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The process of academic literacy in Civil Engineering Computer Science. An approach to academic writing and its genres in a learning community

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Abstract. This paper is inserted in the field of academic literacy processes in the area of engineering. The aim of this study is to understand the current role of academic writing in the undergraduate university teaching in Civil Engineering Computer Science as an influential sub discipline in the world today. This research is based on the notion of academic and disciplinary writing (Bazerman, 1988, 2005; Motta-Roth, 1998; Navarro, 2015; Parodi, 2010; Swales, 1990, 2004) and relies on an ethnographic qualitative research methodology. The main results are presented in an explanatory model that shows, in the studied community, two key elements. On the one hand, the functional, practical, communicative and professional role of writing in this community, given the new requirements of the different production situations that demand a well-prepared computer civil engineer who is prepared to explain, justify and communicate his/her work to diverse audience. On the other hand, the prescriptive, traditional and highly normative rules that conceive academic literacy as a mechanism focused on the formal aspects and on the final product of the writing process. In summary, both elements carry a series of pedagogical implications in the teaching procedure of scientific writing that opens the door for future research.
Keywords: academic literacy, academic writing, genres of undergraduate training, classification of students writing.

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1. Introduction

Writing in the disciplines (WID) as a pedagogical movement and as an area of inquiry has drawn the attention of a large number of specialists (Bazerman et al., 2016). These specialists highlight the epistemic, rhetorical and axiological potential of writing as a means of accessing disciplines and their learning. In fact, disciplinary writing is fundamental in the generation of specific knowledge, and discourse genres play a relevant role in the definitive integration of individuals into their communities of practice.

Therefore, writing in the university environment is essential in the academic field, not only because of its crucial role in the process of academic literacy, in the global context and knowledge industry, or the development of interdisciplinary expertise (Bhatia, 2002), but also in the negotiation of identities, the positioning in the disciplines and power relationships: "Writing is a particularly manifest form of social action for the negotiation of identities, because a written text is deliberate, potentially permanent and used as a statement for many social purposes (such as the evaluation of academic achievement)" (Ivanic, 1998:40).

Different disciplines have focused their attention on the history and functions of the different disciplinary genres (research articles, presentations, lectures, monographs, academic essays, among many others), roughly since the 1980s, Bhatia (1993). A major spotlight of some authors was the research on legal communication, while for other authors was the scientific communication (Halliday & Hassan, 1989, Halliday & Martin, 1993). Alternately, scholars of rhetoric and communication have concentrated their efforts on the experimental article (Bazerman, 1988), the bibliography review in Natural Sciences (Freedman & Medway, 1994), and interpretative essays (Miller, 1984), among others. Hence, genre studies have been of interest not only to linguists and discourse analysts, but also researchers and academics from different disciplines seeking a better understanding of the types of texts circulating in their own specialized community.

On the one hand, in academic discourse, texts related to the field of academic research expressed in expert discourse genres (Thais & Zawacki, 2006) have been extensively investigated in different languages (Conrad, 1996; Groom, 2005; Lim, 2012; McGrath, 2016; Tarone et al., 1998). On the other hand, there is a relatively small number of studies that explore writing genres produced in undergraduate university courses, mainly due to the difficulty to obtain these texts. Based on evidence from surveys of academics and students from four British universities, Gardner and Nesi (2013) argue that this kind of writing is more varied than research writing and manifests itself across a wider range of genres.

In order to explore student-produced genres, or the genres of the concerned academic community, this study attempts to answer the following questions: *What genres are produced by Civil Engineering Computer Science (CECS) undergraduate students? What is the role of writing in the CECS curriculum?* The aim of this paper is to understand the role of academic writing in the training of CECS students. In order to attain this objective, it is necessary to identify genres produced in CECS, based on in-depth interview analysis. Besides, this study intends to determine the roles that professors and students assign to academic writing and characterize one of the emerging academic genres, acquired during

training process, due to its bridging function between academia and the professional world.

Discourse genres correspond to "a constellation of potentialities of discursive conventions supported by the prior knowledge of the speakers/writers and listeners/readers (stored in the memory of each subject), based on contextual, social and cognitive parameters and constraints" (Parodi, 2008, p. 26). This conception emphasizes the interaction between linguistic, cognitive and social dimensions. Consequently, genres are complex and multidimensional entities that involve standardized forms of expression (Bazerman, 2004). Those forms are recognizable by the members of the community and their cognitive, social and linguistic components interact with each other. Therefore, in the academic field, these forms of situated cognition are embodied and updated in diverse disciplinary activities.

This paper is organized as follows: first, the conceptual background that guides the proposed research is reviewed. Then, we present the steps and methodological procedures followed for data collection and analysis. Subsequently, the results obtained are reported and discussed in the light of the theoretical-methodological platform outlined. Finally, we shed light on some final reflections on the process of academic literacy in the academic community concerned.

2. Theoretical framework

2.1 The discourse of engineering

From a sociological point of view, Becher and Trowler (2001) characterize engineering as "a hard-applied discipline [which] is purposive, pragmatic, concerned with mastery of the physical environment, and results in products or techniques" (2001: 36). It is an applied discipline, therefore a field with a strong emphasis on the ability to transfer knowledge and methods with respective principles to diverse settings (Neumann et al, 2002). Engineering as a discipline is embedded in the broader scope of natural and exact sciences tending towards a vertical knowledge structure, in the terms proposed by Bernstein (1999, 2000). From this perspective, the discourse of engineering, similarly to the discourse of science, is characterized as vertical and hierarchical. This knowledge is built as a result of strong grammar that Bernstein defines as follows:

> A hierarchically organized and coherent structure; explicit and governed by systematic principles, and that seeks to create classifications and general theories, which integrate knowledge and show implicit regularities through a wide range of apparently different phenomena (1999: 161-162).

