



**11TH INTERNATIONAL CONFERENCE OF
EDUCATION,
RESEARCH AND
INNOVATION**

**CONFERENCE
PROCEEDINGS**

**SEVILLE (SPAIN)
12-14 NOVEMBER 2018**

Published by
IATED Academy
iated.org

ICERI2018 Proceedings
11th International Conference of Education, Research and Innovation
November 12th-14th, 2018 — Seville, Spain

Edited by
L. Gómez Chova, A. López Martínez, I. Candel Torres
IATED Academy

ISBN: 978-84-09-05948-5
ISSN: 2340-1095
Depósito Legal: V-2884-2018

Book cover designed by
J.L. Bernat

All rights reserved. Copyright © 2018, IATED

The papers published in these proceedings reflect the views only of the authors. The publisher cannot be held responsible for the validity or use of the information therein contained.

COMPETENCES IN THE DESIGN WORKSHOP SUBJECT THROUGH THE LEARNING RESULTS

Margarita Valor, Marina Puyuelo, Ernesto Juliá, Susana Genis

Universitat Politècnica de València (SPAIN)

Abstract

The introduction of Transverse Competences (CT) in the Bachelor's Degree in Industrial Design Engineering and Product Development at Universitat Politècnica de València has led to plan the coordination in the courses that are part of the Design Workshop Subject, which are Design Workshop I, II and III courses, offered in second, third and fourth year, respectively. The work is about defining the learning outcomes, which allow evaluating the level of acquisition of these skills.

To achieve those skills, the relationship between the general and the specific previous competences assigned to the Design Workshop subject and the new competences has been established, among which the transverse competences are included.

The analysis of these competences and their relationship with the contents described in the Design Workshop subject in the present studies programme has allowed distributing the competences among the three courses and defining the appropriate learning outcomes for each one of the levels that each course represents.

Keywords: competences, learning results, coordination, design workshop.

1 INTRODUCTION

The convergence towards the European Higher Education Area (EHEA) has highlighted the importance of the transversal skills during university studies and that is why the Universitat Politècnica de València (UPV) is developing an institutional project [1] to certificate the achievement of Transverse Competences (CT) to students graduated in any of the official degrees.

In this project, the UPV considers the following Transverse Competences: CT-01: Comprehension and integration, CT-02: Application and practical thinking, CT-03: Analysis and problem solving, CT-04: Innovation, creativity and entrepreneurship, CT-05: Design and project, CT-06: Teamwork and leadership, CT-07: Ethical, environmental and professional responsibility, CT-08: Effective communication, CT-09: Critical thinking, CT-10: Knowledge of contemporary problems, CT-11: Lifelong learning, CT-12: Planning and time management and CT-13: Specific instrumental.

In the case of the Degree in Industrial Design Engineering and Product Development, these competences have recently been included into the curriculum, allowing to reflect and to think about the coordination among the courses that compose the Design Workshop subject through an Innovative Project and Educational Improvement. In this Project, in addition to highlighting the importance of the Design Workshop as the backbone of the degree, some rubrics have been developed to coordinate the progress in achieving the competences [2].

The introduction of the Transverse Competences in the Bachelor's Degree in Industrial Design Engineering and Product Development has also made necessary to rearrange not only these competences, but also the general and the specific ones and, at the same time, redefine the latter as indicated in the final report for obtaining the EUR-ACE accreditation [3].

It is convenient to explain the two related concepts in this project: competence and learning outcome. The guide of the National Agency for the Evaluation of Quality and Accreditation (ANECA) [4] states that it is difficult to differentiate between both and sometimes depends on the context where they are used; therefore, in this project the competence is considered as the superior level from which the learning results are determined. The learning results specify the level of acquisition of the competence and, therefore, the final result of the teaching-learning process.

In the studies programme of the Degree, the Design Workshop subject is part of the Design Speciality Module and it is distributed in three courses of six credits in three consecutive years.

