ENGENHARIAS, TECNOLOGIA, GESTÃO E TURISMO
ENGINEERING, TECHNOLOGY, MANAGEMENT AND TOURISM
INGENIERÍA, TECNOLOGÍA, ADMINISTRACIÓN Y TURISMO

millenium 93

Millenium, 2(11), 936-98.

en

DESENVOLVIMENTO DE DESAFIOS INDUSTRIAIS NO ÂMBITO CURRICULAR

INDUSTRIAL CHALLENGE ASSIGNMENT IN CURRICULAR CONTEXT

DESARROLLO DE DESAFÍOS INDUSTRIALES EN EL ÁMBITO CURRICULAR

Vitor Neto[1]

[1] Universidade de Aveiro, Aveiro, Portugal

Vitor Neto - vneto@ua.pt

Corresponding Author
Vitor Neto
Universidade de Aveiro
Campus Universitário de Santiago
3810-193 Aveiro - Portugal
vneto@ua.pt

RECEIVED: 12th July, 2019
ACCEPTED: 03th October, 2019

RESUMO

Introdução: O desenvolvimento de desafios industriais no âmbito das aulas do sistema de ensino superior é uma forma interessante de ensino e aprendizagem que pode promover nos alunos o desenvolvimento de competências vitais. Tais atividades contribuem, para o relacionamento entre os conteúdos ensinados em sala de aula e o mundo real, entre outros benefícios.
Objetivos: Trabalhos onde é requerido a resolução de problemas reais das empresas industriais regionais, envolvendo organização de produção, processos de produção ou questões de inovação produtiva foram propostos, sendo requerido que os estudantes analisem o problema e proponham soluções técnicas e científicas integrais.
Métodos: O presente artigo apresenta dados de seis semestres em que o trabalho foi desenvolvido. Inquéritos abertos foram desenvolvidos e enviados a estudantes, empresas e professores para avaliar a sua aplicação e resultados.
Resultados: Os resultados indicam que, após alguma resistência inicial, a perceção final dos alunos é de satisfação e validação da metodologia adotada.
Conclusões: A mesma opinião é partilhada por empresas e docentes. Além disso, esse tipo de interação parece ter um impacto positivo no relacionamento universidade-empresa.

Palavras-chave: Tecnologias Avançadas da Produção; Aprendizagem baseada em Problemas, Indústria, Ensino em Engenharia

ABSTRACT

Introduction: The development of industrial challenges in higher education classes are an interesting form of teaching and learning that may lead to the development of students' vital skills. It contributes to the connection between context taught in the classroom with the real world, among other benefits.
Objectives: Assignments to solve real problems presented by regional industrial corporations addressing production organization, production processes or productive innovation issues have been proposed, and students are requested to analyze them and seek integral technical and scientific solutions.
Methods: The present paper presents data from six semesters where the assignment has been developed. Open inquiries have been developed and students, companies, and teachers have been inquired to evaluate its application and results.
Results: Results indicate that after some initial resistance, student's final perception is of satisfaction and validation of the methodology adopted.
Conclusions: The same opinion is shared by companies and teachers. Moreover, this type of interaction seems to have a positive impact on the university-business relationship.

Keywords: Advanced Manufacturing Technologies, Problem Based Learning, Industry, Engineering Education

RESUMEN

Introducción: El desarrollo de desafíos industriales en las clases del sistema de enseñanza superior es una forma interesante de enseñanza y aprendizaje que puede promover en los alumnos el desarrollo de competencias vitales. Tales actividades contribuyen, para la relación entre los contenidos enseñados en el aula con el mundo real, entre otros beneficios.
Objetivos: Los trabajos donde se requiere la resolución de problemas reales de las empresas industriales regionales, involucrando organización de producción, procesos de producción o cuestiones de innovación productiva, fueron propuestos, siendo requerido que los estudiantes analicen el problema y propongan soluciones técnicas y científicas integrales.
Métodos: El presente artículo presenta datos de seis semestres en los que se desarrolló el trabajo. Las encuestas abiertas se desarrollaron y envió a estudiantes, empresas y profesores para evaluar su aplicación y resultados.
Resultados: Los resultados indican que, después de alguna resistencia inicial, la percepción final de los alumnos es de satisfacción y validación de la metodología adoptada.
Conclusiones: La misma opinión es compartida por empresas y docentes. Además, este tipo de interacción parece tener un impacto positivo en la relación universidad-empresa.

