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Competencias en carreras de ingeniería. Modelo para evaluar niveles de adquisición y requerimientos del mercado de trabajo

Competencies in Engineering Careers. Model to Evaluate Levels of Acquisition and Requirements of the Job Market

Competências em carreiras de engenharia. Modelo para avaliar níveis de aquisição e exigências do mercado de trabalho

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Resumen

En Argentina, los procesos educativos en el campo de la enseñanza de las ingenierías están transitando por diversos procesos que promueven innovaciones curriculares orientadas hacia el diseño de planes de estudio por competencias y a la definición de nuevos estándares de acreditación.

El Instituto de Investigaciones en Tecnología y Educación (IIT&E) de la Facultad de Ingeniería de la Universidad Nacional de Lomas de Zamora (UNLZ), en el marco de una investigación educativa, desarrolló un instrumento para medir, en relación con la adquisición de competencias, las distancias entre las expectativas, la formación recibida y lo demandado por el mercado de trabajo.

El estudio se desarrolló desde la perspectiva de los modelos de base subjetiva que evalúan la calidad de los servicios, y a partir de un cuestionario *ad hoc* que se administró a graduados. Con el enfoque especificado y con los datos obtenidos, segeneraron dos índices estadísticos.

El presente artículo tiene como finalidad presentar un modelo que, a través de los indicadores de adecuación de la competencia (IAC) y los indicadores de desarrollo de la

competencia (IDC), mide la magnitud y naturaleza del cambio que las instituciones enfrentan cuando inician procesos orientados a innovar curricularmente desde un plan de estudio por contenidos hacia otro por competencias.

Palabras clave: calidad, competencias, ingeniería, innovación curricular, modelo.

Abstract

In Argentina, educational processes in the field of engineering education are going through several processes that promote curricular innovations oriented towards the design of study plans by competences and the definition of new accreditation standards.

The Institute of Research in Technology and Education (IIT&E) of the Faculty of Engineering of the National University of Lomas de Zamora (UNLZ), through an educational research, developed an instrument that allowed to measure, in relation to the acquisition of competences, the distances between the expectations, the training received, and the level of acquisition demanded by the job market.

The study was developed from the perspective of subjective models that evaluate the quality of the services, and froman ad hoc questionnaire that was administered to graduates, two statistical indexes were generated.

The purpose of this article is to present a model that, through the Adequacy of Competence (IAC) and Competence Development (IDC) indexes, measures the magnitude and characteristics of the change that institutions face when they initiate processes oriented to move from a curriculum for content to another by competencies.

Keywords: quality, competences, engineering, curriculum innovation, model.

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Resumo

Na Argentina, os processos educacionais no campo da educação em engenharia estão passando por vários processos que promovem inovações curriculares orientadas para a elaboração de planos de estudo por competências e a definição de novos padrões de acreditação.

O Instituto de Pesquisa em Tecnologia e Educação (IIT&E) da Faculdade de Engenharia da Universidade Nacional de Lomas de Zamora (UNLZ), no âmbito de uma pesquisa educacional, desenvolveu um instrumento que permitiu medir, em relação à aquisição de competências, as distâncias entre as expectativas, a formação recebida e o nível de aquisição da demanda pelo mercado de trabalho.

O estudo foi desenvolvido a partir da perspectiva de modelos de base subjetivos que avaliam a qualidade dos serviços, e de um questionário ad hoc que foi administrado aos graduados dois índices estatísticos foram gerados.

O objetivo deste artigo é apresentar um modelo que, através dos Indicadores de Adequação da Concorrência (IAC) e Desenvolvimento da Competição (IDC), mede a magnitude e as características da mudança que as instituições devem fazer, quando começam processos orientados para inovar curricularmente, de um currículo de conteúdo para outro para competências.

Palavras- chave: qualidade, competências, engenharia, curriculum inovação, modelo.

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Introduction

The purpose of this paper is to present the results of a study whose data were obtained from the application of a model designed to measure levels of satisfaction with respect to the acquisition of competences in engineering careers. Through information provided by two indicators that measure, from the perspective of the graduates and their work experiences, the adequacy, superiority or deficit between the expectations and the learning achieved, we aspire to contribute to the processes of curricular innovation.

The research was developed within the scope of the Faculty of Engineering of the National University of Lomas de Zamora (UNLZ). Specifically, the data presented is the result of one of the

lines of work of the Institute of Research in Technology and Education (IIT & E). It should be noted that the IIT & E is a center associated with the Commission of Scientific Research of the Province of Buenos Aires (CIC-PBA), which, within the framework of its functions, carries out the curricular innovation actions of the academic unit. the case that is presented is the result of his intervention in the process of modification of accreditation standards of engineering careers that in Argentina are promoted as of 2015.

The Bologna Declaration (European Ministers, 1999) was a turning point for university studies, as it called for guaranteeing the acquisition of skills that would ensure the students' job placement. As pointed out by Herrero, González and Marín (2015) and Tejada (2012), at that time they began to explore models that, in addition to knowledge, promoted the development of skills and attitudes. In this way, the perspective of training by competences acquired centrality at the university level.