2 METHODOLOGY

This work is part of an Innovative Project and Educational Improvement (PIME) composed of a multidisciplinary team that includes the members of the Academic Committee of the Degree and the lecturers involved in the Design Workshop courses. It is a multidisciplinary project with 21 teachers (Table 1). The Bachelor's Degree in Industrial Design Engineering and Product Development is offered at two different campuses of the UPV: the Higher Technical School of Design Engineering in Valencia (ETSID) and the Higher Polytechnic School of Alcoy (EPSA).

Table 1. List of the Departments involved in the Project.

ETSID - Valencia				
Graphic Expression in Architecture				
Engineering Projects				
Drawing				
Graphics Engineering				
EPSA - Alcoy				
Graphics Engineering				
Textile and Paper Engineering				
Applied Mathematics				
Continuous Medium Mechanics and Theory of Structures				
Business Organization				
Mechanical and Materials Engineering				
TOTAL: 21 lecturers				

The previous work presented in this communication has consisted of a discussion among all the participants about the content, the approach, the relationship with other subjects, the characteristics of the workspace and the learning outcomes in each of the Workshop courses. The competences of the subject have also been analyzed in the curriculum in both campuses [5]. After this analysis, there has been a modification of the curriculum including the thirteen transverse competences, which has result in reorganising the competences matrix per course to adapt them to this change.

The syllabus and the activities of the three Design Workshop courses have also been contrasted in the two campuses, agreeing and ordering the contents, the activities, the competences and the assessment.

Based on all these aspects and considering the description of the subject in the curriculum, the assigned competences and the evidences in the courses, the learning results for each course have been developed.

3 RESULTS

Several consecutive results have been considered, resulting in a coordinated and consensual definition of the progress in this subject. Firstly, the reorganisation of the competences in the courses of the Design Workshop subject, then the definition of the learning results of each competence in each workshop course and, finally, the method to determine and evaluate the defined learning outcomes.

3.1 The courses and assigned competences

In the reorganisation of the competences to the courses, the following criteria have been considered:

- To continue with the previously established competences, since the Degree in Industrial Design Engineering and Product Development accreditation demand continuity.
- To set a maximum number of competences per workshop. The guide of the ANECA [4] for the learning results suggests a range from five to ten competences to be developed per course.
- The same competence must be connected to the one of the following workshop course.

With these considerations, a new matrix of competences has been established. Table 2 shows the competences previously assigned to the corresponding workshop, with a “T”; the competences that are removed with an “R”; and the ones that are added with an “A”.

Considering that Workshops I and III have seven competences and Workshop II has eight, it has been established that each Workshop must develop seven competences balancing the assignment and at the same time following the ANECA recommendation [4]. With these criteria, the competence 8E (To apply the manual and computer graphic representation techniques) of the Workshop II has been removed since it is assigned to Workshop III. In addition, Workshop II has assigned the competence 23E (To develop the graphic skills and adequate spatial vision to design and present an industrial product), which has been considered to moderate the exclusion of competence 8E to some extent.

On the other hand, Transverse Competence 3 (CT3) has been removed from Workshop III as there is no continuity in its development, and to complete the seven competences of Workshop III, the Transverse Competence 9 is chosen because it minimises the effects of removing CT3. It is considered that the development of the critical thinking is representative and essential at the highest level of the teaching-learning process of this subject.

Table 2. Relationship between competences and workshop courses.

Competences of the Design Workshop Subject	Workshop I	Workshop II	Workshop III
6G - To evaluate and optimize criteria for decision making.	T	T	T
13G - To use the necessary tools and instruments for the observation and solution of problems in engineering and architecture. (13 +20)	T	T	
8E - To apply the manual and computer graphic representation techniques.		R	T
14E – To transmit relevant information of industrial products using formal, graphic and symbolic languages in an appropriate way.	T		
23E - To develop the graphic skills and adequate spatial vision to design and present an industrial product.		T	
29E – To know the industrial reality and, in particular, the concepts of applications of Design. (29+32)			T
CT 3 - ANALYSIS AND PROBLEM SOLVING. To analyse and solve problems effectively, identifying and defining the substantial elements that constitute them.	T		R
CT 4 - INNOVATION, CREATIVITY AND ENTREPRENEURSHIP. To innovate in order to respond satisfactorily and in an original way to personal, organizational and social needs and demands with an entrepreneurial attitude.	T	T	T
CT 5 - DESIGN AND PROJECT. To design, direct and evaluate an idea effectively until it is completed in a project.	T	T	T
CT 9 - CRITICAL THINKING. To develop a critical thinking interested in the fundamentals on which the ideas, actions and judgments, both own and others, are based.		T	A
CT 13 – SPECIFIC INSTRUMENTAL. Ability to use the techniques, skills and updated tools required for the practice of the profession.	T	T	T

