

Knowledge Generation in Higher Education Institutions

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Abstract— Higher education institutions have a significant role in the development of the economy of any society. Its primary goal should lie in the generation, transfer, and application of knowledge. The institutions that take their role in this complex task seriously will achieve closer ties of dynamic collaboration and will be able to compete with other economies. This research addresses the mission, function, and challenges of curriculum and studies plan design and development in higher education institutions, to present a model proposal to foster articulated curricula between academic institutions and society.

Keywords— innovation, undergraduate, transversal competencies, transdisciplinary research, Higher Education Institutions.

I. INTRODUCTION

The sustainable prosperity of society depends directly on its ability to create and apply knowledge to solve real problems [1]. Within societies, *Higher Education Institutions (HEI)* are the organizations responsible for training new generations of innovators and generators of knowledge who must ensure their sustainability. For many years, the generation, dissemination, and application of knowledge have been carried out in isolation [2], this implies that there is little interaction between the production of knowledge that takes place within the educational context, and the use that is made of it. Nowadays, there has been an awakening among *HEI*, industries, and other knowledge producers, as they have come to realize that together they form a synergistic part of the great business of the knowledge generation. According to [2], the great challenge of generating knowledge in *HEI* has been to find a way or a guarantee that what is produced anywhere in the world can be used effectively in the place where a particular problem needs to be solved.

In this sense, *HEI* must be committed to a society in order to preserve, reinforce, promote and contribute to their development and sustainable improvement. It is imperative

for them to train responsible citizens capable of meeting the needs of all aspects of human activity, offering them instruction that is up to modern times. In the current literature, the need for *HEI* to combine high-level theoretical and practical knowledge through courses and programs that are continually adapted to current and future societal needs is being treasured [3].

Nowadays, annual, semi-annual or quarterly structures that handle credits or non-multidisciplinary units in higher education are insufficient and too inflexible to adapt to the emerging models of knowledge generation and innovation that society requires. A large niche of research, has become evident in this educational level in which the efforts to be at the forefront, have not yet managed to get their students to acquire contextualized knowledge of the local, regional and global environment, so they have not promoted their competence to create and execute innovations to solve real problems. It is clear that much remains to be done to link the university study programs with the social and economic requirements of the communities. For *HEI*, it is essential to have the greatest diversity of educational opportunities and new models of cooperation to facilitate learning, employability, creativity, and innovation, in order to strengthen the analytical capacity of young people, the innovative attitude, and the critical and scientific thinking [4].

In response to the questions of knowledge, skills, and attitudes that higher education students need to thrive in this economy and the way in which *HEI* support to develop them; it is necessary to explore diverse ecosystems in higher education to know: (i) how the current university curricula are; (ii) how the link between theory and practice is handled; (iii) what are the challenges of higher education to generate and apply knowledge; (iv) the answer of higher education in terms of the generation of meaningful learning, employability, creativity, and innovation; and (v) transdisciplinarity as a model to solve the problems.

This paper discusses the mission and function of curriculum and study plans, and the challenges of keeping them up-to-date, the new paradigms in the curricular design and its challenges are described in *Section II*. A novel method for curriculum and study plan design of *HEI* based on a transdisciplinary approach is described in section III. *Section IV* concludes the paper

II. THEORETICAL FOUNDATIONS

A. Mission and function of the curriculum.

The *HEI* are committed to preserve, reinforce, promote and contribute to the sustainable development and improvement of society. Relevance must be one of its main characteristics, which must be evaluated according to what society expects from them and what they do. To achieve relevance, *HEI* must have a better articulation with the problems of society and the world of work, founding long-term orientations in social objectives and needs, including respect for cultures, and protection of the environment [3].

The continuous revision and re-design of the curriculum and study plans of *HEI* are essential for its relevance and articulation. The curriculum concept has a long history in the educational area. [5] defined it as the range of experiences, both non-directed and directed towards the development of the person's capacities. The curriculum is the experiences that students have under the direction of teachers, [6]. [7] considered that the concept implies all the learning experiences planned and directed by the institutions to achieve their educational goals. More recently, [8] described the curriculum as a simple course or track to follow in the formation of the human being in formative stages. [9] defines the concept as learning activities that are carefully planned and guided by the educational institution and carried out by the students in groups or individually, in the classroom or outside the classroom.

