Interdisciplinarity under consideration of the Theoretical System of Expanded Affectivity: An essay about overcoming difficulties in learning of Mathematics through Language and Semiotics

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Abstract

This article's general goal is to investigate the approximations between the learning of Mathematics and the formal Language, a conception that originated one of the authors dissertation. The work is based on the bibliographic research on the development of Mathematics and Language, both at phylogenetic as well as at ontogenetic level. It is argued that Mathematics and Language are made possible to the human being by the same basic characteristic - the ability for abstract thinking. Thus, these two disciplines are searched for similarities, as well as for viable paths for a more fruitful work in the intricacies of Mathematics. The authors argument that the field of semiotic studies, which encompasses the two disciplines discussed here (Language and Mathematics), can play the role of a link between the two of them, as well as provide possibilities for an interdisciplinary work that brings fruitful results for the learning of these areas. The work's main theoretical reference is the Theoretical System of Expanded Affectivity (TSEA), which aims to study the human being and its relation with the world in its integrality. Thus, one of the objectives is to seek the integration of knowledge, as opposed to the exacerbated fragmentation currently found in science and in school institutions. It is also intended that this work be a source of reflection on possibilities for an expanded view of the knowledge and the human being itself.

Keywords: Theoretical System of Expanded Affectivity (TSEA). Mathematics. Language. Semiotics.

Introduction

If we look at the education that is currently being practiced in Brazil, which was the scenario of this study, as well as in other countries, it is easy to verify that it is not bearing the outcomes it should be. The results of national assessments show that students leave school without achieving the level of knowledge they should have acquired. In international assessments, Brazil ranks much lower than developed countries. In the international evaluation of the Program for International Student Assessment (PISA) in 2015, for example, of the 72 countries evaluated, Brazil occupies the 63rd place in the sciences ranking, 59th in the reading ranking and 66th in Mathematics, according to data from the Instituto Nacional de

Estudos e Pesquisas Educacionais (INEP - National Institute of Educational Studies and Research Anísio Teixeira). Data from this evaluation showed that seven out of ten Brazilian students aged 15 to 16 years are below the basic level of knowledge. The results achieved by Brazilian students in Science and
Reading changed little if compared to the previous editions of the test, and in Mathematics there was a decrease of 11 points compared to 2012; 70.3% of students were below level 2 in this area, which is considered the minimum level to apply Mathematics in basic everyday situations. The performance of Brazilian students is below the average of the countries of the Organization for Economic Cooperation and Development (OECD) in science (Brazil scored 401 points, while OECD countries averaged 493), reading (407 points, compared to 493 OECD points) and Mathematics (377, compared to the average of 490 OECD points).

By 2013, 90% of high school students did not achieve adequate math learning. Functional illiteracy among people aged 15-64 reached 27% in 2009, according to the Instituto Paulo Montenegro (IPM); 34% of the students who reach the 5th year of schooling still can not read (Todos pela Educação - All for Education)All these indicators show, conclusively, that there is something very wrong in Brazilian education.

If, on one hand, it is true that education in Brazil has made considerable progress in the last decades, regarding access to Elementary Education, it can not be denied, on the other hand, that from the point of view of permanence in school, the challenges remain immense. Dropout and academic failure still present high rates. The failure of many students in school, although having many reasons, is attributed in large part to the discipline of Mathematics. It is known that Mathematics is seen as great ¨villain", being blamed for students' failure and for the high dropout and failure rates found in Brazilian schools (BRASIL, 2002).

These reflections beg the question: Is education, as it is currently practiced in the country, able to meet the needs of the students? What is the cause of so many problems and difficulties, of poor results and of such disorientation on the part of students and teachers?

To answer this question, we began our search for the root of the problem in the work carried out inside the schools. In almost all the schools in the country, we see an exacerbated fragmentation in "contents" and school subjects / disciplines, that are commonly taught without integration, without articulations.

All the school disciplines, though, come from the construction of knowledge about the world (including nature and the human being). Several authors warn of the consequences of such fragmented work, as seen today, in school as well as in science. Sant'Ana (2006) argues that when one seeks to analyze the world in its entirety, what matters are the interconnections between things, not the things themselves or what they represent in themselves. According to the author: "something only has some reality (truth) if it has some interdisciplinary action in the world" (SANT'ANA, 2006, p.194). And he continues: "In this way, the interdisciplinarity (or interconnection) shows that one can not decompose the world into independently existing units (disciplines)" (SANT'ANA, 2006, p.195). Moraes (2002) also points out that if reality is complex, it requires a broad, comprehensive thinking that has the capacity to understand this complexity and build a knowledge that takes that comprehension into account. Yet Gusdorf, in the introduction to the book by Hilton Japiassu (1976) "Interdisciplinarity and Pathology of Knowledge," affirms the need for a common search for the restoration of human meanings of knowledge, and criticizes the distancing of

scientific disciplines from concrete existence, which he reiterates renounced its primordial function of vinculating man to the world in which he lives.

The reading of these authors leads to the conclusion that the educational work, as it is carried out in the schools of our country, separating the various subjects in school disciplines that hardly communicate with each other, is not the appropriate way to work pedagogically, and is causing serious problems for Brazilian education.

