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Function of Language in Learning and Knowledge Construction[I]

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Abstract:
The aim of this paper is to show empirically, albeit in an indirect manner, some aspects related to language development and knowledge construction, in the frame of the relations between thought and language proposed by contemporary philosophy and by systemic functional linguistics (SFL). To do this, we compare two versions of the same two texts, produced by university students as part of an explicit genre-based learning process, and argue for an evolution of their cognition. Different stances of contemporary philosophy, socio-historic psychology and cognitive studies are revised as part of the conceptual framework, along with the language-based pedagogy proposed within systemic-functional linguistics. Based on this theoretical revision, two teaching-learning experiences informed by this genre-based pedagogy and SFL discourse analysis methodology are presented. These experiences offer some achievements in the direction of the goal of the paper. We propose that students evolve in the construction of knowledge and, hence, in the development of thought, through the development of their writing competences, achieved by the application of genre-based teaching for written discourse. Therefore, based on the experience and the theoretical base proposed, evidence is provided for the hypothesis of cognition of the world as a human faculty constituted by the development of language.

Keywords:
Language; Learning; Knowledge Construction; Tertiary Education

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Introduction

There is certain consensus around the world regarding the need of teaching academic and professional literacy at university level. Most of these proposals are based on the concept of genre, as Bawarshi and Reiff (2010) have shown. These authors have provided an account of the different traditions that have, for more than four decades, offered different definitions of genre and developed different teaching models centered around it. In Latin America, an important body of research has also reflected about the need of teaching literacy at university's classes, based on different theories, modalities and practices (NAVARRO, 2017; 2019; TAPIA LADINO et al., 2016; see also the repository of the Asociación Latinoamericana de Estudios de la Escritura en Educación Superior y Contextos Profesionales (ALES, for its acronym in Spanish) for updated and ongoing research on this issue).

Most of the papers produced in this area of knowledge make reference to two key aspects: the teaching of disciplinary discourse and the relationship between language and thinking. Diverse authors have approached the latter, pointing to the fact that the learning of reading and writing contributes to the development of disciplinary knowledge. Some researchers have treat this issue as a theoretical reflection (CARLINO, 2005, 2013, PARODI, 2005, 2008; BAZERMAN, 2009; MOYANO, 2010, 2019; MOYANO; NATALE, 2012). Others have further explored the issue through the development of empirical studies based on diverse methods (MARINKOVICH; CÓRDOVA, 2014; BAZERMAN, 2019; NARVÁEZ CARDONA, 2016; MOLINA; CARLINO, 2019, WAIGANDT et al, 2019; among many others).

For instance, Marinkovich and Córdova (2014) explore the relationship between object of study, method and discourse in four different disciplinary contexts, in order to observe how these disciplines build knowledge. They study teachers and students' understandings of 'writing' in order to reveal how they construe social representations on the link between these aspects. They conclude that the access to the object of study and knowledge construction are mediated by the method of each discipline. From a different approach, Bazerman (2009) studies the manipulation that transforms data into evidence and the way in which this process is manifested in a particular discipline. He shows, through the results of interviews to post-graduate students, how the treatment of data influences text productions. It could be proposed that in this chapter, the author argues that cognition precedes discourse production, which would be a different conception to what he affirmed theoretically in 2009. Bazerman also remarks that each writer shows particular characteristics. Molina and Carlino (2019) show through the observation and analysis of classroom interaction in two different disciplines how teachers support students in their production of knowledge by incorporating writing in the teaching and learning process. They conclude that while writing allows different construction and negotiation of knowledge in each discipline, in both cases this activity promotes learning processes. Finally, Waigandt et al (2019) explore the evolution of text structure in different versions of the same text written by students in the area of Applied Mathematics in Engineering. They remark the value of writing as an instrument for re-elaborating the thought process,

allowing the analysis and transformation of what is known. They show quantitative data, produced in the analysis of texts. This brief exemplification of literature demonstrates that linguistic analysis of students' texts is not a method used frequently to establish the relationship between language, thought and knowledge construction.

The purpose of this paper is to empirically explore these relations, which have been one object of study in Philosophy since Ancient Greece to present days, in a ongoing conceptual evolution. We seek to relate this theoretical conceptualization to linguistic evidence that shows, through examples of different versions of the same texts, the role of language as a resource for construing meaning, for manifesting thought and knowledge and for construing them. To achieve this aim, we use systemic functional linguistics (SFL), a theory understood as social semiotics (HALLIDAY, 1982). In this work, we analyse successive textual versions produced by students to indirectly track a possible evolution in the production of knowledge. These texts have been produced within an initiative of genre-based program for teaching reading and writing in an Argentinian university.

The position we sustain is that the learning of language resources, and particularly of those specialized resources that relate to disciplines, enables a better learning process of the contents of those disciplines, as well as of the dialogue that diverse stances may enter to in the disciplinary discourse. Moreover, we propose that through the use of language and its progressive refinement in successive editions of texts it is possible to advance in thinking, or to put it in other words, in the development of knowledge construction in a discipline. While from a psycholinguistics perspective some limitations are posed to the use of linguistic analysis as empirical evidence for these relations (ZUNINO, 2010), the theoretical foundations sustaining this research enable the hypothesis that students' evolution in the construction of knowledge can be observed, among other variables, through the evolution in the elaboration of a text.

In the first section we briefly explore the evolution of different philosophical, psychological and linguistic trends that have explored the relationship between thought, language and knowledge construction, taking SFL as linguistic foundation. From this theoretical base, we propose an empirical study to determine if genre-based literacy teaching is able to achieve advancement in knowledge production. To this purpose, we collect indirect evidence through linguistic analysis of successive versions of a text. In the second section, we present the research methodology as well as the literacy teaching model and the discourse analysis methodologies. The third section present the results, which show the evolution of the texts to propose the relationship between language and knowledge construction in the context of genre-based literacy teaching.

Theoretical Framework

Relations between thought, knowledge, and language: a glance from philosophy

Questions about the relationship between language, thought and knowledge construction have been the center of the inquiries and theories of knowledge throughout history. These inquiries provoke different interpretations: at least, a broad one and a restricted one. The broad interpretation has to do with the concept of thought in general. It refers to the human disposition to thinking, knowing, construing and telling world and reality. The restricted interpretation investigates learning spaces of specialized knowledge, such as those of the different scientific disciplines.

From a broad interpretation of these issues, diverse philosophical traditions have linked the question of knowledge with the topic of language. When this question focuses on specific disciplinary knowledge, it considers specialized languages, and the process of learning this disciplinary knowledge is related to the progressive control over language resources of this kind. In this sense, we are interested in exploring the relationship of learning processes and knowledge development through the construction and appropriation of linguistic resources.

