Journal of Modern Education Review, ISSN 2155-7993, USA
March 2018, Volume 8, No. 3, pp. 201–216
Doi: 10.15341/jmer(2155-7993)/03.08.2018/004
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Production of Knowledge in Higher Education Policies: Review of Scientific Practices in a Public University

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Abstract: We present the results of an investigation that considers the analysis of the scientific practices that the researchers display in a Mexican state public university; the Autonomous University of the State of Hidalgo. A total of 18 open interviews were applied to full-time researchers belonging to the National System of Researchers of the National Council of Science and Technology (CONACYT). In general terms we try to know and compare the scientific practices of the researchers of the Institute of Basic Sciences and Engineering (ICBI) and the Institute of Social Sciences and Humanities (ICSHU) of UAEH. The results validate the conformation of a categorial apparatus that allows characterizing the scientific practices from three great dimensions of analysis:

(1) Modes of knowledge production in the ICBI and the ICSHU.

(2) Context and organizational dynamics of the scientific activity, both externally through federal programs such as PROMEP and CONACYT, and internally from the logic of state public universities that define the way researchers work, and finally, Strategies of scientific collaboration, based on processes of communication and interaction with the purpose of achieving a common purpose for research groups.

Key words: public university, production of knowledge, higher education policies, scientific practices

1. Introduction

Social studies in relation to scientific practices, specifically the relationship between science and scientists, particularly those related to the training of researchers and their academic trajectories in Mexico, have been the subject of analysis since the 1970s in institutions of higher education in the center of the country (Lomnitz, 1972 and 1976, Fortes and Lomnitz, 1991, García, 1996 and 1997, Landesmann, 2001, Martínez, 2005). In addition, based on the review by Izquierdo (2006), other works have investigated these issues, but from state institutions and have placed special emphasis on the process of institutionalization of science, the formation of research

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groups and the work of Academics (Lloréns, 1993, Valdez, 1995, Barona, 2000, Ortega, 2000, Rodríguez, 2000, Yurén and Izquierdo, 2000, Chavoya, 2002 in Izquierdo, 2006). In the same way, other researches have included academics from public institutions as well as private ones from the center and the interior of the Republic (Gil et al., 1994, Gil, 1997, Grediaga, 2000, Álvarez, 2004).

From the field of science, Campos (2012, p. 388) brings together research in four main themes: (1) Contributions of the Sociology of Science around the social order, normatively, ethos of science, scientific practice, social nature of knowledge, perspective of the actor and construction of scientific knowledge. (2) From the philosophy of science and axiology to understand the plurality of values present in scientific practice. (3) The relationship between ethics and scientific research based on acceptable behaviors or good practices, and (4) The formation of new scientists through a process of socialization and interaction with consolidated researchers and their penetration in the scientific community.

2. Methodology

In order to investigate the scientific practices of researchers from the Institute of Basic Sciences and Engineering (ICBI) and the Institute of Social Sciences and Humanities (ICSHU) of the Autonomous University of the State of Hidalgo (UAEH), we rely on a qualitative methodological perspective comparative that focuses on the understanding of a situation considered from its particular aspects as a result of a historical process of construction and seen from the logic and the feelings of its protagonists, whose elements of inquiry are ordered according to Mieles, Tonon and Alvarado (2012, p. 206) through an “emergent design”, because the results are structured based on the successive findings that are found during the course of the research.

Epistemologically, we position ourselves as a possible form of access to knowledge of reality, based on a comprehensive and interpretative approach that allowed us to explore what are those experiences of subjectivity and intersubjectivity that researchers share or not, as Schutz (1993) (quoted in Mieles, Tonon & Alvarado, 2012, p. 208) conceives as a world of everyday life that is characterized by being shared, intersubjective, where different subjects coexist, different subjectivities that are re-articulating contextualized experiences.

We used the open interview or pre-established standardized interview, according to Denzin (1978) (quoted by Goetz & LeCompte, 1988, p. 133), which asked detonating questions centered on the topics of discussion on: conceptions and interests towards science.

The period of application comprised from August to October 2016. Each interview lasted between 45 and 60 minutes. We interviewed 18 full-time researchers, 11 of them from the ICBI and 7 from the ICSHU. In order to access the 18 researchers, criteria for selecting key informants were defined, according to Goetz and LeCompte (1988, p. 134), individuals who possess special knowledge, status or communicative skills and who are willing to cooperate with the investigator. In other words, because only they, the key informants, by their characteristics or attributes, are those who can provide us with timely, pertinent or sufficient and quality information for the purposes of the investigation that we are dealing with.

Among the criteria for defining the qualitative sample, we first have to belong to several areas of knowledge, the most important by master’s and doctorate, so that we try to guarantee the heterogeneity of the sample, in terms of the diversity of disciplines cultivated in both institutes. In this sense, in the ICBI we identify three areas of knowledge: (1) Exact Sciences and for life, in which are located scientific disciplines such as: Biology, Chemistry and Physics and Mathematics. (2) Technology Sciences, with two disciplines: Information Technology and

Materials Science, and finally, (3) Engineering with Architecture and Industrial Engineering, as the most important disciplines. On the part of ICSHu, we identified two areas of knowledge: The first, Social Sciences, covering scientific disciplines such as: Sociology and Demography, Communication Sciences, Political Science and Public Administration, and Law. The second, humanities, which includes scientific disciplines such as: education sciences and history and social anthropology.