For several decades, this fragmentation of knowledge in increasingly smaller disciplines has been criticized, and an inverse movement towards the completion of the disciplines is pursued by many scholars (POMBO, 2003; NEWELL, 2001; KLEIN, NEWELL, 1998; FAZENDA, 2011). The term currently used to refer to the integration of knowledge is "interdisciplinarity".

Interdisciplinarity has been gaining popularity for decades, initially in the academic-scientific context, later in school education, and today in the most diverse areas of human performance. The vision of the need for interdisciplinary studies was born in opposition to the exaggerated specialization of the sciences, and to the fragmentation of knowledge in smaller and smaller parts, with the intention to better study and understand a phenomenon or a fact. During the Modern Age, the time of unitary knowledge suffered a growing disintegration. Gusdorf pronounces in the introduction of Japiassu's book (JAPIASSU, 1976, p. 47): "The great cut or mutation lies in the Renaissance, the Reformation and the Great Discoveries." This tendency grew stronger in the nineteenth century, where there was a great expansion of scientific work, which was accompanied by the need for specialization, and its characteristics became so marked, that the lack of an inverse path to this, the unification of knowledge and fields of study of the sciences, for a better understanding of the world and of the human being, became more and more evident. Experts and generalists realized that if, on one hand, the division of knowledge into “crumbs” (Definition used by Dr. Angel Diego Marquez, in a lecture given in November 1973 at the School of Education of the University of São Paulo) (FAZENDA, 2011, page 31) which can be better studied and known is a necessary and fruitful phenomenon for the advancement of science, on the other hand there is also the need to integrate knowledge into a comprehensible whole. Georges Gusdorf, one of the pioneers in the area, states in Japiassu’s book cited before:

> We must consider as alienated and alienating any and all science that is satisfied with dissociating and disintegrating its object. It is absurd, it is vain to construct an alleged science of man, if such science does not find in human existence, in its concrete fullness, its point of departure and arrival. (GUSDORF apud JAPIASSU, 1976, p. 15-16).

Interdisciplinarity appears, therefore, as an alternative to the work pulverized in disciplines. Interdisciplinary work, though, far from being a simple activity developed jointly by several disciplines, where each teacher works "his part" of the subject, demands ergodicity[1] of each one of the teachers who will teach the subject, since in order to articulate content from the different disciplines, it is necessary that each one of the involved teachers knows the base of the other areas involved. Despite this difficulty, we

[1] The term refers to a work (ergo) that leads beyond the field of expertise of the teacher, seeking additional sources, definitions and explanations that provide a better understanding of what is not part of his initial field of knowledge.

believe that this is the best way to work on content to provide meaningful learning that will last not only for the school years, but be useful also in the daily life after them.

Believing in the potentialities of the integration of the disciplines, it is necessary to find ways to perform the interdisciplinary work of Mathematics, leading it to "dialogue" with other areas of knowledge. Although the interdisciplinary work is possible for any combination of disciplines, the authors of the Theoretical System of Extended Affectivity – TSEA (SANT'ANA-LOOS; LOOSSANT'ANA, 2013a; SANT'ANA-LOOS; LOOS-SANT'ANA, 2013b) argue that a dialogue is only possible between two disciplines at a time, and propose its implementation through a "bridge". Two disciplines that work in a similar way provide possibilities for building bridges to each other. In this sense, to find a discipline that would adapt to an interdisciplinary work with Mathematics, in order to obtain a work that is enriching for both, we analyzed Mathematics.

If we look at Mathematics, we discover that it primarily studies numbers and the relation between them, making the connections through logical reasoning. To represent numbers, to establish relationships between them and to represent them, Mathematics uses symbols. These symbols, which designate numbers, operations and relations, are signs.

But Mathematics is far from being the only discipline that uses them. The search for another discipline that primarily uses signs will lead to Language. Language is, by definition, a symbolic discipline, either because it uses signs (used to represent concepts and forming words), or because it uses metaphors and figures of language. The language uses letters to symbolize sounds, long before they are used in math. It is thus concluded that Mathematics and language are actually two disciplines which work with the same materiality, and thus it must be possible to find relations between them.

In order to verify these relations, another step is necessary: to find a discipline (or area of knowledge) that is able to establish relations between Mathematics and language, and to form a triadic unity[2] with both. For this, we thought of a discipline that studies the signs and the representations, because it would be the link between these subjects. In addition, one must reflect on what is beyond Mathematics and beyond language, but is part of both. In this way, we arrived at semiotics, since its work is based on signs and meanings, which are matters of extreme importance for the disciplines in question. Semiotics, however, is beyond both of these disciplines.

To understand the arguments brought here, it is crucial to comprehend the Theory on which it is based. Therefore, a brief explanation of this theory follows.

[2] According to TSEA, the constitution of the whole universe follows the same rule, the same basic formatting. This basic form, similar in everything that is part of the world, follows a structure of three components, being therefore called the Triadic Unit by the TSEA authors. The triadic structure is perceptible at the organic, biological level, as well as at the psychological level.

The formation of larger, more complex systems follows the same rule: that is, when two triadic units come together, they form a new unit, more complex than the previous one, but still being triadic (only on a larger scale of understanding than the previous one). It is as if everything that exists, every part of the cosmos, carries within itself, therefore, a fractal of the universe.