At the beginning of 19th century, Humboldt acknowledges the function of language as a constitutive factor of thinking. Language is conceived as a condition for thinking rather than a system of information or communication, that is, it enables cognition. Both individual and society obtain their human condition and may raise to significant levels of understanding of science or social agreements through language (ALONSO CANSINO, 2005).

According to Forsters (2011), Humboldt understand that before language, the human mind only shelter feelings, perceptions and wishes in an indeterminate and not articulated manner. Language allows the individual conceptually organizing her thinking. Humboldt asserts that the appropriation of language by the individual triggers a qualitative anthropological and social leap. Language permits going from non-articulated and diffuse thinking to conceptual and categorially organized knowledge of the world. In sum, language works upon and articulates all perception of the world and gives it form of thought and concept. Language is foremost a cognitive tool. Then, as a secondary function, it is a communicative system.

In 1921, Wittgenstein expounds in the *Tractatus Logico Philosophicus* the meaning and logical form of any figure that represents the world. In his particular style, he says: "Language is tied to reality. In language and reality, in figure and in what is figured, in speech and in what is spoken, there is something identical so than a figure can totally figure the other" (WITTGENSTEIN, 1921; 2.15). For this philosopher, these elements form an association that is difficult to separate, as some propositions of the *Tractatus* show:

4.01. The proposition [of speech] is a model of reality as we think of it […] 4.021. The proposition says the reality, since the state of things is known [by] the meaning of the proposition […]. 5.6. The limits of my language mean the limits of my world […]. 5.61. The limits of the world are the limits of language […].

The *Tractatus* shows the linguistic root of knowledge. Out of language it is not possible to think the world. According to Padilla Galvez (2007), the knot of this work is the structural link between language and world. Beyond language, there is not thinkable world. Hence, it is possible to describe the form of the world, represent its state of things, through language. Thought is a function that enables the shaping of reality. Reality is precisely what can be said with language. But this reality is not extralinguistic, separated or before language. This is why Wittgenstein states that the limits of language are the limits of the world. If something is thinkable, then it would be possible.

The contribution of the *Tractatus* mobilized a "linguistic turn" in the early 20th century Philosophy, not only in the logico-analytical trend but also in other opposed positions, such as phenomenology and hermeneutics. In general, Philosophy cannot make definitions about knowledge of reality without language mediation.

As Lawn (2007) proposes, there are two key works, amongst others, in the philosophical contemporary explanation of the nature of language and its configuration as thought: Wittgenstein's *Tractatus* of Gadamer's *Truth and Method*. According to Lawn, the thesis put forward by both works aimed at elucidating the nature of language, considering it a condition for knowledge. Without planning to, both philosophers put forward an unintentional agreement in the two greatest trends of contemporary Philosophy.

In *Truth and Method*, Gadamer (1977) also characterizes language as the essence of the human being. According to the philosopher, the understanding of the world is construed linguistically. But there is a differentiating hint when comparing his work with Humboldt's and Wittgenstein's in relation to knowing. To Gadamer, knowing is a consequence of the act of understanding. Knowing is not understood, as proposed by Humboldt and Wittgenstein, as the knowledge of a language proposition that adapts to the world, but as the knowledge that emerges from an interpretative comprehension of the world, which is elaborated by language. Knowing is therefore understanding. Understanding is thus a seeking of meaning, an experience of construction of meaning that implies temporality and historicity. Both in the subject's experience of the thing and in the experience between subjects speakers interlocutors, meaning is always a linguistic component that manifests the agreement between speakers and frames the consensus about the thing. This happens within a historical frame and mediated by an interpretative act. Language is the medium in which understanding occurs, and its form is the interpretation.

According to Herrera de la Fuente (2005), Gadamer suggests that there is a particular relationship between the world, the act of thinking and language. Language is thinking as thinking is language. Both form an unbreakable bond that sustains the way in which the world represents itself. Knowledge is transferred from the world to the subject. What is known of the world is known through language. What or who is the subject is known through the language. Gadamer says: "The way something presents or represents itself is part of its own being. Hence, all that can be and can be represented is and is represented by language" (1977, p. 568).

In sum, language guarantees the understandability of the world since the human relation with the world is linguistic and hence understandable. As comprehension of the world requires interpretation, knowledge of the world is a form of encounter with what language provides. Language is a particular and unique process due to the fact it is in the linguistic understanding that the world manifest itself (Gadamer, 1977).

This journey through philosophical trends about language is a response to the first question of this paper: what are the conditions of possibility for knowledge, i.e. its relationship with language. But at this point we can go deeper into our inquiries. We not only aim to examine the relationship between language and knowledge, but also the process whereby a subject controls language to develop knowledge, and the way certain teaching and learning processes allow building knowledge through language. This will be done through a revision of different theoretical propositions that would later enable focusing on empirical field to show how knowledge can be built by language in a process of learning.

Language and knowledge construction in the individual's development

It is relevant to consider the contemporary trends that focus on the process of learning in the evolutionary process of an individual (ontogenesis) and in how learning is related to the process of language control (logogenesis). We will approach different disciplines and traditions that despite their differences converge in some aspects that are relevant to this study.

In 1934, Vygotsky, in his work *Thinking and Language*, expounds his vision about the relationship between cognition and language. He considers that the process of thinking, a psychological superior activity, consists in the interiorization of socio-cultural meanings mediated by signs. Lucci (2006) proposes that Vygotsky reasons according with these premises: 1. the activity of the mind is mediated by signs; 2. the formation of psychological superior functions is mediated by language; 3. language comprises varied kind of expressions: oral, gestural, written, artistic, musical and mathematics. These premises are relevant to understanding the empirical field of research that will be developed in this paper.

Vygotsky considers that language appropriation is the most significant moment of the cognitive development. Language is a symbolic system, elaborated in the course of the human social history. It is a mediation system by which the individual can make the world his own, incorporating concepts and meanings. Language objectifies meanings constructed in the socio-historic process. When the individual internalizes them, he gains access to those meanings, which allow him to mean his experiences in his own way of feeling, thinking, and doing but in the social context (LUCCI, 2006).

Within this framework, one point deserves special attention. In the third premise considered by Lucci (2006), Vygotsky proposes that language assumes varied expressions. Among them, the written language is considered relevant as a particular instrument of learning and knowledge regulation. According to Rabazo *et al.* (2008), Vygotsky remarks the role of the instruments of cognitive mediation. Written language is a privileged mediator in consciousness, intellectual learning and the building of thinking. According to Vigotsky, written language, as opposed to speech, creates a temporal and spatial distance between interlocutors, and therefore there is not common physical and cognitive context between them. Thus, written texts do not construe their meaning immediately, but through successive revisions and drafts that allow revision. This process enable adjusting the writer's own ideas and hence the construction of new learnings.