The second selection criterion was defined as belonging to postgraduate programs that are incorporated into the National Quality Graduate Program (PNPC) of the National Council of Science and Technology (CONACYT), whose institution regulates the scientific activity of the country, and its rules determine the framework of opportunities for Mexican scientists in their strategic interactions; its prescriptions are recognized by the scientific community, materialized in evaluation criteria that condition the entrance, permanence and promotion in the different levels of the National System of Investigators (SNI).

During the period in which the research was carried out, UAEH registered 21 postgraduate courses with recognition from CONACTY, three newly created, thirteen in development and five consolidated. Of the six institutes that comprise it, the ICBI concentrates the largest number of postgraduate courses in the PNPC, with a total of nine, followed by the ICSHu with seven, the Institute of Health Sciences (ICSA) with three, and the Institutes of Sciences Administrative Economics (ICEA) and Agricultural Sciences (ICAP) with a postgraduate degree respectively. The Institute of Arts (IA) to date, does not have postgraduates. As for the degree of consolidation of postgraduate programs, ICBI has the largest number of consolidated programs (three), ICSHu follows with two, but one of them has professional orientation — the Specialty in Teaching — so it is only considered a consolidated program with research orientation.

In the case of ICBI, we selected seven programs with recognition from the PNPC-CONACYT, which are: Master’s and Doctorate in Chemistry, Master’s and Doctorate in Science in Biodiversity and Conservation, Master’s and PhD in Materials Sciences, and Master’s in Science in automation and control; the program coordinators are recognized by CONACYT’s National System of Researchers (SNI). On the other hand, in terms of the postgraduates with PNPC-CONACYT recognition in the ICSHu, we selected two: the Master’s in Population Studies and the Doctorate in Social Sciences. It should be noted that this institute offers seven postgraduate programs with PNPC-CONACYT recognition, the Master’s and Doctorate in Education Sciences, Master’s and Doctorate in Social Sciences, Master’s in Government and Local Management, Master's in Population Studies and the Specialty in Teaching . However, only two coordinators belong to CONACYT's SNI.

The third criterion corresponds to those researchers with recognition in the SNI-CONACYT, preferably with the highest level of recognition. However, we also consider the criteria questions or selection conditions suggested by Gorden (1975 in Valles, 2002, p. 71), which are: a) who has the relevant information? b) who is more physically accessible and socially? c) who are more willing to report? and d) who are more able to communicate information accurately? These questions served as a guiding model for rethinking the selection of potential research subjects. In this sense, these criteria allowed to distinguish and select among the researchers with recognition in the National System of Researchers and those that only have the recognition in the Program of Improvement of the Teaching Staff (PROMEP). In order to select those who belong to SNI-CONACYT with the highest level, at first, we reviewed, collated and debug two databases: PRODEP (Program for Professional Development of Teachers) of UAEH and those that provided us each of the informatics areas of both institutes. However, the institutional data showed serious inconsistencies, since researchers with candidate level are considered as part of the bulk of the National System of Investigators, a condition that is important for us to

separate. For example, in the ICBI, the total SNI population is 124, and a total of 91 researchers with levels 1 and 2 were subtracted from the candidates, whereas in the ICSHu a total of 34 researchers were registered in the SNI, decrease the candidates gave a total of 29 researchers with levels 1 and 2. It should be noted that at the time of reviewing the CONACYT database we did not find in the six institutes of the UAEH researchers with level 3.

The previous institutional review required a third database to be reviewed, whose process we call “data sweeping”, in order to obtain the most accurate data, since in the institutional data we identified another inconsistency, related to the category of researchers in active, which appeared in the registry of both institutes, when in fact no longer worked in these. To address this situation, we reviewed the CONACYT database, which is open access on its official website, which enabled the identification of active researchers or those who currently work in the selected institutes, who actually have recognition in the SNI -CONACYT, considering from level 1

Based on the three sources of information mentioned, a total of 118 researchers with recognition in the SNI-CONACYT were identified, of which 91 belong to the ICBI and are distributed as follows: 69 has level 1 and 22 have level 2; of them, 61 belong to the area of Exact Sciences and Life (Biology, Chemistry, Physical-Mathematics), 24 to the Technological area (Information Technology and Materials Science), and 6 to the Engineering area. As for the ICSHu researchers with recognition in the SNI-CONACYT, we identified a total of 27, of which twenty-four are in level 1 and three in level 2, of which 17 are located in the area of Social Sciences Demography, Communication Sciences, Political Science and Public Administration and Law) and 10 in the area of Humanities (Education Sciences and History and Social Anthropology).