De la Cruz Flores and Abreu Hernández (2014) affirm that society demands subjects that have flexible thinking, critical and reflective judgment, and expects that their knowledge will be used to make decisions, which implies analyzing, interpreting or making deductions derived from a variety of facts and circumstances. On the other hand, Ya-Hui, Li-Yia, Chao-Chin and Tzu-Ling (2012) emphasize that a cumulative learning of knowledge does not guarantee professional success. Both statements lead us to reflect on how competency-based training contributes to the acquisition of those skills and to improve the professional integration of graduates.

In this context, in Argentina, the First Agreement on Competences (Federal Council of Deans of Engineering Careers of the Argentine Republic [Confedi], 2006), which, following Perrenoud (2013), argues that the know-how of engineers it is the result of a complex structure of knowledge, skills and abilities that needs to be explicitly recognized in the learning process, and proposes that engineering careers be taught from curricular designs by competencies. This approach implied a challenge for the educational project of the School of Engineering of the UNLZ; institution that in 2008 created the IIT & E with the mission of accompanying the innovation processes that took place within the framework of said agreement.

The Confedi proposal was structured based on the definition of competency units (Huerta, 2014) that were disaggregated into associated capacities and components (Tobón, Pimienta and García, 2012 and Tobón, 2013), and resulted in a matrix that was presents in table 1.

Tabla 1. Competencias genéricas tecnológicas del perfil del ingeniero

Competencias tecnológicas	***Capacidades asociadas integradas***
1. Identificar, formular y resolver problemas de ingeniería.	- Identificar y formular problemas. - Realizar búsqueda creativa de soluciones y seleccionar la alternativa más adecuada. - Implementar tecnológicamente una alternativa de solución. - Controlar y evaluar enfoques y estrategias propios para abordar eficazmente la resolución de los problemas.
2. Concebir, diseñar y desarrollar proyectos de ingeniería (sistemas, componentes, productos o procesos).	- Concebir soluciones tecnológicas. - Diseñar y desarrollar proyectos de ingeniería.
3. Gestionar, planificar, ejecutar y controlar proyectos de ingeniería (sistemas, componentes, productos o procesos).	- Planificar y ejecutar proyectos de ingeniería. - Operar y controlar proyectos de ingeniería.
4. Usar de manera eficaz las técnicas y herramientas de la ingeniería.	- Identificar y seleccionar las técnicas y herramientas disponibles. - Usar y/o supervisar el uso de las técnicas y herramientas.
5. Contribuir a la generación de desarrollos y/o innovaciones tecnológicas.	- Detectar oportunidades y necesidades insatisfechas mediante soluciones tecnológicas. - Hacer un uso creativo de las tecnologías disponibles. - Emplear las formas de pensamiento apropiadas para la innovación tecnológica.

Fuente: Confedi (2006)

Based on the global review of accreditation standards promoted by the Ministry of Education (National Commission for University Evaluation and Accreditation [Coneau], 2015), the 2006 Confedi agreement regained its validity, as a new document was approved. that future accreditations are developed under study plans designed by competences (Confedi, 2017).

Pérez, Vilariño and Ronda (2017) affirm that all innovation is conditioned by the scope and depth of the guidelines that drive it, but also by the values, beliefs and daily practices, which define

the magnitude and orientation of the actions; This circumstance led to the development of a diagnostic study on the careers of the academic unit and the context in which they were taught.

There is agreement among the authors that policies that institutionalize accreditation processes, as well as curricular innovation processes, are associated with improvement, therefore, IIT & E opted for a quality assessment approach for the study. This is how, based on the recommendations of Duque Oliva and Chaparro Pinzón (2017) about the methods to evaluate the quality of educational programs, it was considered that those that measure perceptions through satisfaction judgments were adequately adjusted to the defined objectives by the institution.

Martínez, Blanco and Castán (2013) warn that, in general terms, quality processes in education have taken as a starting point the hypothesis that those responsible for educational institutions are able to develop programs aimed at satisfying student. However, the current theoretical currents in this field indicate that what is relevant is the user's needs. Taking into account that the main user of the educational service is the student, the opinion of the graduate was considered as the strategic input for the purposes of this work.

Method

Based on the different subjective base methods developed to date, collected by Duque Oliva and Diosa Gómez (2014), an ad hoc adaptation was carried out that resulted in a descriptive and transectional design study, based on a survey that He focused the investigation around the capacities associated with the first generic technological competence defined by Confedi (2006). Therefore, we consulted how graduates perceived the level of development of the competence "Identify, formulate and solve engineering problems, as well as conceive, design and develop engineering projects". To such ends, they were asked what had been , in relation to the capacities and associated components, the level of acquisition during the career, what the expected learning and what the demands of the employers. The instrument collected qualitative information, but, in order for the data to receive statistical treatment, the responses were required to be dumped on a Likert scale (1-10).

The questionnaire was administered during the second semester of 2017 at random from a sample of 108 graduates of the Engineering Faculty of the UNLZ. It was considered that graduates with no more than five years of graduation turned out to be key actors. Because their recent status as students allowed them to provide information with good reliability criteria about their career, as well as about the experiences related to their job placement.