Research about curriculum and study plan development is extensive, [5] studied the principles of curriculum planning that included objectives, content areas, activities, and evaluation criteria. Later, [6] developed a new concept with two approaches, the first included the objectives, functions and scope, and the second the sequence of activities based on students' interests. Although [6] repeat the four basic principles of [5], new details such as materials, teaching procedures, evaluation, and lesson organization appeared in the curriculum development process. [7] gave a new emphasis to the curriculum design process pointing elements for the design of a successful curriculum:

- (1) the educational purposes of the institutions,
- (2) the availability of educational experiences to achieve these ends, and
- (3) the organization of educational experiences and mechanisms to measure if these purposes have been achieved.

Later, [10] used the principles of [5], [6] and the elements of [7] to write an operationalization of the main

steps in the curriculum design. More recently, [8] offered a broader list of 10 components of the curriculum design: foundations, purposes, and objectives, content, learning activities, teacher behavior, materials and resources, grouping, place, time and evaluation. In these ten steps, more than 100 years of curriculum development were summarized in a very dynamic way in which the author drew a spider web; in the center, the objectives and the learning content were found hoping that when changes were made in the core, the rest of the elements would be adjusted.

Recent studies in curriculum and study plan design [11] explain that its development and actualization must imply and take into account an up-to-date body of knowledge, practice, and a context; that is to say, the curriculum is not only about the construction of specific knowledge, but also skills that potentialize the abilities and talents of students in a specific context. In that sense, the development of a modern curriculum and study plans for *HEI* requires a comprehensive approach [12, 13].

In *HEI*, several curricular models based on different educational paradigms coexist. Some models follow disciplinary teaching, others are based on research, and some new models are based on transversal competencies and transdisciplinary work; all models are directed by pedagogical principles pre-established by the educational institutions. Most universities follow a knowledge production model based on a disciplinary paradigm; that is, its curriculum is structured by disciplines, these mark the guidelines of teachers and researchers on the problems and issues to be addressed, as well as the criteria and indicators of the expected learning.

In this model, the first years of the academic life of the students are composed of merely theoretical academic knowledge. In the last year of studies (sometimes before), a practical investigation is developed in which it is expected that the student puts to the test what he/she has learned during his career. In this final work, the student must be able to carry out systematic research including identification of a problem to solve, carrying out a scientific-critical analysis of the current state of the problem, clearly identify their hypothesis, and design instruments to test their hypotheses, collect empirical evidence, analyze results, and share their interpretations with the community [14].

Another common model in *HEI* is the research-based. This model has basic disciplinary training at the beginning that allows students to research the field. Examples of this model are the medical schools, in which some universities from the first semester start with practical cases in real life patients; textbooks and teachers, beyond being, generators of knowledge, become resources that can guide them to explain what happens in practice. Although this model has been used in many universities for many years with good results, it does not seem to have spread to other disciplinary areas [2].

New models based on innovation have left disciplinary education behind, looking for transdisciplinary methods. These models are based on the development of *soft skills*

such as research and critical thinking [15], [16] and a curriculum that integrates transversal competencies [17].

B. Challenges of the curricular design.

In *HEI*, up-to-date curriculum and study plans are a critical condition for the provision of quality of educational programs and services of interest; it is crucial for the well-being and effectiveness of higher education [18]. The curriculum is the heart and soul of all educational institutions; however, its development and updating are processes that are isolated from critical elements such as institutional leadership, social trends, the factor of industry, and the role of the government [12].

One of the main challenges that curricular development face is that the context in which educational institutions are immersed is not static, but slightly malleable. The causes of these changes according to [19] are due to the emergence of a globalized and intercommunicated market; an open and free economic system; a democratic political system; and the revolutionary changes in the field of information and communication technologies, and the development of social networks.

[3] highlights the following challenges and difficulties that *HEI* face in curriculum and study plan development and renovation:

- (1) funding for renovation,
- (2) equal conditions of access to studies among students,
- (3) staff training,
- (4) training based on competencies ,
- (5) the improvement and conservation of the quality of teaching research and services,
- (6) the relevance of the study plans,
- (7) the possibilities for students' employment,
- (8) the establishment of effective cooperation agreements with society, and
- (9) the integration of new opportunities that open technologies offer.

C. New paradigms in the curricular and study plan design.

A paradigm is a model or pattern accepted by a scientific community when a better one comes, the first one ceases to exist, giving place to a new paradigm. A paradigm rarely involves a renewal. Instead, it is the object for further articulation and specification under new or more stringent conditions [20].

In *HEI*, paradigm changes are due to fundamental changes in their educational objectives. From a paradigm that sought the accumulation of knowledge (merely theoretical), some years ago, it was changed to the paradigm of the global economy. The paradigm of the global economy or industrial paradigm that started during the *Industrial Revolution* was based on mass production for mass consumption [21, p. 376] and is to date *an essential part of our vision of the world*.