For the author, vertical and horizontal knowledge structures are different paths in which disciplinary knowledge is structured. Thus, disciplines such as cultural studies and social anthropology tend to construct a horizontal discourse, unlike a hierarchical vertical knowledge structure that characterizes the exact sciences.

While the horizontal knowledge structure accumulates knowledge by adding new segments to the corresponding topics and perspectives, vertical discourse builds knowledge through integrating codes into more general theories or categorizations. This is also reflected in the curricular structure of engineering

undergraduate curriculums that promotes a progression of discursive genres that follows a block-by-block construction:

> Where specific skills, and then combinations of these skills, are targeted in separate assignments, culminating in long projects and design proposals where multiple skills are integrated in assignments that reflect published academic writing and professional writing respectively (Gardner, 2008: 28-29).

Being a hard-science discipline, engineering tends to place greater emphasis on the preparation of the curriculum (Braxton et al., 1995), though disciplinary discourse of engineering is not a single, homogeneous or totally stable discourse. For this reason, authors such as Hyland (2000) and Bhatia (2004) prefer to talk about *disciplinary discourses* by marking the plurality. While it may seem an easy task to recognize a discipline: "people with any interest and involvement in academic affairs seem to have little difficulty in understanding what a discipline is, or in taking a confident part in discussions about borderline or dubious cases" (Becher, 1989:19).

It is not a simple task since within an area there are different perspectives, sub-disciplines, languages, converge to specific ways of doing and saying fashions in the community, which respond to discursive traditions (Kabatek, 2015) or institutionalized ways of speaking and doing in each disciplinary culture.

Considering that engineering is a diverse discipline that encapsulates a multitude of sub disciplines (Ward, 2009), we cannot talk about a single engineering and much less of a single discourse, as the various sub disciplines or constellations of disciplines have a specific history and traditions. For example, civil engineering has a long history that goes back to its origins to 1711 (Ferguson & Chrimes, 2011), while biotechnology announced its beginnings as a new discipline much later, in 1952 (Nebeker, 2002). Civil Computer Engineering, which is the central focus of this research, dates back to 1940 and today is considered a stable profession "Focusing on the systematic application, maintenance and development of computer programs" (Glass, Macey, & Ramesh, 2002: 493). In fact, the quick development of technology has caused a dramatic growth in engineering and has resulted in the proliferation of new sub-disciplines (Kanoksilapatham, 2015: 77).

Nevertheless, it is important to consider that it is not possible to take a Manichean stand between hard sciences and soft sciences in the study of specialized and disciplinary discourses, since genres are often mixed together giving rise to hybrid forms. Such specialized discourse forms respond to existing discursive traditions, merging either academic, professional or mixed discourse (Hyland, 1999, 2000; Jacob & Kabatek, 2001; Swales, 1990) that impose a writing style and a way of selecting textual models (Bolívar, 2005); and this is always done "within disciplinary canons" (Hyland, 1999: 359).

2.2 The academic discourse of engineering

In the field of engineering, textual production processes have been addressed from the notion of "technical communication". The programmatic framework of Technical Communication, mainly developed in the United States, has created a space for reflection and research with its own dissemination channels such as the

magazines "*Journal of Business and Technical Communication*" or "*Technical Communication Quarterly*", both of them published in English. As reported by Navarro and his colleagues (2016), most of the publications in Spanish point to articles interested in the empirical writing research, in diverse environments and genres, but with predominance in undergraduate education in Humanities and Social Sciences, with a specific focus on the scientific research article format.

In general terms, the studies and initiatives that have been addressed from 'Technical Communication' (Poe, Lerner & Craig, 2010) focus on the needs of graduate professionals, those who are already embedded in workplaces and do not consider previous stages or training in writing as students advancing in their undergraduate studies. This dissociation has been highlighted by Artemeva (2007) and shows that communication in academia and at work constitute "worlds apart" and "raised a question of portability of rhetorical strategies from one context to another" (Artemeva, 2007: 1).

In the last decades, as Piirto explains (2000), the role of engineers has been changing from the design of systems to the management of processes and people, so that the communicative needs of this discipline have been increasing and, consequently, the relevance of writing in the profession has been growing steadily. Consequently, a key question arises about how students accumulate and develop rhetorical knowledge in the specific domain of engineering and how that knowledge enables them to communicate successfully in the professional environment. To better understand this rhetorical knowledge, it is fundamental to investigate the discursive genres that circulate in engineering, where and how they are inserted in the curriculum, specifically those that must be updated by students as part of their class work, considering the relevance of writing in the instructing environment and in the simulation of professional demands.

Most of the publications that develop the issue of writing in engineering undergraduate courses address this topic only in general terms and as an introduction to the formulation of proposals or didactic sequences for teaching genre and the generation of specific instances of writing instruction within disciplinary spaces (González-Álvarez, 2014, 2016; Holaday, 2011; Showm & Hirsch, 1999). Paretti (2008) emphasizes the need that exists in this field to go beyond the mere embedding of writing activities in engineering education, as it should provide the necessary tools based on writing models that consider contexts and professional roles beyond the classroom. This is consistent with the epistemic potential of text production and supposes a challenge to have more empirical evidence on textbooks written by students and simulation genres (Freedman & Medway, 1994). In fact, these simulation genres may become a mere imitation of professional practice in case of absence of metacognitive rhetorical knowledge that makes it possible to transfer these practices to new contexts.

In the Latin American context, Narvaez-Cardona (2016) through her study consisting of twenty-two publications about initiatives in engineering´s writing, points out that this is a recent area of inquiry since 2009. An important group of publications in her study tackles the institutionalization of engineering literacy initiatives in the region, strongly driven by curricular change processes and the development of academic support programs.