The fourth criterion refers to those researchers who belong to SNI-CONACYT and are part of Academic Bodies (CA) with consolidated status. To that end, we reviewed the PRODEP database of the UAEH, where we identified a total of 51 Academic Bodies, of which 22 belong to ICBI, 3 to ICEA, 8 to ICSA, 6 to ICAP, 2 to IA, and 10 to ICSHu. This criterion allowed reducing the number of researchers that could be interviewed, being as follows: for ICBI, it went from 91 researchers to 81 and for ICSHu it went from 27 to 22 researchers. Given that the number of SNI-CONACYT level 2 researchers, which has ICBI, is 22, compared to the three identified in the ICSHu, a fifth selection criterion was defined, in order to balance such absence in the latter. In this sense, the fifth criterion was to select, for the case of the ICBI, the SNI-level 2 researchers with the highest seniority and in the ICSHu, in addition to this criterion to the SNI-level 1 with greater seniority. This allowed us to adjust the number of potential interviewees, leaving for the ICBI case of 81 to 11 effective interviewees and, for the ICSHu, from 22 potentials to 7 staff

3. Modes of knowledge production in ICBI and ICSHu

For Clark (1983), the organization of higher education systems is shaped by three elements: discipline and institution (establishments), beliefs and authority. Thus, we start from the fact that science is a plural activity that seeks the pursuit of scientific knowledge, although at the moment we do not contemplate the analysis that implies to polemizar the theses of Echeverría (1995), whereas the science not only refers to the search of knowledge, but also attend to the values and rules that govern said activity.

The main concepts or categories to understand the knowledge territories in both the ICBI and the ICSHu are the “disciplinary structures” (Becher, 2001), which are defined from a global framework that allows locating a set of domains or areas of knowledge: hard-science science; pure soft science; hard-applied science and applied soft science. The author defines the areas of scientific knowledge from two dimensions: hard versus soft, deriving

from it, “four domains of knowledge”: hard and soft, pure and applied, which are characterized as: (1) Abstract-reflective (hard-pure), which includes the disciplines of Biology, Chemistry and Mathematics. (2) Abstract-active (hard-applied), which includes engineering. (3) Concrete-active (soft-applied), covering education and social work and (4) Concrete-reflexive (soft-pure), which includes the humanities and social sciences. They are classificatory exercises of the different academic disciplines that although, as the author affirms, they cannot properly appreciate the complexity and variation of the research processes and the structures of knowledge of the different disciplines, they allow to recognize useful dimensions to describe the disciplinary variations , and to highlight continuities and interconnections. (Becher, 2001, pp. 35–36)

Another category refers to the “mode of production of knowledge”, developed by Gibonns et al. (1997), which can analyze the different ways in which academics produce scientific knowledge, whether from multidisciplinarity, disciplinarity or interdisciplinarity.

The answers given by the ICBI scholars on the purposes of science resemble the characteristics defined by Becher in relation to the exact and natural sciences or pure and applied hard sciences, since, for example, these scholars, who cultivate hard sciences and applied sciences, consider that the main purposes of science are to generate new scientific knowledge, to develop new technology, to solve technological, industrial and social problems.

From Becher’s classification, these responses can be summarized as the scientific knowledge cultivated in the hard sciences is characterized by being cumulative, relatively sustained (linear) and can be associated with channels of implication, ie the ability to predict problems that are directly linked to future developments. In addition, new results typically develop in a linear fashion from the existing state of knowledge (scientists often see themselves on the shoulders of their predecessors and locate themselves with reference to a boundary of moving knowledge). The accumulation of pure hard knowledge (where disciplines such as Biology, Chemistry, Mathematics) are connected, in an easy to define way, with diverse characteristics, among which is the apparent clarity of the criteria to establish or to refute the new knowledge. When a new conclusion is accepted, it is considered a discovery and can become a new type of explanation. Knowledge grows, metaphorically, like a crystal or branches like a tree.

At the level of analysis and synthesis, pure hard science reduces complex ideas to their simplest components, that is, to a reductionist and atomizing process. The explanations seem solid because they derive from the systematic scrutiny of the relationships between a few carefully controlled variables. Causal connections are relatively easier to establish in the natural world.

On the other hand, Becher refers that knowledge is practical, because applied hard knowledge (where disciplines such as industrial and technology engineering) are not necessarily cumulative, although, from time to time and from area to area, it can depend substantially on techniques and results of accumulated knowledge (it is stable and has a sense of progression). Nor is it totally quantitative, since the application always includes some element of qualitative judgment. This science usually focuses on the control of the physical world, the activities that originate are typically directed towards some practical purpose and are judged by the effectiveness of its operation, i.e., by intentional and functional criteria. Its main results are products and techniques, ie develop new technology, and solve technological and industrial problems.

Among ICSHu scholars, who cultivate the pure soft sciences (where they are Sociology, Communication Sciences and Political Science) and applied soft sciences (History and Education Sciences), they consider that the main purposes of science are: to construct new knowledge, explain and understand social reality, and solve social

problems. Since the classification of Becher (2001), the answers that the scholars shared can be summarized in that the type of scientific knowledge tends to a predominant recursive or repetitive (circular) pattern of development, where the academic work often crosses lands already explored by others. The most recognized contributions commonly take the form of an interpretation, with the result that some familiar object of knowledge is perceived or understood more clearly. Intellectual roots originate in the often rewritten interpretations of the humanities and social sciences and not in the sustained growth of the natural sciences. On the other hand, applied soft sciences (History and Education Sciences) resort to pure soft knowledge as a means to understand and accept the complexity of human situations, but it does so with a view to raising the quality of personal and social life.

