Original article

Human capital formation in the industrial biotechnology center. Impact on external evaluations

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ABSTRACT

In accreditation processes, the human resource variable has indicators that define the evaluation of careers, academic programs and institutions. This paper explains the impact of the human capital formation strategy in the Industrial Biotechnology Center on the accreditation processes of the Faculty of Natural and Exact Sciences. The hermeneutic, analytical-synthetic and inductive-deductive method was used in the analysis and processing of the information. Relevance and impact indicators are the main contributions to the accreditation processes. The training strategy has strengthened the faculty's faculty and master's degree and master's degree courses.

Keywords: Human Capital; Quality; Accreditation; Excellence; Biotechnology

Introduction

The formation of competent human capital committed to institutional processes is essential for any organization, academic or scientific institution, since its impact transcends society (Armijos-Mayon *et al.,* 2019). Based on this statement, universities have the commitment to contribute with a preparation that ensures to respond to the demands of society in perfect harmony with scientific, technological, cultural and social

advances (Samá, 2020). Any organization that seeks to position and maintain itself within the established quality standards and at the same time differentiate itself from its counterparts, requires highly qualified human capital (Montoya and Boyero, 2016).

The Center for the Study of Industrial Biotechnology (CEBI), Order Carlos J. Finlay (2022), is a science, technology and innovation entity (ECTI) of the University of Oriente (UO). Since its creation in 1992 as a study center of the Faculty of Natural Sciences and Mathematics, it has invested in its human capital as a key strategy for growth, visibility and scientific recognition, ensuring their professional development with the skills and competencies that provide teaching and research leadership. For CEBI, the formation of specialized human capital is an essential condition for quality and contributes to the development of the UO with relevance and impact. It also promotes technical and inclusive preparation for all employees and the full and effective participation of women with equal leadership opportunities in decision-making positions. CEBI's human capital formation is harmoniously integrated with goals 4 and 5 of the 2030 Agenda.

The concept of quality in higher education is the result of the academic excellence-relevance relationship. The accreditation of substantive processes in Higher Education Institutions (HEIs) evidences objective information on the quality of universities and their programs (Noda, Surós, 2020). In addition, it allows certifying to society the quality of the human capital trained and how they contribute to the advancement of the organization towards higher levels of quality. External evaluation is the recognition due to the satisfaction of established criteria, indicators and standards.

The Regulations of the Higher Education Evaluation and Accreditation System (SEAES), for all established sub-systems, evaluates the quality, relevance and composition of human capital within dimension 2 (Saborido-Loidi, 2018, Baluja-García, 2024). It grants an important weight to PhDs in science in a given area of knowledge. Since 2020, the Ministry of Higher Education (MES) recognizes in the indicators of strategic objective 2; the preparation and completion of the faculty and cadres, with a high percentage of PhDs. This indicator is evaluated directly in the Undergraduate, Graduate and Human Resources processes, while the Science, Technology and Innovation process evaluates it indirectly, using criteria of relevance and impact: publications, awards, patents, products and technologies transferred.

The Faculty of Natural and Exact Sciences (FCNE) of the UO trains, among other specialties, graduates in Chemistry, Biology and Pharmaceutical Sciences. These careers

were delayed in achieving the highest category of accreditation (Excellence) because they did not meet the number of PhDs required by the National Accreditation Board (JAN). The percentage of PhDs in Chemistry, Biology and Pharmaceutical Sciences is a problem that was identified in the analyses prior to the evaluation process. One response to this difficulty was the incorporation of CEBI professors to the faculty of these careers.

At the graduate level, CEBI's teaching activity is manifested in four academic programs: Masters in Chemistry (Chemistry department-career), Pharmaceutical Services (Pharmacy department-career), Biotechnology (ECTI-CEBI) and a doctoral program of the same name (ECTI-CEBI). In these postgraduate programs, professors from the above-mentioned departments are also qualified under the supervision of CEBI professors. The scientific activity of CEBI is visualized through research projects, in which the student scientific group Biotechnology is integrated.

