Spatial thinking in preschool education: the construction of geographic knowledge

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Abstract: *This research starting point was the importance of geographic knowledge in preschool education through spatial thinking, considering the fact that that children can broaden their spatial knowledge. We developed this research as a doctoral thesis in education, and our main objective was to propose theoretical and methodological references for the spatial knowledge of children aged between 4 and 6 years old. The study was based on the following question: Which spatial abilities and concepts can be addressed in activities aimed at developing spatial thinking in children aged 4 to 6 years old? To answer this question and achieve the main objective, we developed teaching situations based on spatial thinking theories, children drawings and concept construction under a cultural and historical perspective and analyzed the patterns established in the children dialogues and their graphic representations as well. The sequence of activities were video recorded and the participants' spatial thinking expression was analyzed considering their gestures, words and graphic representations. The objective of this study was to present the investigative paths and their results. We followed the conception of childhood as social category and the children's right to knowledge, in this case, spatial. Analyzing the research data, we concluded that words are fundamental elements for the concretization of thinking, and drawing is part of cartographic initiation.*

Keywords*: spatial thinking; preschool education; Geography; school cartography.*

Pensamento espacial na Educação Infantil: a construção do conhecimento geográfico

Resumo: *Como ponto de partida, tomamos a importância do conhecimento geográfico na Educação Infantil, por meio do pensamento espacial, pois as crianças podem ampliar seus conhecimentos espaciais. Desenvolvemos a pesquisa em Doutorado em Educação cujo objetivo principal foi propor referenciais teórico-metodológicos para o conhecimento espacial de crianças de quatro a seis anos. Partimos da pergunta: quais habilidades e conceitos espaciais podem ser abordados em atividades para o desenvolvimento do pensamento espacial de crianças de 4 a 6 anos? Para respondê-la e alcançarmos o objetivo principal, desenvolvemos situações de ensino, com base nas teorias norteadoras sobre pensamento espacial, desenho infantil e construção de conceito sob a perspectiva histórico-cultural e analisamos os padrões estabelecidos nas representações gráficas realizadas pelas crianças e os diálogos entre elas. As sequências de atividades são instrumentos da investigação. Para analisarmos a expressão do pensamento espacial, transcrevemos as vídeo-gravações e mapeamos os registros, considerando as palavras e gestos das crianças, e analisamos as representações gráficas das crianças. O objetivo deste artigo é apresentar os caminhos trilhados na investigação e seus resultados. A concepção assumida é a da infância*

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enquanto categoria social e a criança enquanto sujeito de direito ao conhecimento e, neste caso, espacial. Ao longo da análise dos dados de pesquisa, concluímos que as palavras são elementos fundamentais que concretizam o modo de pensar, no caso, a habilidade do pensamento espacial, e o desenho é parte da iniciação cartográfica.

***Palavras-chave**: Pensamento espacial; educação Infantil; geografia; cartografia escolar.*

Introduction

Spatial thinking is a cognitive activity developed in daily living, and can be systematized through different school disciplines, mainly Geography. The spatial concepts, representations and abilities are the components of this type of thinking, and are inserted in the culture. Culture is a critical factor, it allow us to understand the subject's conceptions about the space, e.g., children who live in the city usually represent their living space drawing paved streets and associated elements. Drawings, as spatial representations, concretize an idea about the space, either experienced or imagined.

Understanding the concept of spatial thinking and investigating how it can be developed in a systematized way has become a central issue in contemporarity, marked by the presence of several languages and technological instruments that require the use of spatial notions.

Recognizing the importance of deepening studies on spatial thinking development, we noticed the lack of theoretical/methodological geographical references for preschool education. We emphasize the importance of developing studies in school cartography, once an analysis of The Colloquium on Cartography for Children and Students editions (main event involving researchers in the area) shows that this segment has not been thoroughly discussed; therefore, more investigation on spatial thinking is needed.

Based on this evidence we developed the doctoral research project "Space-time relation and school Cartography in childhood" – research funded by the Sao Paulo Research Foundation (FAPESP) – with the main purpose of proposing theoretical and methodological references for spatial knowledge in preschool education, more specifically children aged 4-6 years old.

To develop the present research, we considered the relationship between spatial thinking, Geography and preschool education elements, once we addressed spatial relations and geographic principles from the perspective of representative problems and topics inserted in the childhood universe, mediated by language.

Language is known to be the essential factor in the cultural context, once it mediates culture. Regarding space, we understand that the cartographic language concretizes spatial thinking and is expressed in different ways during childhood, through gestures, speech, drawings, object handling, etc. Thus, the cartographic language expresses spatial content and thinking.