Considerations on The Theoretical System of Extended Affectivity (TSEA)

The choice of the Theoretical System of Expanded Affectivity (TSEA) as the primary theoretical basis for this work was based on the search for alternatives to the linear, cognitive view, which has often been used for the interpretation of the world / the reality in almost every facet of human activity: In educational practice, in the academic field, in economics, and today even in art. This perspective usually neglects important aspects, such as the influence of emotions and feelings, valuing excessively facets related to reason. Such a dichotomized view, which separates reason from emotion, is not able to explain in a minimally adequate way the reality in which we live, since it is multifaceted We argue, therefore, that it is not possible to separate cognitive and affective aspects in the study of the human being. For TSEA, it is important to see the human being and the reality / the world in a broad way, taking into account the many aspects that interfere (or affect) the phenomena.

The excessive fragmentation present in school education, as well as in science, which has pulverized knowledge in smaller and smaller pieces with the claim of the need to study in detail each aspect of the phenomena for their better understanding was discussed earlier. We argued that this meticulous study brings benefits as it leads to deeper and more detailed knowledge of the subject in question. On the other hand, if this analytical movement comes alone, it bears the risk of leading us to loose sight of the whole, distorting the understanding of reality. It is of the utmost importance that during and after the study of each facet, the reverse movement, of integration and search of understanding of the connections between the fragments and of these with the world, in a broader way, happens. This is one of the basic characteristics of the Theoretical System of Extended Affectivity (TSEA), that is, the search for a holistic view of reality.

Furthermore, the Theoretical System of Expanded Affectivity considers that there must be several methods for analyzing the universe in which we live, and that it is not feasible to choose one of them as being the only one to be accepted. The ideal would be a cross-link between the various methods (SANT'ANA-LOOS; LOOS-SANT'ANA, 2013a), and thus, it would be necessary to have a "method of methods" to organize the various methods and their findings; that is, a meta-theory. This would be important in the analysis of the data investigated, after the data collection in the empirical research and in the theoretical reflection on them. This is one of TSEA's purposes. The TSEA seeks to "overfly" the theories already created, searching for the existing connections between them, articulating them and believing that it is possible to reach a dialogue between them. In order to find such connections it is necessary to revise them carefully and sometimes to rearrange them in order to detect aspects that serve as links between them.

Another key concept of TSEA is the *expanded affectivity*. Every human being, incorporated into the universe, is part of an immense network of connections, in which he is constantly being affected and affects others. These "affectations", on the other hand, allow connections, similarities, repulses and other possibilities of interaction. The term "expanded activity", coined by the authors of TSEA, refers to these constant "affectations" experienced by the human being, during his interactions with others (the various 'others' he encounters throughout his lifetime).

What is meant by affectivity in this context contemplates the whole existence of the human being. It refers to interactions that occur between everything and everyone, to encounters that occur, whether in the form of affinities or clashes, shocks or connections, conflicts or solutions. These diverse interactions that

happen in the dynamism of reality, are called *Expanded Affectivity* by the TSEA. Everything that comes into contact with a being interacts with it, the result of which is an “affect”. The quality of these affections, on the other hand, determines the physical, psychic and cognitive alterations of the individual, causing modifications in the emotions, sensations, feelings, passions and moods, which in turn cause the mobilization of human thoughts and actions (SANT’ANA-LOOS; LOOS-SANT’ANA, 2013a).

The last key concept of the TSEA we will present here is *homeostasis.* The understanding of this concept is essential for understanding the entire TSEA. The authors assume that it is fundamental to recognize that the various interactions experienced by the subject affect him, at the same time that he affects those who interact with him. These constant interactions and "affectations" occur dynamically as part of an immense system. This system, on the other hand, is governed by universal laws, leading itself and its parts to a constant search for balance, stability, homeostasis; or, putting it another way, being affected in the best possible way by the interactions that take place among the members of the system.

Based on what was said in the Introduction and on the TSEA topic, we present now the goals of the study.

Goals of this Study

We intend to lead, in the scope of the present study, to critical reflection on the current situation of teaching and learning Mathematics and language in school. We also aim to highlight the interrelations between these disciplines, using the TSEA as main theoretical contribution. Our goal is to come to some analysis of the consequences caused by the kind of fragmented approach used by academic science and school education today. In this way, we hope to create alternatives to deal with these disciplines, which will make work more enjoyable and avenge better results in students' lives.

Therefore, the problem that guides the present work can be expressed in form of three questions:

1. What indicators of connections and affinities can be raised between formal Language andMathematics?
2. Can Semiotics and Extended Affectivity articulate the connectivity between Mathematics andLanguage?
3. How can this new interdisciplinary stance facilitate the learning of elementary algebra in school?

Our hypothesis is that school education can minimize gaps and difficulties in the formal learning of Language and Mathematics, specifically during the insertion into elementary algebra with the establishment of Semiotics and (Expanded) Affectivity in the symbolic and scientific understanding of the interactional sense of reality.

Our goal is to denote gaps and difficulties of formal education concerning the learning of symbolic language and Mathematics, particularly during the insertion into elementary algebra, especially when Semiotics and (Expanded) Affectivity are neglected; and, therefore, to defend the need for its implementation in school education.