The data obtained received statistical treatment in order to measure the distance between expectations, training received and demands of the labor market. Two indexes were constructed from the averages obtained: a) Competence Adequacy Index (IAC), which measures the perceived relationship between what was expected and what was received by the graduates; and b) the Competency Development Index (IDC), which evaluates the perception in relation to the level acquired and what is required by the labor market.

For the determination of these indexes, the means obtained in each of the components of the associated capacities were applied the following calculation:

- IAC = observed value (VO) - expected value (VE).
- IDC = VO - required value (VR)

Next, the conceptual schema from which the measurement instrument was developed is presented schematically (see table 2).

Tabla 2. Competencia desagregada en capacidades asociadas y sus respectivos indicadores

Competencia 1. Identificar, formular y resolver problemas de ingeniería, como así mismo concebir, diseñar y desarrollar proyectos de ingeniería	
Capacidades asociadas	**Capacidades componentes o indicadores**
Identificar y formular problemas.	- Identificar una situación problemática. - Identificar y organizar los datos pertinentes a un problema. - Evaluar el contexto particular del problema e incluirlo en el análisis. - Delimitar el problema y formularlo de manera clara y precisa.
Realizar búsqueda creativa de soluciones y seleccionar la alternativa más adecuada.	- Generar diversas alternativas de solución a un problema ya formulado. - Desarrollar criterios profesionales para la evaluación de las alternativas y seleccionar la más adecuada en un contexto particular. - Valorar el impacto sobre el medio ambiente y la sociedad, de las diversas alternativas de solución.
Implementar tecnológicamente una alternativa de solución.	- Realizar el diseño de la soluciónteconológica. - Incorporar al diseño las dimensiones del problema (tecnológica, temporal, económica, financiera, medioambiental, social, etc.) que sean relevantes en su contexto específico. - Planificar la resolución (identificar el momento oportuno para el abordaje, estimar los tiempos requeridos, prever las ayudas necesarias, etc.). - Optimizar la selección y uso de los materiales y/o dispositivos tecnológicos disponibles para la implementación. - Elaborar informes, planos, especificaciones y comunicar recomendaciones. - Controlar el proceso de ejecución.
Controlar y evaluar enfoques y estrategias propios para abordar eficazmente la resolución de los problemas.	- Controlar el propio desempeño y saber cómo encontrar los recursos necesarios para superar dificultades. - Establecer supuestos, de usar técnicas eficaces de resolución y de estimar errores.

	- Monitorear, evaluar y ajustar el proceso de resolución del problema. - Usar lo que ya se conoce; identificar lo que es relevante conocer, y disponer de estrategias para adquirir los conocimientos necesarios.

Fuente: Elaboración propia con base en Confedi (2006)

Results

In this section, the means corresponding to the VO, VE and VR are presented for each of the components of the analyzed competition. Secondly, the IAC and IDC indices are presented.

Ability to identify and formulate problems

When analyzing the capacity and its disaggregated components, it is observed that the learning with the highest level of acquisition demanded by the employer sector was "Delimit the problem and formulate it in a clear and precise manner" (8.40), while the one with the lowest requirement was "Evaluate the particular context of the problem and include it in the analysis "(8.07). From the perspective of the graduates, this was the component with the highest expectation of acquisition (7.87) (see table 3). On the other hand, the highest observed value was "Identify a problematic situation", whose average was 8.56.

Tabla 3. VO, VE y VR para los componentes de la capacidad "Identificar yformular problemas"

Componentes de la capacidad	*VO*	*VE*	*VR*
Identificar situación problemática.	8.56	7.44	8.15
Identificar y organizar los datos pertinentes a un problema.	7.75	7.47	8.33
Evaluar el contexto particular del problema e incluirlo en el análisis.	7.55	7.60	8.07
Delimitar el problema y formularlo de manera clara y precisa.	7.87	7.45	8.40

Fuente: Elaboración propia

Ability to perform creative search for solutions and select the most appropriate alternatives

By focusing the analysis on the ability to perform creative searches of solutions and select the most appropriate alternative (see table 4), the component with the highest level of development required by the employer sector was "Generate various alternatives to solve a problem already formulated" (8.45), which was found to be consistent with what was perceived by the respondents, whose answers placed the observed value above eight points (8.29) and thus turned out to be the component with the highest weighting.

The component with the greatest expectation for this capacity was "Assess the impact of the various solution alternatives on the environment and society" (7.73), which was significant because it was the lowest level of requirement by the employer sector (7.27).