In contrast to the reality of the United States, the Latin American panorama is not prompted by the state of technical communication in the region nor by the dilemmas and disputes in its development (Reave, 2004). Instead, in Latin America there is a marked interest in pedagogical devices: "The analysis of Latin-American publications that report pedagogically-oriented initiatives suggests that the field has emerged primarily focusing on the "writing to learn" approach. (Narvaez-Cardona, 2016: 237).

In the field of research, in some Latin American countries, especially Chile and Argentina, there is an interest to characterize and understand the overlapping transitions and practices between industry and academia in a better way, (Bernhardt, 2002; Natale, 2015; Natale & Stagnaro, 2015; Parodi, 2010), the limited and artificial teaching of professional genres (Natale, 2012) and the need to unite academic writing practices and professional writing (Natale, 2012; Natale & Stagnaro, 2015; Parodi, 2010), which confirms that the final year in engineering undergraduate studies is an academic space that must be investigated for its relevance in the education of engineers.

When we talk about academic genres, disciplines and curriculum, it is necessary to define academic literacy as a process that allows students to gradually integrate themselves into the discourse community to which they aspire to belong. The genres in this sense, when building the construction of disciplinary knowledge, are part of pedagogical, curricular and institutional practices that are broader both at a macro-curricular level (the university institution) and at a micro-curricular level (the university classroom) as they build the foundations of disciplinary knowledge.

Academic literacy as a program of research and intervention (Carlino, 2005b, 2006; Marinkovich, 2002) has highlighted the concern about the development of communicative skills in the field of Higher Education. Accordingly, discourse analysts, specialists in language teaching, and discourse genre scholars have geared their efforts to detect communicative needs (Bazerman, 1994), to describe discursive and linguistic characteristics of the texts circulating in the academic field (especially for the School of Linguistics of Valparaiso (ELV): Parodi, 2008, 2009, 2010, 2012) and propose steps to facilitate the insertion of students into academic culture (Carlino, 2004; Cassany, 1995; Marinkovich et al., 2009; Marinkovich & Poblete, 2014; Montolio, 2000) and the mastery of scientific writing (Sabaj, 2012).

International studies, which have been carried out for more than three decades in the English-speaking, French-speaking and more recently in the Spanish-speaking field, show the relevance of the development of discursive skills both to establish effective communicative relationships within the specific communities and to facilitate the respective learning processes (Bhatia, 1993; Bazerman, 1988; Carlino, 2005a; 2005b; Di Stefano et al., 1988; Teberosky, 2007).

The university as a particular community of practice requires, in order to fulfill its institutional objectives, to meet and satisfy the communicative needs expressed and evidenced by the different members of the academic culture. In this sense, at the base of all this research emerges the diagnosis of the deficiencies and weaknesses in the field of communicative competence, necessary to successfully deal with the demands of the Academy and, therefore, an explicit and directed process of literacy in university disciplines arises as a fundamental part of it. This

academic culture is extremely complex and within it converge different discursive practices, "different disciplinary ideologies, ways of thinking and varieties of language" (Harvey, 2009: 628).

2.3 Genres and undergraduate education in Computer Science Engineering

University, as a community of practice, as per Loudermilk (2007), has a very characteristic culture in which it is very rare for students to present or submit their writing to persons other than their professors, so those texts can be considered as hidden or closed genres: "little research has focused on the occluded genres of academia—genres whose exemplars are typically hidden, 'out of sight' or 'occluded' from the public gaze by a veil of confidentiality'' (Loudermilk, 2007: 191; Swales, 1996:46). We must add that the concentration of investigation of research articles (Anthony, 2010) and the more accessible instructional materials (Hyland, 2008) also responds to a prescriptive and stigmatizing belief that the texts produced by students are imperfect and artificial versions of expert academic discourse (Russell, 2002).

The written output of the university student was thus linked to the "crisis narratives" (Bazerman, 2005) with respect to the quality of university students writing. These "crisis narratives" are based on the different diagnoses reported in literature on what students could not do and, consequently, the research and teaching practices focused on deficits and the need to overcome them through a remedial approach (Carlino, 2006; Di Stefano et al., 1988). This remedial approach did not consider the specificity of the reading and writing in the disciplines nor the new demands faced by students in each of the levels of the university system.

To the previously mentioned we must add, from the point of view of academic literacy, (Marinkovich & Poblete, 2014; Parodi, 2010; 2012), that many studies focus on scientific research articles as models that university students should aspire to produce, thus they neglect the existing diversity in academic writing forms, as well as the rhetorical potential and the specificity of the student´s textual productions. Therefore, this approach opts for the teaching of expert genres or, as a counterpart, didactic proposals such as those focused in essay writing as preferred and overemphasized genres in academia.

2.4 Proposal of academic genres classification for undergraduate phase

Since the birth of textual linguistics, the interest to classify and sort textual reality has been a constant concern for researchers, analysts and language practitioners. The classification of texts produced by the students during their academic training has become a central research task for numerous investigation projects lately. One of the grouping types that can be found, according to Stagnaro and Natale (2015) is based on two poles: university life and disciplinary and professional cultures. Whereas it is extremely difficult, as raised by Ganobcsik-Williams (2004), to distinguish accurately between, for example, a "Book Review" or a "Book Report" and one of the most important difficulties faced by those undertaking classification tasks is the diversity of tags and categories, due to a lack of consensus in the field (Gardner & Nesi, 2013; Graves, Hyland & Samuels, 2010; Zhu, 2004;).