To start this investigation, we intend to explore semiotics, and what enables humans do have language and to do Mathematics. To facilitate the understanding of the connections we are drawing on in this study, we chose the following representation:

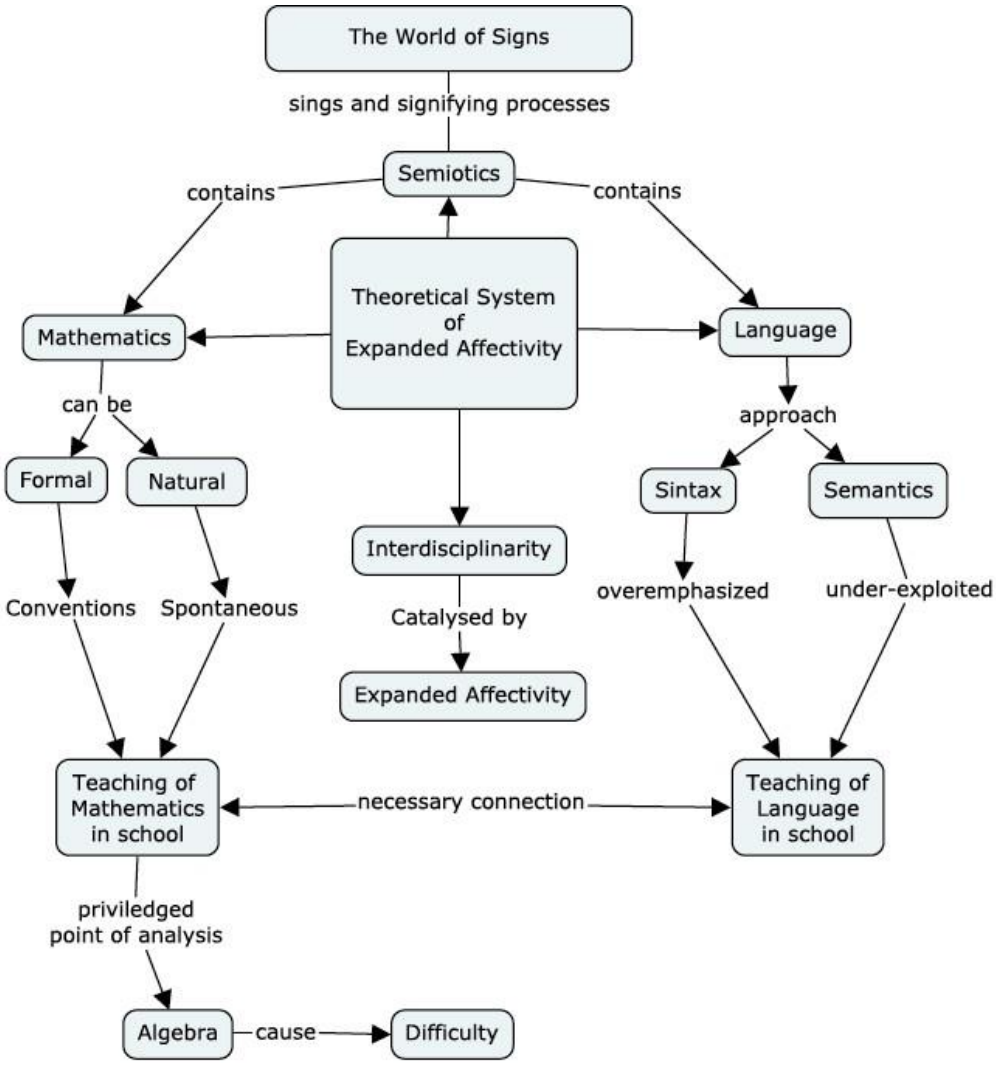

Figure 1: The World of Signs: Schematic summary of the ideas of the study
Source: The authors of this paper

Human plasticity and the ability to learn: A Semiotic process

Cerebral plasticity is the adaptive capacity of the central nervous system, i.e. its ability to modify its structural and functional organization, in response to the individual's experiences. It allows humans to learn, which, according to Kolb and Wishaw (2002), is an intrinsic characteristic of the human being, on which it's survival depends. But what is plasticity and how does learning happen?

In order for learning to take place, the human being must interpret reality, that is, create a "mental world" that corresponds (within his perceptions) to the real world, in order to reflect on it and look for possibilities of adaptation to the environment; or, in the inverse movement, adaptation of the environment to his needs, as stated earlier (PIAGET, 1973). This transcoding from the real world to the mind is what we can call "give meaning", that is, the attribution of meanings to what each individual sees in the real world.

The translation that the human being makes of reality, importing it into his mind and creating, so to speak, a "model" of the real world, is only possible with the help of signs and representations. And this is the field of study of Semiotics.

According to Winfried Nöth (1995, p.17), "semiotics is the science of signs and signifying processes (semiosis) in nature and culture". The author emphasizes, however, that this definition is not accepted by all schools of semiotics, since some prefer more specific definitions, while others opt for more extensive expositions, reaching the position of not defining it as a theory of signs, but only as a theory of signification.

For Peirce "[...] cognitions, ideas and even man are essentially semiotic entities." (NÖTH, 1995, 61). He had, therefore, a universal semiotic view of the world. In a letter to Lady Welby (23.12.1908), he wrote:

> It has never been in my powers to study anything - Mathematics, ethics, metaphysics, gravitation, astronomy, psychology, phonetics, economics, history of science, card game, men and women, wine, metrology - except as a study of semiotics. (PEIRCE, 1908 apud NÖTH, 1995, p.62).

From this perspective, semiotics would be a science by which one can arrive at the understanding of the most diverse knowledge, since it can be applied to different areas, and serves as the basis for a better understanding of innumerable subjects of knowledge.