From a cognitive perspective, Bereiter and Scardamaglia have carried out numerous studies regarding the nature of knowledge production in different evolutive stages. For instance, in one of this works (SCARDAMAGLIA; BEREITER, 1992) the authors go back to their proposal of two text production models: "telling knowledge" and "transforming knowledge". The first model is found in immature writers, while the second is identifiable in mature writers. Both processes have been identified using think out-loud protocols.

The process "telling knowledge"creates a text from the writer's representation of what he was asked to write, taking into account the content and the genre. From that starting point, processes of memory recovering take place automatically, without conscious control or coherent planification by the part of the writer. In the process "transforming knowledge", there are two spaces-problems: content and rhetoric. Both interact dialectically, so that modifications in one of them may redound in the other when developing the text. Thus, changes in the content may produce changes in the organization of the text and vice versa, in a recursive way. "Rhetorical needs are transformed in sub-objectives related to content" (p.48), and this is how new ideas emerge, according to the protocols. The authors point out that expert writers give account of writing as a "discovering" process, that "influence the thinking of the writer", and explain it as the effect of the rhetorical space over the content space (p.50). In this sense, the resolution of rhetorical problems in interaction with content influences the construction of new knowledge.

Regarding pedagogical recommendations, Scardamaglia and Bereiter (1992: 63) propose the need of offering students "explicit models of mature competence" and means to broadening the spontaneous competence.

We have said that there is a restrictive sense in the interpretation of the questions about knowledge and language. In order to approach it, we introduce at this point linguistics, in particular systemic functional linguistics (SFL). Within this frame, Halliday (1993) outlines a learning through language theory. He considers that language is the most sophisticated semiotic system produced by humans, a resource to construe an image of the world (i.e., the medium to construing knowledge by processing the experience), to enact human interaction and to produce texts. Through a long research tradition, SFL has shown that language not only enables fulfilling communication needs but, in its evolution, also specialized knowledge construction as occurs in scientific knowledge (HALLIDAY; MARTIN 1993; MARTIN; VEEL, 1998; CHRISTIE; MARTIN, 2007; CHRISTIE; MATON, 2011; MARTIN, 2017; MARTIN; MATON;

DORAN, 2020; MATON; MARTIN; DORAN, 2021). Such an evolution involves the development of particular grammar and discourse resources for construing specialized discourse. These resources function as well to evaluate the world construed in discourse and to construe a dialogue between different social positions about it (MARTIN; WHITE, 2005; HOOD; MARTIN, 2005; MOYANO, 2019). Hence, the development of competences of meaning production through language involves the augmentation of the capacities of producing knowledge. Language development is, at the same time, the development of learning (HALLIDAY, 1993). Taking into account that language is the prototypic form of human semiosis, then the genesis of language is at the same time the genesis of learning. It cannot be argued that language is only a knowledge domain, but it is the essential condition for the process through which experience is transformed and become knowledge. Learning is a process of meaning production. Learning to mean is learning to expand the meaning potential, i.e. learning to expand the general system of language potential and its uses, that allows the knowledge construction.

Halliday (2004) also distinguishes in the learning processes throughout life, three modalities related to language: the first, "learning language", using its resources for interaction in different contexts; second, "learning about language" being conscious of the available resources in a given context to meaning production; third, "learning through language", the development of competencies to the comprehension and production of knowledge through language.

In sum, the contribution of different disciplines and trends, such as philosophy, socio-historical psychology, educational psychology and systemic functional linguistics, allows understanding the importance of working with discourse in the context of learning in classrooms, especially using the strategy of learning through language. Indeed, the exploration of discourse allows the recognition of linguistic resources used to construe meaning and the structure of discourse, the way how meanings are deployed to achieve the social purposes pursued. Identifying those resources, systematizing them, learning them to recognize them when reading and to use them in writing or orality is what we understand as language development. Applying this practice in classrooms allows not only the development of reading and writing competences in genres of different disciplines but also the construal of disciplinary knowledge. Thus, favoring the appropriation of genres as forms of specialized spheres of knowledge enables the access to disciplinary knowledge construction. We understand genre as a recurrent configuration of meanings in a cultural given practice (MARTIN ; ROSE, 2008). Genre is, then, a staged social activity with a specific purpose, realised through language, in this case written language and specialized, as it will show in the empirical study that we present ahead.

Finally it should be pointed out that over more than 30 years, the so-called Sydney School, which developed from the theoretical frame of SFL, has designed genre-based reading and writing teaching methodologies in order to promote not only the learning of reading and writing but also the understanding and production of knowledge (ROSE; MARTIN, 2012; DEREWIANKA; JONES, 2012; DE SILVA JOYCE; FEEZ, 2012).

Taking into account the theoretical account presented to this point, the purpose of this investigation is to explore the possible correspondences between the development of language and the development of knowledge through teaching-learning processes of textual production. In concrete, in this work we propose an initiative of genre-based literacy teaching-learning in an Argentinian university and we analyse the evolution across successive versions of texts in order to track indirectly a possible evolution in knowledge production. Our purpose is to determine in classroom experiences how managing a genre leads to learning disciplinary concepts involved in a text and, vice versa, to what extent the progressive construction of knowledge requires the realization of a discourse structure, according to the literature revised. Both are dimensions of an evolutive phenomenon of learning known as logogenesis. We understand by logogenesis

the quality of a text in relation to the way it meets genre expectations, and by ontogenesis the construction of knowledge as a consequence of changes in the discourse (MARTIN, 1997).

Methodology

Context

In this paper we show the linguistic analysis of students' texts that tracks the evolution of different versions aiming to effectively achieve its purpose. In order to do so, we attempt to collect evidence supporting the thesis that the evolution in textual production is related with the evolution in knowledge construction. To do this we present two cases of conceptual learning processes and thinking development through language (HALLIDAY, 2004), in two first year subjects at the mentioned university. The first is Science, Technology and Society (Case 1), which is a compulsory unit for freshmen students in all degrees at the university. The second is Epistemology and History of Mathematics (Case 2), a unit oriented to students aiming at completing a Bachelor degree in secondary education in Mathematics.

The literacy model implemented in both cases is descripted by Moyano (2017), and it involves teaching literacy within the subjects across the curriculum. The literacy model is not a complementary teaching activity nor an optional unit in the curriculum oriented to writing development, but a pedagogic work that occurs inside one specific subject of each degree in each semester[2]. The process is carried out by both the disciplinary lecturer and a specialist in literacy in a joint work. The disciplinary lecturer guides the teaching of the theoretical and practical contents of the subject related to a genre and the literacy specialist guides the production of a text that instantiates the genre in question.