The objective of this study is to present the investigation paths and results regarding the methodological procedures involved in the activities based on historical and cultural theory, focusing the speech's role in the construction of spatial thinking.

Before presenting our research and results, we describe the theoretical basis regarding the relation between thinking and spatial representation in children's development. Such basis sustained the elaboration, development and analysis of the children's activities, productions and dialogues investigated herein.

Spatial thinking and preschool education

Childhood is secured and protected by law; therefore, children's rights shall be preserved and respected; likewise, their full development shall be ensured. Currently, children are subjects and protagonists, thought as subjects of rights, such as (re) create, play, interact and speak.

Develop a research with children, in which the activities have emphasis on geographic content, enabling the exposure of the children's thoughts and focusing on drawings and dialogues, is to work upon the conception of the child as subject of right. The learning process and children's interaction with other children and adults are facilitated by the school environment, once the school provides contact with people and with knowledge as well.

Children are subjects of the right to acquire knowledge, and preschool education has the purpose of fully developing social, affective and cognitive aspects. The present

research adopted the conception of childhood as a social category, and the child is the subject of the right to acquire knowledge, in this case, spatial knowledge, i.e., children are regarded able to learn, reflect, create, exchange, dialogue, and teach about the space.

Spatial thinking development in preschool education is based on this conception, once it allows the reflection on the space and issues involving spatial abilities, concepts and representations, since childhood, and these elements are critical for the reflection on one's place in the world, associated conditions and connections with other places. In this sense, preschool education environment can provide the development of spatial thinking in a systematized and intentional way.

Spatial thinking can be defined as a type of reasoning that involves concepts related to space, such as location, condition, connection, distance, proximity, graphic and tridimensional representations, spatial materialization through maps and scale models, thinking abilities and cognitive operations of the subjects regarding space and the comparison of places. **Figure 1** shows spatial thinking and its elements, whose intersection is inserted in the culture.

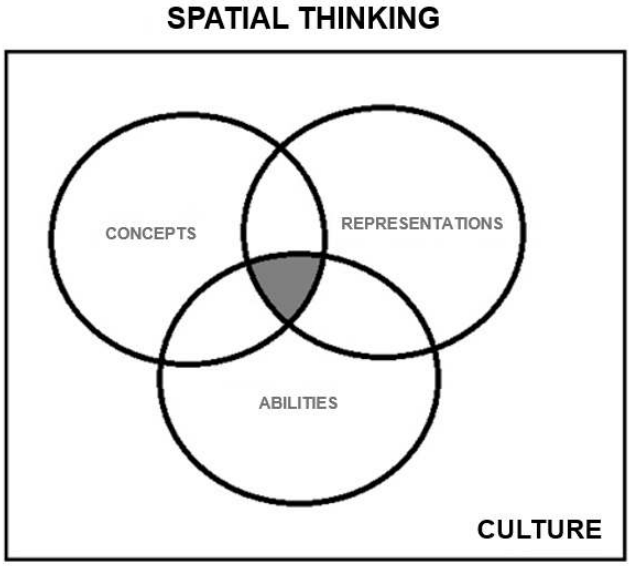


Figure 1: Spatial thinking inserted in culture.
Source: Juliasz (2017, p. 68)

Spatial thinking abilities are modified over time as they are mobilized and challenged. In school age, Geography and Cartography can significantly contribute for the development of this type of thinking, once the understanding of geographic principals

and their cartographic representation, through drawings, maps and scale models mobilize spatial thinking abilities, which in turn mobilize a reflection on the concepts (Geography) and on the representation and language (Cartography).

Spatial thinking abilities correspond to eight operations, according to Gersmehl (2008, 2014), as shown in Chart 1. These processes occur in different parts of the brain and involve different memory networks; therefore, they do not correspond to an isolated type of intelligence.

Basic Spatial Thinking	
1. Comparison	bigger/smaller, rounder/squarer, darker/lighter, redder/grayer. Examples: Iowa is smaller than Texas, Poland rounder than Italy. China has more dots than Australia on this map. Botswana has a darker color than Zimbabwe.
2. Proximity	next to, near, close to, within its area of influence (its "aura"). Examples: cabin near a lake, noisy house near an airport, gas station near an interstate highway exit, refugee camp near a country under civil war.
3. Region	part of a group of places with something in common. Examples: farms with corn fields in the Corn Belt, abandoned factories in the Rust Belt, people speaking Spanish in Latin America,
4. Sequence	in order, along a line, on the way from one place to another Examples: third block along a particular street, grassland between rainforest and desert, middle-age houses between city and suburbs.
5. Hierarchy	inside something larger. Examples: counties inside a state, states inside a country, creeks inside the watershed of a large river, rivers or mountain ranges inside a continent.
6. Analogy	in a similar position in a different part of the world. Examples: ports near mouths of different rivers, neighborhoods near downtown areas of different cities, places in similar positions in different continents.
7. Pattern	arranged in bunches, lines, arcs, waves, or other non-random ways. Examples: forts in a line, coral reefs in a ring around an island, oil wells in a bunch in one part of a country, sand dunes arranged like waves in a desert.
8. Association	tending to occur together with specific other features. Examples: stoplights at major intersections, people with malaria in places with A. mosquitoes, earthquakes at borders between crustal plates.