3.2 The competences and learning outcomes

To define the learning outcomes it is necessary to consider what the studies programme [6] indicates as content for the Design Workshop Subject and what it is specified for each workshop course in the following way:

Workshop I: solving basic problems from the experimentation and creativity. Knowledge from the testing, trial and error to improve the proposed solution. Planning the design process. Design and planning three-dimensional models. Construction techniques. Functional, aesthetic and ingenious evaluation.

Workshop II: solution of intermediate complex problems based on prototyping as designing a project process. Development of prototyping based on the conceptual solution. Techniques of construction of moulds and patterns. Techniques of reproduction of prototypes: thermoforming, casting, resins, machining. Technical constructive evaluation.

Workshop III: product detail design. Solution of complex problems. Technical, productive evaluation and tests.

This content demonstrates the progress of the acquisition and development of the competences from a basic level to a complex problem, and that must be considered in the description of the learning outcomes.

In order to set the results, the ANECA recommendations have been considered [4], of which the following ones are emphasised:

- To describe the learning outcomes with an action verb followed by the object of the verb and the context.
- To include only the learning outcomes that the student will be able to achieve.
- To establish the level of achievement for the relevant result for a given academic level.

With these considerations, the following tables 3 and 4 have been developed, in which the learning results of each course associated with each competence are reflected.

Table 3. Learning outcomes 1.

Competences of Design Workshop subject	Learning outcomes		
	Workshop I	Workshop II	Workshop III
6G - To evaluate and to optimise the criteria for decision making.	Justify the possible improvements of a product.	To estimate the alternatives particularised for a product.	To discuss the different decisions made in the development of ideas for a product.
13G - To use the required tools and instruments for the observation and solution of problems in engineering and architecture. (13 +20)	To test with the most appropriate techniques in the realization of sketches, prototypes and models.	To select and use the most appropriate techniques in the development of sketches, prototypes and models.	
8E - To apply the relevant manual and computer graphic representation techniques.		R	To represent a product graphically using manual and computer graphic techniques.
14E - To transmit relevant information of industrial products using formal, graphic and symbolic languages in an appropriate way.	To describe graphically the suggested alternatives of a product.		
23E - To develop the graphic skills and appropriate spatial vision to design and present an industrial product.		To visualize in two and three dimensions a product using different graphic techniques.	

Table 4. Learning outcomes 2.

Competences of Design Workshop Subject	Learning outcomes		
	Workshop I	Workshop II	Workshop III
29E - To know the industrial reality and, in particular, the concepts and applications of Design. (29+32)			To know a product through the state of the art.
CT 3 - ANALYSIS AND PROBLEM SOLVING. To analyze and solve problems effectively, identifying and defining the significant elements that constitute them.	To examine a product providing a critical analysis.		R
CT 4 - INNOVATION, CREATIVITY AND ENTREPRENEURSHIP. To innovate in order to respond satisfactorily and in an original way to personal, organizational and social needs and demands with an entrepreneurial attitude.	To propose multiple improvements and product alternatives.	To use different techniques and strategies in the search for new ideas of a product.	To develop multiple solution alternatives and new concepts for a product.
CT 5 - DESIGN AND PROJECT. To design, direct and evaluate an idea effectively until it is completed in a project.	To define a product through functional, ergonomic and formal criteria.	To certificate the activities carried out in the development of the proposal of a product.	To prepare the necessary documentation when the development of a product is considered.
CT 9 - CRITICAL THINKING. To develop a critical thinking interested in the fundamentals on which the ideas, actions and judgments, both own and others, are based.		To analyze from different points of view the alternatives proposed for a product, objectively discussing its validity.	To enquiry from different points of view the ideas of the design of a product.
CT 13 – SPECIFIC INSTRUMENTAL. Ability to use the techniques, skills and updated tools necessary for the practice of the profession.	To use the techniques and basic tools of a model workshop.	To use the common techniques and tools in the construction of models and prototypes.	To use the techniques and specific tools of an industrial designer.

