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CURRICULAR ANALYSIS IN THE INDUSTRIAL CIVIL ENGINEERING CAREER OF THE UNIVERSIDAD DE AYSÉN, UNDER ABET CRITERION 3

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Abstract: The Industrial Civil Engineering career of the nascent Universidad de Aysén is in its 7th cohort and has already graduated its first students, who are the first professionals graduated from the University. At the birth of the career, its design was highly influenced by our tutor University, the University of Chile, so that once the first students graduate, it is necessary to begin a work of curricular adjustment, so preparing for that moment is essential. A world class engineer is expected to respond to global considerations that cannot be subordinated only to a subjective information survey at a local level, in this sense it is pertinent to observe the requirements for any engineer in the world and the importance given to them by the accreditation processes in different countries. This article analyzes the result of applying criterion 3 of the ABET international standard, referring to the formative results, to the curriculum of the Industrial Civil Engineering career, ICI, of the Universidad de Aysén, UAY.
Keywords: Curriculum, Civil Industrial Engineering, Competencies, ABET

INTRODUCTION

When defining competencies for the career, it is necessary to go beyond the competencies or performances that each institution has defined, it is necessary to carry out a bibliographic search that allows to recognize the different standards that arise from different institutions and organizations of the educational world, proposing what is expected for an engineer who will have to act in a globalized, changing and complex world.

There is certainly a lot of material to review, from the CACEI criteria of Mexico, CEAB of Canada, EQF of Japan, those of the Washington Accord, ABET of USA to the National Qualifications Framework for Higher Education in Chile, developed by the Ministry of Education in 2016, with the objective of establishing a coherent, transparent and legible system of certifications for higher education, allowing lifelong learning and recognition of prior learning (Montt and Rosso, 2014).

In recent years, academic programs have been growing rapidly and access to more information by prospective students has generated greater interest in being able to recognize the best positioned institution among one or another Higher Education Institution (HEI); therefore, the institutions themselves strive to achieve, through accreditation processes, that their programs are recognized nationally and internationally, as indicated by (Valencia et al., 2020).

In general, these accreditation processes subject an academic institution or an academic program to a thorough review in order to demonstrate whether it meets the quality standards established by an accreditation agency (Rosado and Nieto, 2019).

It is important to recognize that these accreditation processes are of a temporary nature and seek more than the milestone itself, to install in HEIs the look of continuous improvement and as indicated by (Cañón, 2016) if they maintain or have improved the quality of their educational processes.

Currently there are different international accreditation seals such as the CACEI criteria of Mexico, CEAB of Canada, EQF of Japan, those of the Washington Accord, ABET of USA up to the National Qualifications Framework for Higher Education in Chile, developed by the Ministry of Education in 2016, with the objective of establishing a coherent, transparent and legible system of certifications for higher education, which allows evidencing as pointed out by (Montt and Rosso, 2014) lifelong learning and the recognition of prior learning.

Undoubtedly it can be overwhelming, facing so much information from different sources, but a positive aspect is that from

all the options of standards and/or criteria one can find similarities and areas that all approaches recognize as fundamental to develop and translate into competencies. Some similar elements, often recognized by experts and in general by employers, are the knowledge of basic sciences and engineering sciences, hopefully as applied as possible, to develop the ability to investigate complex problems, use appropriate methods and experiments and analyze and interpret data, so that students from the beginning of the career and as they advance in the curriculum understand the role of the engineer in society and their contribution to problem solving. Along with the disciplinary aspect, there are strong transversal competencies such as citizenship, history and/or culture, aspects that undoubtedly take the engineer to a field little known to him/her and very relevant nowadays because of all the inter and multidisciplinary work. Finally, some standards emphasize innovation and design competencies such as the ability to innovate systems, design solutions to complex problems that respond to specific needs with attention to health, public safety and legal and regulatory aspects. Design must consider economic, social, environmental, cultural, political and ethical implications.