Chart 1: Summary of spatial reasoning basic processes.
Source: Gersmehl (2014).

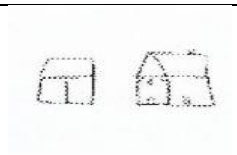
Our research was based on the integrated relationship between concepts, abilities and spatial representation, once we understand Cartography as a language that concretizes the spatial thinking embodied by geographic knowledge. While developing their spatial thinking, children live, experience, assimilate the space, and further represent it, and this involves several cognitive processes associated with the concepts of space and time.

The drawing of the space mobilizes the thinking to spatial relations, to solve a problem involving the concept of volume. The child deals with the problem of tridimensional

projection of the reality to the paper in a bidimensional format. Therefore, the map made by the children introduce notions of space representation, as well as the idea of a map while social production. While drawing, children think about the space and particular geographic knowledge can be introduced.

A child's drawing is the result of a symbolic game in which the child creates symbols to represent scenes and experiences new forms in constant transformation over time. The graphic representation is a way for expression and action in the environment, a language – among other expressing mechanisms used in childhood – used, created and recreated by the child. This language is the product of the human creating activity, grounded on the relation between the subject's memory and imagination. (VYGOTSKI, 2009b).

To understand the development of children's drawings regarding the human figure and spatial representations, Greig (2004) discussed the representations of volumes and space organization, i.e., the problem of three dimensions, which starts to be explored between the ages of five and eight years, sometimes four. The graphic representation of the space can be defined by four stages for thickness definition, according to Greig (2004): one-point perspective, syncretic conjunction with rabatments, search for depth and conventional perspective. The author performed a study on the drawing of a table with cutlery, which in some moments are continent, and, in others, the table profile, indicating two points of perspective. The same occurs with drawings of houses, i.e., after some time the child is not satisfied with the frontal view and starts to use cubes in the drawings. In this phase, the volume starts to be represented (**Chart 2**).

Organization of volumes and space	
Type A - *Single point of perspective* Space with ground line, grass, flowers Space with a line delimiting the sky or clouds Space with three bands (ground, free space, sky) Space with a line representing the skyline (including hills or mountains) Juxtapositions or stereotypes	
Type B - *Syncretic junction* Rabatments Overlay transparencies Action materialization	

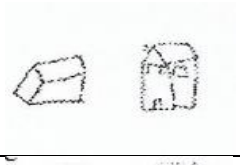
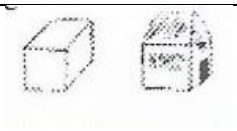
Type C - *Attempt to represent depth* First manifestations of interruption – continuity Start to coordinate positions and plans Schematization transparencies (interior part of bodies or houses)	
Type D - *Conventional perspective* Good use of interruption-continuity Good coordination of positions and plans (e.g. circle)	

Chart 2: Components of volume and space organization.
Source: Greig (2004, p.227).

In addition to the elements that constitute spatial thinking, it is necessary to consider *the children's knowledge to represent the space.* According to Piaget and Inhelder (1993), spatial representation by the child begins with topological spatial relations, characteristic of elementary relations under a theoretical reconstruction of the space point of view. This type of spatial notion comprises the following abilities: 1) spatial location (neighborhood relation, involvement and continuity); 2) proportion relation (size); 3) perspectives (unfolding and rabatment); 4) graphic equivalents (symbols). These spatial relations do not consider distances, measurements and angles; however, they involve elementary and fundamental spatial notions that support the development of other relations, e.g., Euclidean and projective relations.

The notion of neighborhood consists in the perception and representation of close objects, in relation to each other, and is expressed by terms as *beside, near, far, there*, when children start to understand that objects are not united, the notion of separation starts to be developed. This notion allow the children to perceive that each object has a location that can be expressed by terms as *between, in the middle of, below, above.* Likewise, the notion of order and sequence starts to be developed, once objects are close to each other and separated, following an order. The notion of order can be expressed by the terms *before* and *after*, mobilizing the notion of time as well, promoting the ability of spatial transition, the cognitive operation that establishes the order of objects in the space.