According to Santaella:

> In the face of any phenomenon, that is, in order to know and understand anything, consciousness produces a sign, that is, a thought as an inexcusable mediation between ourselves and phenomena. And this, already at the level of what we call perception. To perceive is to translate an object of perception into a judgment of perception, or rather to interpose an interpretative layer between consciousness and what is perceived. (SANTAELLA, 2007, p.11).

The importance of Semiotics for the learning process becomes easily discernible under this scenario, and we believe that this subject can aid studies on understanding the world in an interdisciplinary way.

We said before that Semiotics is the science of signs and signifying processes (NÖTH, 1995). But what is a sign?

There are numerous definitions of signs in Peirce's writings, some very detailed, others more summarized. One of them, which perfectly serves the purposes of this study, is the following:

> I define a sign as something that on the one hand is determined by an Object, and on the other hand determines an idea in the mind of a person, so that this last determination, which I call Interpretant of the sign, is thus mediately determined by the Object . Thus, a sign has a triadic relationship with its Object and its Interpretant. (PEIRCE, 1931).

Or, in a synthetic form: "A sign stands for someone in the place of something." The triadic nature of the sign is already perceivable here: the object, the sign and the effect in one's mind.

Based on the definition of sign, we easily see Language and Mathematics as areas that are possible through Semiotics, specially at advanced levels. It would be wise, therefore, if students of Language and Mathematics would get acquainted with this area, for it's importance seems unquestionable. Unfortunately this doesn't happen in most cases. Looking at the Language and Mathematics courses offered in Brazilian Universities, we verify that most of them do not include Semiotic studies. In the following paragraphs, we will take a closer look at these areas.

Language and communicative activity

Throughout the ages, many scholars have devoted themselves to the theme of Language, its origin, its acquisition, and its purpose. There is no doubt about the importance of Language for the development of the human being, the construction of his representation of the world and, of course, his communication with it. After all, as the TSEA authors state, man is a "being of Language."

Chomsky says that animals - even primates receiving intensive training of humans - can not learn to manipulate a symbolic system as complicated as the natural language of a three- to four-year-old child (CHOMSKY apud LIGHTBOWN; SPADA, 1999). Other animals also communicate, which means that they too have some kind of language. As far as we know, however, its language dispenses arbitrary symbols, and it would not be proper to transmitting abstract thoughts, as it is possible to do with the human symbolic system.

Based on the statements above, one can deduce that Language is something that differentiates humans from other living things. Thus, and knowing the immense role that Language plays in human development, it is necessary to reflect on the appropriate form of acquiring it.

The restructuring programs of the Secondary Education of 1988, and of the Basic Curriculum of 1990, already warned of language teaching crystallized in vicious and repetitive practices that focus on the transfer of grammatical contents (PARANÁ, 1988) and highlighted the right to linguistic education (PARANÁ, 2008).

In order to overcome the teaching of the language practiced until then, the National Curricular Parameters (NCPs) brought a different view of how it should be worked in schools. They advocate: "The domain of Language, as discursive and cognitive activity, and the domain of Language, as a symbolic system used by a linguistic community, are conditions for the possibility of full social participation" (BRASIL, 1998a, p. 19).

For Silva, Pilati and Dias (2010), this means that the document opposes the teaching of prescriptive grammar, centered on the repetition of grammatical nomenclatures and unrelated to the context of language use. Thus, it is possible to perceive the search in the official documents for a Language teaching with a very different approach from that practiced previously; in other words, the guidelines suggest that one moves from a grammar-based teaching, a lexical-grammatical description and a linear and superficial perception of the texts (GERHARDT, 2015, p. 232), in its rules and exceptions, which makes it a dogmatic and repetitive teaching to a view of language from the text and social practices.

However, it is questionable whether the guidelines, at both national and state level, lead to a satisfactory understanding of the language and the human being. In addition, it is necessary to verify to what extent the guidelines given by the official documents are effective in the reality of the Brazilian schools, and what was the impact caused in them by the suggested changes.

For Silva, Pilati and Dias (2010), the reflection on the teaching of Language in school has not yet caused changes in teachers' pedagogical practices. According to the authors, there seems to be a major gap in teacher training. Faraco and Castro (1999) point out that in the last decades linguists have integrated into the debate about language teaching, criticizing the excessively normative nature of working with the mother tongue, and stating that the multifaceted nature of the work is not considered in schools. the transmission

of rules and concepts is emphasized disproportionately, while relevant aspects are left out. According to Silva (2010, p. 364), 'the teaching of written language in school has remained' caged 'in traditional practices. " The author points out that the main concerns of the school have been spelling and grammar, with textual construction and understanding in the background. With this approach, writing is transformed from a social object into a school object, which is reflected in meaningless textual productions, "just a pile of words on paper" (SILVA, 2010, p. 363).

Based on the above, it seems convenient to reflect on some questions: Why, despite the fact that Language is a specific human characteristic, is working with it in school something so truncated, problematic, distant from interactional reality? What leads teachers to develop work so closely linked to the norms and rules of the Portuguese Language, rather than investing in their many rich possibilities? It is imperative to review the crystallizing practice of language teaching, and to seek fruitful alternatives to it.

After this brief analysis of Language and it's teaching in Brazilian schools, we would like to draw the reader's attention to the other subject of interest: Mathematics.

