# The Spatial Thinking in Pre-primary Education: a Relation between Cartography and Geography

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Abstract. The cultural context underpins the development of spatial thinking and the space-time relationship; i.e., the representation of space. Understanding childhood as a historical and social construction and the conception of the child as subject and protagonist is the basis for the investigation of how the children develop the space and time relationship from their actions and language. Therefore, teaching activities which relate the personal knowledge, the one brought to school by the child with the scientific knowledge are fundamental to the social and cognitive development of the children. Pre-primary Education plays this role, consisting in the first stage of the Brazilian Basic Education, according to the Law of National Education Guidelines and Bases. According to that, the spatial reasoning, through the cartographic language, allows the individual to develop geographic analysis skills, due to the focus of Geography: the study of the relationship between society and space. Thus, it is desirable for children to develop from kindergarten or pre-primary. Therefore, the cartography is not a discipline rather it is a language which has several manifestations due to the many expressive languages of childhood. These aspects have been studied by PhD research (The relationship space-time and the School Cartography in Childhood), which aims to establish theoretical and methodological frameworks to relevant school cartography to children 4-6 years of age, in the other words, the first stage of Brazilian Education. This paper has the objective to present considerations about the cartographic language in pre-primary education as the first approach toward the geographical knowledge through teaching activities for children aged 4-5 in a public school in the state of Sao Paulo and about our research on space and time in pre-primary education. The research has been developed at school with children and teaching situation, producting data for analyze how the children establish the space notions. Besides that the data will be discussed based on the theories of children's drawings (Goodnow 1977), the spatial reasoning established by the children (Gersmehl & Gersmehl 2007)

and spatial taxonomy (Jo & Bednarz 2009), together the Vigostki's theory, comprising the interaction of people as a means of knowledge production.

Keywords: Cartography, Geography, Spatial Reasoning.

### 1. Introduction

Currently, we live in a world composed of different universes and languages, such as technological, and this is also the context of Geography and the school, as they are in the daily life of students and teachers. Therefore, the Geography plays the role of developing the critical faculty in connecting the place, the social and spatial structure and the world.

According to that, the spatial reasoning, through the cartographic language, allows the individual to develop geographic analysis skills, due to the focus of Geography: the study of the relationship between society and space. Thus, it is desirable for children to develop from kindergarten or preprimary. Therefore, the cartography is not a discipline rather it is a language which has several manifestations due to the many expressive languages of childhood.

We should emphasize that the Brazilian researcher Oliveira (1977) states the importance of the development of spatial thinking, because the learning space is essential for the survival of the human body and, due the proportion of land space, men need to manipulate this space.

Years later, other studies have indicated this importance and also further developed issues related to teaching and learning cartographic concepts, based on the theory of genetic psychology of Jean Piaget, and authored theoretical and methodological frameworks especially about primary education. Some of these studies were collected in the book School Cartography, organized by Almeida (2007). These researchers have strengthened an area that until the 1990s did not have many studies at the national level, In Brazil: the School Cartography.

Currently in Brazil, there is a significant increase of publications in this area, as Lastória, Moraes & Fernandes (2013) have asserted. The significant increase in the amount of researches in School Cartography reflects a new moment in the relationship between Geography, Cartography and Education. This means that we are experiencing a period of revaluation of cartographic knowledge as a means of improving the understanding and representation of space in which we live. However, the studies developed in pre-primary are scarce, what concerns us, since this step is the first of Education National and the failure to study it promotes a reference gap to compose your resume. Pre-primary Education consists in the first stage of the Brazilian Basic Education, according to the Law of National Education Guidelines and Bases. Thus, we believe that understanding the development of ways of thinking about space and time in this stage and how children establish spatial reasoning are important and essential for the establishment of theoretical and methodological frameworks in early childhood education related to learning the cartographic language.

These aspects have been studied by PhD research (The relationship spacetime and the School Cartography in Childhood), which aims to establish theses frameworks to a relevant school cartography to children 4-6 years of age, in the other words, the first stage of Brazilian Education. If we go into a early childhood education room, will not be strange the presence of materials and practices for the Teaching of Mathematics, for example, is common to see children exploring and organizing geometric solids, such as Logical Block, which mobilizes the child's thinking for some mathematical relationships. What about the cartographic initiation, which can be developed with children 4-5 years of age, since it consists principally in a language used in geographical studies?

In this paper, we aim to present this research and considerations about the cartographic language in early childhood education as a first approximation of geographical knowledge from teaching activities with children 4-5 years in a public school in the state of São Paulo and our studies on space-time in pre-primary.