Type of research

This is an action-research (STENHOUSE, 1984; ELLIOT, 1993; LEWIN 1993; PÉREZ SERRANO, 1994), which implies that the lecturers designing and implementing the teaching-learning process are the same who evaluate the texts. To do this, the investigator creates a methodological distance to observe her own practice in a process with two different moments: 1) analysis of the experience in light of the theory; 2) reconstruction of it for explanation. Hence, a phenomenon is identified as a problem in order to transform it through action. In this case, the phenomenon is the knowledge construction through teaching and learning of resources that includes the schematic structure of a genre and the linguistic choices for construing the world and negotiating evaluations in a text using a pedagogic proposal design in action-research (MOYANO, 2007).

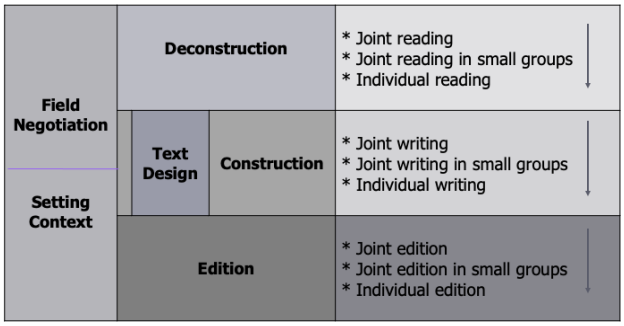
Throughout the whole research process, the identities of the participants have been protected.

Pedagogical option

Regarding the pedagogical proposal for teaching genre-based literacy, we adopt that designed by Moyano (2007; 2017) in the frame of the developments of the Sydney School (Figure 1).

[2] In Argentinian universities, a period for each subject is about four months long.

Figure 1. Pedagogical model for teaching genre-based literacy (MOYANO, 2007).



This model considers fundamentally three stages: *Deconstruction* of a genre through the analysis of one or more texts that instantiate it; *Construction* of a new exemplar in a field related to the subject and *Edition* of the text produced by each student or group of students. The stage Construction comes after the Design of the text, and the whole text proposal is permeated by the reflection on the context, particularly the field (MARTIN, 1992), i.e. the disciplinary contents at risk. The lecturer guides the students in these activities in order for them to successfully move from heteronomy to autonomy. In the stage Edition he also includes the elaboration of specific guides for the revision of the text in each genre.

The experience referred here was carried out during the first semester of 2020, which was affected by the Compulsory Preventive Social Isolation (ASPO, for its acronym in Spanish) disposed in Argentina because of the COVID-19 pandemic. The genre-based literacy teaching model was to the context of interaction mediated by digital technologies. This meant that the model could not be applied interactively, but the process was scaffolded through videos presented to the students in the institutional platform where the virtual classroom of each subject was located. Even in these conditions, all the stages of the proposal were conducted and the expected results were obtained.

In the Deconstruction stage, we analyze the schematic structure of the genre and the key linguistic resources that unfold in a text that instantiates it. Then a videorecording guided the activities of the Design stage and the Construction of a first version of the text. Finally, we offered to the students a guide for Edition, along with a videorecording where the lecturer worked with some of the students' texts to model how to carry out the edition process. After this modelling, the students were expected to edit their own text.

In the Results section, we show the evolution of the students in writing two different genres as well as their progress in the knowledge of the contents involved. In Case 1, they had to write a Project; in Case 2, an Exposition.

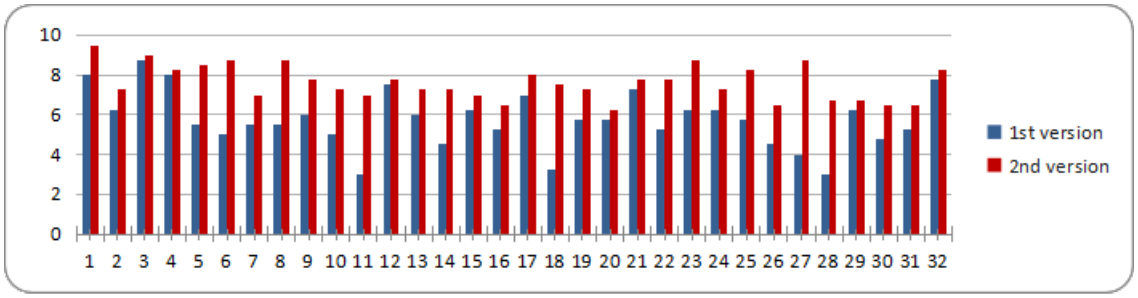
Methodology for textual analysis

The analysis of the text used in the Deconstruction stage follows the methodology proposed by Martin (2009), along with key principles proposed by Martin and Rose (2007). As a first step, we hypothesize the genre instantiated by the text and the stages in which it is deployed. This can be done considering the options identified in different fields (MARTIN; ROSE, 2008) or recognizing regularities when dealing with genres not yet described (MOYANO, 2014). As a second step, we analised the relevant linguistic resources, those that appear as more important than others and those that articulate with them to work together in the production of meaning.

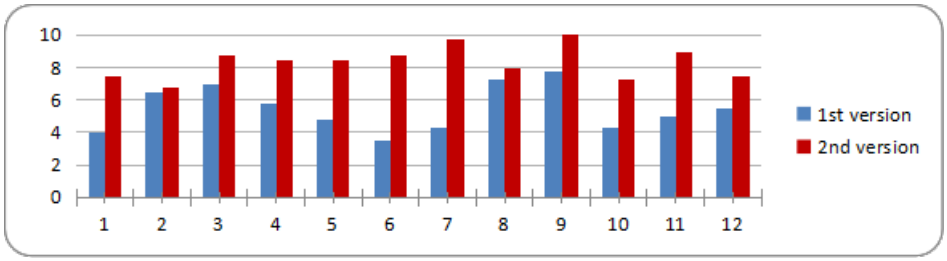
Collecting student's texts

In the educational process, the students submitted their texts through a digital platform set up by the university for the implementation of online classes, submission of assignments and their assessment. For Case 1, 32 exemplars of each version (those produced in the Construction and Edition stages) written individually were collected; in Case 2, we received 12 works from small groups. All the students or groups of students showed evolution (Graphics 1 and 2), according to the evaluation carried out by applying rubrics made *ad hoc*. In each Case, we analysed two versions of one work, considering especially those that show better results (Student 27 in Case 1; Group 7 in Case 2).

Graphic 1: Evolution of Case 1 student's texts.



Graphic 2: Evolution of Case 2 student's texts.