Mathematics and the reading of the world

Mathematics has already been defined in many ways, and is seen in very different ways by different groups. The etymology of the word helps us understand its meaning. The term derives from the Greek word "mathemathike", in which "thema" means understanding, explanation, knowledge. The suffix ¨thike¨ is a Greek term for art. Thus, Mathematics can be defined as the art of explaining, of knowing, of understanding the reality / the world.

According to TSEA, the reality is dynamic, and is full of connections and interactions, which occur in the most diverse spheres. Mathematics, in this perspective, is understood as an effort to translate these interactional properties, in order to arrive at a broader understanding of reality / the world.

In order to be able to "translate" reality, however, it is necessary for the human being to be able to recreate what he perceives around him in his mind, generalizing situations, and then to reflect on what he has perceived. The ability for this form of thinking is a specifically human trait, which we can call the capacity for distanced thinking.

Capacity to abstract thought as a base for human production

It is a commonplace to assert that what differentiates humans from other species is language. Keith Devlin states, however, that there is another unique human characteristic: the capacity of mathematical thinking. Mathematics is omnipresent in nature in the most diverse forms. In addition, there are animals that have a numerical sense, being able to identify small quantities, learn the symbols for the numbers (with great effort, and being trained for a long period of time), as well as to compare sets with small quantities of elements (DEVLIN, 2000). The human species, however, seems to have a special ability to do so, as children quickly learn the symbols corresponding to the numbers, as well as the realization of simple operations involving small numbers. It is possible, therefore, to admit that the human being has an innate ability for Mathematics.

This ability, although innate, only develops from the acquisition of knowledge culturally constructed by previous generations. In addition, math skills are not a unique feature, but are made up of several attributes that complement each other. Among the most important are numerical sense, numerical ability, algorithmic ability, ability to manipulate abstraction, sense of cause and effect, ability to construct and follow a causal chain of facts or events, logical reasoning ability, relational reasoning ability, spatial reasoning ability, and brain size (DEVLIN, 2000).

Among these attributes, what is likely to cause major difficulties in Mathematics is the ability to manipulate abstraction. However, this is the attribute directly linked to the use of language, which is easy to acquire and used by almost the entire world population. The human mind has a capacity, seemingly absent in all other species, which is the ability to think in abstract entities. Although other species are able to reason about real objects in their immediate environment, or even on absent real objects, the human species can think about real present objects, about absent real objects, about unknown real objects, or about fictitious objects (DEVLIN, 2000).

This leads to the conclusion, therefore, that the human being has a unique capacity, which enables him to perceive patterns, be they concrete or abstract, and to reason about them. This ability, which Devlin (2011) calls offline thinking, is what enables us for language and Mathematics. In this sense, the author states that Mathematics and language are the two faces of the same coin. It could be argued, therefore, that the connection or closeness between these two specifically human skills, suggests the need to treat them not as totally different things, but to seek similarities and possibilities for the joint development of the two aptitudes.

We discussed the teaching of Language in Brazilian schools previously, and detected some problems. In the next section, we will discourse about the teaching of Mathematics, and try to discover if there are better alternatives to do it.

The teaching of Mathematics in school

The 1980s witnessed the birth of a new world movement in ideas about Mathematics teaching, which suggested a shift from basic education to the acquisition of basic skills, as opposed to the previous emphasis on preparation for further studies. This conception believes in the importance of the performance of an active role by the student in the construction of knowledge (BRASIL, 1998b).

Despite this movement, however, classroom practice has remained largely unchanged, and changes, when applied, often occur in a wrong way, sometimes because of the lack of adequate teacher training, others because of a lack of understanding about what the proposals suggest (BRASIL, 1998b). According to Valente (2008), the Mathematics teacher continues to use the practice of exercise lists, and memory still forms the basis of mathematical learning. For the author: "Within schools, the exercise, the repetition, the activity reigns. To solve the exercise correctly means to learn Mathematics: an inheritance that already has a century in our practices.¨ (VALENTE, 2008, p. 22).

The teaching of Mathematics, with its excessive emphasis on the instrumental, on how to do it, leaves a great gap in aspects related to the understanding of its essence. It teaches Mathematics in an isolated way, in instructional modules, without making the connection between them, and without providing the student

with a broad view of Mathematics, that is, without showing him what Mathematics really is. Pinheiro, Alves and Silva (2016) argue that the excessive valorization of the mathematical concepts, reflected in the exhaustive training of techniques, can be the cause of "so much confusion in the distinction of the mathematical objects and their representations." (PINHEIRO; ALVES; SILVA, 2016).

It is interesting to note that what happens in Mathematics is analogous to what is happening in the teaching of the Mother Tongue. Earlier we pointed ou the need to approach the Language in a broader way, contemplating semantic aspects, nowadays not addressed in a satisfactory way. The emphasis given to syntax in Language teaching is reiterated, which, although important, is not sufficient for an adequate understanding of it. It could be said that the teaching of Mathematics follows the same pattern, emphasizing "syntactic" aspects of the discipline, to the detriment of the "semantic" aspects.

These similarities lead us to reiterate the proximity between the two disciplines, here in the sense of the approach given to them. In addition to this, however, we see throughout the work several other facets that encourage reflection on the possibility of a closer approach to these disciplines. In the sequence, this theme will be analyzed in more detail.