The notion of neighborhood is a fundamental character in the space constitutive actions, once the space is a continent composed of interrelated parts. The notion of separation, involvement, order and thinking abilities and spatial hierarchy are developed from the understanding of these parts.

When we approach displacement in a particular environment, as the school, the children start to perceive, in their daily routine, that the rooms can be close to each other, separated, they are placed in an order; additionally, the children notice that the rooms are part of a bigger environment, the school. Thus, children understand that an object is connected to others and the notion of involvement starts to be developed and expressed through the terms *inside*, *outside*, *next to* and *between*.. Through these notions, children start to conceive of space as continuous, without ruptures.

When discussing space representation, we have to consider that it is a social construction, involving the school, the family and the relations of the children, in addition to movement and dislocation in the environment. How do children perceive the space? In what sense they understand spatial relations? To answer these questions, we must understand that the first space for children is the body. From the perspective of the body, children construct the notions of front/back, on/under and right/left. The space of the body, which children discover since they were born, gradually opens to the exterior space, the space of the things. Manipulating objects and naming places, children start to deal with a strange space, the one that is not their body, the one of which their body is part.

Dealing with spatial issued involves the learning process, and the teacher can help the children explore broader and more real spaces. To reflect about the school's role in this process, we must understand what Hannoun (1977) named evolution of the ways children apprehend space.

The space apprehension evolution corresponds to three essential stages: lived space, perceived space and conceived space. The first stage consists in experiencing "here", in which children experience distance through the movement of the body. A common example observed of this stage is the children's attempt to reach very distant objects, ones that only their sight can reach, e.g., tree leaves. This stage comprises the physical space.

As this physical space starts to be thought without the need to be experienced, children advance to the perceived stage, where they are able to analyze a particular space through a photograph, observing the arrangement and the distance between the objects. In this stage, children start to understand that the space dos not need to

be physically experienced to be understood, and that there is a 'here' space and a 'there' one. Hannoun (1977) understands that the perceived space consists in the analysis of the "there", and the comprehension of the arrangement of a non – experienced space consists in the geographic science field.

Based on the framework developed over the two previous stages, eleven/twelve year-old children start to apprehend the conceived space, the abstract space. The shape is not related with a concrete content; it corresponds to relations, e.g., geometric shapes, as a square. "These stages are correlated with the child's development, from concrete to abstract, from physical to mental, from experience to reflection. Respecting children with our pedagogic actions involves respecting the laws psychologists established for us." (HANNOUN, 1977, p. 78).

Children live, experience and assimilate the space before representing it, and this involves cognitive processes associated with the spatial concepts. Thus, representation is the result of the intellectual relationship with the reality and the material representation of space through a map, drawing or a scale model, it derives from graphic language learning, and, in the case of spatial representation, cartographic language.

According to Hannoun (1977), the development of spatial notions involves five main aspects: space orientation, the object in space, the relative position of the objects in space, distances and measurements. Space orientation is formed by three main categories that are related to body-space: laterality (left and right), depth (above-below, ceiling-floor, on, under, over-under) and anteriority (front/back, right/left, ahead/at the back, before/after).

To understand the objects in the space and their relations, children need to develop the notion of composition, distinguishing the characteristics of the object itself. Four categories are involved in this process: interiority - what composes the object (in, inside, in the interior), exteriority – what does not compose the object (outside, what is excluded) and delimitation (extremity, end, limit, along, around).

For young children to understand the peculiarities and individuality of an object (as a window in a wall, something not obvious of already constructed), object recognition occurs in a syncretic way. Even in the comprehension of a landscape, it is difficult to

comprehend the peculiarities of each object or place constituting the whole. The observation of the peculiarities of an object is an ability, and can be developed in preschool education activities and in the interaction of the teacher with the children and among the children, in a way that spatial thinking and concepts are mobilized.

After comprehending the object, children will be able to relate it with other objects, i.e., understand the relative position of the objects in the space, considering the following categories: 1) interiority - object B is inside object A; 2) exteriority - object B is outside object A; 3) intersection - object B crosses object A; 4) continuity - object B is in contact with A (**Figure 2**).

