Experience report

Working with Space and Shape in Early Childhood Education: Experiences in Collaboration

O trabalho com espaço e forma na educação infantil: Experiências em colaboração

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Abstract

This report shows the experience of a work conducted with the Meli-Melo puzzle in two early childhood education classes at two different schools in the state of São Paulo, Brazil. With the work's activities as a starting point, aspects related to space and shape, as well as quantities and measures, were approached. Children from two and a half to five years old participated in the playful activities, which had the following goals: to develop spatial and geometric skills, to allow measuring actions, to favor dialogue and to boost group work experience. There were several activities, like handling the pieces, assembling images freely or according with outlines and models, assembling three-dimensional figures, and the length game. The following questions were considered in the evaluation of the work: how was the children's participation in large groups and small groups? How did children of different age groups engage in the different proposals? Which activities were easier or more difficult for each group? Which behaviors and conversations showed us new knowledge? The fulfillment of the planned activities showed that the children had several hypotheses regarding shapes and that they were able to identify similarities and differences, use geometry vocabulary, and discuss their thoughts, particularly when working in small groups, which favored the participation of nearly all children. We believe the work reported has allowed learnings and a contact with mathematics in early childhood education.
Keywords: Early Childhood Education. Learning Mathematics. Puzzles.

Introduction

In this article, we report the process of collaborative planning and development of two didactic units using the Meli-Melo puzzle with children of two early childhood classes in two different schools in the state of São Paulo to approach the teaching and learning of geometry, quantities and measures on this educational phase.

We begin the text by presenting a few reflections about children's mathematics education as a knowledge that is important and necessary to their development, as well as the theoretical conceptions that underpin the work we conducted. We be-

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lieve it is important for educational units to plan and develop pedagogical practices based on investigation, dialogue, games and reasoning in order to allow students to learn mathematics and other types of knowledge on this important phase of their education.

In the course of this article, we present the GEProMAI (Teachers Mathematizing in Initial Years Study Group) as the context which allowed discussions about children's mathematics education, and, in turn, motivated this work. The GEProMAI is a study group linked to the Pontifical Catholic University of Campinas (PUC-Campinas) which seeks to articulate theory and practice, having investigation as one of the key elements of its work.

Then we present and comment on the didactic units we developed with the two early childhood classes, and analyze what the children learned from their involvement in the activities.

Reflections about Mathematics Education in Early Childhood

Mathematics education in early childhood is a relevant, up-to-date subject for both researchers and teachers/educators working in early childhood education institutions. Organizing the curriculum, defining the topics to be approached, indicating or planning pedagogical practices and the best way to conduct the teaching and learning of mathematics in an educational environment with young children are important questions. They mobilize studies and reflections about learning and teaching mathematics at this education level and are relevant subjects that make up a teacher's professional knowledge.

National official documents such as the National Curriculum Guidelines for Early Childhood Education (BRASIL, 1998) and the National Curriculum Guidelines (BRASIL, 2010), which guide the teaching of mathematics for this educational phase emphasize that mathematics must be approached by starting with contexts that are multiple, varied, and meaningful to students. Therefore, when it comes to designing pedagogical proposals involving mathematical content, one cannot dispense with a dialoguing perspective or the exploration of various practices that enable learning.

Mathematical knowledge in early childhood is discussed by authors who study learning practices and contexts that can provide viable routes for children to start their contact with mathematics. Articulating mathematical topics and children's literature, using various games, playing, proposing investigations on and solutions for problems adequate to this educational level are considered important practices for approaching mathematics in early childhood education (MOURA, 1995; LOPES; GRANDO, 2012; LORENZATO, 2006).

Using well-known stories for children, such as fairy tales, and having children produce short texts and stories, are considered strategies which promote mathematics learning. To Oliveira and Passos (2008), these interdisciplinary practices are important to educate very young readers, in addition to allowing autonomy of thought and the establishment of relations and inferences that can be conjectured on, explained, or countered.

In discussing a curriculum perspective for early childhood, Lopes and Grando (2012) indicate that problem solving must be valued, promoted, foreseen and sus-

tained on this educational phase, since various opportunities for solving problems occur in the context of a child's life. To the same authors, approaching problem solving in early childhood education facilitates cooperative learning and promotes the diversity of ideas, which allows children to experience a constant process of communication and appropriation of mathematical procedures.

Using games in early childhood education is another subject approached by researchers in the area. According with Moura (1995), games can be classified in two main types: learning-triggering games and application games. To her, this differentiation is not established by the toy or the game itself, but rather it depends on how they will be used with students. She also stresses that it is the teacher's attitude, the dynamic created, and the goal that is set for the game which will put it in one classification or another.

Considering the proposals presented by the various authors who discuss mathematics education in early childhood, we believe it is fundamental for the pedagogical practices used on this educational phase to value children's interest, thought and feelings, thus promoting interaction, games, experimenting, discovering, establishing relations, reflecting about a question, proposing hypotheses, considering colleagues' ideas, arguing, and other opportunities.

The studies about the importance of literature, investigations, problem solving, and games in early childhood education, as well as the situations these authors found concerning the difficulties met in their teaching of mathematics – particularly geometry, quantities and measures – on this educational phase motivated the planning and elaboration of didactic units using the Meli-Melo puzzle. The experiences we will report in this article took place in two different early childhood education institutions in the state of São Paulo, with two classes, one formed by children ages 2 to 3 years old (class 1), and the other with children ages 3 to 5 years old (class 2).