The strategy of sustained training of CEBI's human capital conditioned its participation and impact on the accreditation processes of the careers and master's degrees and boosted the progression in the external evaluations received at FCNE and CEBI itself until reaching the highest category of accreditation and successive ratifications.

The paper explains the impact of CEBI's human capital formation strategy on the accreditation processes, taking as a case of analysis the external evaluations of careers and master's degrees of the Faculty of Natural and Exact Sciences and CEBI's master's degree in Biotechnology.

Development

The quality of university processes is the responsibility of both the faculties and the ECTIs located in the universities. Science institutions constitute an important reservoir of scientific-technical potential for the country, and also ensure the specialized training of skills from secondary and higher secondary education. In the university, the postgraduate has to form a unit from the formative process and research, integration that gives life to the postgraduate and will facilitate an effective and efficient development in the postgraduate training.

The human capital of the ECTI that belongs to a university is recognized for the dual function of teaching and research and distinguished for two reasons: on the one hand, as the human capital of the ECTI and on the other as the talent susceptible of promotion for the benefit of a more competitive university management (Martínez-Navarro and Romero-Suárez 2021). This distinction is only possible with the integral preparation of this human capital, an issue established and consolidated in the CEBI as a system and which has a direct impact on scientific development and the quality of university processes.

CEBI's active participation in accreditation processes began in 2005 with the master's degree in Biotechnology, a program that has been in existence for more than 25 years. In the 2006-2007 academic year, the Chemistry degree program was accredited and in 2008 the Biology degree program, while the Pharmaceutical Sciences degree program was accredited in the 2013-2014 academic year (Abalos *et al.*, 2016). The three careers were reaccredited in 2011-12, 2017; 2013-14 and 2017-18 respectively. Regarding the postgraduate degree, the master's degree in Biotechnology, has received three external evaluations by the National Accreditation Board, JAN (2005, 2010 and 2018) and an international one in 2014 by the Association of Ibero-American Universities for Postgraduate Studies (AUIP). The master's degrees in Pharmaceutical Services and Chemistry were accredited in 2017 and 2019 respectively. CEBI's human capital, in all accreditation processes, defined the quality indicators established in the JAN pattern (Saborido-Loidi, 2018).

What elements distinguish CEBI's human capital formation?

The question is answered in the strategy for the formation of this capital (Figure 1), a science entity with 11 professors (73% women who stand out for their participation in decision-making positions, academic categorization and scientific and administrative leadership).

The strategy consists of four stages and is designed for students and workers. It begins with the personnel selection and recruitment stage. The selected students must be students of high teaching achievement because they are linked to CEBI research projects in the three lines that are developed and join the student scientific group of Biotechnology, a multi-awarded group that brings together students from different careers of the UO. The best performers (Scientific Merit Award, Gold Title, outstanding results in events,

publications) are recruited as future researchers. The selection of workers is based on previous work history and other elements considered relevant (Figure 1).

Recruitment begins with familiarization with the ECTI CEBI processes, defining the orientation of the specialization. New workers are engaged in socialization activities that provide them with satisfaction. Union tasks are an important element of this stage, since aptitudes and attitudes are assessed for future management responsibilities and reveal the moment to start more specific improvement.