Early classifications of the texts produced by university students have been carried out based on literature review and reflection, in addition to, academic surveys and analysis of course documentation (Gillet & Hammond, 2009; Jackson

et al. 2006; Zhu, 2004), but not on the collection of the texts already produced in real contexts of the university classroom. One of these early ratings is attributed to the North American Susan Peck MacDonald (1994) who classified the texts in terms of progression based on four stages: The first stage is a personal nonacademic or non-pseudo-academic writing, typical of secondary education. The second stage is a general academic writing in the first year of university that provides a basic background information about academic genres. On the third stage, students acquire some specific writing forms to the discipline, and finally in the fourth stage students reach the *prose of the expert*, which becomes evident by the end of the training paths.

This schematization, while interesting in terms of the steps to achieve a final goal, is very rigid, since student´s progression in other parts of the world follows different paths. In Chile, for example, undergraduate degrees tend to be highly specialized from the very beginning of university education, and therefore, disciplinary writing begins earlier. In addition, the incorporation of a first composition module is not a common practice in all university courses or in all institutions (Ávila et al., 2013).

A relevant work in the identification and classification of academic genres is the one elaborated by the Linguistics School of Valparaiso (Parodi et al., 2008, 2010, 2015). The authors, through an empirical study, distinguish academic from professional genres, both types belonging to a specific type of specialized discourse. The investigation was based on the use of corpus linguistics and genre analysis tools where researchers describe twenty-nine academic and professional genres identified in the PUCV-2006 corpus, which consists of the texts from four undergraduate academic programs: Construction Engineering, Industrial Chemistry, Social Work and Psychology.

The professional and academic genres identified are as follows:

Academic Gender and Professional Genres taught

1. Scientific research article	16. Operations manual
2. Tender basis	17. Memorandum
3. Commercial catalogue	18. Financial report
4. Certificate	19. Regulation
5. Convocation	20. News
6. Conference	21. Medical Order
7. Quotation	22. Observation guideline
8. Declaration	23. Development plan
9. Dictionary	24. Map
10. Medical record	25. Research project
11. Brochure	26. Record
12. Didactic guide	27. Thesis
14. Law documents	28. Test
15. Manual	29. Disciplinary text

Table N° 1: Academic and professional genres identified in Parodi et al. (2015)

According to the reported results, only the didactic guide belongs exclusively to the academic field, eight genres are used in academic fields and other twenty in the professional world. This characterization makes it possible to establish a

continuum: at one extreme, in the level of access to the university world, the Didactic Guide as an informative and general genre, going through the eight genres of a more specialized character that are also found in the working environment to reach a wide and heterogeneous set of genres that students will face in a professional context. This continuity, however, is not necessarily a product of "careful conscious planning" (Parodi et al., 2010: 286).

The configuration of this *continuum* shows that working life requires the use of a greater number of different genders in its communicative purposes, organization and lexicogrammatical resources, but this great diversity is scarcely represented during the course of university education: "This diversification of genres between academia and the professional world imposes new discursive mechanisms to access knowledge and the practice the professional activity, carried out at a great extent through written linguistic mechanisms" (Parodi et al., 2010: 286). These findings are consistent with the research conducted by Cassany and López (2010): "the literate practices of the professional world differ markedly from the academic ones, not only in the types of texts and their stylistic features, but above all in their pragmatic parameters (author, function, reader, etc.) and in the production and reception processes, which usually involve more people, languages and tasks" (Cassany & López, 2010:369). The contribution of the Sidney School guidelines (Rose & Martin, 2012; Gardner & Nesi, 2013) develop a classification based on the analysis of a corpus of 2,858 texts produced by university students at different levels in more than thirty study programs. Each of the programs is grouped into large areas of knowledge. The texts are classified into thirteen families of genres. The differentiation criterion is attributed to genre goals, the steps and phases that make up the genres.

The thirteen genre families are the following:

Family	Goal
Case study	Develop/demonstrate understanding of professional practice based on the analysis of a particular case.
Critique	Develop/demonstrate understanding of an object of study and the capacity to evaluate its relevance.
Design Specification	Develop/demonstrate the ability to design a product or a procedure that can then be manufactured or implemented.
Empathy writing	Develop/demonstrate the ability to translate academic issues to other non-expert areas.
Exercise	Practice of basic skills to consolidate key insights from the disciplines.
Essay	Develop/demonstrate the ability to build a coherent argument and use critical thinking from a question.
Explanation	Development and demonstration of understanding of an object of study.

Literature survey	Develop/demonstrate the knowledge of the literature about a topic.
Methodology recount	Develop/demonstrate some familiarity with the procedures, methods and conventions.
Narrative recount	To enhance awareness about the motivations and behaviors of individuals and organizations.
Problem Question	Provide practice for the implementation of methods in response to professional problems from cases that simulate real-world situations.
Proposal	Develop/demonstrate skills to organize a series of actions out of certain purpose.
Research report	Develop/demonstrate the capacity to carry out an investigation, which includes the design, implementation and estimation of its contribution to a field of study.

Table N° 2: Theoretical classification of genres (Gardner & Nesi, 2013).

In their analysis through education process levels and across disciplines, the authors point out

In their analysis through formative levels and disciplines, the authors emphasize that all gender families are present in three of the four disciplinary areas covered by the corpus, namely, life sciences, physical sciences and social sciences. Not all families are found in the areas like Humanities or Arts. In terms of curricular progression, there is a greater presence of essay and explanation at level 1 (first year of college), a high number of methodological recounts specially in level 1 and 2, empathy writing and research report at level 3 (last year of undergraduate) and an increased number of cases, proposals and criticisms at level 4 (first year of postgraduate).