3.3 The assessment of the learning outcomes

When considering the learning outcomes, it is necessary to know how they can be measured and evaluated. To do this, a rubric has been proposed as the most appropriate method to coordinate the progress and the evaluation of the learning outcomes.

To illustrate in the present communication the relationship between the learning outcomes and the evaluation rubrics developed in the Education Project [2], it has been considered the 6G competence: to evaluate and optimise the criteria for decision making. Table 5 shows the learning outcomes defined for each workshop course, as well as the corresponding evaluation rubric for each course.

Table 5. Rubrics of evaluation of learning outcomes.

		Workshop I	Workshop II	Workshop III
Learning outcomes		Justify the possible improvements of a product.	Evaluate the alternatives proposed for a product.	Discuss the different decisions made in the development of product proposals.
RUBRIC	EXCELLENT	Value coherently the alternatives proposed. Obtain conclusions, suggest improvements and apply them in the development of the final solution. Develop criteria for the evaluation of conceptual proposals.	Evaluate in detail, in an experimental and systematic way, the explained alternatives (from graphic representations and/or with real-scale models). Test, compare and validate the options to make decisions with widely logical criteria.	Explain methodically the existence of conflicts between the different decisions that must be carried out. Make optimal use of the tools to decide and incorporate decision-making criteria unrelated to the development of the Workshop and that are significant for the project.
	ACHIEVED	Evaluate the alternatives proposed. Obtain conclusions, suggest improvements and apply them in the development of the final solution. Develop criteria for the evaluation of conceptual proposals.	Evaluate, in an experimental and systematic way, the explained alternatives (from graphic representations and/or with real scale models). Test and compare the options to make decisions with logical criteria.	Explain properly the existence of conflicts between the different decisions that must be carried out. Make appropriate use of the tools to decide and incorporate criteria of decision makers involved in the development of the Workshop.
	IN PROGRESS	Select the alternative by slight reasoning. Suggest some improvement that applies in the development of the final solution.	Evaluate experimentally only some of the alternatives developed. Test and compare options slightly, obtaining poorly logical criteria for decision making.	Explain the existence of conflicts between the different decisions that must be carried out. Make little use of the tools to decide and incorporate criteria of decision makers involved in the development of the Workshop.
	UNACHIEVED	Select the alternative without discussion and do not propose enough improvements for the development of the product.	The student does not evaluate the options experimentally. It does not get some reasoned criteria.	Explain scarcely existing conflicts. Make intuitive decisions. Make poor use of the tools to decide.

3.4 Evidence from the Design Workshop Subject

As a last result, evidence is provided to verify the progress in the acquisition of the competences in the Design Workshop Subject.

In Workshop I course for second year students, an example of a work is to create, based on a thematic or formal suggestion and on an intuitive development, a different and attractive product for a company. From some initial requirements, the student must propose innovative solutions for a company, whose manufacturing process, in this example, is the rotational moulding that requires the production with the minimum number of parts. One of the results is shown in Figure 1 where, starting from an organic element, a luminaire has been defined, whose novelty is based on its use, the grip system and its different positions. The project shows experimentation and play with the natural object to feel and know its properties and characteristics. Then, its graphic representation as a reference leads to the development of alternatives that, at the same time, offer suggestions and help to observe functional possibilities.

In these projects of Workshop I course, the development of the competences "Analysis and resolution of problems", "Use of the required tools", "Use of formal languages, graphics and symbolic", "Innovation, Creativity and Entrepreneurship" and "Design and Project" are worked in the solution process.