Possibilities for Interdisciplinarity between Mathematics and Language

We now intend to conclude the relationship between the studied subjects, Mathematics and Language, as well as the role of Semiotics in this context. In addition, we aim to explore the role of (Expanded) Affectivity for the feasibility of the proposal presented here.

In the course of science, the two disciplines in focus were treated as two entirely separate things. Usually a dissociation between Language and Mathematics is made, sometimes considering them even "antagonistic", leading one to believe that a closer interdisciplinary work among them is impossible. This position is due in large part to the lack of perception of the connection between these areas, noting only their differences. In this sense, we will synthesize what has already been said throughout this work, a summary of the approximations found between them.

The reflections on Language brought contributions to this study, in the sense of pointing out several relevant aspects. The first thing we mention here it is a specifically human characteristic, since the other species that inhabit our planet, as far as we know, do not present even near human abilities in terms of articulated language and high level of abstraction, even if compared to pre-school children. It is thus pointed out that Language is one of the distinctive differences between humans and other species.

In addition, it is necessary to point out that language is a key element in the humanization of the individual, since it only happens in the contact with others, as well as in the exchanges effected with him. These exchanges, however, are enriched significantly by Language. The use of Language allows the communication of complex ideas, elaborated reasoning, at an unattainable level in the absence of this resource. It can be affirmed, therefore, that the use of Language takes the human being to levels inaccessible without it.

Another relevant aspect of Language is its close relationship with thought, one of the themes deepened by Vygotsky. This author points out that thought and language are inseparable, that one is not possible

without the other. One might say that thought provides language, and that language supports thought. There is no way to imagine one of these characteristics happening in isolation in the human being.

In order for Language to be possible, the ability to abstract thinking is necessary, which could be called "distanced thinking" (LOOS-SANT'ANA; SANT'ANA-LOOS, 2014). Language requires a level of abstraction that, as far as we know, is only reached by the human species. This is due to the symbolic character of language. This characteristic is precisely what abstract thinking requires, since there is no way to operate with signs without mastering a relatively high level of abstraction. Although the communication is viable also through simpler structures, the use of arbitrary signs potentiates the possibilities of Language, amplifying it enormously.

Proceeding to the other analyzed discipline, Mathematics, one perceives that it presents several characteristics similar to those of Language. The first of these is its unique presence in the human species. Although other species have some mathematical ability, there is no way to compare them with the human capacity to perform Mathematics.

Also the requirement of abstract thinking is common to Mathematics and Language. It should be noted, however, that Mathematics requires a higher degree of abstraction. In any case, both need this characteristic, and are only made possible by the human being's ability to transit between the concrete and the abstract-symbolic world.

The symbolic character that was observed in Language is another factor of approach between the disciplines. In fact, mathematical symbols allow you to reach levels of reasoning that would not be possible without it. In this way, symbolic notation propulses both Language and Mathematics, being responsible for the advancement of both.

All these similarities lead to the conclusion that Mathematics and Language are fields much closer than conventionally seen. Therefore, it is necessary to review the disciplinary perspective of them, as well as how to work with them, as "opposing" areas. It is also necessary to invest in the perception of the connection between the disciplines, so that an interdisciplinary work becomes viable.

From the TSEA's perspective, the integration of disciplines, the interdisciplinary work, is possible and necessary. Possible because they have similar essences, which makes interdisciplinary work profitable and achievable. Necessary because for a meaningful comprehension of the whole, it is important to explore the different forms of articulation, in search of a holistic vision.

In addition, this Theoretical System advocates the search for balance, for homeostasis, which must therefore be realized in all spheres, including, thus, also that of Education. In this sense, we suggest here an interdisciplinary work between the fields that, par excellence, make use of the signs, and are part of the field of studies of the signifying processes.

According to the authors of the TSEA, the basic configuration verified in the universe has a triadic form. It is necessary, therefore, to complete this pair that we have so far, with a third area, so that the basic functional unit is sought. This is precisely the role of Semiotics in this work. It is perceived as an integral part of this "cell", having the function of emulating, pairing - as in an equation - the two disciplinary areas involved, as well as making possible the transit between them.

Semiotics as a field of studies of signs and signifying processes can provide valuable aid in the proper understanding of how the comprehension of the knowledge covered by Mathematics and Language is given. Both disciplines are part of the great field of studies of Semiotics, as seen previously. Nevertheless, the study of this area is not sufficiently contemplated during the exploration of the mentioned fields, when viewed separately. It is proposed, therefore, the investigation of the adequacy of Semiotics as equalizer between the other two areas, forming the three together, Mathematics, Language and Semiotics, a functional unit that is considered useful for advances in the three fields. We do not inted to approach Semiotics as a discipline, since it stands on another scale, compared to Mathematics and Language, in this work. It would be, therefore, not a third discipline to be contemplated, but rather the area of studies to which the other two belong, and which allows the connection between them.

It should be noted, however, that Semiotics, which is perceived as fruitful for this approach, needs to be catalyzed to be effective. This is because, if treated in the same way that the other disciplines are treated - that is, in an isolated, utilitarian, crystallized way - the expected results can not be achieved. It is therefore necessary that Semiotics be "enlarged", i.e. that it takes into account aspects of human sensibility in order to become profitable. It could be said, therefore, that it is an extended Semiotics, a Semiotics catalyzed by (Expanded) Affectivity.