3. Methodological Framework

This study has a qualitative character with an exploratory-descriptive scope that seeks to organize the findings into a theory. To achieve this purpose, this study is based on the Empirically Grounded Theory (Glaser & Strauss, 1967) that relies on the data to explain a phenomenon and its possible causes through a constant comparative method. In this way, the data is examined in order to be interpreted through a theoretical sampling. This sampling is flexible and subject to constant change during the study, according to Corbin and Strauss (1990, 1998, 2015) and it is refined as it progresses over time, independently of the number of cases, to reach a deeper degree of understanding of a certain social situation that fulfills the adequacy and relevance of the case in question (Sandoval, 1996).

Furthermore, three sources of data have been contrasted to get a detailed look of the emerging problems. The first data source is the in-depth interviews to four directors of Computer Science Engineering schools belonging to regional universities that are part of the Council of Rectors of Chilean Universities

(CRUCH) and a *focus group* in which undergraduate students have participated. The second data source corresponds to the final year of Civil Engineering Computer Science (CECS). The third source is composed by written texts from students in the framework of their graduation final project.

Finally, in order to get a detailed look at emerging issues, three research sources have been triangulated. The first data source consists of in-depth interviews with four directors from Computer Science Engineering schools from regional universities that are members of the Chilean Council of Rectors (CRUCH). In addition to a focus group in which undergraduate students have participated. The second data source corresponds to curricular documents of the final year in undergraduate of Civil Engineering Computer Science (CECS). The third source is composed of written texts from students in the framework of their graduation final project.

Instrument of data collection	Participants	Quantity
Semi-structured in-depth interviews	Professors, directors of schools or departments of the following universities	4 interviews 4 professors
Focus group	Civil Engineering Computer Science students enrolled in their last academic semester.	2 focus group 13 Students

Table N°3: Characterization of the sample

3.1 Phases of research

The following research has developed the following phases:

1) *Approaching the field:* This phase consists of delimiting the units of analysis in light of the objectives of the research. As a gateway to the field, an initial meeting has been held to inform the professors and management of the School of Civil Engineering Computer Science (CECS) about the research and its purposes.

2) *Data Collection:* As a second step the guiding questions of the interview have been formulated. Semi-structured interviews have been conducted with the directors or heads of CECS programs from the four universities. All interviews have been recorded in digital audio files and subsequently transcribed separating speech shifts to facilitate their interpretation and analysis. The interviews covered the following dimensions: discipline´s context, program genres, curricular organization and teaching of academic writing in this sub discipline.

3) *Data Analysis*: This phase begins with an open coding. In this coding the context and registration units have been established by means of a detailed line by line analysis of the interviews that allows a close up to the studied phenomenon. Subsequently, by means of a constant comparison of data segments of direct quotations have been selected from the most relevant interventions of the professors to constitute the registration units and paraphrase them for a later use. Then, based on the paraphrasing, we grouped and defined the concepts to identify the preliminary categories (PCs) after an agreement among the researchers.

Later, in the axial coding, categories have been grouped to general categories (GCs) according to relationships of meaning. This categorization has resulted in a total number of thirty categories that their position in the hierarchy has been established according to their dimensions and properties with respect to the others. During axial coding, the relationship between the categories has been examined and a conceptual map has been drawn up, which makes it possible to clearly see the link between them in categories and subcategories.

To gain a deeper degree of insight into the phenomenon, the opportunities for comparative analysis are broadened. In this sense, curricular documents such as the CECS subject programs have been collected and eighteen progress report texts have been obtained from the student's thesis from one of the four universities involved in the study. In addition, a focus group was convened with the participation of thirteen volunteer students who are in their final graduation process. The focus group addresses the following aspects: writing skills, reading and academic orality. New categories have emerged out of the focus group and have led to reclassification, review and reorganization of the initial categories several times. Refining the categories has redefined the relationship between them. Finally, in selective coding, the analysis is concluded after reaching the saturation of the categories and all possible relationships between each category and the other.

4. Results and discussion

In this section, we present the analysis of the data and its discussion in the light of the revised conceptual and methodological background.

4.1 The role of academic writing in the last years of undergraduate engineering programs

During the final year of CECS, both students and professors are under the pressure of professional requirements that demand graduates better management of writing skills and the ability to present in public. These two skills are highlighted by professors. One of them states:

> They start in the first module in the first subject and they continue in the second one. They have one hour or one period a week where they are taught composition. In the past, the first module had an emphasis on writing skills and the second one in oral skills, but *the truth is that they had such a high deficit*, that nowadays practically both modules focus on writing skills, and just at the end they study some aspects related to oral presentations. Because in meetings with employers something that is constantly repeated is that one of the *shortcomings* they had was their inability to communicate (ICI_Ent01, 9).

However, these demands lead teachers to focus on the role of academic writing in achieving learning outcomes. In this sense, the relationship between reading and writing is highlighted, whereas if both are done in an appropriate way, they can facilitate the student's appropriation of information. Indeed, once this appropriation has been achieved, the engineer in training will be able to communicate clearly. In this regard, one of the academics mentions:

> That's what I tell my students: you do not have to be experts on that topic, you may mention in the written text or in the oral presentation you are going to do, that there was something you did not understand, and you searched on the internet and found several things, some people say this, others say that. Then, ***you have to read it, to summarize it in written form and present it, you do not need to fully comprehend the topic*** because what you present is just what you understood (ICI_Ent03,05)

At the same time, these expectations demand students who have the necessary argumentative and expressive skills that enable them to dialogue with peers, with specialized addressees in their area and with non-specialized audiences. In order to construct their discourse, writers rely on the use of multimodal resources such as tables, graphs, formulas, schemes, etc. One of the professors points out:

> This is the right aim. The CECS students take a lot of data and generate information. And ***generating information means creating a trend chart [...] and that's it.*** (ICI_Ent04, 07).