In the case of the ICSHu academics, the idea of transforming society with the intention of improving the living conditions of the people is reiterative. What is possible, through proposals that academics make to politicians to improve educational or social policies that benefit society. The pure soft sciences have as their main result, protocols and procedures, whose functions are judged primarily in pragmatic and utilitarian terms. At the level of analysis and synthesis, hard soft and applied soft science considers that complexity is a legitimate aspect of knowledge, which must be recognized and appreciated more as a holistic characteristic and not as reductionist. The quantitative-qualitative dichotomy forms a grouping not too far removed from the humanities and social sciences. The notion of intentionality plays an important role in the study of human action and thought.

Finally, Gibbons et al.'s "knowledge production mode" category is very useful in distinguishing a series of epistemological, economic, social and political practices that are vital for understanding the processes of knowledge generation in different moments or from different interests. The scientific practices of researchers are associated with the nature and characteristic of the different disciplines whose generation of knowledge can be explained in terms of multidisciplinarity, disciplinarity or interdisciplinarity.

For the author, the term "mode" refers to a form of knowledge production, a complex of ideas, methods, values and norms that have grown to control the diffusion of the Newtonian model to more and more fields of research to ensure their conformity with what is considered as a sound scientific practice. Hence it defines and characterizes two modes of knowledge production: mode 1 which is characterized by being disciplinary, knowledge is produced for the progress of humanity, with the intention of controlling and predicting phenomena from the exact and natural sciences, and understanding social processes from the social sciences. Mode 2 is characterized by being transdisciplinary, it is through which knowledge is produced with the intention of being useful to someone, either for the government or in general for society.

To understand the terms of multidisciplinarity and interdisciplinarity, we rely on Cutcliffe (2003) who in turn cites Thompson's approaches to define and distinguish such terms. In this sense, Thompson (Cutcliffe, 2003) defines and distinguishes three terms related to the evolution of disciplines: multidisciplinarity, interdisciplinarity and transdisciplinarity. The first involves the juxtaposition of more traditional disciplines with the intention of solving some problem or gain perspective. Jantsch (1972 in Gibbons et al., 1997) considers multidisciplinary or multidisciplinary as characterized by the autonomy of the various disciplines and does not lead to changes in previously existing disciplinary and theoretical structures. Cooperation consists in working on the common theme, but under different disciplinary perspectives.

The interdisciplinarity implies a more extensive integration that includes the loan of concepts, the resolution of common problems, a greater coherence of the subject to study or of the methodology, or even the emergence of an interdiscipline. On the other hand, Gibbons et al. (1997) mention that interdisciplinarity is characterized by the explicit formulation of a uniform terminology that transcends discipline, or by a common methodology. The form

adopted by scientific cooperation is to work on different topics, but within a common structure that is shared by all the disciplines involved. Finally, transdisciplinarity goes beyond any of them, to create conceptual frameworks capable of influencing more than one discipline.

According to the definition of Thompson (Cutcliffe, 2003), ICBI scholars are closer to the approach of interdisciplinarity and transdisciplinarity, which is typical of the mode of production of emerging knowledge or mode 2, defined by Gibbons et al. (1997), as a heterogeneous, hierarchical and transdisciplinary structure. The production of knowledge is carried out in an application context, which constitutes a broad reference, configured by a diverse set of intellectual and social demands. Hence it can be affirmed that the production of knowledge in the new mode of production is heterogeneous (in skills and experience), in addition, knowledge is produced through individuals from different disciplinary fields or thematic specialties that meet as a team and establish temporary work networks in order to solve a problem.

The knowledge generated from mode 2 is created in a wide variety of organizations and institutions with diverse demands and expectations, it is intended to be useful to someone, therefore knowledge by knowledge ceases to be valuable in itself, and only obtains this value as soon as it is requested for a series of specific uses that are necessary to him to other actors other than the academics. In this sense, the relevance in terms of the demand for knowledge cannot be satisfied from the offer of only one discipline, but of several, therefore, the final result will be beyond any particular discipline; hence its transdisciplinary character or context of application. In this sense, the scientific community of the ICBI not only makes a more extensive integration of the concepts, or solves problems in common, or not only they have coherence the methodologies and subjects that investigate, but also: they develop a peculiar but evolving structure , to guide efforts to solve problems; contribute to knowledge, although not necessarily to disciplinary knowledge, that is, they develop their own unique theoretical structures, research methods and modes of practice, the effort is cumulative.

Likewise, the results are communicated among those who have participated in the course of such participation, and the dissemination of the results is initially achieved in the same process of its production. Its interdisciplinary structure is dynamic, in terms of the ability to solve problems in movement; there is an increasingly close interaction of knowledge production with a secession of problem contexts. In contrast, the academic community of ICSHu is closer to the approach of multidisciplinarity or mode 1, from the approaches of Gibbons et al. In this sense, there are problems within the disciplines of the scientific community of ICSHu, which do not promote the transition from multidisciplinary to interdisciplinary, because they present problems of extensive integration and less coherence of the subject or methodology to be studied.