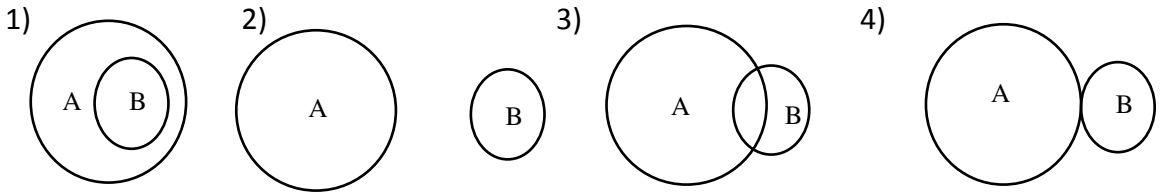


Figure 2: Main categories of relative position of objects in space.
Source: Adapted from Hannoun (1977, p.87).

The concepts of distance is assimilated over the years and is associated with the position of the objects in space. To understand the development of the concept of distance, the teacher must understand three categories: proximity, through the notions of 'near', 'beside', 'nearer', 'here' and 'this'; ; distancing, through the notions of 'far', 'in another place', 'farther', 'there', 'that', 'infinite'; intervals, which involve distance and repetition through the notion of object separation from place to place, and contiguous and noncontiguous. Almeida and Passini (2013), based on Hannoun (1977), concluded that these categories can be applied to the geographic space, and exemplified an urban area study.

> Initially, the students will distinguish urban areas (houses, streets, industrial and commercial premises, warehouses, etc.), what is found within this area, and non-urban areas (farms, reforestation areas, roads, etc.). The confrontation of such areas allows their delimitation. (ALMEIDA; PASSINI, 2013, p. 43)

According to Almeida and Passini (2013), these operations require the classification of elements, i.e., what is similar between the places, the elements that make them urban

or non-urban. This type of operation corresponds to the ability of spatial comparison. (GERSMEHL, 2014).

Therefore, the spatial notions approach in preschool education is pertinent, developed through activities that mobilize spatial thinking from contextualized spatial concepts, focusing on geographic knowledge.

The investigation path: theoretical and methodological assumptions

The lack of theoretical and methodological support for preschool education regarding spatial thinking can lead to a displacement of contents and practices developed in the initial years of fundamental school. Moreover, spatial thinking is progressively developed. It starts at early age, with the observation and manipulation of objects. Posteriorly, through displacement in the space, crawling and walking, establishing the relations 'front/back', 'from one side to the other side' and 'on/under'.

These are spatial notions with which children start operating at home, with the mediation of adults and other children; however, the school can work such notions in a contextualized way, relating them with space-related issues. Thus, it is necessary to investigate the spatial representations and abilities, as well as the geographic principles through practical activities with children aged between five and six years old. The central research question is: which spatial concepts and abilities can be approached in activities aimed at the developments of spatial thinking in children aged between 4 and 6 years old?

To construct this research question, we worked from a theoretical body on spatial thinking and on the development of concepts in childhood, having as central point the understanding of how children establish spatial relations in their surrounding context and in relation to Geography themes.

To answers the research question and achieve our main objective, specific objectives constituted the guidelines for the development of the investigation:

a) Investigate and analyze spatial thinking pertinence, possibilities and approaches in preschool education

b) Develop teaching situations, based on the children's universe and on this research's guiding theories (GREIG, 2004; VIGOTSKI, 2009a; GERMEHL, 2008), allowing the creation of new forms of spatial representation

c) Analyze the patterns of the children's graphic representations

d) Analyze the elements of spatial thinking inserted in the dialogues and argumentations.

Analyzing the children's interaction through gestures and speech, as well as their production, we found elements that show the construction of thinking, once both words and drawings are representations constructed upon reality.

The study of dialogue and graphic representations requires a qualitative methodology in data construction and analysis, ensuring coherence with the research objectives and theoretical references. Such methodology allows us to interpret the children's dialogues and identify which spatial thinking abilities are being developed in the activities proposed.

We used a video camera for data collection. We conceived of this material as an essential instrument for the development of the whole research, once recording allowed us to capture the students gestures and speech with precision, registering what our memory or visual field are not able to apprehend (Carvalho, 2011). Moreover, the speech as students' representation is fundamental in this research, to comprehend how they analyze and conclude their activities, according to Vygotsky's view on the language theory and the role of words in spatial thinking development.

However, to establish the relation between the empiric activity and theory, the recordings must be transformed into data, in a process of sense construction that requires from the investigators the description of the nature of their interest throughout the whole investigation process, from the initial stages of research questions formulation to the final phases, in which the results are presented. (MARTINS, 2011, p. 300).

Thus, based on Martins (2011), we mapped the recordings to extract relevant elements for the research, according to **Chart 3:**

Functional Classification	Activity	Semiotic modes			Central concepts	
		Verbal	Visual	Gestural/Action	Spatial reasoning	Spatial concepts

Chart 3: Record mapping model.
Source: Adapted from Martins (2011, p. 311).