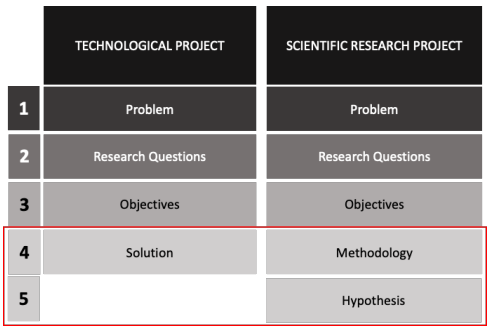
Results

Characteristics of the texts presented in Deconstruction stage

In order to obtain a characterization of the genre Project (Case 1), we analysed, together with the disciplinary lecturer, a group of texts produced by a previous cohort, to establish its schematic structure. Two kinds of Projects were identified: a Technological Project and a Scientifical Research Project. Both had a simplified structure when compared to academic and professional instances of the genre. These simplified projects constitute the first written work in the first year at the university, initiating a process that will continue to unfold along the degree. Figure 2 shows the schematic structure of the Projects. Both share the first three stages: Problem ^ Research Questions ^ Objectives[3]. Then, they diversify their structure: the Technological Project presents a Solution, the Scientific Research Project presents Methodology ^ Hypothesis. After establishing the schematic structure, the language-specialised lecturer performed the discourse analysis that allowed identifying the most relevant language resources, especially those of the ideational and interpersonal metafunctions.

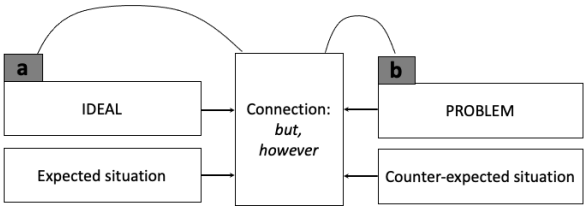
[3] The symbol "^" means "followed by".

Figure 2: Technological Project and Scientifical Research Project schematic structure



In this paper, we consider specially the Problem (Figure 3) and Solution stages. The Problem has in general two phases, connected by a conjunction of contrast ("but", "however", "on the other hand"), option of the system conjunction (MARTIN; ROSE, 2007). This logic relation suggests that while a desirable or ideal situation is proposed, this is followed by a problematic situation that occurs as contrast, which is thus positioned as the Problem that will be dealt with in the Project. Regarding other relevant linguistic resources, some resources from the discourse semantic system of appraisal (MARTIN; WHITE, 2005) were identified. These corresponds to positive tokens to construe the ideal situation and, by contrast, negative tokens to build the problem. These resources may be explicit, realised by adjectives or adverbs, or evoked, through ideational resources with positive or negative connotation (HOOD; MARTIN, 2005).

Figure 3: Problem

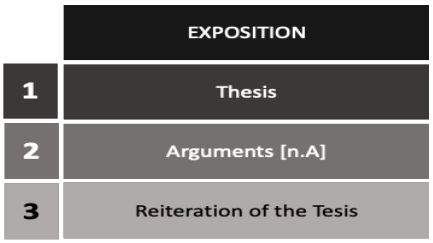


The Solution stage in Technological Projects comprises at least four phases: Solution, Solution Description, Implementation and Advantages. This organization in phases is variable in each text (MARTIN; ROSE, 2007), although maintaining certain regularity.

The Deconstruction stage of the pedagogic model focused the teaching not only the schematic structure itself but also on the logical relations between its parts, including Research Questions and Objectives. The relevant linguistic resources identified in these stages were also taught.

In Case 2, a fragment of a text from the bibliography used in the subject was selected to take it as a model for Deconstruction. The genre instantiated was Exposition (MARTIN; ROSE, 2008). The teaching was focused on the schematic structure (Figure 4) and on some of the key linguistic resources identified, particularly those from the ideational metafunction that enable maintaining the topic of the discourse, used to construe the Thesis and the Reiteration of the Thesis, and also those that construe the relationship between arguments. Among the interpersonal resources, the focus was on those of engagement, that allow introducing the voice of other authors to support the sustained position.

Figure 4: Exposition schematic structure



Regarding resources of ideation, the repetition relation between lexical items maintains the topic of the text. Another resource that contributes to it is nuclear relations, i.e. the way in which the selected elements are related in different figures construed in this case with verbs like "generate" or "produce", that express causal relations. In the construction of the Thesis and the Reiteration, figures realised by declarative affirmative clauses appear, considering the interpersonal metafunction. The Reiteration picks-up new elements generated in the Arguments.

In the teaching of this genre, it is very important to show how the Arguments can be construed and the way they relate to the Thesis and between them. To do this, some segments were chosen to show how they respond to the question "why is possible to say what is sustained in the Thesis"? In technical terms, this question points to the internal cause relation between the Thesis and the Arguments, i.e. relations between elements of the texts. The logical relations between Arguments are relations of addition, realised by internal conjunctions, as "on one hand"… "on the other"… or "first"… "second"… "finally".

Resources to introduce direct or indirect quotes to sustain the arguments were requested by the disciplinary lecturer in the instructions of the assignment. Therefore, those resources were taught in a traditional way and the relationship asked was remarked (attribution: acknowledge[4]), although this is not the only option, as show Martin and White (2005).

Students' works evolution

In this section we present the progress in the logogenetic evolution of a student's text from Case 1 and of another written by a group of students from Case 2.

For Case 1, we show the first version of the Problem stage from one student's project (1). The text does not present a sub-heading for this stage; it does not achieve the proposed structure nor it construes opposition between appraisal resources underlined by the use of a counter-expectation connection. However, we can infer the problem that the student wants to present, because he formulates an ideal situation (underlined), in which he introduces a token of appreciation:valuation (bold) and a resource of graduation (italics). In the rest of the fragment, the student approaches the topic of plastic "in modern life", the existence of rubbish dumps that contain great quantity of elements made by this material and proposes as problem the "disproportionate" contamination (double underlined). However, the problem is not clearly outlined.

(1) Proyecto de Acción Tecnológica - Social
"Construir una ciudad mejor"

[4] This way for referencing linguistic resources respond to the convention used in the theoretical frame selected (Cf. MARTIN; WHITE, 2005). The use of colon means that the second denomination constitute one kind of the first category.

En la vida moderna el plástico ha sido un fenómeno de trascendencia. Todo habitante merece vivir en condiciones **dignas y apropiadas**, desarrollando así una *mejor* calidad de vida. Hoy en día el hombre vive rodeado de objetos plásticos innecesarios para la vida cotidiana. Los plásticos se han fabricado para satisfacer las demandas de una diversa variedad de usos y dando lugar a una gran industria donde la civilización debería llamarse la civilización del plástico y debido al papel determinante que ha desempeñado este material en su desarrollo y en el mejoramiento de las condiciones de la vida del hombre y el acelerado crecimiento de la ciencia y la tecnología.