# 2. Approach and Method

#### 2.1. Spatial Reasoning and Language in Geography

The cultural context underpins the development of spatial thinking and the space-time relationship; i.e., the representation of space. Understanding childhood as a historical and social construction and the conception of the child as subject and protagonist is the basis for the investigation of how the children develop the space and time relationship from their actions and language.

Thus, the children, from an early age, discover the relationships of objects to each other in daily activities. The action on the things associated with the name of the locations, positions and displacements in space is the main source of spatial knowledge. According to that, the representation of space implies the integration of these two sources of knowledge, which depend on the cultural context.

We know that the cartography consists in a language and geography in a science that deals with studying the earth's surface with all its relations. So how can we define spatial reasoning? This kind of thinking "refers to the knowledge, skills and habits of mind related to the use of: space concepts, Spatial representation tools and spatial reasoning processes (NATIONAL RE-SEARCH COUNCIL 2006)

The researchers Jo & Bednarz (2009) complement this definition, stating that spatial concepts can be distance, direction and region, the representation tools can be maps and other graphic representations and reasoning process is developed for conceptualization and problem solving.

The research of these authors is based on the idea that spatial thinking can and should be facilitated by careful planning, selection and use issues. In this sense, teachers should know which good questions can facilitate this kind of reasoning.

These researchers have formulated taxonomy of spatial thinking, composed of four types of spatial concepts: primitive space, simple space, complex spatial and non-spatial. Space primitive concepts are related to the basic and fundamental characteristics of an existence in space: Specified place identity, location and size.

The simple spatial concepts refer to those established by the set of spatial primitives (e.g., the distance is the interval between the spots) and can be classified as distance, direction, connecting, bonding, movement, transition boundary region, form , reference, arrangement, adjacency and involvement.

But the complex space concept that is derived from simple spatial concepts, the authors present the example of "hierarchy" is developed by the combination of "location" and "size" with other "connectivity". Thus, combinations of simple and primitive spatial produce more complex and abstract concepts. The complex spatial concepts are: distribution, standard, dispersion and grouping, density, distribution, dominance, hierarchy and network, spatial association covering layer, slope, profile, relief, scale and map projection.

The non-spatial concepts are those that do not represent any characteristic of an existence in space, such as population. The spatial taxonomy is showed in *Figure1*.



Figure 1. Taxonomy of spatial thinking by Jo & Bednarz (2009)

Therefore, we understand that the cartographic language embodying the spatial thinking and can be expressed in different ways in Childhood, such as gestures, speech, drawing, object handling etc, so it emits a spatial reasoning. About this, we draw heavily on Philip Gersmehl's studies related to spatial cognition and how children learn Geography.

This author states that geography has as main objectives: 1) to know different places to understand what they mean to people and because in certain places act in a certain way; 2) know how to organize things in our own place. Thus, Gersmehl (2008) developed their research basing on four cornerstone: location, condition, connection and region. Factors involved in what it calls spatial cognition, as to thinking about location and spatial relationship.

His studies indicate three conclusions: a) the brain has structures for spatial reasoning and are fully functional at a very early age; b) adult intervention can improve both the use as the representation; c) practices in the early grades are essential for learning Geography years later (Gersmehl & Gersmehl 2007).

In his studies at a school in New York, Gersmehl, based on neuroscience and Geography, developed a series of activities in which teachers participated in adapting to their students and the problems encountered in the classroom. In the article "Spatial Thinking: where pedagogy meets neroscience" Philip Gersmehl together with Carol Gersmehl claim that spatial reasoning has eight distinct processes occurring in different parts of the brain and also involve different networks of memory, so not to a type isolated intelligence. (Gersmehl & Gersmehl 2007).

According to Gersmehl, Gersmehl (2007), the different forms of spatial reasoning are: spatial comparison, spatial influence, space groups (regions), spatial transition, spatial hierarchy, spatial analogy, spatial patterns and spatial associations.

From these considerations, we indicate the importance for further study about the notions of time and space. This will allow us to study the development of logical principles of geography, which according to Moreira (2011) are the basis for the development of geographical categories.

The logical principles are related to localization, distribution, length, distance, position and scale. Understanding a phenomenon in its geographical dimension is first of all locate, distribute, connect, measure the distance, determine the scale and verify the scale of its manifestation in the landscape (Moreira 2011). These principles consist in the rational raw material of construction of geographical categories: landscape, space, territory. Moreira (2011) discusses the development of these concepts in geographical science, which allows us to expand these questions for teaching, from its principles and spatial representation.