This is an important tool for the construction and analysis of data, and allows the identification and illustration of the activities. “Unquestionably, neither the map nor the transcription describe the sequence of events in the class in an objective and complete way; however, these tools indicate the significant elements regarding our specific interests.” (MARTINS, 2011, p. 311).

Our main interest was to listen to the children and allow their interactions, aiming to understand how they establish spatial relations and which spatial thinking abilities are explored in the problems we presented in a sequence of activities.

The didactic sequence and the role of words in the construction of spatial notions o

The investigation field was structured based on three sequences with the central concept of location. The first sequence had the main objective of understanding, through the identification of the places belonging to the way walked by the children, that this way – the whole – is composed of parts: the places.

In this specific proposal, we tried to develop the idea that the rooms are part of something bigger, the school, and that there is a transition between the places, i.e., a sequence of rooms. While elaborating this sequence, we considered as possible abilities the spatial comparison, hierarchy and transition. The sequence of activities is described in **Chart 4**.

Activity	Sequence and development	
How can we map the way from the gate to the classroom? *Mental Map*	*Can we map the way from the gate to the classroom?* Objectives Exercise the memory and create a map of the way from the gate to the classroom; Create graphic equivalents corresponding to the places and objects Material Paper and crayons Dynamics Conversation about the use of the map; Graphic representation of the way gate-classroom; Conversation about the productions	*What else can we see in the way?* Objective Think about the way and the aspects that might have been forgotten in the first representation; Create graphic equivalents corresponding to the places and objects Material Assembling toys, paper and crayons Dynamics Conversation about the way; Walk through the way; Representation using assembling toys; Drawing of the way

Chart 4: Sequence of activities: What is the way from the gate to the classroom like?
Source: Juliasz (2017, p.40).

In this activity, the children expressed the spatial sequence through the words *and, then* and *after*, in a way that the continuity and spatial order involved time-space notions. The main concept presented to the children in this activity consisted in the connection and articulation of the school places, expressed by the verbs as *pass* and *enter*, indicating the action in the space. Therefore, the **transition ability,** or spatial sequence was mobilized when the order of the way was problematized from a place to another. The dialogue below clearly demonstrates what we call transition ability: ISA presents the objects and places, the door, the cafeteria and the room, while PAO describes the same way using the words “I enter, have breakfast and come here” (the classroom). The words that correspond to the spatial transition, according to Gersmehl, such as “first/after/last, between, before/after, moderate/steep [inclination] / gradual / abrupt”, can be *and*, *then*, *after* when we are analyzing the thinking expressed by the children’s words.

> ISA: I *pass* through the door, *after* I pass through the cafeteria and through the room...
> PAO: When I am in my house, the gate of my house... the gate is of the street... then my mother closes the gate, I pass by the houses and I arrive here...
> Researcher: And when you arrive here, which is the way?
> PAO: I get in, have breakfast *and* I come here...

The same activity, developed in a larger school, in which the classroom was on the first floor of the building, the children made other relations, which were not found in the smaller one. The spatial influence ability was present when the children indicated the notion that we were above the children education center, called "baby school", a referential to locate the classroom and the connection between the places.

> Researcher: Where is the baby school?
> GREG: Down here... (making gestures, pointing to the floor)
> MIG: Down... (making gestures, pointing to the floor)
> KEI: Down...
> NIC: Down here, under the pink room...
> Researcher: Down here... To visit the babies, what should I do? I would get to the CEU (education center) gate, pass by the swimming pool, and then? Should I go up the ramp or not?
> Some children: ([Yes])...
> MIG: No... there is a gate to enter there...
> Researcher: What if I go up the ramp, where am I going to get?
> MIG: Here...

When the children talked about the places that constitute the whole, we noticed the use of words as *inside* and *outside*, expressing spatial hierarchy abilities and developing location notions. Talking about the way they walk in the school every day, the children used the word "pass", demonstrating action in the space and mobilizing the spatial transition ability. We consider the use of words evidences of a type of thinking associated with spatial thinking, once the word consists in generalization, in this case, regarding a spatial order problem.

> Word meaning is a phenomenon of thinking only to the extent that thought is connected with the word and embodied in it. It is a phenomenon of speech only to the extent that speech is connected with thought and illuminated by it. Word meaning is a phenomenon of verbal thought or of the meaningful word. It is a unity of word and thought. (VIGOTSKI, 2009a, p. 398)

While we walked together throughout the school, the children talked about the characteristics of the places, such as color and shapes, and made comparisons. When the children talked about the location of the buildings inside the educational complex,

the concept of distance or proximity was mobilized through the central words *near* and *far*, involving the abilities of transition and spatial influence.