Tabla 4. VO, VE y VR para los componentes de la capacidad "Realizar búsqueda creativa de soluciones y seleccionar la alternativa más adecuada"

Componentes de la capacidad	VO	VE	VR
Generar diversas alternativas de solución a un problema ya formulado.	8.29	7.51	8.45
Desarrollar criterios profesionales para la evaluación de las alternativas y seleccionar la más adecuada en un contexto particular.	8.00	7.04	8.16
Valorar el impacto sobre el medio ambiente y la sociedad, de las diversas alternativas de solución.	7.36	7.73	7.27

Fuente: Elaboración propia

Ability to technologically implement a solution alternative

It is observed that this capacity has been globally evaluated in a positive way, since, for all the components, the observed means were higher than their corresponding ones in terms of expectations (see table 5). The highest levels observed were for the component "Prepare reports, plans, recommendations and communicate them" (8.45), followed by "Optimize the selection and use of technological materials and devices available for implementation" (8.44); coincidentally, the labor market required a higher level of acquisition for the same components (8.71 and 8.53 respectively). It is interesting to note that the result of the expected value for the component "Perform the design and modeling of a technological solution" was 5.93, which is widely exceeded by both the observed value (7.51) and the level of acquisition required (7.69).

Tabla 5. VO, VEy VR para los componentes de la capacidad "Implementar tecnológicamente una alternativa de solución"

Componentes de la Capacidad	VO	VE	VR
Realizar el diseño y modelado de una solución tecnológica.	7.51	5.93	7.69
Incorporar a un diseño las dimensiones relevantes al contexto del problema.	7.42	6.40	7.35
Planificar la resolución identificando momento y tiempos requeridos.	7.80	7.16	7.96
Optimizar la selección y uso de materiales y dispositivos tecnológicos disponibles para la implementación.	8.44	7.45	8.53
Elaborar informes, planos recomendaciones y comunicarlos.	8.45	6.80	8.71
Controlar el proceso de ejecución.	8.22	6.80	8.22

Fuente: Elaboración propia

Ability to monitor and evaluate approaches and strategies to effectively address the resolution of problems

When analyzing the corresponding results, this capacity, in Table 6, shows that the component with the highest level of requirement was "Establish assumptions, use effective techniques and estimate errors" (8.49). And although the observed value turned out to be the highest (8.27) of all the components, it can be seen that there is a gap that would mark the dissatisfaction of the employer sector with respect to the formation of the related competition, since the value of the requirement was located in (8.49).

The components "Identify what is relevant to know and have strategies to acquire necessary knowledge" and "Monitor, evaluate and adjust processes of problem solving" were the ones that verified the lowest level of acquisition by respondents (7.78 and 7.80 respectively).

Tabla 6. VO, VE y VR para los componentes de la capacidad "Controlar y Evaluar enfoques y estrategias para abordar eficazmente la resolución de problemas"

Componentes de la capacidad	VO	VE	VR
Controlar el desempeño y saber cómo encontrar los recursos necesarios para superar dificultades.	8.04	7.18	8.16
Establecer supuestos, usar técnicas eficaces y estimar errores.	8.27	7.95	8.49
Monitorear, evaluar y ajustar procesos de resolución de problemas.	7.80	7.64	8.20
Identificar lo que es relevante conocer y disponer de estrategias para adquirir conocimientos necesarios.	7.78	8.11	8.24

Fuente: Elaboración propia

IAC and IDC index

As indicated in the previous sections, two indexes were constructed from the averages:

a) IAC: This is an indicator of perceived quality that measures for each component the distance between the statistical means of the VO and the VE. In this way, the satisfaction of the graduate during their training process is evaluated, that is, it measures to what extent the expectations were met through the training activities developed in the different curricular spaces.

b) IDC: This indicator indirectly measures the satisfaction of the employer sector. It takes into account the difference between the statistical means obtained between the VO and the VR. Therefore, it measures through a variable of the context (opinion of the employer sector) the need to deepen the results of the apprenticeships.

Ability to identify and formulate problems

The results presented in table 7 show that the IAC was satisfactory for all the components, with the exception of "Assess the particular context of the problem and include it in the analysis", since there is a slight dissatisfaction (-0.05) depending on the that the expectation was higher than the perception of learning outcomes. The best adaptation is observed for the component "Identify a problematic situation" (1.12).

The IDC, on the other hand, presents negative results, since with the exception of the component "Identifying a problematic situation", which shows a superiority of 0.41, in the rest of

the cases the relation is inverted. It is observed that employers demanded higher levels of development for the components "Identification and organization of data relevant to a problem", "Evaluation of the particular context of the problem for inclusion in the analysis" and "Delimitation and formulation of the problem in a clear manner and accurate ", whose indexes were 0.58, 0.52 and 0.53 respectively.

Tabla 7. IAC e IDC para la capacidad "Identificar y formular problemas"

Capacidad	Componentes de la capacidad	IAC	IDC
Identificar y formular problemas	Identificar situación problemática.	1.12	0.41
	Identificar y organizar los datos pertinentes a unproblema.	0.28	-0.58
	Evaluar el contexto particular del problema e incluirlo en el análisis.	-0.05	-0.52
	Delimitar el problema y formularlo de manera clara y precisa.	0.42	-0.53

Fuente: Elaboración propia

Based on the indexes obtained for the "Identify and formulate problems" capacity, it is observed that, in general terms, there is adequacy with the training expectations of the students, while, in relation to the labor market, the results of the apprenticeships are located in 75% of the cases, slightly below the requirements, and do not adequately meet the expectations of the one (see figure 1).