DEVELOPMENT

The competencies to be analyzed are those indicated in the international ABET criteria corresponding to Criterion 3: Learning Outcomes.

a) Ability to apply knowledge of mathematics, science and engineering.

b) Ability to design and perform experiments, as well as analyze and interpret data.

c) Ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturing, and sustainability.

d) Ability to work in multidisciplinary teams.

e) Ability to identify, formulate and solve engineering problems.

f) Understanding of professional and ethical responsibility.

g) Ability to communicate effectively.

h) Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and social context.

i) Recognition of the need and ability to engage in lifelong learning.

j) Knowledge of contemporary problems.

k) Ability to use modern engineering techniques, skills and tools necessary for engineering practice.

The first step is to develop the matrix for the distribution of competencies in the curriculum and, together with this, it is necessary to establish the level of depth that the competency will reach as the curriculum progresses. For this purpose, low, medium and high levels are defined and for each of these levels, criteria are established to be developed with respect to teaching (the what), practice (the how) and learning outcomes (LLOs).

Level	Teaching	Practice	RdA
B Basic	The essential knowledge of the competence is provided.	Use is made of the knowledge provided.	The student recognizes information and ideas as well as principles in approximately the same form in which they were learned.
M Medium	Different methods of applying competition are identified.	Methods are used to describe how to approach new situations.	The student understands or interprets information based on prior knowledge.
A High	Possible problems to be solved are described.	Problems are solved using methods and knowledge.	The student selects, transfers, and uses data and principles to solve a problem.

Table 1: Competency development level

Once the levels of achievement for the competencies have been defined, it is necessary to assign for each of the subjects of the study plan the expected level of achievement of each of the ABET competencies of the formative results criterion.

RESULTS

In the initial cycle, from the first to the fourth semester, the basic science subjects necessary for the career are found and the behavior is quite similar to that expected. Most of the subjects present a B level of development in the different criteria and as the next cycle approaches, the first evaluations of level M appear. However, the subject Engineering Workshop III (third semester, valued at M) and Engineering Workshop IV (fourth semester, valued at A) present a different evaluation than expected.

For the undergraduate cycle, it considers subjects from the fifth to the eighth semester. In this section, the subjects are of a disciplinary nature, linked to engineering sciences and a level of achievement M for the different criteria is observed for the most part, except for some subjects that, since they do not have prerequisites and are subjects of a particular line, are valued at level B in some aspects.

Finally, in the professional cycle, from the ninth to the tenth semester (last year of the career), the subjects correspond to disciplinary electives and those linked to the degree process, which allow reaching a certain level of specialization and play a role of integration and application of knowledge and skills achieved in the first four years of the career, therefore, the ABET criteria are mostly valued in level A, except for one subject that achieves level M.

Based on these findings, it is possible to identify and propose some adjustments at the curricular level to better prepare students for world-class engineering.

CONCLUSIONS

In this exercise of first review and approximation of the ABET criteria, it allows us to identify how we are preparing our students to face an increasingly challenging professional world.

It is important to be able to define how each of the ABET criteria are gradually achieved throughout the course and what level of achievement will be required for the same criterion in different subjects, each of which can contribute to total compliance.

The exercise allows at least some issues to be identified:

- Is it the best option to develop the Engineering Workshop line in the first four semesters, or would it be better to distribute these subjects every other semester? With this change, previous knowledge could be constantly integrated throughout the career, reaching up to the fourth year, students could develop better solutions and perhaps better face the different challenges.