The notions of representation were applied in two moments, in the assembly of a scale model and in the elaboration of the drawing. While making the scale models, the children established relations regarding the number of pieces and buildings and shapes – represent the three swimming pools and the round building.

Based on the notion of spatial transition by Gersmehl (2008), and understanding their direct relation with graphic representations of the way, we classified the children's productions performed in the first sequence in three groups, with the objective of understanding the patterns found in the productions (**Chart 5**):

a) Relation between places: the drawings showed relations between the places that constitute the way. In this category, it is important to understand how this relation is established through the signs created by the children;

b) No relation between the places: the children presented the places that constitute the way; however, they did not establish an explicit relation between them;

c) Line and dots: the children referred to lines and dots as 'way'.

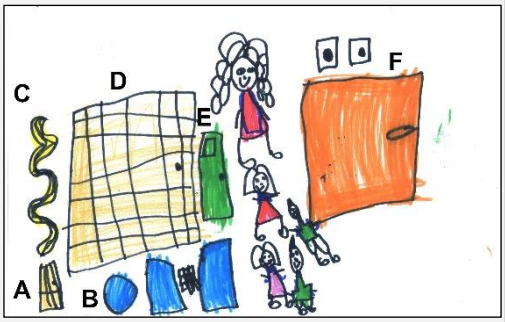
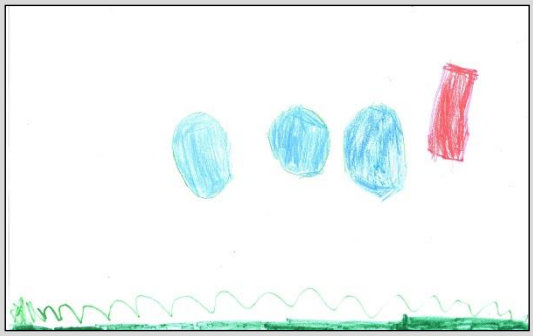
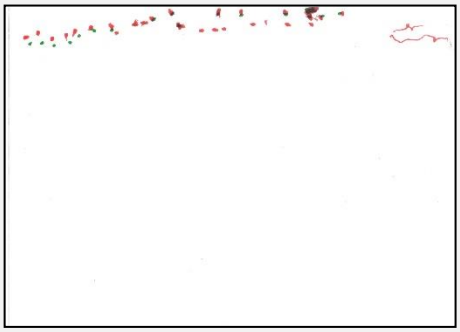
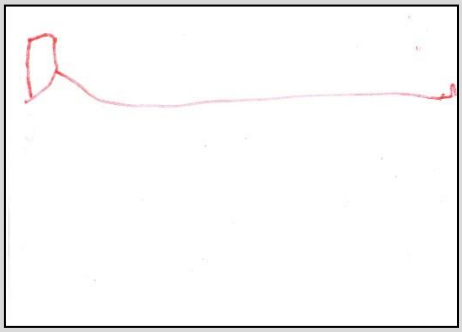
Category	MAP 1	MAP 2
Relation between the places		
	NIC (5,10)	NIC (5,10)
No relation between the places		
	HEL	ART (6)
Line and dots		
	LUK (6,4)	LUK (6,4)

Chart 5: Categories and maps.
Source: Juliasz (2017, p. 107).

The first drawing contains a ground line and the school building from a one-point perspective, corresponding to type A volume and space organization proposed by Greig (2004). This drawing also presents aspects of type B, with a swimming pool, indicated by letter A, with rabatment, as if it was seen from above, from a vertical perspective. The line surrounding the swimming pool finishes in the building and

presents evidence of depth (type C), once it consists in a pedestrian pathway, still incipient, considering that spatial hierarchy is not consistent yet.

The second drawing of the first category presents two main points that reveal the spatial transition: the gate, the beginning of the way, and the school building, the end of the external way. In this drawing, the space has three bands - ground, space filled with elements present in the way, and sky, with the sun – and some depth in the ground, in the pedestrian way and in the rabatment of the three swimming pools.

HEL's first drawing in the second category shows a sequence in the order of the elements in the two drawings. We see a gate (A) followed by three swimming pools in the foreground, in the bottom of the page (B), and, above, a sequence walked by the children in their everyday routine: the yellow ramp (C), the gate with bars (D), the door (E) and the orange room door (F).

In this drawing from memory, we notice the doors drawn from a one-point of perspective, frontal, aspect type A, also, the rabatment of the swimming pools and the ramp, aspect type B. The repetition of the doors could be understood as stereotypy; however, knowing the way and listening to HEL, it was possible to go beyond mere repetition and understand this element as important for the child, once it is an essential to establish the sequence in the drawing.