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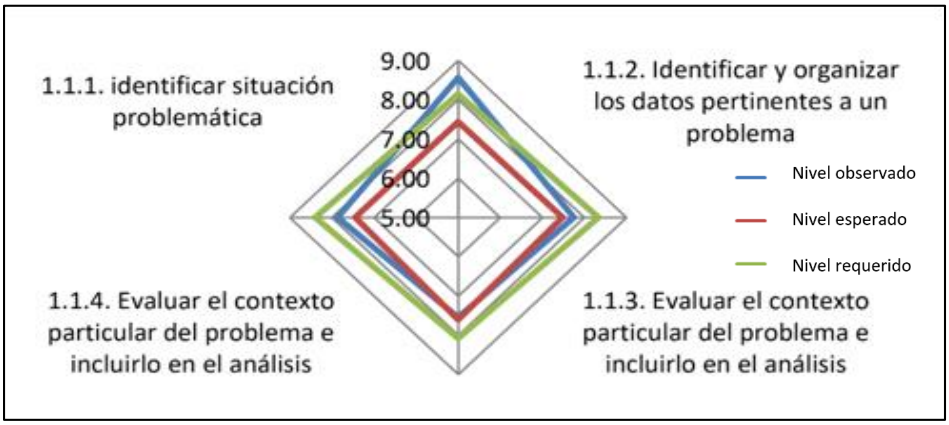
Figura 1. Brechas por cubrir para la capacidad "Identificar y formular problemas" en función de los índices IAC e IDC



Fuente: Elaboración propia

Ability to perform creative search for solutions and select the most appropriate alternative

When analyzing the IAC (table 8) it is noticed that the component "Assess the impact on the environment and society, of the various alternatives of solution" was not satisfactory, because the value obtained was -0.37; This result would indicate that the graduates perceived that the learning obtained was less than their expectations. This case is significant because the IDC for the same component was 0.09, that is, the employer sector did not demand a higher level, but the requirement was lower. On the other hand, a negative IDC (-0.16) is observed for the components "Generate different solution alternatives to a problem already formulated" and "Develop professional criteria for the evaluation of alternatives and selection of the most appropriate to a particular context", result that would indicate that the labor demands were greater than the results of the acquired learning**.**

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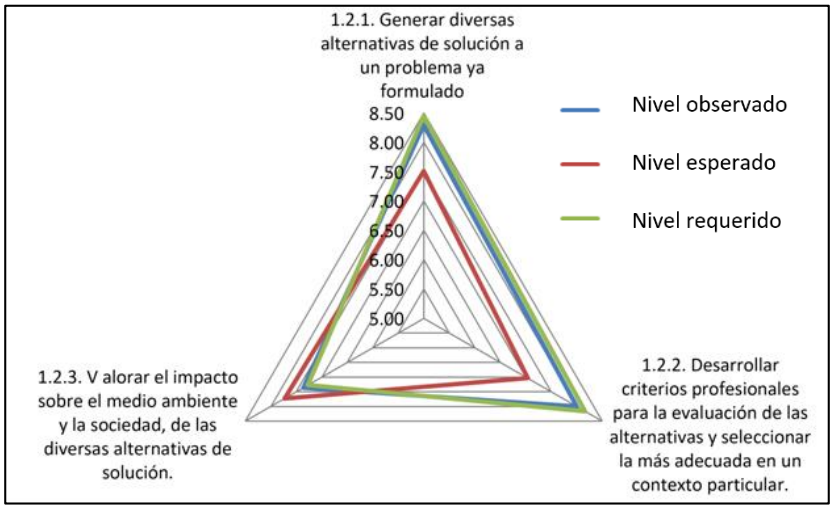
Tabla 8. IAC e IDC para la capacidad "Realizabúsqueda creativa de soluciones yseleccionar la alternativa más adecuada"

Capacidad	Componentes de la capacidad	IAC	IDC
Realizar búsqueda creativa de soluciones y seleccionar la alternativa más adecuada	Generar diversas alternativas de solución a un problema ya formulado.	0.78	-0.16
	Desarrollar criterios profesionales para la evaluación de las alternativas y seleccionar la más adecuada en un contexto particular.	0.96	-0.16
	Valorar el impacto sobre el medio ambiente y la sociedad, de las diversas alternativas de solución.	-0.37	0.09

Fuente: Elaboración propia

Figure 2 shows the gaps to be covered in order to adapt both the satisfaction of the students and the employer sector. Also, as in the previous case, the IAC presents a good level of adequacy, while the IDC would indicate the need to propose a work to improve the level of capacity development in order to contribute to the acquisition of competencies according to the requirements of the employer sector.