Palabras Clave: Tecnologías de fabricación avanzadas, Aprendizaje basado en problemas, Industria, Educación en ingeniería

INTRODUCTION

The integration of societal challenges, coming from real industrial corporations, within higher education teaching and learning is becoming of fundamental importance (Felder, Brent, & Prince, 2011; Nottingham, 2016). By doing so, students learn how the

Neto, V. (2020). Industrial challenge assignment in curricular context.
Millenium, 2(11), 93-98.
DOI: https://doi.org/10.29352/mill0211.10.00256

things they learn in the classroom are connected to the real world, and, at the same time, explore career options. Corporations have the possibility to interact with future employees that will have a better comprehension and expectation knowledge of the workplace. Higher education institutions benefit from a generalized improvement of students' motivation and improve the schools' relationship with the community (Gabriel, Valente, Dias-de-Oliveira, Neto, & De Andrade-Campos, 2018; Lester & Costley, 2010). Furthermore, it is a perfect methodology to relate the teaching content, either fundamental and applied knowledge, with societal challenges and achieve a good balance between intense fundamental skills and transversal soft skills that are currently demanded by employers (Davide, 2013; Lemanski, Mewis, & Overton, 2011). It is in this context that the curricular unit of Advanced Production Technologies of the University of Aveiro has been promoting assignments to solve real problems presented by regional industrial corporations. Students are requested to analyze technical challenges and seek solutions sustained technically and scientifically, but also considering economical aspects. The challenges presented have addressed issues of production organization, production processes or productive innovation. Commonly, students present some initial resistance to the assignment, probably because it is one of the first time, they must deal with industry environment, nevertheless, the final perception is of satisfaction and validation of the methodology adopted. In this paper, some of the challenges presented in the last years will be highlighted, as well as the evaluation of its application.

1. CHARACTERIZATION OF THE CURRICULAR UNIT AND ASSIGNMENT

1.1 Advanced Production Technologies course

The curricular unit of Advanced Production Technologies is offered as an optional course to fifth-year mechanical engineering students (Integrated Master in Mechanical Engineering of the University of Aveiro, Portugal) and it's a mandatory course of fourth-year industrial management and engineering students (Integrated Master in Industrial Management and Engineering). It is also an optional course of the Nanosciences and Nanotechnology Ph.D. Program. It is classified with 6 ECTS credits (European Credit Transfer and Accumulation System) and has 4 hours per week of theoretical and practical contact.

The course scientific area is in Mechanical Engineering and its learning objectives are to promote an entrepreneur mindset in the use of manufacturing technologies, whatever applying conventional processes or making use of the most recent and cutting-edge scientific breakthroughs. Topics such as product requirements; materials and material properties; processing technologies; additive manufacturing; microtechnology; nanotechnology; design for x; fabrication economical costs and environmental impacts are covered. Different activities, such as the one described in the present paper, intend also to promote training in transversal skills. The evaluation of students, in discrete evaluation (the main evaluation form), is done by means of two group assignments and a final semester test. The test account 30% of the final grade, the present assignment 30% and the second assignment 40%.

1.2 Assignment description

The assignment intends that students analyze a real industrial problem and suggest a solution. Before the challenge presentation to students, a regional production company is selected and invited to offer a production problem that can be analyzed within advanced manufacturing technologies.

The assignment must be developed in groups of 3 to 4 students and represents 30% of the final grade of the curricular unit for students in discrete evaluation. Students in final evaluation are not enrolled for this assignment.

Students and other people involved in the assignment must compromise to keep all information accessed confidential. Additionally, students and companies are informed that if the assignment creates truly innovative products or systems that may be object of intellectual property registration, the copyright will be given to the University of Aveiro and to the company. The copyright given to the University of Aveiro will not jeopardize the rights of the students to be designated as creators, inventors or authors of the invention or creation, as well as the teachers and other involved staff.

The assignment has as evaluation criteria: (i) problem identification; (ii) solutions presented (and their technical and scientific accuracy); (iii) investment prediction; (iv) revenue forecast; and, (v) compliance with established rules. Solution proposals that are merely commercial solution will have a penalty of 25% in their score. It is intended with the latter to motivate students to pursuit engineering solution, eventually integrated with solutions available in the market.

The assignment is developed in the first part of the semester, within one and a half month to two months. In the middle of the development period, a follow-up presentation must be done in class. In the end, students must present their proposal in class, with the presence of the contact persons of the company, handover a technical poster of the proposal using a given template and a technical report with a maximum of six A4 pages plus annexes. The presentation time is limited to 6 minutes. Questions and answers to each group are done only after all groups have presented their proposals. Figure 1 illustrates three posters developed within the assignment. The template is provided.