Actualmente estos plásticos son muy utilizados como envases o envolturas de sustancias o artículos alimenticios que al desecharse sin control y tras su utilización se han originado gigantescos basureros. De este modo, surge el problema asociado a la contaminación ambiental. Debido a la contaminación desenfrenada de desechos plásticos que se ven en las calles, es necesario empezar por concientizar a la población residente más cercana a esos focos de infección.

(1) Technological and Social Action Project
"Building a better city"

In modern life plastic has been a transcendental phenomenon. Every inhabitant deserves living in **respectable and appropriate** conditions, developing a *better* quality of life. Today, the humanity lives surrounded by plastic objects that are unnecessary for daily life. Plastic objects have been fabricated for satisfying demands of a diverse variety of uses, giving place to a big industry where the civilization should be called civilization of plastic and due to the determinant role that have been played by this material in its development and in making better the human life conditions and the accelerated growing of the science and technology.

Nowadays these plastics are very utilized as containing and packaging of food and when are thrown away after its utilization have origin giant rubbish dump. This way, the problem associated to the ambience contamination emerges. Due to the **disproportionate** contamination with plastic waste that is seen in the streets, it is necessary to beginning to make aware the resident population that lives near those infection focus.

After the instruction offered in the Edition class, the student re-elaborated his production and presented as a second version of the text in which he has modified completely its structure, adopting that proposed in the Deconstruction, and displaying as well more adequate linguistic resources (2).

(2) **Proyecto de resolución tecnológica o social.**
Construcción con materiales PET.
Problema:
Todo habitante tiene el derecho a una vivienda propia y merece vivir en condiciones **dignas y apropiadas**, desarrollando así una *mejor* calidad de vida.

SIN EMBARGO, la inestabilidad socio-económica que sufrió el país en los últimos años provocó la suba **desmedida** de los materiales de construcción, la pérdida de empleo, la devaluación y el elevado costo de los alquileres; y esto trajo como consecuencia que los vecinos de Almirante Brown, al igual que en otras localidades del conurbano bonaerense, se resignaron al dejar sus hogares parcialmente terminados, y a las personas que no tienen un terreno propio a ocupar asentamientos, lo cual generó un aumento de barrios emergentes.

(2) Project of technological or social resolution.
Construction with PET materials.
Problem:
Every inhabitant has the right to their own housing and deserves to live in **respectable and appropriate** conditions, developing a *better* quality of life.

HOWEVER, the socio-economical instability that the country suffered in the last years provoked a **disproportionate** rise of construction materials, the loss of employments, the devaluation [of money] and the high cost of rents;

and this brought as consequence the fact that the neighbors of Almirante Brown, likewise other locations of the conurbation of Buenos Aires, gave up on having their houses partially finished, and the people that hadn't their own piece of land to occupy settlements, which generated a raise of the emergent neighborhoods.

First, the title of the text has been modified in a way in that adjust better to the Objective of the new version of the Project: "Elaborate materials for the construction based on plastic waste and, in this way, help low-resources families to accomplish their dream of having a home". Then, the Problem with a sub-heading. Regarding the construction of the text, the ideal situation is presented in first place. It displays invoked evaluation (double underlined) as judgement:capacity, a use of inscribed evaluation, appreciation:valuation (bold) referred to life conditions to every inhabitant and the construction of positive evaluation through graduation (italics). Then the counter-expectation connection (capitals), that anticipates the problematic situation. This is construed specially through invoked evaluation (underlined) as a negative socio-economic situation, with the use of an inscribed token of evaluation (bold) referring to the increase of the material's price. With these resources, the student clearly construes the problem: although having the right to an appropriate housing, the socio-economic conditions of the country put a social group in severe difficulties to exercise their right.

After the Research Questions and the Objectives stages (not showed here), the student proposes the Solution to the Problem. In this stage (3), the student picks up the topic of the plastic and proposes to transform waste in building materials.

(3) **Solución:**

La solución que proponemos al problema planteado es abrir una fábrica con maquinarias que van a transformar los residuos plásticos en materiales, como ladrillos, chapas y tablones, destinados a la construcción de viviendas.

La fábrica funcionará en el barrio de Sakura, Burzaco - Alte. Brown, donde se ayudará al 75% de la población, ya que esta localidad presenta el mayor porcentaje de pobreza y desocupación en el Municipio.

Los residuos recolectados serán comprimidos y transformados en materiales de construcción, utilizando las maquinarias de fundición. Sin lugar a dudas estas máquinas requieren un bajo nivel de energía para funcionar, y que, a diferencia de los ladrillos de adobe, los materiales producidos no necesitan cocción, por lo tanto, no contamina el medio ambiente en su proceso productivo.

Los productos elaborados se presentarán en el mercado a un precio relativamente accesible para toda la comunidad. Además, cuentan con una resistencia mayor que los materiales que actualmente conocemos, es decir resisten a la corrosión, agua, frío, calor y al contacto con cualquier tipo de suelo, y no requiere de mantenimiento algún.

Finalmente, lo que busca este proyecto es ayudar a las personas de menores recursos y desempleados a poder construir su propia vivienda.

(3) **Solution:**

The solution that we propose to the problem stated is the opening of a factory with machines that transform the plastic residues into materials, e.g. bricks, plates, boards, to build housing.

The factory will be located at the neighborhood of Sakura, Burzaco – Almirante Brown, the location of major percentage of poverty and unemployment, where 75% of the population will be benefited.

The collected residues will be compressed and transformed into building materials, with melting machines. Undoubtedly, these machines require a low level of energy and, differently than the adobe bricks, and the produced materials do not need cooking, hence they do not pollute the environment in the productive process.

The products will be inserted in the market with a relatively accessible fare. In addition, they have a better resistance than the materials already known, which means that they resist corrosion, water, cold, heat and contact with any kind of soil and they do not need any kind of maintenance.

Finally, this project seeks to help low-income and unemployed people to build their own housing.

As shown in (3), the phase Solution (first paragraph) responds to the Research Question ("How to acquire lower-price building materials?"). The second phase, Solution Description (second and third paragraphs), proposes the way to achieve the purpose, with the localization of a plastic-waste factory and a brief process of elaboration. The phase Advantages starts in the same paragraph, and continues into the following. The final paragraph restates the last part of the Objective proposed and functions as a closure for the text.