Currently, a new paradigm is imposed, not only in *HEI* but also in scientific research. This paradigm emerges from the need to build a society based on knowledge [22], in which research and knowledge generation are the engine that sustains economic, social, political and natural development. The paradigm of knowledge societies is a great challenge because it means that society learns to use the infinite and cumulative information with an intelligent and critical sense [22]. A knowledge-based economy is where knowledge is created, acquired, transmitted and used more effectively by enterprises, organizations, individuals, and communities for greater economic and social development, that considers:

- (a) an economic that provides incentives for efficient use/creation of knowledge,
- (b) an educated and entrepreneurial population,
- (c) a dynamic information infrastructure and
- (d) an efficient innovation system that promotes interaction to create knowledge and technology [30].

Although the crisis among new paradigms in *HEI* is imminent, university curricula have remained relatively static. Higher education programs that refrain from developing in their students the skills to establish their businesses and create knowledge-based enterprises put their students at a clear disadvantage [23]. *HEI* that do not respond to the demands of the labor market, where people can continually expand their capacities, in which they can nourish thought patterns, and in which collective aspirations and lifelong learning can be established [24], will be at risk of becoming obsolete.

In the case of *Latin America*, the structure of *HEI* has remained motionless for many years. The model of the structure of higher education and its articulation with labor insertion can be seen in Fig #1.

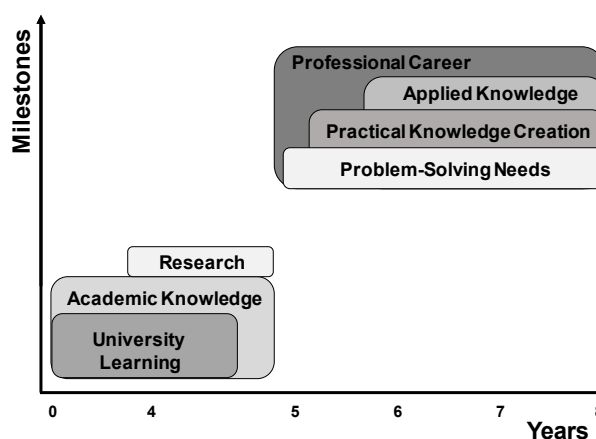


Figure 1. Structure of teaching in *HEI* and labor insertion.

Academic knowledge and disciplinary learning are found in the first years of university life, followed by a year of practical research. Subsequently, and entirely unconnected to university learning, is the professional activity, and with it, the need to solve problems. It is then when the student sees the need to create knowledge and

apply what he or she has learned in his or her formative years to solve real problems creatively

D. New educational models

Some universities in the world have addressed the challenge of the relevance of *HEI* in two different ways: through the insertion of transversal competencies, or using transdisciplinary research.

Transversal competencies. In countries such as Australia, Hong Kong, and India, the *HEI* curriculum has been transformed seeking integration of transversal competences. Some have opted for

- (i) Adding cross-curricular competencies to the existing curriculum as new topics or as new content within traditional subjects, others for
- (ii) Integrating transversal competencies to all school subjects; also,
- (iii) Renewing w curriculum, or even
- (iv) Completely transforming the traditional structure based on the disciplinary paradigm, converting universities into learning organizations [17].

Transversal competencies in education are defined as a framework consisting of four broad domains:

- (1) Critical and innovative thinking,
- (2) Interpersonal skills,
- (3) Intrapersonal skills, and
- (4) Global citizenship.

In the first domain, critical and innovative thinking, creativity, entrepreneurship, and resourcefulness, application of skills, reflective thinking, and reasoned decision-making are propelled. The second domain corresponds to interpersonal skills such as communication, presentation skills, leadership, organizational skills, teamwork, collaboration, initiative, sociability, and collegiality. The third domain, intrapersonal skills, refer to self-discipline, enthusiasm, perseverance, self-motivation, compassion, integrity and commitment. The last domain, global citizenship, refers to a mentality of awareness, tolerance, openness, and respect for diversity, intercultural understanding, and the ability to resolve conflicts, civic/political participation, conflict resolution, and respect for the environment [15].

Transdisciplinary research programs. Transdisciplinary research is widely defined as a holistic approach that goes beyond the perspectives of different disciplines to create a conceptual, theoretical, and empirical structure common for research. [25] explains that transdisciplinary research is characterized by the process of collaboration between scientists and non-scientists in a real-world problem, thus improving decision-making. [26] argues that this type of research puts a problem at the center of research, which is viewed from a global perspective that integrates the knowledge of different disciplines.

