15%
		MTVehicles	22			
	2019/20	CBAnalysis	10	75%	10%	15%
		MTVehicles	15			
	2020/21	MTVehicles	24	75%	10%	15%
Business context	2018/19	MTVehicles	19	75%	10%	15%

Thus, in the academic years 2016/17 and 2017/18, it was proposed to the students of CBAnalysis and MTVehicles courses attending the CU, that the practical group work on the Safety theme should be focused on the laboratories more directed to each course. The CBAnalysis students developed the group work in the Chemical Processes laboratory, based on a laboratory test, and the MTVehicles students in the Mechanical Technology laboratory, where they chose a machine tool. The proposed work was divided into three stages: 1) data collected by the students in the laboratories; 2) risk analysis (identification of hazards and consequent risks associated with the laboratory test/machine use and applicable legislation); 3) risk assessment (application of one of the methods studied in the theoretical part) and 4) preventive measures to be implemented in the situations concerned. Based on the analysis carried out, the students performed a written assignment and made their presentation to the class [5-7]. In the academic year 2019/20, the group work was similar to that of the academic years 2016/17 and 2017/18. However, given the pandemic due to COVID-19, and the impossibility of traveling to the laboratories, the data were not collected by the students, but were made available by the teacher of the CU (one of the authors of this paper). As the classes were mixed (CBAnalysis and MTVehicles) the presentation of the practical group work was carried out between courses.

In the academic year 2020/21, a methodology was followed which involved interconnecting the CU of Safety and Environment with the CU of Automotive Materials Processing I of the MTVehicles course.

As, in the 2nd semester, the students still attend the CU of Automotive Materials Processing I, where they produce a metal piece, also in the same laboratory, it was considered relevant to take advantage of the work they were developing in that CU and make a connection with the Safety work. In this sense, it was proposed that the 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 measures, collective protection, and safety signs; individual protection equipment; work organization and administrative control; training and information). Based on the analysis made, the students prepared a PowerPoint presentation to show their productions and present the conclusions to the class [9].

For the 2018/19 academic year, a teaching proposal was designed in which, in addition to valuing learning in a real work context, the aim was to promote the exchange of knowledge acquired by students from different CUs. This proposal involved the CUs of Mechanical Technology I and Manufacturing Processes I, of the 2nd year of Mechanical Engineering and Technology and Industrial Management Bachelor degree courses, respectively, and the CU of Safety and Environment from the 1st year of the CTeSP in MTVehicles. In summary, besides carrying out two study visits to companies in the metal-mechanics area, an exchange of knowledge among the students was promoted. In this context, Bachelor's students were assigned the role of performing communication sessions to clarify some of the mechanical processes observed in the companies. Similarly, the CTeSP students were responsible for sharing the hazards and risks inherent to the real work context in the visited companies and for raising awareness about the means of protection to be used [8].

3 RESULTS

Tab. 2 shows the different methodologies applied in the Safety and Environment CU between the academic years 2016/17 and 2020/21, as described in the Methodology section.

Table 2. Methodologies associated with each context.

Practical group work	Laboratory context	Data collected in the laboratory	▪ Safety related to machine tools - data collected by students ▪ In-class presentation
			▪ Safety related to machine tools (MTVehicles) or laboratory tests (CBAnalysis) - photos provided by the teacher ▪ Knowledge sharing between CTeSPs (online classes)
			▪ Safety related to the construction, by the students, of a metal piece in the scope of another CU ▪ In-class presentation
	Business context	Study visits to companies	▪ Safety associated with companies' industrial machinery ▪ Knowledge exchange with Bachelor degree courses

All work was done in groups and was oriented so that there was knowledge sharing (lectures and group interaction) among students attending: (i) the CU (academic years 2016/17 and 2017/18); (ii) the CU in another CTeSP (the academic year 2019/20); (iii) another CU in Bachelor degree courses (the academic year 2018/19). In some situations, connections were established with other CUs, within the same course (the academic year 2020/21) or from different courses (the academic year 2018/19).

All the experiences carried out allowed them to study the contents of the theme of Safety in a contextualized manner, which allowed them to work in a significant manner on the contents inherent to the Safety and Environment CU they were attending, as well as to acquire greater awareness of these aspects.

The business context gave them the opportunity to observe in a factory context the hazards underlying certain activities. The study visits also gave the students' knowledge about the type of work that a mechanical engineer can do, in case they want to continue their studies in this area. However, at the level of the laboratory context, the manufacture of the metal piece, allowed them to apply the knowledge acquired in the CU.

Regarding the group work and its presentation, it can be verified, according to the opinion of more than 60% of the students [5-9], that it contributed to improving the capacity for argumentation and communication, to become aware of their difficulties and overcome them, to learn to be more objective

and organized. The presentation to other audiences and all the constraints associated with its preparation promoted the development of transversal skills such as the ability to work in a team, select materials and synthesize information, communicate, and deepen the knowledge of technological means.

The difficulties that arose during the work, which were overcome with the help of the teacher, can be seen as a source of learning and a positive factor in favor of this type of experience, insofar as students end up having to overcome obstacles in scenarios close to the professional reality they will face in the future.

There are, however, other aspects that do not depend directly on the student's learning, which may constitute an obstacle to the realization of these experiences. Some of these aspects experienced are shown in Tab. 3.

Table 3. Problems in performing the tasks.

	Laboratory context			***Business context***
	Presencial in the CU	***Presencial (base in another CU)***	***Online***	
Logistics for carrying out the work	Resource availability	Dependence on work done in the other CU	Availability of computing resources	Time-consuming process Third-party availability Increased costs for the Institution/students
Classroom presentations	-	-	-	Difficulties in articulating schedules Adequacy of technical language

4 CONCLUSIONS

Approaches with a connection to the professional reality of the course, regardless of whether the context is a laboratory or business, and where students have an active role in their learning, help to contribute to academic success [3,5-9]. The knowledge and skills acquired by the students during the practical work can be useful for other CUs, and can also be an important aid in the internship that integrates the study plan of the courses. The laboratory or business contexts, associated with methodologies similar to the ones described in this study, can also serve as a basis for works to be carried out in the Environment component of the CU in a perspective of raising awareness for the Sustainable Development Goals (SDGs) [10].

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