The difficulties faced by students during their formative path that prevent them from improving their academic writing level does not come in line with professors' expectations and the demands of the professional world. In the view of academics, students make different types of mistakes in their writing: they commit spelling mistakes, they do not use discursive connectors to link the ideas in the different paragraphs, they formulate introductions and objectives of the work incorrectly and are not able to present in public. This is how orality becomes a major challenge, as one of the faculty directors explains:

> A CECS graduate was selected to speak, and we heard that she told people in the Students Affairs Department that she was ***unable to speak in front of 1,500 people.*** Then, they chose another person (…) (ICI_Ent03,02).

Professors conceive students' difficulties in academic writing and orality as serious deficiencies or issues that must be solved as soon as possible. The emphasis on the deficit in this context is linked to the 'crisis narratives' identified by Russell (2002).
Regarding the teaching of academic writing, the emphasis is placed on the writing final product of writing or 'format' that is obtained as output as indicated one of the professors below:

> ***To be honest, some of the first-year academics suffer***. Anecdotes do happen and it's incredible. You know, when they explain the students about the sequence to be followed, academics indicate that the introduction should be written at the end, after everything else has been done, and some students hand in the report with the introduction written actually at the end of it. And a lot of similar situations happen all the time (ICI_Ent01,12).

While from the students' point of view, the problem is due to the refusal of the teachers' accompanying in academic writing, as well as the lack of unified criteria, according to one of the students clarifies:

> What happens is that it depends on the professor and the type of project; some professors for example prefer to mention what we have done in the conclusion or what we will do in the future, others just focus on the results, so at the end the conclusion section is ambiguous, ***it all depends on the professor's ideology***. (ICI_Foc01,03).

The students recognize the importance of the university professorship, as we can see in the above quote, (Lemke, 1997). Though, adhering to this by means of different discursive strategies or the imbalance caused by not understanding the implications of the subjects of the study plan of the program influence as determining factors in the conception and the importance students assign to it in their undergraduate studies.

4.2 Genres of academic training in Civil Engineering Computer Science

Through interviews, the focus group and the analysis of the curriculum documentation, twenty-one genres that students must produce as part of their undergraduate insertion in the disciplines have been relieved from the final year of CECS program context as shown in table N°4.

Genres relieved	Preliminary definition
Technical Report Family: 1.Lab Report 2. Practice report 3.Project Report	These types of genres have as their central purpose to give an account of the state of progress of experimental work. It requires students to provide information from one or more sources, analyze such information and provide recommendations about the process developed based on the analysis.
Final Grade Project Family (Parodi et al., 2010) 4. Degree project progress report 5. Degree Project. 6. Oral Defense of Degree Project.	Written Research Work with an evaluative and accrediting character presented by university students at the end of their studies as a requirement to obtain their bachelor degree, master's degree or PHD. Usually, the presentation and the defense of those genres is oral, in the presence of a committee of experts for its approval. It is distinguished for its intermediate nature between the academic and professional field.
Scientific Research Article Family 7. Paper 8. Translation of paper	In this type of writing assignment, the student must report on results of the research or original application by using the canonical structure: introduction, methods, results and discussion (IMRD) (Swales, 1990).

Plans or Proposals Family 9. Business Plan 10. Tender basis	This family integrates eminently professional genres. Its aim is to present the method or strategy to carry out a certain business within a certain period trying to convince readers about the feasibility of the business idea and benefits from their participation in it (Navarro, 2015).
Requirements Family 11. Requirement 12. Requirement Use Case 13. Usage Scenario	This type of genre has as a macro communicative purpose requesting a set of background information to enhance or support a process. It implies the description of the steps or activities to carry out a process.
Procedures Family 14. Implementation Manual. 15. Manual of Procedures.	In this family of genres, the macro-purpose is to instruct on how the tasks could be carried out by the professional (Stagnaro, Camblong & Nicolini, 2012).
Explanations Family 16. Multimodal model (predominantly). 17. Description.	These genres intend to develop an understanding of a subject of study or system design. It includes descriptive counts and explanations.
18. Problem solving	Evaluative academic gender with applied orientation (Jarpa, 2016) for the transfer of knowledge that requires processing of information, deductive reasoning and requires carrying out an in-depth analysis of the particular situation.
19. Executive Summary	The student texts that belong to this category encapsulate the essence of the text; either the major text or the one following the implied one. In other words, it indicates the content and structure to be followed in the text in a few paragraphs.
20. Exam	This properly instructional genre requires the analysis of data and a response to a series of mathematical questions and exercises with the aim to put into practice key skills how to develop complex calculations and explain them in technical terms.
21. Oral Presentation	Oral report generally accompanied by audiovisual support material that gives an account of the results of experimental work or research. Usually it is a generic chain (Swales, 2004) with a writing genre of greater complexity.

Table N°4: Genres declared by professors and students in the final year of CECS undergraduate programs.

The above results show us how some academic genres intersect with professional ones; therefore, inside the families of genres we can find imported ones (Bolivar & Parodi, 2015) as a connection between the professional world and the university curriculum. Hence, research, professional and curricular writing genres converge in this disciplinary space, which implies the appropriate handling of different registers in various semiotic modes.

4.3 Characterization of the genre 'Thesis project progress report'

This exploratory research is complemented by the collection, in an initial research phase, of undergraduate students' written texts. The 'Thesis project progress report' belongs to the family of the final grade work and is characterized by a connection between academia and the professional word. As well as the integration of knowledge of various kinds, including textual and rhetorical knowledge. A professor mentions this:

According to what I recently discussed with the current language coordinator of the university. I said, "*They write a lot*", but she said they did not, "they might program", instead. I said "no, *they write a lot, but those are technical texts like; requirement analysis, design, implementation, manuals, etc.*" "Then for example, the degree project work can easily have 120 pages of documentation; we reduce it to 60 or 70 pages, but it usually has annexes of *requirement analysis, design, implementation*, *implantation; all of them are written texts having norms and Computer Science Engineering standards, so as to say.*" (ICI_Ent02_9).