Transdisciplinary research eliminates the limits of disciplines through a collaborative process [27]. For the correct functioning of this type of research, is necessary the exchange of knowledge, conceptual frameworks, tools, methodologies and technologies of all disciplines to solve common unstructured problems. Therefore, the main characteristics of the transdisciplinary research projects are the collaboration and the high quality of the integration between the methods and approaches of the different disciplines [28]. According to [29], transdisciplinarity purpose is the search for the unity of knowledge.

Some universities that have turned the university into a learning organization are *Stanford University*, *University of Washington*, *University of Technology of Sydney*, *University of Texas Tech*, lately *Tecnológico de Monterrey* among others. In their new transdisciplinary research programs, they have successfully integrated transversal competencies (e.g., TREC Center of Washington University School of Medicine, The Transdisciplinary research projects of the University of Technology Sydney (UTS), TransDesign project of Parsons The New School, The transdisciplinary Research Texas Academy (TTUTRA) Tech University, Modelo Tec21).

“In this educational model the competences they are defined as the conscious integration of knowledge, skills, attitudes and values that allows to face successfully situations both structured as uncertainty. The competitions they integrate both knowledge and procedures proper to the discipline, such as attitudes and values that allow to form participatory professionals and committed to society”. “There are 2 categories of competences: the disciplines and the transversal ones. Disciplinary competences refer to all those knowledge, skills, attitudes and values that are considered necessary for the exercise professional. On the other hand, transversal competences they develop throughout the training process of any discipline, are useful for the life of the graduates and directly impact on quality of the exercise of the profession”, [31].

III. NEW MODEL FOR CURRICULUM AND STUDY PLAN DESIGN

Nowadays, the curricular development models on which *HEI* are based, have significant areas of improvement. The disassociation between *HEI* and society needs cannot be supported any longer. We are facing a significant challenge in research in education since new theories that are challenging the traditional paradigm are being applied to redesign both, the curricular structure and the pedagogical models. Perhaps one of these theories could go into a period of crisis [20], leaving in its wake a new paradigm that has better articulation and specification in the new conditions in which we currently live.

The direction that the curricular design has been taken in the last decade must be reassessed from its foundations; uniquely, the objectives and goals of higher education institutions must be renovated. A new model for the

development of the curriculum and study plan design according to the literature reviewed in this study, must shorten the existing gap between professional and university activity articulately and gradually. This structure requires that the professional activity form part of the university education through activities in which students are challenged to solve real problems creatively, with the aim of generating innovative solutions; thus, problems or real-world needs are at the core of the curricula.

The teaching and the pedagogical model should follow the same structure; this implies changes in methodologies and teaching strategies, as well as in evaluation and accreditation strategies, Fig. #2.

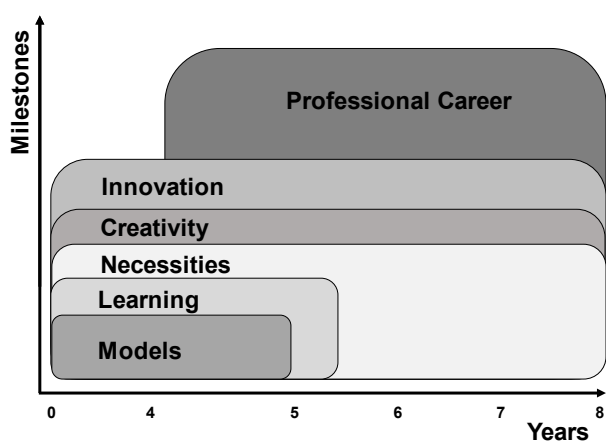


Fig. 2. A new structure for curricular development in HIEs.

IV. CONCLUSIONS

HEI have a significant role in the development of the economy of any society. Its primary goal should lie in the generation, transfer, and application of knowledge. The institutions that take their role in this complex task seriously will achieve closer ties of dynamic collaboration and will be able to compete with other economies. The university of the future is formed by inclusive learning communities in which its walls are replaced by bridges that link society and mainly entrepreneurs from small to large companies.

If it is sought to generate significant learning, improve employability, creativity, innovation, and motivation in *HEI*, it is essential to encourage the creation of new practical learning communities during university studies. These communities can become the bond of cooperation between public and private schools, businesses and society. In this study, the challenges of *HEI* were identified to present a proposal with the objective of creating a new way to foster articulated curricula between academic institutions and society.

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