4. Context and Organizational Dynamics of Scientific Activity

The concept of “intellectual production conditions” proposed by Pérez-Mora (2011) allowed us to understand the context and organizational dynamics of scientific activity in ICBI and ICSHu. From a structural perspective, we analyze the conditions of intellectual production of the researchers of both institutes based on a set of structured dispositions, which refer to normative principles typical of the university and institutes that tend to regulate, guide and condition development of the scientific practices of a particular academic community. According to Pérez-Mora (2011), these principles involve mechanisms of vigilance and control, of normativity, to the new forms of academic organization and management processes that are imposed on academics. At the institutional level, “the structured provisions are reflected in an increase and diversification in the roles, activities

and responsibilities of academics, within the framework of the transformations in their forms of organization, generated to a large extent by the demands of educational policies, operationalized in mechanisms of evaluation and regulation, which obey the new rules of the game imposed by the new logics of the global society, in which knowledge, its raw material of work, has been given a central role" (Pérez-Mora, 2011, p. 26).

For the analysis of the structured provisions we rely on the category "environment, authority and research", which served to uncover three major tensions, as part of the conditions for intellectual production: 1) Management, teaching and research; 2) Academic times and institutional times, and 3) Research, financing and infrastructure. These tensions are the result of the interrelationship between the environment and authority, between the pressures exerted by both the normative framework that regulates and evaluates scientific activity through CONACYT, and the forms of control and domination of human interactions that have existed since the administrative and legal organization of the institutes of UAEH.

4.1 First Tension: Management, Teaching and Research

According to Aguilar (1988), authority is a system of collective action, associations or organization whose central objective is the realization of collective goals. In order to fulfill these aims, the authority as an organization or in our case, the UAEH, as a university organization, executes pertinent and effective instrumental decisions that favor the development of the essential functions of researchers, that is, to ensure that they only invest time and effort in research activities, and that administrative and academic management activities are minor. However, administrative and academic efforts are abundant and far exceed the time spent on research, that is, that management activities are considered as factors that captured the greatest amount of negative feelings between the academics of both institutes, due to which are time-consuming activities.

These academic-administrative activities reflect a strong limitation for the researchers of both institutes, since the organizational authority does not offer the conditions for a more productive development in the generation of knowledge, in addition to that the research activities give way to those of court administrative, which are often directed more towards compliance with the indicator, as can be seen in the following testimonies:

> [....] I am very excited when I review my data and I am getting my results and find interesting things, I really like that, I like to write it, if I could dedicate much more time to that activity and publish much more, we do what we can, unfortunately, no scientist, I think, is exempt from having to dedicate ourselves to things that we do not like very much, but that there is no other option, for example, we waste too much time managing projects, doing administrative work, it sometimes takes me days to get the bills, order them, photocopy them, which could make a secretary, no scientist has a secretary, not even the secretary of the area give us. From each of the checks I invest days and days of my work doing these things, then thanks to those projects of CONACYT with financing, because I can give scholarships to my students to buy equipment, but each one of those small things to me costs administratively very long time (ICBI-10).

> [....] I say here in college many of us are overworked in terms of management, we do more management than research, what we call research, we have to teach bachelor's, master's and doctoral studies to which we have a program that covers all that, and sometimes we are much more time there, we have to charge or also face the bureaucratic structures of the same university, that good, battling with resources, generate them, give them (ICSHu-2).

The excess of teaching is another negative aspect that attracted the attention among the academics of the ICBI and the ICSHu. Excess that may be a consequence of the new parameters of demand of the global economy of knowledge. From Chaparro's point of view (2010), a greater democratization of higher education, translates

into a greater expansion of enrollment and the consequent increase in coverage, accompanied by a need to develop quality and accreditation parameters, in order to ensure the adequacy of the human resources required by the knowledge economy environment. With regard to the excess of teaching, to which the academics of ICBI and ICSHu are subject, we recover the following testimonies:

> We have to give many classes, or be a state university, because we are teaching, research, but we are therefore as more, because more focused on teaching because they require many hours and then sometimes research then, there like that to ratios that one can, plus the administration.... We wanted to have more time to do research and they do not leave us (ICBI-6).

> We make every effort to comply with all substantive areas of PROMEP, which are five, and obviously since that is not done in 8 hours a day, is done in double basically, you do enough more, I only teaching last year was giving 30, because I am in the political sciences degree program, the social science master's degree, the social science doctorate, the master's degree in government and local management, then there are four programs that are in the PNPC and that they need SNIs and need PROMEP profiles (ICSHu-3).

4.2 Second Tension: Academic Times and Institutional Times

According to Aguilar, authority as a legal institution supposes a type of regime or structure of government when it comes to the rules regarding the ways of obtaining, conserving, exercising and losing collective control. In terms of legitimate command, authority is an organization that, in accordance with current beliefs of legitimacy, regulates, on the one hand, the processes of membership and membership, as well as the type of legal interactions within it, on the other, the obtaining, exercise, scope and loss of collectively binding decision-making power (Aguilar, 1988). Emphasis is therefore placed on the standard character of collective action and, as regards authority; the legitimacy of ownership and decisions is emphasized. It operates from a strategic rationality, which seeks to control or dominate human interactions and actions, imposing institutional ends and interests.