Neto, V. (2020). Industrial challenge assignment in curricular context.
Millenium, 2(11), 93-98.
DOI: https://doi.org/10.29352/mill0211.10.00256

1.3 Challenges cases

The assignment has been proposed since the first semester of the academic year of 2015-2016. The companies and challenges proposed in the assignments from that date until 2017-2018 are presented in Tab 1. The presented challenges involved production organization, production processes or productive innovation.

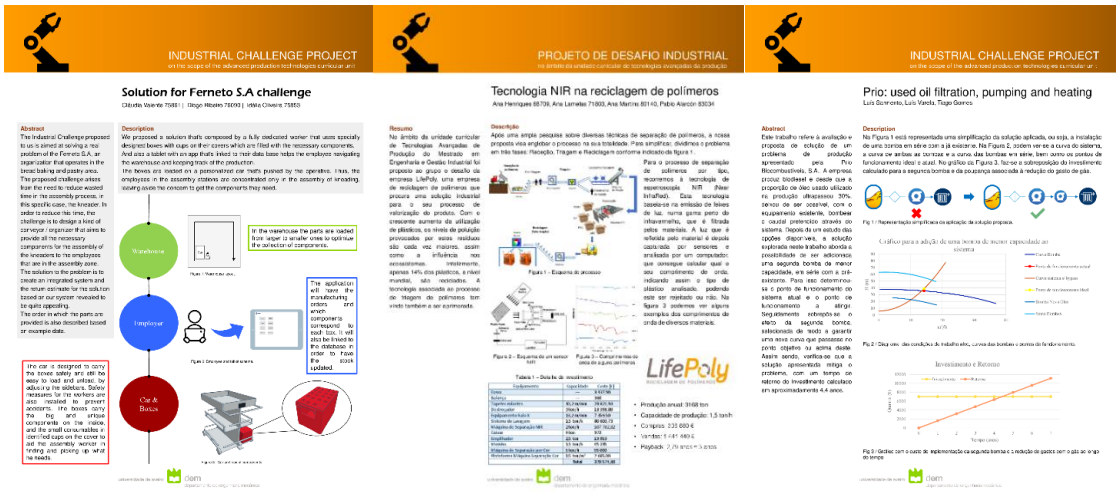

Figure 1. Three examples of posters developed within in the assignment.

Table 1. List of companies and challenges proposed in the analyzed time.

Acad. year	Semester	Company	Location	Challenge
2015-2016	1	Autofer	Águeda	Metal profiles cleaning
2015-2016	2	PJF	Aveiro	Reduction of the number of rejected parts from the stamping line
2016-2017	1	Pinha	Águeda	Stainless steel sheet welding
2016-2017	2	Lifepoly	Oliveira do Bairro	Screening and identification of plastic waste
2017-2018	1	Prio	Gafanha da Nazaré	Oil Pumping
2017-2018	2	Ferneto	Vagos	Organization of the manufacturing process

Some of the companies were contacted with the help of RM Consulting, a consulting company working in production organization, such as lean processes.

2. METHODS

Within the framework proposed by the assignment, it is relevant to analyze the perception and appreciation of the leaning and teaching outcomes by the involved agents – the students; corporations; and teachers. For that, open inquiries were developed considering the three different agents.

Is the assignment contributing to the goal of integrating societal challenges within student's mindset development? Are students being able to connect the subjects that they learn in the classroom with the challenges of the real world and develop a better comprehension of the workplace? Are students motivated by the assignment? Are companies satisfied by the technical results proposed and with the interaction with students? Is the university-business relationship improved? Are students fundamental and transversal soft skills improved?

For students, making use of an online form tool, one single open question was placed. For companies, again one single open question inquiry was placed and sent by email. In the case of the teacher and collaborators, the register data was compiled in groups, as part of the assignment self-evaluation routine.

Neto, V. (2020). Industrial challenge assignment in curricular context.
Millenium, 2(11), 93-98.
DOI: https://doi.org/10.29352/mill0211.10.00256

3. RESULTS AND DISCUSSION

A resume of the obtain answers is presented in the following sub-sections.

3.1 Students appreciation

Students main appreciation to the assignment were:

- *The problem showed us the difference between an academic assignment and an assignment for a company.*
- *We realized that some concepts cannot be applied linearly in the company.*
- *There should be more initiatives such as this one so that we could understand how companies work.*
- *I loved doing the work. It put us close to the industry and facing real problems. It was one of the few works that gave me joy to do since I entered university.*
- *It would be good to see some of our solutions being implemented by the company, and to have information on how the solutions changed the organization.*
- *This challenge did not add or contribute to a deepening of the topics taught in this curricular unit.*

Globally speaking, students attribute value to the assignment and even encourage that more curricular unit assignments could be developed with interaction with the industrial sector. Nonetheless, not all feedback was positive. Some students didn't attribute significance to the work.