The drawings organized from the ground line imply a spatiotemporal sequence, once the spatial transition is mobilized and represented considering the order of places and objects in the represented space.

Chart 6 shows the spatial concepts, the words and abilities expressed by the children throughout the activities about mental map. The concepts of connection and articulation operated by spatial transition were expressed by the words *and, then, after* and several verbs describing action in the place, e.g., "pass", showing the connection between the places in the way. The connection is also present when the children say that the school of the younger children is under their school. This observation demonstrates the spatial influence, once the position occupied in the space influences the position of the other.

Comparing the buildings and rooms by their size (smaller or bigger) or by the colors and shapes (blue building and round building), the children were analyzing, isolating characteristics of a bigger space, initiating the principles of condition as well as

location, developed throughout the activity, mainly when the children dialogued about being inside or outside the school.

Mapping the way		
Spatial concepts	**Words**	**Spatial abilities**
Connection and articulation	and then after verbs (action in the place)	Spatial transition
Condition	bigger/smaller colors and shapes	Spatial comparison
Location	inside/outside	Spatial hierarchy
Connection	on	Spatial influence

Chart 6: Relation between concept, ability and verbal representation.
Source: Juliasz (2017, p. 109).

Spatial transition is related to the notions of time and space together through the sequence of places, having the word “between” as key in the thinking mode, once it consist in moving from a place to another. The central question is “what is there between the elements (e.g., places) in the space?”

Chart 7 shows the relation between this activity and the respective components of spatial thinking, as well as the knowledge regarding space representation based on Hannoun (1977) and Piaget and Inhleder (1993).

Sequence of activities	Concepts	Abilities	Drawing of the space	Knowledge regarding space representation
How can we map the way from the gate to the classroom?	*Location* Fundamental to locate places and objects *Map* Space representation *Condition* Classification of the constituting elements of a place or object *Connection* How places and objects are connected	- *Spatial comparison* Classify the aspects that are similar and different comparing two spaces. Word: more/less, wide/narrow, bigger/smaller. - *Spatial transition* Identify the order of the objects and places in a space. Words: before, first, after. Words: and, then, after and verbs. - *Spatial influence* Verbalize the position of an object or place using another one as reference. Word: above/below. Word: on - *Spatial hierarchy* Identify that a place or object is inside or outside a particular space Words: inside/outside	- *Frontal view* ground line; one point of perspective - *Vertical view* syncretic junction - order of the places without graphic indicator - Creation of equivalents	- *Orientation* Displacement: ahead, from one side to another. - *Relative position in the space* Interiority: an area inside another one; Continuity: adjacent areas *-Topological spatial references* neighborhood, order, separation, involvement

Chart 7: Activities, spatial thinking and representation.
Source: Juliasz (2017, p.158).

Conclusion

The construction of concepts occurs through the relation between thinking and words, which implies in teaching procedures in which the students are active, i.e., allowed to speak, create, remember, reflect and imagine. The pedagogical proposal must be based on a dialectic perspective on children's learning and development, aiming to broaden children's knowledge.

Preschoolers understand a proposed problem and develop functional equivalents to adult concepts; however, they do not operate in more complex concept levels, once the reasoning mechanisms are different. One of the school roles is to develop concepts and provide conditions for the children to obtain knowledge in an active and participative way.

In the scientific context of school cartography and preschool education as part of basic education, research on space representation – theoretical contents associated with spatial representation, cartographic language, mental maps and representation of social and spatial concepts – and teaching methodology – theoretical and practical studies on didactic paths in school cartography teaching is fundamental.

Throughout the research data analysis, we concluded that words are fundamental elements to concertize the thinking mode, in this case, the spatial thinking ability.

Children express the abilities of comparison, transition, hierarchy and spatial influence through words. In addition to these abilities, the proposed activities mobilized the different forms of spatial representation and other knowledge regarding the representation of space, such as orientation, topological space relations and relative position in the space.

The concepts of location, condition, connection and mapping were present according to the childhood context, as well as spatial representations expressed in different ways. These four aspects – concept, ability, representation and knowledge regarding spatial representation – compose the activities and references to develop spatial thinking focusing on geographic knowledge.

The development of spatial concepts through contextualized and intentional activities allows students to access ways of thinking that will subsidize other types of knowledge about space, representing a meaning network for the children. Words play a fundamental role in the construction of concepts, once they materialize a generalization, a thought, and, dialoguing with others, the children learn other words and senses, i.e., meanings.

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