Figura 2. Brechas por cubrir para la capacidad "Realizar búsqueda creativa de soluciones y seleccionar la alternativa más adecuada" en función de los IAC e IDC



Fuente: Elaboración propia

Ability to technologically implement a solution alternative

Regarding this capacity, the IAC proved to be satisfactory in all cases (see table 9), with very significant levels of adaptation, as in the case of "Carrying out the design and modeling of a technological solution", "Preparing reports, plans, recommendations and communicate them "and" Control the execution process ", whose indexes turned out to be 1.58 and 1.65 and 1.42, respectively. However, when analyzing the results of the IDC, it is noticed that there is only a comparison or superiority for the components "Incorporate the dimensions relevant to the context of the problem into a design" (0.07) and "Control the execution process" (0).

Tabla 9. IAC e IDC para la capacidad "Implementar tecnológicamente una alternativa de solución"

Capacidad	Componentes de la capacidad	IAC	IDC
Implementar tecnológicamente una alternativa de solución	Realizar el diseño y modelado de una solución tecnológica.	1.58	-0.18
	Incorporar a un diseño las dimensiones relevantes al contexto del problema.	1.02	0.07
	Planificar la resolución identificando momento y tiempos requeridos.	0.64	-0.16
	Optimizar la selección y uso de materiales y dispositivos tecnológicos disponibles para la implementación.	0,99	-0,09
	Elaborar informes, planos recomendaciones y comunicarlos.	1,65	-0,26
	Controlar el proceso de ejecución.	1,42	0

Fuente: Elaboración propia

Due to the results obtained in the IAC, it can be affirmed that there is a good level of adequacy between the expectations and the levels of training achieved. However, the IDC has 66% deficits for the components, that is, there are gaps, although not very significant, between what was observed by the graduates and the level of labor market requirement, as can be seen in figure 3.

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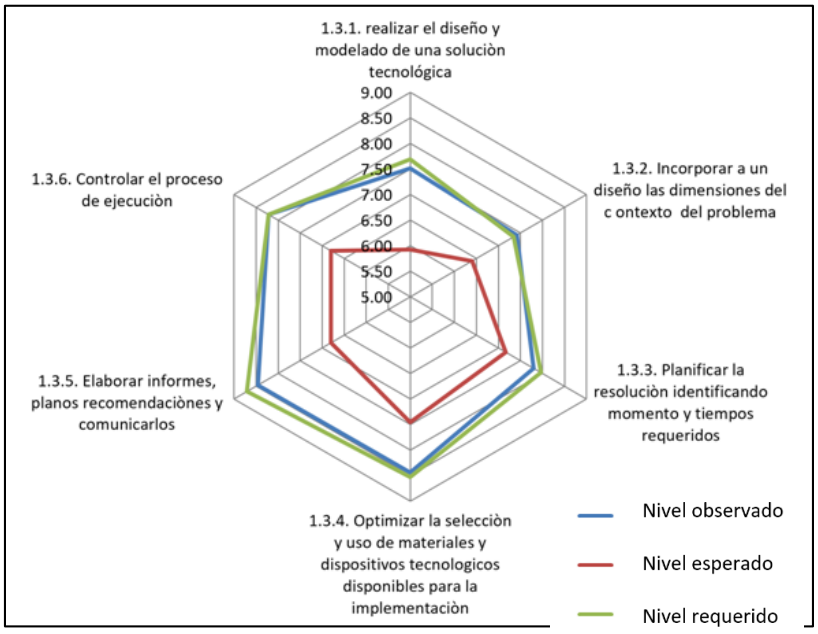
Figura 3. Brechas por cubrir para la capacidad “Implementar tecnológicamente una alternativa de solución” en función de los IAC e IDC



Fuente: Elaboración propia

Ability to monitor and evaluate approaches and strategies to effectively address problem solving

The IAC presents for this capacity lack of adequacy between the expected value and that observed only for the component "Identify what is relevant to know and have strategies to acquire necessary knowledge"; In the IDC, meanwhile, there are non-conformities in all the components (see table 10).

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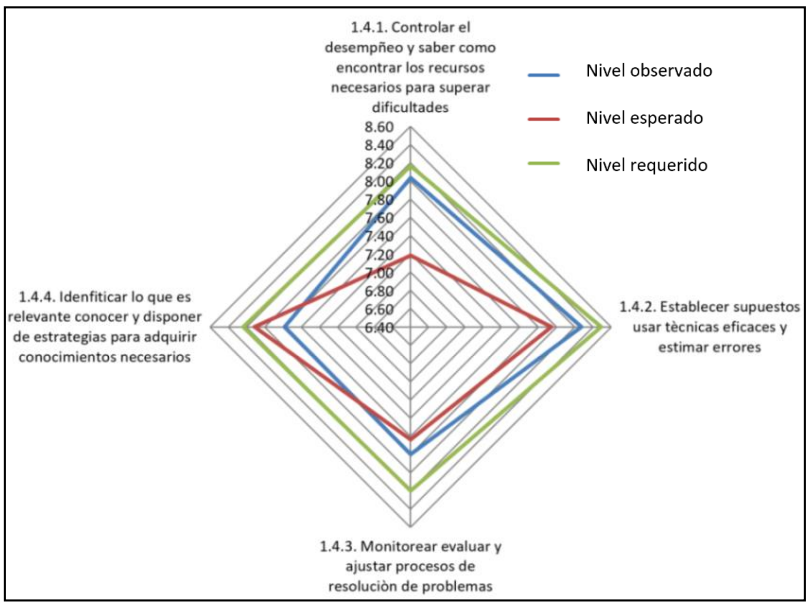
Tabla 1. Índices IAC e IDC para la capacidad "Controlar y evaluar enfoques y estrategias para abordar eficazmente la resolución de los problemas"