This version allows to hypothesize that the student has reorganized his thinking to construe the necessary stages to achieve the purpose of the genre that he should produce. The reorganization takes place in discourse while at the same time a better comprehension of the matter is evident. In the Problem stage, the student proposes that a social group has difficulties to build their own housing. In the Solution stage, he suggests the installation of a factory to solve the problem. In this way, she reconsiders the content of the first version (1), which she did not organize appropriately as a point of departure for the Project. This reorganization to achieve a coherent text has be done using the linguistic resources proposed in the Deconstruction stage of the teaching practice. It is the adequate use of language which allows the construction of the logic of a Project. This shows how the student learns how to construe knowledge in science or technology, a concept that is at risk in the subject.

In relation to Case 2, we will show how the group of students has re-elaborated the first version of their text to obtain a much clear Exposition. The topic chosen was the inductive method as an adequate resource for teaching Mathematics. The title proposed was "The inductive method generating mathematic knowledge". The first version was two pages and a half long while the second is only one and a half. This fact allows assuming that, in first place, the selection of legitimate information and its reorganisation to construe the argumentation enables producing a clearer text. This resource has been already noted for scientific English by Halliday and Martin (1993).

To show the evolution between the two versions of the text, we will take here relevant fragments. In the first version (4) we observed a long text that does not realise the structure of an Exposition. Although it is centered in the inductive method (capitals) and proposes a Thesis oriented by the title (underline), it departs from concepts which do not contribute to it (special underline). In addition, it does not show a clear construction of Arguments, their internal cause relationship with the Thesis nor that of addition between them. The closure, however, proposes a Reiteration of the Thesis (double underline), but yet the text does not achieve the intended purpose.

(4) Cuando razonamos en forma deductiva podemos tener la seguridad de que si comenzamos con premisas verdaderas, terminaremos con una conclusión verdadera. No ocurre lo mismo con el RAZONAMIENTO INDUCTIVO, que puede llevarnos de premisas verdaderas a una conclusión falsa. […]

Asimismo, los científicos emplean el MÉTODO INDUCTIVO frecuentemente al pasar de datos particulares a una conclusión más general. Si consideramos a la matemática como una ciencia, entonces el MÉTODO INDUCTIVO también será válido para generar conocimiento matemático. […]

Si entendemos el MÉTODO INDUCTIVO como medio para hacer ciencia, también lo podríamos pensar para hacer matemática. […]

Claro que se presentan dificultades, fundamentalmente en lo relativo al aprendizaje de los PROBLEMAS DE DEMOSTRACIÓN. […].

También plantean que los docentes tienden a utilizar en sus clases el contenido exacto extraído de los libros de texto, sin realizar la necesaria transposición didáctica que facilite el aprendizaje de los MÉTODOS DE

DEMOSTRACIÓN. […]
El profesor será quien promueva la búsqueda de patrones en los problemas que se aborden y el descubrimiento de las leyes que rigen estos patrones, conociendo que ambas actividades están estrechamente vinculadas al proceso de generalización, que forma parte del RAZONAMIENTO INDUCTIVO. Debe propiciar que sus estudiantes aprendan estrategias heurísticas, como trabajar con casos particulares y que comprendan cómo pasar de casos particulares a una propiedad común (conjetura o hipótesis), además deben enseñar a transferir propiedades de una situación a otra (analogía), entre otras estrategias de gran utilidad para lograr la necesaria generalización, que se construye gracias a la abstracción de invariantes esenciales. […]
Si consideramos al MÉTODO INDUCTIVO como medio para lograr aprendizajes matemáticos, será importante dejar que las ideas surjan en la mente de los estudiantes y el profesor actúe tan sólo como un orientador que los dirija hacia el descubrimiento, hacia la solución del problema […].
[…] El MÉTODO INDUCTIVO será válido para la generación de conocimientos, por lo tanto, desde la enseñanza de la matemática debemos crear las condiciones para que esto suceda.

(4) When reasoning in deductive way, we can be sure that if we start with true premises, we will arrive at a true conclusion. It is not the same with INDUCTIVE REASONING, which can lead us from true premises to a false conclusion. […]
Likewise, scientists employ the INDUCTIVE METHOD frequently in order to go from particular data to a general conclusion. If we consider mathematics as a science, then the INDUCTIVE METHOD will be also valid in generating mathematical knowledge. […]
If we understand the INDUCTIVE METHOD as a means for doing science, we also could think of it for doing mathematics. […]
It is clear that some difficulties will appear, specially in which is related to learning DEMONSTRATION PROBLEMS. […]
They also say that teachers tend to use in their classes the exact content from text-books, without making the necessary pedagogic transposition to facilitate learning of DEMONSTRATION METHODS. […]
The teacher will promote searching patterns in the approached problems and the discovery of the laws that govern these patterns, in the knowledge of both activities are closely related to the process of generalization, which forms part of the INDUCTIVE REASONING. He should facilitate that his students learn heuristic strategies, like working with particular cases, and that they understand how to go from particular cases to a common property (speculation or hypothesis), they also have to teach to transfer properties from one situation to another (analogy), among other strategies of great usefulness to achieve the necessary generalization, that is construed thanks to the abstraction of essential invariants. […]
If we consider the INDUCTIVE METHOD as a means for achieving mathematical learnings, it will be important to leave the ideas appear in the student's minds and that the teacher acts only as a guide that conduct them to discovering, to the problem solution […].
[…] The INDUCTIVE METHOD will be valid to generating knowledge, hence, from teching mathematics we need to create the conditions for this to happen.

Differently, the edited version of the text (5) presents a clear schematic structure, in which it is possible to distinguish the Thesis (underline), the Reiteration of the Thesis (double underline) and the Arguments, connected explicitly by internal additive conjunctions (bold). The internal causal connection with the Thesis is implicit, as it is characteristic in the genre, but the Reiteration of the Thesis is initiated with a Circumstance that express consequence (bold+underline).

(5) En la enseñanza de la matemática se pueden utilizar diferentes métodos para producir conocimiento, uno de ellos es el MÉTODO INDUCTIVO.

En primera instancia, el MÉTODO INDUCTIVO se utiliza como herramienta a la hora de hacer ciencia. Los científicos, quienes emplean ESTE MÉTODO, son quienes pasan de datos limitados a una conclusión más general. En este sentido, Okasha (2002), menciona:

[…]

En segundo lugar, quienes hacen ciencia, es decir los científicos, generan líneas de investigación a través de la experiencia; reafirmando que la ciencia emplea el MÉTODO INDUCTIVO. […] En consecuencia la tarea del científico es generar estrategias, ya sea trabajar con casos particulares y comprender cómo pasar de casos particulares a una propiedad común (conjetura o hipótesis), como así también establecer analogías entre una situación y otra, logrando la necesaria generalización, parte fundamental del MÉTODO INDUCTIVO.