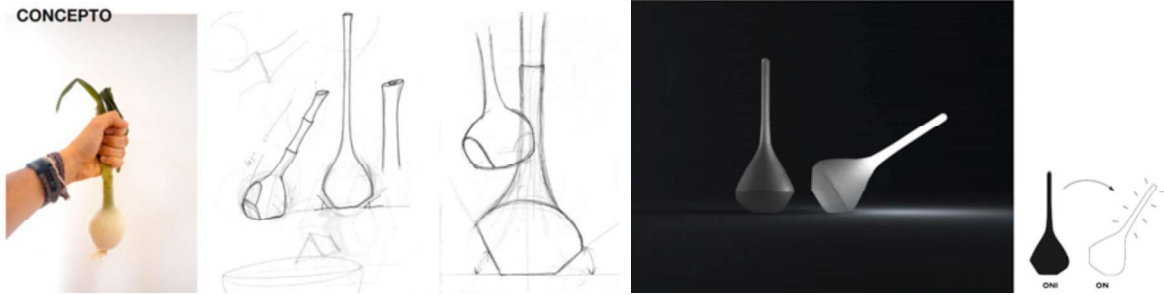


Figure 1. – Work of the students N. Marquina, A. Popova, T. Heng y .M.A. Fernández in Workshop I.

In the Workshop II course for third year students, an example of work proposed consists of the design of an itinerant auxiliary table with a small number of parts, easy to fold or disassemble that resolves the need to eat in the sofa space and that has a portable tray. An obtained result is the proposal in Figure 2, in which the solution is evaluated experimentally.

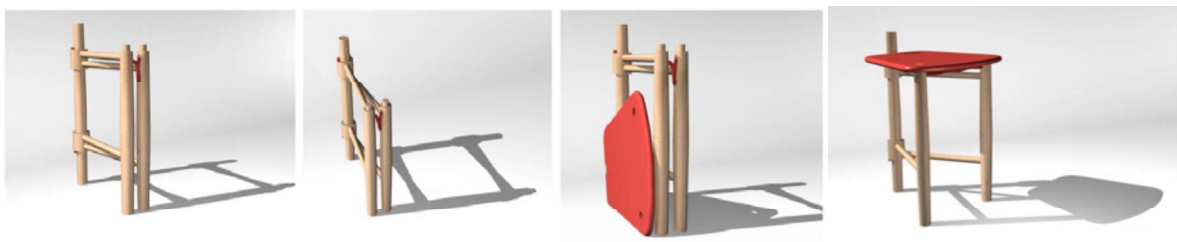


Figure 2. – Work of the students M. Ibáñez, M. Ruiz y L. Soriano in Workshop II.

In Workshop III course for fourth year students, a proposed work model is the design of a product that allows the subtraction of small waste. In this case, not only the formal aspect of the new product is defined, but also an exhaustive examination of the different components, that are functional elements, is carried out to observe which modifications can be developed to improve the solution. Finally, the detailed design of the product is developed as shown in Figure 3.

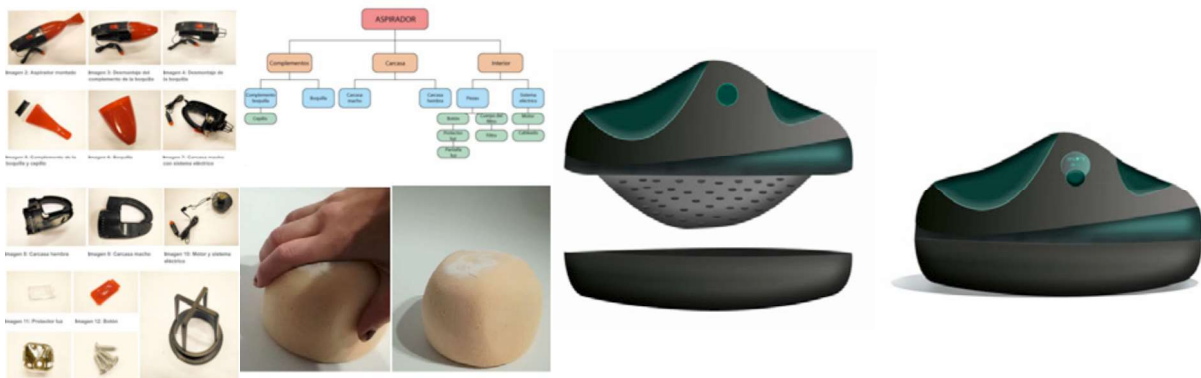


Figure 3. – Work of the students C. Sánchez, L. F. García, M. Rodríguez y E. Torrejón in Workshop III.