Source: Self elaboration

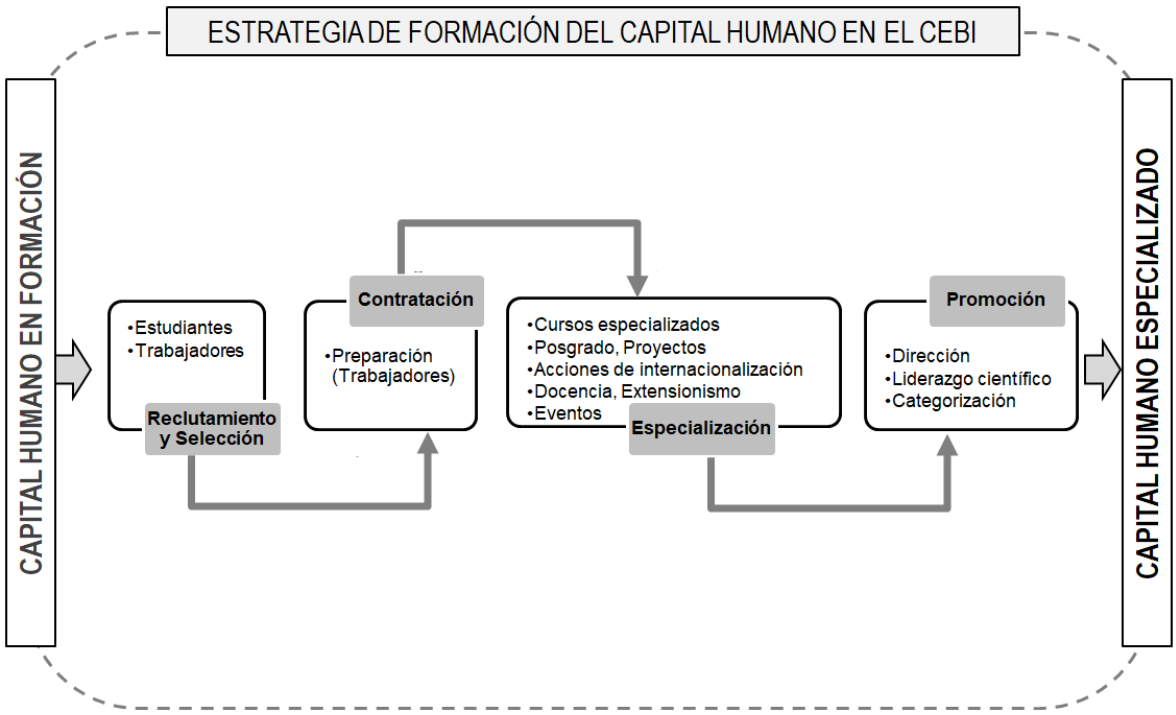


Figure 1. Human resources training strategy at CEBI

The third stage is specialization. It determined the impact of CEBI on the external evaluations of the faculty of Natural Sciences and the progression achieved in the accreditations (Figure 2). It is mandatory, but not synchronous for all the human capital of the entity. It leads to postgraduate improvement, enrollment in a university career, insertion in research projects as task leader, participation in publications and scientific events, inclusion as teachers in related careers, execution of internationalization actions, extensionist responsibilities and dissemination of the knowledge acquired and the results achieved in academic and social networks.