The role of Expanded Affectivity in this work has already been approached in general terms, and the relevance of its focus when applied to several areas of human life. In Education, its importance is crucial, since it is the area that is concerned with the development of future generations. In the following we will explore, therefore, how (Expanded) Affectivity fits into this proposition.

The role of affectivity in the development of the human being has not received the deserved attention historically. This constellation began to change slowly with the dissemination of the works of several scholars on the ontogeny of knowledge. Researchers such as Piaget and Vygotsky, among others, have significantly broadened research on how children learn, and both pointed out the importance of the affective-emotional environment for the development of infants.

Piaget found that affectivity is the motivating agent of cognitive activity. For the author, affectivity and reason are complementary terms: affectivity is the energy that moves action, and reason is what enables the individual to identify desires, feelings, and success in actions (PIAGET, 1982).

Vygotsky's works, in particular, have revealed the importance of the educator for the development of the child, and the way in which his action should be given to enable this to occur. Being an adept of dialectical historical materialism, Vygotsky understands that the formation of the human being is related to his involvement in the environment in which he is inserted, and thus the affective process is very important for development (BENATO, 2001). For him, the human being is essentially social, and it is in the social interactions that he develops, humanizes himself. Although his theory does not delve into the issue of affectivity, it highlights the need for the connections between the cognitive and affective extensions of human psychological functioning, because it understands that thought has its origin in the field of motivation.

In response to the work of these and other authors, the dualism present in science and school education, prioritizing, in the teaching-learning processes, reason at the expense of emotion, has been questioned. This

vision, hegemonic until a few decades ago, has been dismantled by recent efforts in psychology, which show the uniqueness of the human being, that is, the impossibility of a split between reason and emotions. It is necessary to study the human being as a whole, not just a part of it - whatever it is.

Despite a growing interest in the area of affectivity, as well as the understanding of its importance for education, it is pointed out that teachers' practices have not yet been transformed by these new findings. It is therefore necessary to raise the awareness of teachers about the importance of these aspects in the teaching-learning processes.

In addition, it should be taken into account that the definitions for the affective processes, present in the available bibliography, do not cover their great latitude. Therefore, the contribution of the Theoretical System of Expanded Affectivity (TSEA), which has the potential to broaden our view on affectivity, is presented here. Kloeppel (2014) sums up very well the meaning of the Expanded Affectivity, and of affecting and being affected, the central idea of TSEA, in her text on the "Affectively Expanded Teacher":

> It is understood, therefore, that the Expanded Affectivity is the quality to affect and to be affected in all the types and kinds of encounters and contacts that embrace the existential movement. A movement that implies letting yourself be affected (or not) and know how to affect (or not) in all interactions. Affectiveness in the search for the best possible interactions. It is a movement of interaction with the world (people, animals, plants, objects, ideas), of admiring and causing admiration. (KLOEPPEL, 2014, p. 64).

This movement requires the awakening of sensibility, because without it it is not possible to perceive adequately the *affectations*. Therefore, an education that takes into account the development of other skills but only the cognitive ones is necessary. It is essential, for a healthy development, that the individual is able to grasp and interpret information also by the other senses, and is led to perceive the interactions happening in their dynamicity, being able to act in a way to improve them.

In this sense, it is pointed out that also Semiotics must be seen in this expanded perspective, that is, under consideration of how things affect each other and complete each other. In addition, it is imperative to keep in mind the indispensability of the pursuit for balance among members of any equation from reality that one wishes to represent: in the present case, between Mathematics and Language. This one equilibrium can and should be provided by Semiotics. That is, the Extended Affectivity approach predicts a "happy marriage" between Language and Mathematics, through Semiotics.

We reiterate what the TSEA authors argue about homeostasis and the search for equilibrium. In this sense, the reality

> [...] in order to harmonize, must carry out, in one way or another, some type of dialogue (interactional reactivity) so that homeostasis among the involved elements is reached. That is, reality is always needing to "accommodate" the interactions, at all levels or dimensions. Between the individuals: me and you. Between subjectivity and objectivity. Between energy and matter. Between (abstract) ideas and (empirical) materiality. (SANT'ANA-LOOS, 2016, p. 116).

Thus, in the specific case of Mathematics, a harmonized work with the teaching of the Formal Language is proposed. For this to be possible, however, it is necessary for teachers of these disciplines to have a broader view of the field of Semiotics, and to understand the processes of signification as inherent

to the two areas. In addition, the professionals of these areas need to know the subject of the discipline with which they will work in an integrated way. An interdisciplinary work is not possible if each teacher remains closed only in his discipline, without entering at any moment the field of the area with which he intends to work "interdisciplinarely". This, in turn, requires a work of ergodicity, a study beyond the knowledge acquired by the teacher in his initial formation.

Finally, it can be said that the responsibility of the teacher in this perspective goes far beyond the simple concern with the transfer of knowledge. According to Kloeppel (2014, p.14), "a teacher who can develop a more conscious, intentional perspective for himself and for others, "widening" to the world and its various kinds of interactions" is needed.

We close with a phrase, written by Kloeppel (2014, p. 13) in her dissertation, which translates the hope that we have in education as transforming reality: ¨This movement - the search for quality of life, developing harmony in the interactions, homeostasis - configures a path and goal for a new perspective of seeing and interacting in the world. And this can and should be achieved through Education."

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