There are differences in both institutes in the way in which authority operates as a legal institution. Control or subtle forms of control become a basic problem in institutes. The differences lie in the intensity of the controls or in the obsession for control, which often results in orders and overwhelming controls on the behavior of researchers that impact in turn, in the academic times of the latter.

This intensity is more pronounced in ICSHu, because academics perceive more control of spaces and times, there is little room for flexibility for academics to do research as a vital function. Unlike the academic community of the ICBI, they consider that there is greater academic freedom and, therefore, a greater margin of flexibility, not only to define the research topics, but also a greater freedom of time to carry out their research activities. Hence, academic times are more valued than institutional times, because most consider that science is an activity that does not depend on a strict schedule, therefore, they are not subject to an eight-hour working time from Monday to Friday, as reported in the following testimony of an ICBI scholar.

Science is an activity that does not depend on a strict schedule, then one can organize to have a compatibility and be able to dedicate, since from personal issues exercise for example, to family issues and there are people who decide to dedicate 100 percent of their life to scientific activity and can do it, is happy, then one can organize that is very good [....] are satisfactions from the strictly labor point of view let's not say, in the sense of having that freedom in terms of what interests one can dedicate himself, but also personally, because one has many advantages in this activity, I think if for example, I told you, the freedom of time we can have to accommodate us (ICBI-10).

4.3 Third Tension: Research, Financing and Infrastructure

One of the main problems faced by academics at both institutes is the insufficient funding they receive. However, there are notable differences in the way of doing science between one institute and another, that is, the science that is done in the ICBI is more expensive than that of the ICSHu, since in the latter, the resources are basically destined to purchase and update computer equipment, to acquire specialized software, to expand bibliographical and furniture collections, as well as to support researchers who carry out fieldwork and to attend and participate in academic events, while in the case of ICBI, the type of research that they consider considers the purchase of expensive equipment, for which they often do not receive enough economic support to do such activity, as expressed by a researcher:

> Science has many problems in Mexico, there is no funding, in fact for example, here at the University of Hidalgo, because science has no support from the economic point of view, if there is no economic support it is difficult for you to do science, because it is expensive, very expensive to do science, the equipment and laboratories are expensive, chemical reagents, materials are expensive, training of quality human resources require much attention and much support in the laboratory, it is necessary to consume materials, reagents, equipment and all that (ICBI-9).

5. Strategies of Scientific Collaboration

ICBI and ICSHu researchers develop differentiated strategies for scientific collaboration to achieve the ends of science. The “scientific collaboration” or “collaborative research”, following González and Gómez (2014) and Macrina (2014), involves processes of communication and interaction between two or more individuals in order to achieve a common purpose for the research group. In this sense, González and Gómez affirm that the scientific collaboration is not a new phenomenon nor recent, since the scientists have worked cooperatively since science exists, therefore, science and collaboration have been constituted in an inseparable binomial to enable the progress and advancement of knowledge.

The processes of communication and interaction can be worked, basically, from four elements that are mutually conditioned and that allow to develop, from the point of view of Macrina, “successful scientific collaborations”. These elements are: 1) formal collaborative agreements through the formation of research networks. 2) external collaborative agreements, which facilitate and intensify the use of a research structure shared with several academic units; 3) internal collaborative agreements based on tutor-apprentice interaction, and 4) collaborative agreements that are supported by constant and open communication, with a sense of responsibility, trust and respect among the members of the research group. For the purpose of this paper, only formal and external collaborative agreements and those based on constant and open communication are retrieved (Macrina, 2014, p. 255).

5.1 Formal Collaborative Arrangements

The first element of scientific collaboration is associated with the formation of collaborative agreements, which from the point of view of Macrina, refer to agreements that are established among all members of the research team. These agreements determine the objectives, responsibilities and duties of each of the participants. Agreements can be formal or informal, that is, do not necessarily imply a written document that must be written at the beginning of the collaborative process. This level of collaboration is strongly linked to the “research networks” alliances, also defined by Macrina (2014) as “interdisciplinary partnerships” that foster universities and

researchers themselves, or as Kreimer (2008), “mega-networks” made up of several hundred researchers that deal with a set of topics that are at the same time more complex (involving different types of knowledge, different methods, etc.) and more specific, to the extent in which they seek concrete and cognitive social objectives that can be applied by well-identified actors.

One aspect in common, which ICBI and ICSHu scholars consider, regarding the motivations and expectations they have towards science, is the generation of national and international research networks, as expressed by researchers from both academic communities:

> I do not really know how long it lasts as a coordinator, but even if it is the teaching floor, we will try to get our program to an international level, we want to see if we can bring teachers, imagine that they come from other very good institutions to teach, that would be ideal and also that the teachers can go outside, and that students can leave, but with more security, that really generate a network of research at national and international level, and why not, because we are talking about the two levels, and that I would love (ICBI-1).

> [...] we are also about to generate a network for the study of violence and we have to respond to that, and we must involve another sector, there are stages to do research (ICSHU-6).