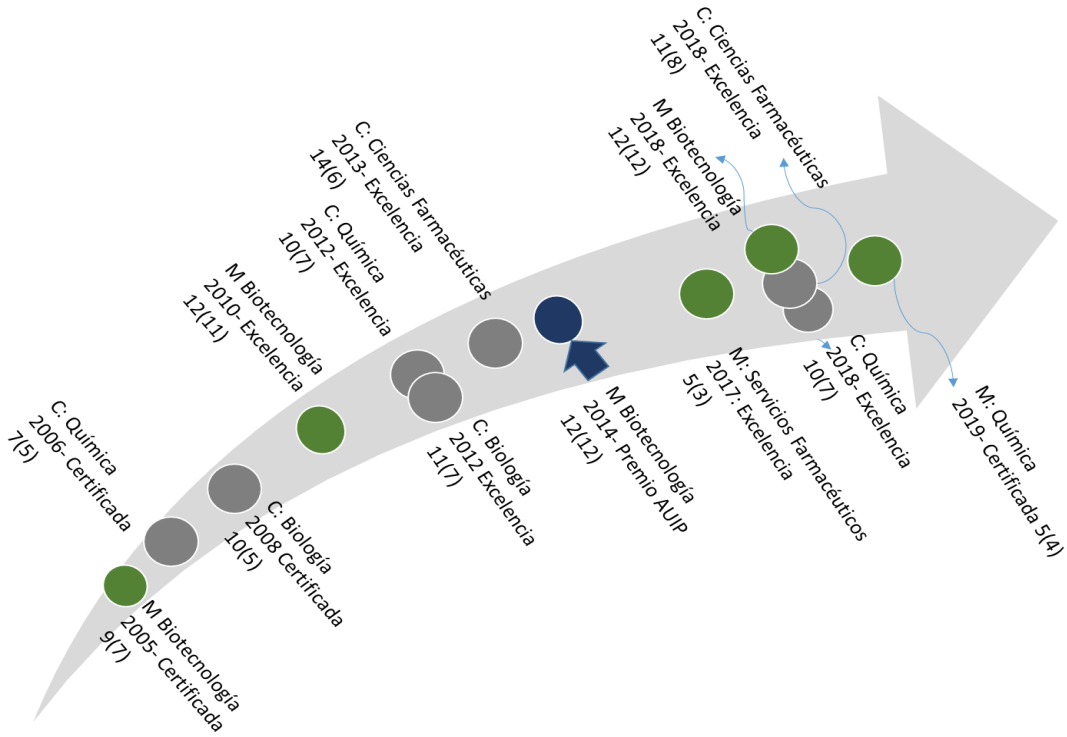
Specialization is also a stage of professional growth and maturity. Skills are perfected and consolidated, future academic, scientific, administrative, political and mass leaders are

identified, and work experience is gained. It ends with the attainment of the scientific degree or academic qualification and defines the type of promotion: scientific leadership, administrative (or both), teaching and scientific categorization. Promotion takes place within the ECTI itself, to the faculty, university or territorial level.

To ensure that the strategy is sustainable and successful, strategic work is done from the recruitment and selection stage to achieve a professional development motivation where the individual's need is the starting point to provoke an attitude conducive to success (Peña and Villón, 2018). Motivation is approached from three perspectives: 1 the ability to overcome the difficulties of the work context and adapt to unexpected changes (professional resilience), 2 the worker's level of knowledge of his/her interests, strengths, weaknesses and abilities to achieve his/her goals (professional astuteness) and 3 the willingness to do what is necessary to accomplish a task and feel pride in belonging to the work team (professional commitment).

As shown in Figure 2, there is qualitative progress in the careers and graduate academic programs of the Faculty of Natural and Exact Sciences, reflecting the relevance of CEBI's human capital formation strategy for the continuous improvement of processes. It is noteworthy how CEBI's human capital certifies its own master's degree in Biotechnology (2005) and joins the faculty of Chemistry (2006) and Biology (2008), which could only be certified by the variable faculty. The Pharmacy program, for this reason (faculty) does not achieve accreditation until 2013, however, it achieves Excellence since the first external evaluation.

Source: Self elaboration



Legend: The numbers indicate the professors who specialized in CEBI, in parentheses those who specialized in ECTI. C: Career, M: Master's degree.

Figure 2. Progression of careers and academic programs of the Faculty of Natural and Exact Sciences in the accreditation processes derived from CEBI's human resources training.

It should also be noted that in the specialization stage (Figure 1), 21 professors (76% women) from the Chemistry, Biology and Pharmaceutical Sciences careers of the FCNE were inserted. Sixty-seven percent of the professors who specialized, 9 women for 64%, integrated the faculty that accredited the respective careers since the first external evaluation.

The specialization achieved ensured the advancement towards the academic degree of Master in Biotechnology, the scientific degree of Doctor of Science in a specific area and the teaching categories of Assistant or Full Professor. The progress of the faculty was recognized by the JAN experts and the FCNE directors in the 2012 accreditations for the Biology and Chemistry careers, and 2018 for Pharmaceutical Sciences, processes where Biology and Chemistry reach the condition of Excellence and Pharmaceutical Sciences ratifies it. Similar recognition received the master's degrees in Biotechnology in 2010 by reaching the category of Excellence and ratifying it in 2018 and Pharmaceutical Services,

accredited of Excellence since its first evaluation (Figure 2); as well as the master's degree in Chemistry reaching the category of Certified.