Based on the classification of Parodi et al. (2008, 2015), we define the Thesis Project Progress Report (TPPR) as a discursive genre that has as a macro-purpose to persuade about a theoretical-methodological approach in the area of Computer Civil Engineering. As a secondary purpose, this genre intends to reflect the status of processes or products that are disseminated inside a scientific-pedagogical environment. The relationship among participants is between a semi-expert writer and an expert or semi-ley reader. The predominant discourse organization mode is the explanatory-argumentative one, that uses a variety of multimodal resources.

The overall purpose of the subject that demands the production of this genre: 'Seminar degree' intending to prepare the students to design a Civil Engineering Computer Science project or a research project based on the analysis of a set of established requirements or of the state of the art of a genuine problem, in response to the defined graduate profile. This genre fulfills a specific communicative macro-purpose (Swales, 2004) that consists of reporting and persuading about the state of progress to obtain the engineering degree in CECS. This state is communicated in a context (Swales, 1990, 2004), in this case scientific-pedagogical context in the final stage of undergraduate instruction. Whereby the meaning is constructed by different semiotic modes and with the support of various multimodal artifacts such as tables, formulas, graphs and diagrams (Kress & van Leewen, 2002; Parodi, 2010).

An asymmetric relationship between participants may be observed at communicative situation level, in which a semi-ley participant is evaluated by an expert and subsequently exposed to other semi-ley readers' opinions, who are their peers in the professional program. The discursive organization of the genre

follows an explanatory, descriptive and argumentative textual organization (Adam, 1990) to provide information about the state of progress of the research project. Finally, it establishes the development of research, analytical, critical thinking and professional decision-making skills as learning objectives (Anderson & Krathwohl, 2001). Therefore, it is a highly relevant evaluation academic genre for undergraduate education.

In this way the components of the process of academic literacy in the Civil Engineering Computer Science undergraduate program are displayed in an explanatory model in Figure 1. This explanatory model was configured, as explained in the methodological design, starting from the analysis of interviews, focus group, and curricular documentation. Besides, the analysis was enriched with a first approach to student-produced texts, specifically a genre associated with the final grade work macro-genre.
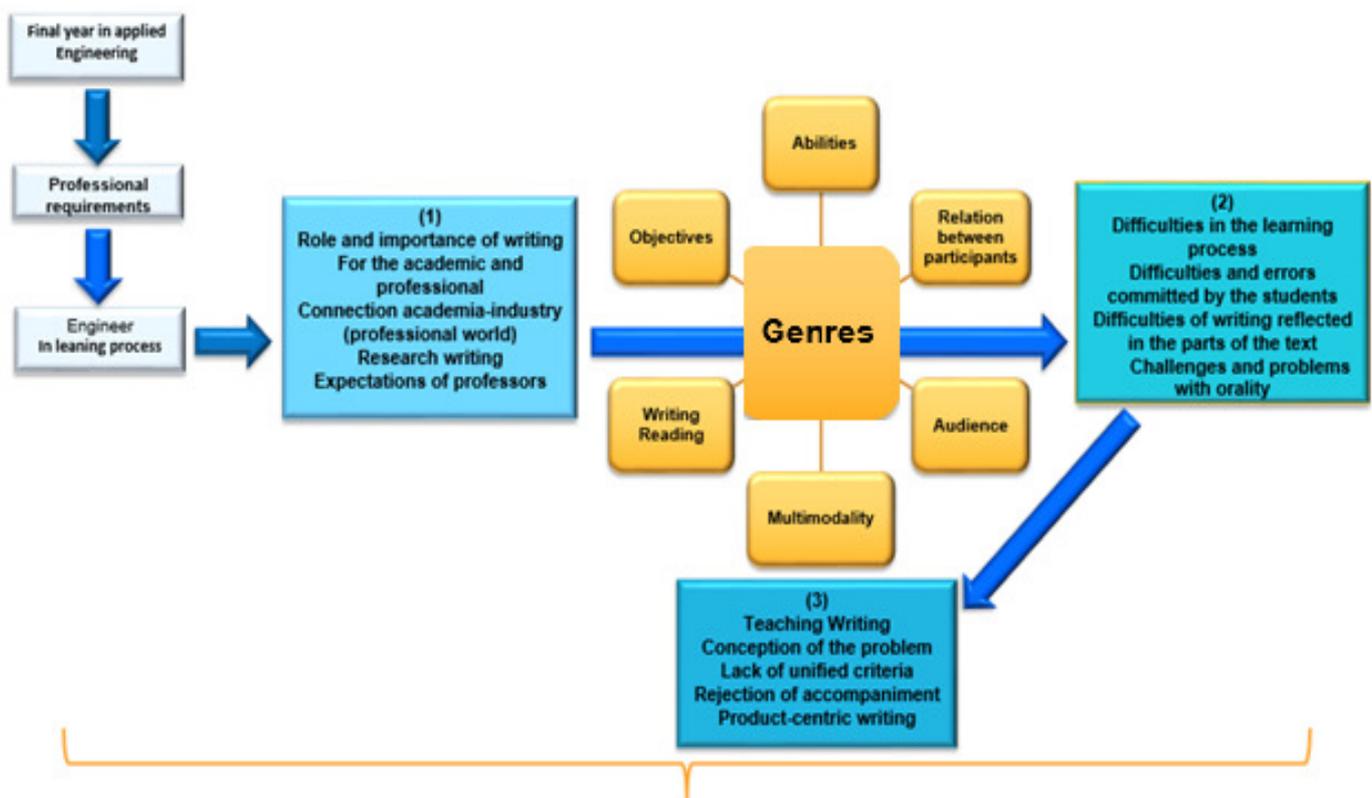

Figure 1. Explanatory Model of the process of academic writing literacy in Computer Civil Engineering.