3.2 Companies appreciation

Corporations main comments to the assignment were:

- *The fact that the students must analyze the investment and the return is very important.*
- *It's a pity we did not have more time to dedicate to you.*
- *Be persistent.*
- *Although the solutions presented may not be directly applicable, they are the source of new ideas.*
- *The challenge is a great way for future professionals to get to know our company.*

Most of the companies, if not all, pointed out the importance of merging the technical proposals with the required investment, training of staff and revenue of the investment. This was considered an added value of the assignment and it was recommended that teachers reinforce this point in their classes along the curricula. The openness of companies to receive students and interact with them after the first visit depended very much on their own availability, but company personal always pursuit students to be pro-active and persistent to attain the information needed. Companies also recognize that the assignment is a good source of new ideas and solution proposals, besides considering that it was a good opportunity for them to interact with potential future collaborators.

3.3 Teachers appreciation

Teachers evaluation of the application and results of the assignment were:

- The challenges contribute significantly to the promotion of students' transversal skills.
- Technical skills are also better internalized by students.
- In general, both students and companies consider that the challenges have an added value.
- The work helps to link classroom teaching with the factory shop floor practice.
- Students begin by having a lot of resistance to this kind of assignment.
- It is not always easy to come up with challenges that are completely aligned with the programmatic contents of curricular unit.
- Logistics of visits is always complex.

The teacher and other staff involved with the application and management of the assignment consider that it is a good methodology to open students' mindset to the challenges they will face in a near future in the workplace. It promotes competencies that were not yet developed within their academic path, such as a direct relationship with companies. Probably because of the originality of the assignment, the number of students reluctant to the assignment is considerable, nevertheless, at the end of the work, it is positively considered by the most. Some students still consider the assignment a waste of time and that it does not contribute to their academic development. The logistics of the assignment is always complex. Not all companies are willing to receive a group of about 50 students and share with them their problems. Then, transportation is required for the first visit and a suitable date for the final presentation, that can suit the class but also companies' personnel.

CONCLUSIONS

In conclusion, one can state that the proposed assignment contributes to the goal of integrating societal challenges within student's mindset, while developing their technical and transversal skills. In most of the cases, the challenge creates the condition for a real interaction between students and industrial agents for the first time in their university studies. The assignment also contributes to the integration of the knowledge obtained from different classes to solve a concrete problem and for a better comprehension of the industry.

Although not all students consider the assignment to have a positive impact in their academic studies, most of them value the experience. Companies have expressed their satisfaction with the assignment, and it is considered that this type of interaction has a positive impact on the university business relationship.

ACKNOWLEDGEMENTS

The author greatly thanks the openness of the companies involved in the six editions of the assignment and the assistance of RM Consulting establishing the contact with some of these companies. Part of the research presented in this paper received support of the Portuguese Foundation for Science and Technology through TEMA strategic development project with reference UID/EMS/00481/2013 and TEMA Research Infrastructures project with reference CENTRO-01-0145-FEDER-022083.

REFERENCES

Davide, M. (2013). *Work-Based Learning in Europe - Practices and Policy Pointers*. European Commission. Brussels.

Felder, R. M.; Brent, R. & Prince, M. J. (2011). "Engineering Instructional Development: Programs, Best Practices, and Recommendations". *Journal of Engineering Education*, 100(1), pp. 89–122. https://doi.org/10.1002/j.2168-9830.2011.tb00005.x

Gabriel, B. F. C. C.; Valente, R.; Dias-de-Oliveira, J. A.; Neto, V. F. S. & De Andrade-Campos, A. G. D. (2018). "A model for the effective engagement of all stakeholders in engineering education and its pilot implementation". *European Journal of Engineering Education*, 43(6), pp. 950–966. https://doi.org/10.1080/03043797.2018.1479375

Lemanski, T.; Mewis, R. & Overton, T. (2011). *An Introduction to Work-Based Learning - A Physical Sciences Practice Guide*. Hull: Higher Education Academy - UK Physical Sciences Centre.

Lester, S. & Costley, C. (2010). "Work-based learning at higher education level: value, practice and critique". *Studies in Higher Education*, 35(5), pp. 561–575. https://doi.org/10.1080/03075070903216635

Nottingham, P. (2016). "The use of work-based learning pedagogical perspectives to inform flexible practice within higher education". *Teaching in Higher Education*, 21(7), pp. 790–806. https://doi.org/10.1080/13562517.2016.1183613