In this sense, the development of these principles and their geographic representations, through cartography, either through drawings, maps, models or other representations, mobilize spatial reasoning and this, in turn, mobilize both to think their own language and representation (Cartography) as well as its concepts (Geography). In this sense, we take the following diagram, dialectically, in *Figure 2*.



Figure 2. Relations between Cartography, Geography and Spatial Reasoning

We understand that there is an integrated relationship, once we understand the cartography as a language embodying the spatial thinking, imbued with geographical knowledge, such as location, distance and connection. It is important to state that we understand that the child lives, experiments and grasps the space to then represent it, which involves several cognitive processes in relation to the concepts of space and time. In this sense, we understand that the development of this language is through a cartographic education and representation is the result of intellectual relationship with reality.

Thereby we take the cartography as a language that allows space-time relations as orientation, distance and location, which provide the basis for understanding the concepts of geographical science (landscape, territory and space). In Geography, we can infer that the space has system characterized by parts into a whole, which should be analyzed and understood as simultaneous and successive. Space is simultaneously the measure that occurs several actions the same time and time is succeeding because there is an order in space itself.

According to that, we assert that space and time notions are built during childhood gradually and within social groups. These aspects are fragmented and are slowly taking some consistency and relations are established, for example the sequence of activities at school or following days of the week. The formation of these concepts does not occur spontaneously and does not follow the immediate activity of manipulation of objects, however, depends on the cultural environment, mediated by language and the actions that mobilize their thinking.

Regarding the School Cartography, knowledge of space by the child from an early age, occurs through the action and language, which involves movement and manipulation of objects and the appointment of places and objects. The action constitutes a source of knowledge along with language, i.e. the symbolic activity.

In this regard, we have found support in the Vigotski's theory about language and the role of memory and imagination on the development of scientific concept. Vigostki's works are an important set of references for the research with focus on the development of thought in childhood, both on the field, where we will develop activities with children, as in the analysis of the records of teaching situations.

Furthermore, language is an essential factor for the apprehension of the space of the body and then to the space-environment. In this sense, language is the means by which it gives communication, utterance and under-

standing, since the word has meaning and significance. The meaning is simultaneously language and thought because it is a unit of verbalized thought, is an inalienable part of the word, because in its absence becomes empty sound (Vigotski 2009). The relationship between thought and language appears as the best aspect studied by Vigotski (2009), who asserts that the development of thought and language depends on the instruments of thought and the child's cultural experience.

#### 2.2. Inquiry about School Cartography in Pre-primary Education

From our readings here exposed, especially in relation to the subject of spatial reasoning, we ask: what is already planned and developed with children 4-6 years old in early childhood education? What elements could be inserted and thought for a proper cartography to this segment of early childhood education? These issues are guided by the hypothesis constructed on the basis of authors discussed above, if the space-time thought starts in childhood, within the social groups, the genesis of cartography is in kindergarten.

Thus, the main theme of this research is the School Cartography as a language in kindergarten. This research will have as a guiding understand "how the children learns, establishes relationship with the world and how identifies and represents the place where lives (Castellar & Moraes 2013)

And then establish theoretical and methodological foundations for a proper cartography to childhood. Although there are books and papers about School Cartography, with different approaches and issues - representation of space in different cultural contexts, knowledge mapping and teacher training, teaching practices with information and communication technologies – the studies about cartography and Pre-primary Education are still few.

The lack of a theoretical and practical support for this segment of Brazilian Basic Education can lead to displacement of practices before aimed at older students for the courses for early childhood education, in order to prepare them for the studies to be conducted in the 1st year of elementary school.

In order to advance towards the knowledge of cartography, this research has been developed with children of four years old in two schools of Early Childhood Education. This age group was chosen because it is the first compulsory stage of basic education, according to the latest change in the Law of Guidelines and Bases of National Education (Brasil 1996) as shown in the following excerpt from the item "the Right to Education and the Duty to Educate": " The duty of the State to public school education shall be fulfilled by ensuring the following: - compulsory and free basic education of four (4) to seventeen (17) years of age." (Brasil 2013). Before that, the preprimary educational was not compulsory.

In the sense, the objective of this research is to establish theoreticalmethodological reference about relevant school cartography to mandatory first stage of basic education. To achieve this, we also seek to understand how space-time relationships occur in everyday school life, investigate the relevance and the approach of spatiotemporal notions in the official curriculum, develop teaching situations, based on the children's universe and the theories guiding this research. We expect to understand the standards established in the graphical representations made by children.