				ABET Competencies										
	Sem	**Code**	**Subject**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
Initial Cycle	**I**	IN1001	Mathematics	B			B						B	
	I	IN1013	Chemistry	B			B						B	
	I	IN1003	Engineering Workshop I	B			B	B	B	B	B	B	B	B
	I	IN1004	Computer Tools				B							
	II	IN1006	Calculation I	B			B							
	II	IN1007	Linear Algebra	B			B							
	II	IN1008	Physics I	B	B		B						B	
	II	IN1009	Engineering Workshop II	B			B	B	B	B	B	B	B	B
	II	IN1010	Programming I			B	B							
	III	IN1011	Calculus II	B			B							
	III	IN1012	Physics II	B	B		B							
	III	IN1002	Biosciences	B			B						B	
	III	IN1014	Engineering Workshop III	M		M	M	M	M	M	M	M	M	M
	III	IN1015	Programming II			B	B							
	III	FTIN01	English I				B			B				
	IV	IN1016	Calculus III	B			B							
	IV	IN1017	Discrete Mathematics	B			B							
	IV	IN1018	Physics III	B	M		B							
	IV	IN1019	Engineering Workshop IV	A		A	A	A	A	A	A	A	A	A
	IV	IN1020	Experimental Methods		M		B							
	IV	FTIN02	English II				B			B				
Undergraduate Cycle	V	IN1021	Probability and Applied Statistics	M			B							
	V	IN1022	Optimization	M	M		B	M						
	V	IN1023	Physics IV	M	M		B							
	V	IN1024	Micro and Macroeconomics		M		B							
	V	FTINE1	Transversal Elective I				M					M		
	V	FTIN03	English III				B			M				
	VI	IN1025	Operations Research	M	M		B	M						
	VI	IN1026	Entrepreneurship and Innovation			M	M	M	M				M	
	VI	IN1027	Project Evaluation		M		B		M					
	VI	IN1028	Introduction to TICA			M	M	M						M
	VI	FTINE2	Transversal Elective II				M					M		
	VI	FTIN04	English IV				B			A				
	VII	IN1029	Operations Management I		M		B	M						
	VII	IN1030	Marketing				B						M	
	VII	IN1031	HR Management				B		M				M	
	VII	IN1032	Data Engineering			A	M	M	M				M	M
	VII	INED01	Disciplinary Elective I	M	M		M	M	M			M	M	
	VIII	IN1033	Operations Management II			M	M	M						
	VIII	IN1034	Finance	M			B							
	VIII	IN1035	Project Management (PMO)		M		B		M				M	
	VIII	IN1036	TICA Project Workshop			A	A	A	A					A
	VIII	IN1005	English. Conversation Workshop							A				

Professional Cycle	**IX**	IN1037	Title I Workshop			A	A	A	A		A		A	A
	IX	INED02	Disciplinary Elective II	A	A	A	A	A	A		A	A	A	A
	IX	INED03	Disciplinary Elective III	A	A	A	A	A	A		A	A	A	A
	IX	IN1038	Strategic Management			M	M		M					
	IX	IN1039	Engineering Law						A		A			
	X	IN1040	Title II Workshop			A	A	A	A		A		A	A
	X	INED04	Disciplinary Elective IV	A	A	A	A	A	A		A	A	A	A
	X	INED05	Disciplinary Elective V	A	A	A	A	A	A		A	A	A	A

Table 2: Matrix of competencies in the ICI UAysén curriculum

- Another interesting aspect is that the review reveals those subjects that are disconnected in the curricular plan and that do not contribute to the current formative process, fail to develop an A level and do not connect with others, therefore, it is suggested to review those connections and somehow evaluate how those learning processes are delivered in a new plan.
- Regarding the professional cycle, it is undoubtedly the group of subjects that allow advancing towards a certain specialization and are expected to integrate learning, knowledge and the criteria should already be reflected at a high level, therefore in this space should not appear subjects of another nature, therefore it is suggested to exchange the disciplinary elective I for the subject of Strategic Management.

Finally, recognize the scope of this review. It is a first exercise that prepares us to continue researching and designing curricular improvements. It is necessary to identify the strategies that allow us to actually measure the achievement of the criteria at the predefined level and how these indicators allow us to monitor the learning trajectory throughout the curriculum.

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