Capacidad	Componente de la capacidad	IAC	IDC
Controlar y evaluar enfoques y estrategias para abordar eficazmente la resolución de los problemas	Controlar el desempeño y saber cómo encontrar los recursos necesarios para superar dificultades.	0.86	-0.12
	Establecer supuestos, usar técnicas eficaces y estimar errores.	0.32	-0.22
	Monitorear evaluar y ajustar procesos de resolución de problemas.	0.16	-0.40
	Identificar lo que es relevante conocer y disponer de estrategias para adquirir conocimientos necesarios.	-0.33	-0.46

Fuente: Elaboración propia

Figure 4 shows the gaps to be covered from both indexes; and it is noticed how the IDC shows that the learning achieved during the race for all the components was not enough to satisfy the requirement of the labor market.

Figura 4. Brechas por cubrir para lacapacidad "Controlar y evaluar enfoques y estrategias para abordar eficazmente la resolución de los problemas"



Fuente: Elaboración propia

Discussion

Table 11 shows the results corresponding to the adequacy between expectations and the perception of the educational service (IAC). The data were ordered for each capacity with decreasing criteria and it is noted that there is satisfaction in 83% of the 17 components evaluated. Only the inherent learning, namely: a) Evaluate the particular context of the problem and include it in the analysis ", b)" Assess the impact on the environment and society, of the various solution alternatives "and c) Identify what is relevant to know and have strategies to acquire necessary knowledge, failed to meet the expectations of respondents. Depending on the values obtained, the gap is not significant; and although the current curricular design is part of the content approach, it can be inferred that the strategies developed during the implementation of the current curricular proposal would be guaranteeing an adequate level of acquisition of the capacities from the expectations of the graduates.

The ability to technologically implement an alternative technological solution deserves a special mention, since its components ("Incorporate a design the relevant dimensions to the context of the problem, plan the resolution identifying moment and times required", "Optimize the selection and use of materials and technological devices "," Prepare reports, plans, recommendations and communicate them "and" Control the execution process ") obtained a positive weight for the IAC in all cases.

It is also important to highlight the interest of graduates in having strategies to acquire knowledge, since the expectation exceeded the perception of their acquisition. It is a capacity directly associated with the competences of continuous learning and autonomy in studies that are significant for an adequate professional development. They are considered cross-sectional, since their characteristics are not acquired in a specific curricular space, but are gradually developed throughout the entire career, an aspect to consider particularly when defining the new curricular design.

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Tabla 11. Nivel de adecuación y disconformidad en función del IAC

Capacidad	**Componente de la capacidad**	**IAC**	
		Adecuación	**Disconformidad**
Identificar y Formular Problemas	Identificar una situación problemática	1,12	
	Delimitar el problema y formularlo de manera clara y pre	0,42	
	Identificar y organizar los datos pertinentes a un problema	0,28	
	Evaluar el contexto particular del problema e incluirlo en el análisis		-0,05
Realizar búsqueda creativa de soluciones y seleccionar la alternativa más adecuada	Desarrollar criterios profesionales para la evaluación de las alternativas y seleccionar la más adecuada en un contexto particular	0,96	
	Generar diversas alternativas de solución a un problema ya formulado	0,78	
	Valorar el impacto sobre el medio ambiente y la sociedad, de las diversas alternativas de solución		-0,37
Implementar tecnológicamente una alternativa de solución	Elaborar informes, planos recomendaciones y comunicación	1,65	
	Realizar el diseño y modelado de una solución tecnológica	1,58	
	Controlar el proceso de ejecución	1,42	
	Incorporar a un diseño las dimensiones relevantes al contexto del problema	1,02	
	Optimizar la selección y uso de materiales y dispositivos tecnológicos disponibles para la implementación	0,99	
	Planificar la resolución identificando momento y tiempos requeridos	0,64	

Controlar y evaluar enfoques y estrategias para abordar eficazmente la resolución de los problemas	Controlar el desempeño y saber cómo encontrar los recursos necesarios para superar dificultades	0,86	
	Establecer supuestos, usar técnicas eficaces y estimar errores	0,32	
	Monitorear evaluar y ajustar procesos de resolución de problemas	0,16	
	Identificar lo que es relevante conocer y disponer de estrategias para adquirir conocimientos necesarios		-0,33

Fuente: Elaboración propia

The IDC, which in Table 12, has also been ordered for each capacity with decreasing criteria, shows a different performance compared to the IAC, since only 23.5% of the components presented a very low or neutral superiority index, as in the case of the component "Control the execution process" (0).