Finalmente, los estudiantes son científicos en el aula. Dentro de su labor, para generar conocimiento matemático, parten de la experiencia para poder obtener una conclusión general. […]

En conclusión la ciencia utiliza el MÉTODO INDUCTIVO a la hora de crear conocimiento. Los científicos son aquellos que utilizando ESTE MÉTODO, partiendo de la investigación y de la experimentación, logran construir el conocimiento. Los estudiantes actuarán como científicos dentro del aula para poder generar conocimiento matemático, partiendo de experiencias particulares a generales. […]

(5) In teaching Mathematics it is possible to use different methods to produce knowledge, one of them is the INDUCTIVE METHOD.

In first place, the INDUCTIVE METHOD is utilized as a tool when doing science. The scientists, who employ THIS METHOD, go from limited data to a general conclusion. In this sense, Okasha (2002), mentions:

[…]

In second place, those who do science, i.e. the scientists, generate research lines through experience; reaffirming that the science employs the INDUCTIVE METHOD. […] In consequence the scientist task is generating strategies, e.g. working with particular cases and understanding how to go from particular cases to a common property (speculation or hypothesis), or establishing analogies between one situation and another, obtaining the necessary generalization, fundamental part of the INDUCTIVE METHOD.

Finally, students are scientist in the classroom. In their work, in order to generate mathematical knowledge, they depart from experience to be able to obtaining a general conclusion. […]

In conclusion the science utilizes the INDUCTIVE METHOD to create knowledge. Scientists are those who using THIS METHOD, departing from investigation and experimentation, achieve the construction of knowledge. Students will act as scientists in the classroom to be able to generate mathematical knowledge, departing from particular experiences to generals. […]

It is interesting to observe in the second argument how the students are able to elaborate a clearer explanation about the inductive method. They do this by generating a Procedure embedded in the Argument (6). The Procedure is built connecting temporally a series of activities (underline). The relations between them are of additive addition ("and") or alternative addition ("or"). The use of the gerund in Spanish ("logrando"/ "obtaining") indicates consecutive relation: the "generalisation" will be the consequence to achieve from this procedure. This resource results much clearer in explaining how induction works, which is not achieved when the students talk about "demonstration" in (4).

(6) […] la tarea del científico es generar estrategias, ya sea trabajar con casos particulares y comprender cómo pasar de casos particulares a una propiedad común (conjetura o hipótesis), como así también establecer analogías entre una situación y otra, logrando la necesaria generalización, parte fundamental del método inductivo.

(6) […] the scientist's task is generating strategies, e.g. working with particular cases and understand how to go from particular cases to a common property (speculation or hypothesis), or establishing analogies between one situation and another, obtaining the necessary generalization, fundamental part of the inductive method.

Through this Case we propose, like in Case 1, that throughout the Edition of the text the students not only achieve a more adequate instance of the genre but that they also improve the knowledge construction in relation with the method adopted for teaching Mathematics: the inductive method. They not only achieve proposing the method clearly as Thesis but they also explain its characteristics and advantages. Again, discourse construction and cognitive construction seem to converge.

Conclusions

This research has two phases. First, we established theoretical premises from philosophy, psychology, cognitive studies in education and systemic-functional linguistics. They remark, in different degrees, the relationship between thinking and language at a general level (broad interpretation) and at a specialized level of a disciplinary knowledge (restrictive interpretation). Second, we presented a genre-based literacy teaching model that guides students in a path of learning the management of those written genres and of the concepts construed by instances of them.

In the first part we suggest, with Humboldt, that through language it is possible to gain access to knowledge conceptually and categorially organized; with Wittgenstein, that knowledge has a linguistic root, to the extent that the limits of the world are the limits of the language and that outside of language it is not possible to think; and with Gadamer, that knowing is a temporal and historical act that takes place as a linguistically-based interpretation of the world. We understand, with Vygotsky, that language, and in particular its written expression, is a cognitive mediator that works through the construction of conceptual meanings. With Scardamaglia and Bereiter, we understand that mature writers evolve in knowledge construction in the dialectic interaction between genre and content, i.e. that writing influences thinking. These authors also suggest that this can be taught. Finally, with Halliday and with Martin and Rose, we find explanations about the way that language allows specialized knowledge construction, e.g. scientific knowledge, through the development of linguistic resources to produce specialized discourse.

In the second phase of the research, from the discussion of two cases of classroom experiences, we observe results that could be understood as processes of logogenesis and ontogenesis, i.e., the articulated evolution between the production of a text and the construction of knowledge related to the field of the text. These results are related to what has been established in the theoretical frameworks mentioned, construing evidence to sustain the postulates we took from those different sources. In Case 1, that treats the instantiation of the genre Technological Project, a constructive process in two steps to satisfy the demands of the genre is shown. In this process, the student construes also a conceptual organization and a cognitive appropriation of contents necessary to elaborate the Project. The case exhibits the process of individual development in which learning occurs along the progress in adjusting the written texts that instantiate the genre. In Case 2, that presents an instance of the genre Exposition, the Construction and Edition of the text, made in groups, evolve through adjustments of writing, together with a progressive argumentative and conceptual adjustment of the thesis proposed. This means that in both cases processes of discourse and cognitive construction seem to converge.

The results are consistent with the hypothesis that relate cognitive learning to the progressive control of language and writing. In other words, in a context of disciplinary teaching, it is possible to observe indirectly the appropriation of concepts as well as the production of learning through the

development of the abilities of writing a genre. This contributes, from a linguistic perspective, to what has been showed by other authors using different methods (MARINKOVICH; CÓRDOVA, 2014; BAZERMAN, 2019; NARVÁEZ CARDONA, 2016; MOLINA; CARLINO, 2019, WAIGANDT et al., 2019; among many others). Unlike these precedent investigations, this research provides detailed discourse evidence from the systemic-functional conception of language, that allows to closely link language development, thought development and knowledge construction.

In conclusion, the pedagogical experience of writing competences development, applied to the teaching of disciplinary contents, shows itself as a field of mutual implication between learning concepts and language development. The experience suggests, in both Cases, that the adjustment of the written textual production coincides with the adjustment in the learning of concepts. The management of content, i.e., the knowledge construction, depends on the management of discourse. Hence, this experience can contribute evidence in favor of the necessary relation between learning and writing, which corresponds, in a broad level, with the relationship between language, thought and knowledge construction.

However, further replications of the study are needed in order to broaden the case analysis, both in repetitions of the production of the same genres in the same subjects as well as in different subjects of distinct degrees, with the same pedagogical model with different genres or macro-genres in varied disciplinary fields.

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