4 CONCLUSIONS

The task of specifying the learning outcomes has allowed us to reflect and value the importance that competences have as statements of what a student is expected to know, understand and/or assume and be able to do at the end of the learning process [7]. In the same way, a discussion has been established between the teachers with the purpose of continuity and to generate consensus concerning the planned progress and communication with the students regarding their knowledge of the competences to be acquired.

The large number of participant members in this educational project, the contribution of teachers not involved in the project workshop and the fact of developing it in two different faculties has resulted, on the one hand, in being an obstacle for the coordination of the team, but on the other hand, it has allowed us to enrich the proposals by observing the teaching-learning process from different points of view.

It is also important to note that the level of definition reached in the description of the learning outcomes is an open field to specify and validate in the next courses. As it was mentioned earlier, the workshop subject initiates the student in the approach and development of design projects that are evolving in complexity and implementation demands [5]. The multiple parameters that come together in a quality design require an in-depth analysis of the discipline itself, which allows us to determine which aspects (functional, constructive and symbolic) are really those that can establish the levels of the "complexity" and resolution of a project of design.

ACKNOWLEDGEMENTS

The work reported here has been a part of the educational innovation project "*Integración y coordinación de la materia Taller de Diseño como fundamento de la adquisición de competencias en el Grado de Ingeniería en Diseño Industrial y Desarrollo de Productos de la UPV*" (project B06), supported by the Vicerectorat d'Estudis, Qualitat i Acreditació at the Universitat Politècnica de València.

REFERENCES

- [1] Universitat Politècnica de València, Competencias Transversales, Accessed 2 July, 2018. Retrieved from <http://www.upv.es/contenidos/COMPTRAN/>.
- [2] M. Puyuelo, E. March, J. Aparisi, B. Pacheco-Blanco, C. Esteve, M. Valor and E. Julià, "Rubrics as a tool to coordinate assessment and progress in different design workshops of the degree in Industrial Design Engineering and Product Development", INNODOCT, 2018. Accepted.
- [3] Universitat Politècnica de València, Informe final para la obtención del sello EUR-ACE®, pp. 2, Accessed 2 July, 2018. Retrieved from http://www.upv.es/titulaciones/GIDIDP-A/menu_urlc.html?titulaciones/GIDIDP-A/info/U0712180.pdf.
- [4] Agencia Nacional de Evaluación de la Calidad y Acreditación (ANECA), "Guía de apoyo para la redacción, puesta en práctica y evaluación de los resultados del aprendizaje. Version 1.0", Accessed 2 July, 2018. Retrieved from <http://www.aneca.es/Sala-de-prensa/Noticias/2013/ANECA-presenta-la-Guia-para-la-redaccion-y-evaluacion-de-los-resultados-del-aprendizaje>
- [5] M. Puyuelo, M. Val' C. Esteve, E. González, E. March, J. Aparisi and M. Valor, "El Taller de Diseño como núcleo de innovación docente y eje de adquisición de competencias en la formación del grado en Ingeniería en Diseño Industrial y desarrollo de productos" in Congreso Universitario de Innovación Educativa en las Enseñanzas Técnicas, 2018. CUIEET 2018, pp. 759-587, 2018.
- [6] Universitat Politècnica de València, Memoria Verificación actual, pp. 53, Accessed 2 July, 2018. Retrieved from http://www.upv.es/titulaciones/GIDIDP-A/menu_urlc.html?titulaciones/GIDIDP-A/info/GIDIDP_mva.pdf
- [7] Bologna Working Group on Qualifications Frameworks, "Learning outcomes, including competences" in *A Framework for Qualifications of the European Higher Education Area* (Ministry of Science, Technology and Innovation, Copenhagen), pp.37, 2005, Accessed 2 July, 2018. Retrieved from http://www.ehea.info/media.ehea.info/file/WG_Frameworks_qualification/71/0/050218_QF_EHEA_580710.pdf