5.2 External Collaborative Agreements

The second element of scientific collaboration is associated with external collaborative arrangements that facilitate and intensify the use of a shared research structure with several academic units. This type of scientific collaboration is more associated with research and development activities, specific to the area of the natural sciences, since according to Bermeo (2007), they jointly establish a research structure, which aims to share and gain knowledge to increase technological capabilities and to achieve common goals in the field of science and technology. Also, the external collaborative agreements that are self-managed by ICBI researchers, impact on the production of knowledge seen as a socially distributed process, or in terms of Gibbons (1998), because they are linked to the notion of “socially distributed knowledge” so that ICBI academics are involved in a global network of knowledge or network where they cross a number of interconnections that increase continuously when new points of production are created. In other words, and from the perspective of Gibbons (1998), we will say that the external collaboration agreements developed by this academic community are based on a greater number of points — called external academic units — that give rise to a constant combination and recombination of the resources of knowledge, therefore, what we identify in that academic community is what Gibbons (1988) calls “the multiplication of the nerve endings of knowledge”.

5.3 Collaborative Agreements Based on Communication

The researchers construct collaborative agreements through constant and open communication, with a sense of responsibility, trust, respect and motivation among the members of the research group. In this regard, Macrina (2014) states that the most important aspect during the collaboration process is not only what can be achieved scientifically, but how to maintain a healthy relationship among group members. Hence the role of the leader or leaders in the research groups is important, both to promote discipline and participation of the group and to generate a climate of trust and cohesion within the group.

ICBI researchers are able to maintain a healthy relationship among members of the group, due to the existence of researchers who take on the role or role of participatory leaders. On the other hand, ICSHU researchers, rather than seeking a healthy relationship among group members, find more problems of integration due to the lack of participatory leadership, as one researcher says: “everyone complains and nobody finds

solutions to the problems." Likewise, in relation to the poor academic training undergraduate students in the ICSHU, a researcher shares his perspective:

> [...] The main problems is that we all complain and well, we all complain about the deficiencies that students bring in this question, understand social theories, more than anything, because the master of epistemology and the teacher of social theory emphasize it seems that these students got into a PhD they did not know they were going to see social theory and they always tell me, they all complain, because they get very poor students, and well I say, or blame those of mastery or those of bachelor's degree, and so we are going (ICSHU-2).

The academic community of ICBI offers more solutions to the problems they present, and even efficiently solve organizational problems, thanks to the efforts of the participatory leaders that from the concept of Becher (2001) resembles the development of "leadership organizational", which implies that the assigned person is responsible for arranging and organizing times, funds and facilities for research and, in general, for providing the administrative support necessary for a complex collective enterprise.

The role of these leaders, within the academic community, is to generate an atmosphere of rapprochement through forms of inclusion, which according to Macrina (2014) means that inclusion is evidenced through active participation within the group in the decision making and the contributions that the members make with the organizational process of the group, as expressed by an ICBI researcher:

> When we are presented with a problem, we are all very close, and that speaks very well that [the area of] chemistry has grown a lot, we have to do this, how they see, they may not agree two, but it will be done, the other, not so that, yes, that is done. For example, teachers who come new, who are not in Lines of Generation and Application of Knowledge, to see we will encompass, nothing that you have arrived, there is no, you do not enter, no, the other way, you have to support it, and you have to support it because if not the creature is not going to do anything, do you understand me ?, ah, because the SNI has not achieved such, you have to give economic support, how many reagents you need, what you need, you do not have nitrogen, let's buy the child nitrogen, if you understand me ?, and those things I am part of it (ICBI-1).

The sense of inclusion generated by the participatory leadership of ICBI researchers is strengthened by elements of motivation, with the intention that all members of the academic community participate. In this regard, Macrina (2014) exemplifies the motivation factor in the tutor-apprentice relationship; says that an activity that tutors can do is motivate their learners to develop written agreements, in which they articulate their goals, positions and expectations, among others, with the context of the research team. This exercise will allow the learner to define well their needs; in addition, will enable the most experienced researchers to know what the learner expects from the collaborative work of which he is now part and the contributions that could be obtained from the collaborative work for the research team. One of the ICBI interviewees, in her role as coordinator of the PhD, confirms the importance of motivation in the teacher-student relationship:

> If there is a problem teacher-student, I as a coordinator, I am aware of them, to see what happens, what has been the problem, provided, therefore, having solutions, between the head of the area and the tutorial committee of the program, I never do alone, because, because we are a, as it were, a guild not, and that everyone has to participate, and everyone, again, that we do not lack the situation of respect. So, yes it is important, the motives of look you see, you have these things, with your scholarship you can go to the library here, you can go, ask your boss, between the bosses or the thesis directors themselves have networks, well, you know that they have gone, and they have done so (ICBI-3).

For a research group to work comfortably (norming) it is necessary that trust be consolidated among the members of the group through the relation power-responsibility-respect. In this way, Macrina (2014) states that

power can be expressed in different ways: through the skills that an individual possesses: charisma, for their work ethic: performance, for achievements: reputation, for their contacts, titles, charges, skills to reward or punish others: knowledge, information management, and even physical structure, can be a visible source of power. Individuals with more power have a responsibility to create an environment where other participants feel secure. Therefore, trust and respect in the group are consolidated when the participatory leadership exercised by ICBI researchers is supported by a "balanced power", that is; active listening, consider the suggestions of other members, prioritize communication, be inclusive and not resort to exaggerations when a mistake is made. Trust among the members of the research group will allow the conflicts and disagreements that may arise to be solved without so many inconveniences.