We have performed a careful literature review, selecting books, doctoral theses, dissertations, articles, texts, reviews, documents, and more, that will subsidize the organization of a theoretical discussion of topics such as childhood, school cartography, space-time representation space, cartographic initiation, geography education, early childhood education and child drawing.

To start the first contact with children, we developed some observations to know the environment and establish a contact with them. During this period, we could understand how space-time relationships occur in everyday school life and how children express these elements in their daily productions.

From these observations, we have planned some activities sequences based on the development of spatial skills, discussed by Gersmehl & Gersmehl (2007) - a) comparison; b) aura; c) transition; of) region; e) analogy; f) hierarchy; g) standard; h) association - and three main axes: scientific literacy, education for research and argument, especially regarding the importance of the type of question to be held.

We have conducted detailed records of these teaching situations by filming and notes in field notebook. These are essential to this project due to work with the arguments and speaks of the students in order to understand how analyze and conclude their activities according to Vigotski's theory of language and also in our readings on the argument in science.

As a means of recording and data source, we have written narratives about each activity, which has been complemented with the transcripts and the production of the children. At the end, we will have data to understand the standards set in the graphical representations made by children and thus establish theoretical and methodological frameworks. From our theoretical frameworks, as Vigotski, and our main goal, we take the methodology of participatory research as the foundation of this research. This methodology assumes that the presence of the investigator at place of research provide an understanding of the actions of individuals, in their usual activities and environments.

This methodology in a mode of qualitative methodology, composed of features that allow the researcher to increase the involvement with the environment and the individuals.

Therefore, it is important to emphasize the importance of listening to participants, in the case the kids. This is because the speech with the productions will be documented and analyzed in the study, as the drawings, for example, are informants of the historical moment and childhood. (Gobbi 2002). We emphasize that this is also combined with our understanding of child as an individual entitled, talking and is part of a historical and social context. Besides that, the childhood seen as infans without knowledge, as blank paper, without the right to play, not should have space in contemporary times, which adopts playful analogy in all fields of knowledge (Kishimoto 2013).

## 3. Method of Analyze the Data

The records prepared will be discussed based on the works of developmental psychology and child learning, the theories about children's drawings and the studies of Vigotski, who understands the interaction of people as a means of producing knowledge.

The studies of L. S. Vigotski showed that the emergence of speech in children leads them to develop a new structural organization of action. He attributes an organizing function to symbolic activity which begins with the speech, producing new forms of behavior. There is a convergence between speech and practical activity (action), that children before control their own behavior, control the environment with the use of speech. (ALMEIDA, 2001)

Besides that the data will be discussed based on the theories of children's drawings (Goodnow 1977), the spatial reasoning established by the children (Gersmehl & Gersmehl 2007) and spatial taxonomy (Jo & Bednarz 2009), together the Vigostki's theory, comprising the interaction of people as a means of knowledge production.

So, the spatial skills by children in the activities will guide our analyses, then, our methodological framework about the development of notions space-time in pre-primary education.

## 4. Final Consideration

We shall consider that appropriate cartography to childhood has been committed to provide a bridge between scientific knowledge and the childhood universe, considering the way that is accessible and understandable for children. We believe it is important to investigate some forms of working the cartographic content so that spatial reasoning is mobilized from kindergarten.

In another study, we verified that the sphere, the map and the model are materials which require complex mental operations. However, the use of them introduces some concepts that will be explored in later years in geography and cartography, for example, maintaining a base plane for building floor plan or any idea that the Earth's rotation is the determining factor of the references up / down and right / left (one side and the other). (Juliasz 2012; Almeida & Juliasz 2014).

Is worth noting that this does not mean that the goal of learning programs in Early Childhood Education is the accumulation or the deepening of scientific content, however, develop the capacity to ask, hypotheses, seek information from various sources in connecting them , develop ideas, argue (Galian 2012). Thus, we understand the child as a subject that should have education as a right, based on the importance of learning in early childhood education, as a first approach to scientific knowledge.

The instruments of this research have been developed and released in the classroom, trying to understand the arguments of the children on the spatiotemporal concepts. We know that international studies show that children 3-6 years old can already start identifying places on maps, landscape features in maps and landscapes as well as locate familiar places on maps. Children of this age group can identify, for example, the size of objects (major and minor), but can confuse the scale of an object with the number of objects therefore indicated that at this age the concept of scale should be approached by its principle, increase or decrease an object.

Nowaday, this research is in progress, and we can only discuss its theoretical foundation and the next scientific meeting we will present their results.

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