In summary, this model explains the process of academic writing that engineer students undergoing the final year of CECS undergraduate program must go through. In this process, there are three relevant milestones. First: the recognition of the importance of writing centered in its practical or professional role, in contrast to writing focused on the epistemic role, according to Marinkovich et al (2016). In this case, the functional, evaluative and accrediting role of writing is emphasized in this academic program context.

Second: The difficulties and challenges of academic writing and orality manifested in the declarations of professors and students show communication needs at different levels, as well as the comprehension and production of discourse genres of diverse nature, complexity and discipline origin. Lastly, the conceptions of academic writing teaching of reveal a prescriptive and traditional orientation of the literacy process of the discipline, which may partly explain the current difficulties in the literacy process of this learning community.

This view of writing makes that the different genres and their textual instances are thought of as static, impossible to manipulate textual products, thus relying on a simply contemplative approach towards them, which explains why professors generally believe that the responsibility of teaching linguistic abilities lies solely on Language Sciences specialists, thus neglecting the situated discipline components of literate practice. These tensions and contradictions are a concrete sample of the different perspectives of writing in the discipline, especially when viewing engineering as a writing-free discipline, which leads to the question, is engineering a writing-free discipline?

In fact, this prescriptive orientation comes into tension with the relevance assigned to literate practices from both industry and academia, which outlines some didactics centered on the textual surface: it focuses in format as a recipe rather than conceiving the teaching and evaluation of writing with those aspects that are mainly related to the superficial construction of disciplinary and professional knowledge.

This vision of writing makes the genre and its textual instances to be conceived as a static product, impossible to manipulate. However, configuring a contemplative perspective of the textual product explains why professors believe that the responsibility for the teaching linguistic skills only concerns specialists in language sciences, relegating the disciplinary and situated component of the literate practices. These tensions and contradictions are a palpable sign of the different conceptions about writing in the disciplines and especially when viewing engineering discipline writing, which raise a question about to what extent it's writing-free discipline?

5. Final Thoughts

The aim of this work was to answer the following research questions: What role does writing play in the field of CECS? What genres are produced in this undergraduate program? The results obtained, and the explanatory model proposed clarify that the relevance of writing is evident and transcends the academic context. Its functional, practical, communicative and professional roles are highlighted given the new demands from the different production scenarios that require a civil engineer prepared to explain, justify and communicate his work to diverse audiences. This relevance in the field of education is not matched by a formative role, but rather by the fact that guidance is prescriptive, highly normative and traditional. This tension and divergence can be seen in the following diagram:
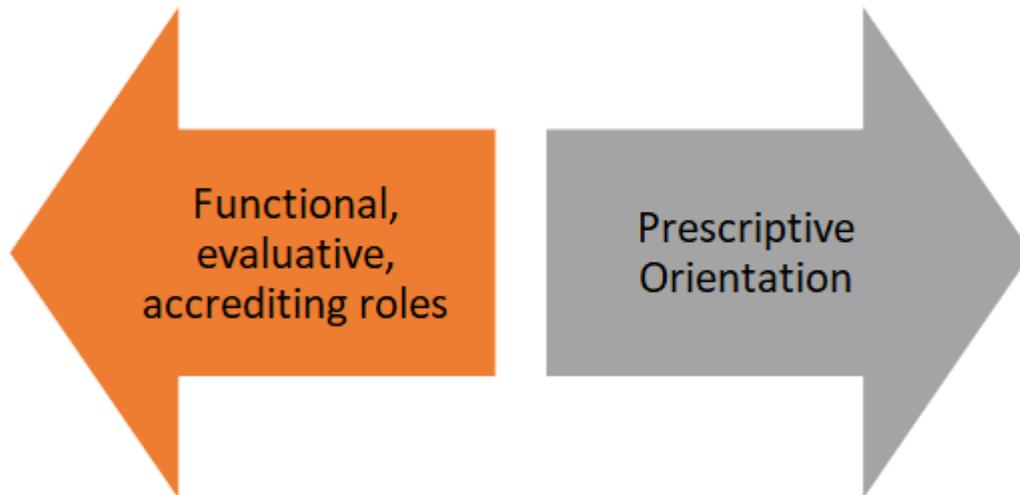
Figure N°2: Orientation and character of academic writing in the learning community investigated.

Indeed, the existence of professional requirements arouses professors' attention to the issue of academic writing at CECS, but does not solve it. In this way, from the data it is possible to observe the impact of teaching on writing problems as an imminent cause. CECS final grade year instruction is not responsible for providing students with the knowledge needed to enhance their level of writing and attain the quality desired by their professors. Normally, other experts from the Departments of Linguistics are hired to guide students in this academic writing literacy process at CECS. Nevertheless, this is not enough, because there is a need for teaching that encompasses writing as part of the discipline.

Another aspect to highlight along with the above is the relevance of the professors' accompaniment for the students. Moreover, students need unified assessment criteria in this academic and professional literacy process. In relation to the second question, the explanatory model makes a high emphasis on the relevance of undergraduate genres in CECS degree.

In this first approach, twenty-one preliminarily families of genres have been distinguished and grouped into six families, each of which shares a communicative macro-purpose and a curricular objective. In the next phase of this research, it is contemplated to deepen the analysis of these genres produced by students, through the collection of a corpus of learners specialized in this sub-discipline. Furthermore, although the results obtained in this research are not generalizable, they allow to increase the research variables and the factors involved in this process. Finally, the valuable information provided by the declarative quotes of students and professors, has opened the door to explore more closely the types of genres circulating in CECS academic training that enables professional development.

Acknowledgment

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