Once the ICBI academics manage to work comfortably on a balanced power that is managed through participatory leadership, they are in the possibility that the research group performing well and that the collaborative process is successful due to the existence of a communication constant and open. In this sense, Macrina (2014) affirms that the most valuable aspect, when the collaborative link is initiated, is communication, since it is precisely when members of a research group that bring different perspectives about the project, exchange them . Therefore, it is pertinent to talk or communicate ideas about the information and results that are obtained in the research, on the interpretations of those results and, most importantly, to know how to listen (active listening / considering the norms of the good listener) the comments made about it and do not ignore them. That is why it is crucial that all members commit themselves to constant communication, as witnessed by an ICBI researcher:

> Notice that we have a friendly teacher-student relationship with a lot of respect, that is, if the boy comes, I have doubt, I have to, then you, at all times you are open to what he has doubt, and for us that has worked very well , if you understand me, that is, without maltreatment, without bad manners, but always tending to respect, that everyone respects themselves, among their companions and us, then, if that ultimately has resulted, then, for me has been good, yes, that is, for me that has been good, maybe the pedagogues will say that you do wrong, because no, because that is what has not, that is, I do not know if it happens, he is the doctor, retire no, no, no, not really here is the doctor that you can go to see, hears I have doubt, so be the student of who is, has the confidence to go to see, to go to ask, then, openly ... (ICBI-1).

6. Conclusions

From the information presented, we can derive that the structure of the scientific disciplines in the ICSHu moves more in the "instrumental" terrain of science, seeing the formative exercise as irreconcilable between pluri and multi-disciplinarity and therefore, the interdisciplinarity appears blurred or simply does not appear. In the first situation, because the multidisciplinary conception with which one works in this institute is more adaptive in function of each of the disciplines, because each discipline defends its own "autonomy", without there being by means of changes in the disciplinary structures which point to a more comprehensive academic work exercise.

With regard to interdisciplinarity, it is more difficult to develop in this institute, because it requires other training and other requirements for its implementation. For example, Follari (2007) refers that interdisciplinary research is essential for certain topical issues, border issues, high complexity, or certain issues that have to do with solving pragmatic problems. It is often slow and expensive, because it is not simply about putting together disciplinary fragments. Hence, interdisciplinarity does not occur naturally, but is built on and based on a specific work of production.

Transdisciplinarity takes on greater weight and meaning in the answers given by ICBI scholars, since according to Martínez (2007), transdisciplinarity is an intellectual movement that wants to go "beyond", not only for uni-disciplinarity, but also of multi-disciplinarity (which enriches one discipline with the knowledge of another) and of inter-disciplinarity (which even carries the epistemic and methodological order of one to another). The ways in which knowledge is produced by ICBI academics are developed in an interdisciplinary environment, but also with a tendency towards transdisciplinarity. The latter is explained by the way in which ICBI scientists conceive of science as a producer or generator of new scientific knowledge, which is seen as the result of a continuous process and of multiple changes occurring in the ways of producing it. But more importantly, it is the displacement of interests that ICBI scientists assume to study not only simple systems but also the study of the properties of complex systems.

The intellectual production conditions of ICBI and ICSHu scholars are developed from two logics: political and institutional, which have defined new forms of academic organization. On the one hand, the one that emerges from CONACYT, which favors individual production and, on the other, which derived from PROMEP that favors collective production through the balanced development of teaching, mentoring, management and research, the latter under the figure of academic bodies. The scientific practices of full-time academics are developed between two rational logics: on the one hand, there are the public policies of the federal government (CONACYT and PROMEP) or functional rationality, which define the type of teacher and researcher to be reached at the level individual and collective, based on a series of activities to be carried out, under criteria of efficiency and effectiveness (academic productivity) and, on the other, institutional rationality, characteristic of the state university that functions as a legal institution and organization that defines for the researcher a series of activities to be carried out. As stated by Izquierdo (2006), researchers from higher education institutions have to comply with the Conacyt, but also with the institution's own rules that are giving them shelter. These two logics are the trigger for great tension, between individual academic production and collective academic production. They are the result of what Perez (2011) calls "cross signals", between the mechanisms of evaluation of individual work and the new mechanisms of evaluation of collective work that have led to a tension in academics for responding between one dimension and another.

Scientific collaboration strategies, through collaborative agreements based on communication, are essential to share the scientific knowledge generated in each of the scientific disciplines that are cultivated in both institutes. These strategies, seen as the "structure of efforts" carried out by academics in both institutes, are based on the implementation of internal and external collaborative agreements, as well as on forms of intensive and extensive communication that are sometimes similar, but they often differ among institutes. ICBI academics conduct collaborative and self-managed resources and external infrastructure agreements with greater intensity than ICSHu academics. The former demands to build much more specialized and complicated knowledge than the latter, so they require increasingly complex means of communication and data processing, as well as access to state-of-the-art infrastructure, which can only be obtained from other universities and research centers.

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