The JAN experts also recognized the promotion of ten CEBI professors and twelve workers (80% women) to higher responsibilities.

Indicators such as quantity and quality of publications, number of PhDs and Masters, training of new PhDs, awards and recognitions derived from scientific results, research projects in strategic sectors, presence and visibility in academic networks, community outreach activities, links with the business sector and international collaboration are the main contributions of CEBI professors to the accreditation processes (Table 1).

The analysis and review of the documentation evidenced the progression of the impact of the human resources of the Center for Biotechnology of Industrial Studies both in quality and quantity of participating professors. The indicators of the SEA-CU and SEA-M subsystems evaluated in the variables Relevance and Social Impact, Faculty and Curriculum demonstrated this. Several authors point out that the preparation of human resources is a challenge for any organization since they condition excellence, quality and relevance (Rocha-Vázquez *et al.*, 2019, Hernández-Mompie *et al.*, 2020).

Table 1. Impact of CEBI human resources on the accreditations of the faculty of Natural and Exact Sciences.

Chemistry Career		
Year/Result	**R. Humans ***	**Indicators**
2006 (**Certified**)	5	Dr. C. (2); PT (60), Pr (4); R (5); Py (3); RA (No)
2012 (**Excellence**)	7	Dr. C. (6); PT (105), Pr (10); R (6); Py (10); RA (No)
2018 (**Excellence**))	7	Dr. C. (6); PT (107), Pr (11); R (6); Py (10); RA (No)
Biology Career		
2008 (**Certified**)	5	Dr. C. (3); PT (60), Pr (5); R (5); Py (4); RA (No)
2012 (**Excellence**)	7	Dr. C. (4); PT (90), Pr (4); R (8); Py (16); RA (No)
Pharmaceutical Sciences		
2013 (**Excellence**)	8	Dr. C. (3); PT (95), Pr (6); R (4); Py (16); RA (No)
2018 (**Excellence**)	7	Dr. C. (4); PT (110), Pr (6); R (10); Py (20); RA (4)
Master's Degree in Biotechnology		
2005 (**Certified**)	6	Dr. C. (2); PT (100), Pr (5); R (5); Py (5); RA (No)
2010 (**Excellence**)	11	Dr. C. (8); PT (180), Pr (10); R (10); Py (10); RA (No)
2014 (**AUIP Award**)	11	Dr. C. (8); PT (180), Pr (15); R (12); Py (12); RA (No)
2018 (**Excellence**)	12	Dr. C. (9); PT (165), Pr (11); R (18); Py (15); RA (4)
Master's Degree in Pharmaceutical Services		
2017 (**Excellence**)	3	Dr. C. (3); PT (45), Pr (10); R (10); Py (3); RA (No)
Master's Degree in Chemistry		
2019 (**Certified**)	4	Dr. C. (4); PT (45), Pr (10); R (10); Py (14); RA (2)

*DrC. + MSc (only Full and Assistant Professors are included)

**Doctors (Dr.C.), Total Publications (PT), Awards (Pr), Recognitions (R), Projects (Py), Academic Networks (RA)

Source: Self elaboration

The directors of the FCNE recognized that the experts highlighted as regularity the scientific and administrative leadership, the relevance of research, the percentage of PhDs and its strategy for training human talent, the number of awards, recognitions and projects led by CEBI PhDs. These last three indicators also stand out internationally. The visibility of professors in academic networks was also distinguished with an average H index of 12.

Conclusions

CEBI's human capital formation strategy favors its participation in accreditations and guarantees the maintenance or improvement of the indicators of the faculty dimension in the external evaluations of careers and master's degrees of the Faculty of Natural and Exact Sciences.