It is observed that the employer sector noticed deficits for 76.5% of the components; Due to its number and magnitude, the most significant was "Identify and formulate problems", which turns out to be a question of the competence that is analyzed, since if the professional does not have the tools to identify and formulate a problematic situation technically, It becomes a further difficulty both for the search for solutions and for their subsequent implementation, control and evaluation. However, it is interesting that, in relation to this capacity, the component of "Identifying a problematic situation" in the IAC obtained the highest adaptation value (1.12) and in the IDC the highest superiority index (0.41).

The deficits identified through the IDC warn about the need to carry out an exhaustive work of reflection and adjustment at the moment of thinking about curricular innovation towards a competency-based design, in order to ensure that a coordinated work oriented towards the development of the capacities among the different curricular spaces that are defined.

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Tabla 12. Niveles de superioridad y déficits en función del IDC

Capacidad	**Componentes de la capacidad**	**IDC**	
		Superioridad	**Déficit para sector empleador**
Identificar y formular problemas	Identificar una situación problemática.	0.41	
	Identificar y organizar los datos pertinentes a un problema.		-0.58
	Delimitar el problema y formularlo de manera clara y precisa.		-0.53
	Evaluar el contexto particular del problema e incluirlo en el análisis.		-0.52
Realizar búsqueda creativa de soluciones y seleccionar la alternativa más adecuada	Valorar el impacto sobre el medio ambiente y la sociedad, de las diversas alternativas de solución.	0.09	
	Generar diversas alternativas de solución a un problema ya formulado.		-0.16
	Desarrollar criterios profesionales para la evaluación de las alternativas y seleccionar la más adecuada en un contexto particular.		-0.16
Implementar tecnológicamente una alternativa de solución	Incorporar a un diseño las dimensiones relevantes al contexto del problema.	0.07	

Fuente: Elaboración propia

	Controlar el proceso de ejecución.	0	
	Elaborar informes, planos recomendaciones y comunicarlos.		-0.26
	Realizar el diseño y modelado de una solución tecnológica.		-0.18
	Planificar la resolución identificando momento y tiempos requeridos.		-0.16
	Optimizar la selección y uso de materiales y dispositivos tecnológicos disponibles para la implementación.		-0.09
Controlar y evaluar enfoques y estrategias para abordar eficazmente la resolución de los problemas	Identificar lo que es relevante conocer y disponer de estrategias para adquirir conocimientos necesarios.		-0.46
	Monitorear evaluar y ajustar procesos de resolución de problema.		-0.40
	Establecer supuestos, usar técnicas eficaces y estimar errores.		-0.22
	Controlar el desempeño y saber cómo encontrar los recursos necesarios para superar dificultades.		-0.12

Conclusions

Based on the functional competency map developed by Confedi for the training of engineers in Argentina, the IIT & E has structured a model that measures its level of acquisition from the perspective of evaluating the quality of educational services.

The model allowed the construction of two statistical indexes based on judgments of graduates and a weighted criterion of their satisfaction with the learning achieved, as well as an ordering of the deficits based on the work experiences they went through.

The IAC and the IDC provide information on the adequacy of the expectations of the graduates and the superiority or deficits in relation to the requirements of the labor market that is strategic for decision-making during innovation processes that require, from the perspective of the educational quality, user satisfaction.

It is observed that value judgments regarding the coverage of personal expectations were not always consistent with the concrete experiences in terms of job placement, since there were cases in which the IAC was appropriate and the IDC indicated a deficit. In this sense, the IAC obtained 83% adequacy for the 17 components, while the IDC only resulted with a superiority indicator in 23.5% of the cases; that is to say, that for the employer sector 76.5% of the components presented deficits. This issue warns about the need to work with methods that triangulate data to give validity and reliability to the methodological constructs that sustain them. The development of a second instrument that measures exclusively the requirements of the employer sector and whose results are compared with the IDC can be a valid alternative.

Although these are partial results, it can be anticipated that the careers of the Engineering Faculty of the UNLZ, in general, cover from the perspective of the graduates the expectations regarding the acquisition of skills associated with the competence "Identify, formulate and solve engineering problems, as well as conceive, design and develop engineering projects ", despite the fact that their work experiences have revealed certain deficits.

Finally, the analysis has been circumscribed only to one of the five technological competences defined for the training of engineers, therefore, the development of indexes for the remaining four competences of a technological nature is still pending, as well as for the five social, political and attitudinal order. Although at the moment there are data that allow inferring a diagnosis with respect to the analyzed competence, it is necessary to have a complete analysis of

the current training profile to prepare the functional map, which includes all the engineer's competences and links them with the indices obtained. This matrix will allow the Engineering Faculty of the UNLZ to infer the gaps to be covered in the new curricular design of their careers, assess the magnitude of the change and coordinate with those responsible for its implementation the articulation of the activities that ensure the quality of the results of the new design and guarantee both the satisfaction of the students for the education they receive and the coverage of the expectations and needs of the productive sector.

It can be concluded that the model developed has made available to the institution a tool that, in addition to measuring the results of learning from the perspective of its graduates and assessing their level of satisfaction with the skills acquired, contributes to weigh the training gaps in function of the requirements of the labor market.

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