The Collaborative Context in Planning, Elaborating and Analyzing the Approach to Geometry in Early Childhood Education

The GEProMAI (Teachers Mathematizing in Initial Years Study Group) was formed in 2014 from a desire shared by several people to study the mathematics approached in early childhood education and the initial years of primary education. It is worth stressing that by initial years we mean the beginning of basic education, which comprehends early childhood education and the first stage of primary education (1st to 5th grade).

The group is formed by teachers working in basic education and graduate researchers who come together to study, problematize, investigate, understand and produce knowledge about teaching and learning mathematics in the beginning of basic education. We consider GEProMAI a collaborative group, as participants are committed to the collective in a voluntary way. Therefore, the organization of themes and study/work schedules are collectively planned and defined, and discussions about mathematics teaching and learning are based on mutual respect (FIORENTINI, 2004).

Discussing teacher practice is considered fundamental for teachers to participate in the group:

> A constitutive element of GEProMAI which we deem relevant is the possibility to discuss pedagogical practices at meetings. We plan classes, develop activities, and elaborate records for further discussion. The practice accounts highlight not only details of activities and interventions, but also the dialogues, hypotheses and procedures conducted by students in classes. (ALMEIDA et al., 2014, p. 183).

The writing of this work derived from studies conducted in the group about geometry, quantities and measures, and the discussions about how this subject could be approached with children. The teachers stressed that intentionally approaching mathematics did not occur very often in the early childhood institutions they had worked for, and, due to their participation in the study group, they were creating a few actions involving geometry. Another discussion that emerged in the group was the feeling that geometry is always and almost exclusively related to its approach with multi-base blocks and/or their naming. Teachers Karina and Gislaine said they were interested in using games and problem solving more effectively to promote mathematics teaching and learning with their classes. Therefore, we decided to elaborate three different didactic propositions based on the Meli-Melo puzzle, which was originally created as a toy consisting of 5 pieces: 3 isosceles rectangle triangles; 1 square; and 1 rectangle trapezoid (SMOLE; DINIZ; CANDIDO, 2003).

It is worth stressing that, although we were working in a specific subgroup to conduct the activity, the interaction with the other GEProMAI members remained constant. During the meetings, accounts of the conduction of the activities with both classes, as well as children's engagement, the learnings observed, and remarks about the most pertinent questions in each situation were shared with the members of the group.

The Activities Conducted with Each Class in Early Childhood Education

We start detailing the actions by considering a multi-age group with children ages 2 to 3 years old. This class has 28 students, and the pedagogical work is conducted by a teacher and an early childhood education assistant.

To allow children contact with the Meli-Melo, the teacher made the puzzle from color poster paper. First, the children got to freely explore and play with the material, and they spontaneously tried to form a few figures with the pieces.

Figure 1: Becoming familiar with and exploring the poster paper Meli-Melo.

Source: the authors' archive

After this initial phase, the teacher presented a succession of proposals which were conducted over the week. In this group, the following activities were conducted:

1. Introduction and dialogue about the Meli-Melo puzzle in circle.

• The children freely explored the pieces in a large group and in small groups.

• They manipulated and observed the pieces and talked about their differences and similarities.

• They commented on and compared the shapes of the figures with the objects in the reference classroom.

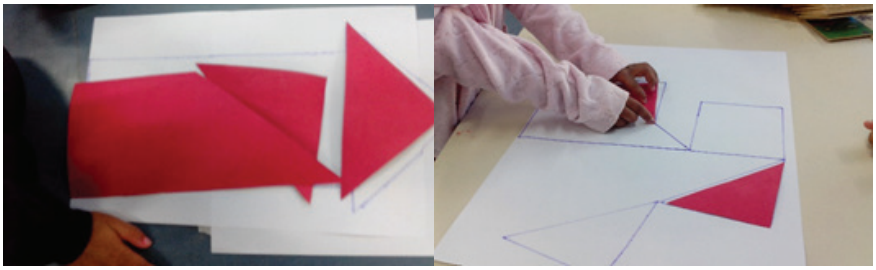
• They talked about the names of geometric figures already known with triangular and quadrangular shapes (triangles and squares).

• They discovered the trapezoidal shape (trapezoid).

• They explored the pieces to assemble a few figures with the puzzle, and told their friends and educators about what they produced.

2. Presentation and composition of figures based on outlines provided so children could fill them up with their pieces: a house, a small building, and a girl.

Figure 2: Compositions of figures based on outlines provided



Source: the authors' archive

• The children got to choose the figure they wanted to fill up.

• They tried different superpositions to fill up the figure chosen (rotation, orbit and reflection movements with the puzzle pieces).

• The children used demonstrations and reasoning to try and help each other to complete the activity, showing each other how to move the pieces.

3. Free composition with a Meli-Melo puzzle made from another material (Styrofoam).

Because the puzzle had first been made from a material that could not endure handling by the children, the teacher decided to make the same puzzle from Styrofoam covered with poster paper.

Figure 3: Free exploration of the Meli-Melo puzzle

Source: the authors' archive

• The children freely explored the material in small groups, making compositions that were different from the previous ones because of the type of material used, i.e., 2-centimeter thick Styrofoam covered with poster paper.

• They told the class about the assemblages they made, paying attention to use the names of the figures with geometric shapes.

• They also made other remarks, such as the possibility to make a trapezoidal shape with this material from a square-shaped figure and a triangular one.

These activities were recorded by means of photographs and a diary where the teacher reported the questions, arguments and hypotheses presented by the children, as well as information related to their participation in activities, and aspects of the proposals considered relevant for learning. These records allowed analyzing the activities and what students learned from the didactic unit that was created.

The second class studied consists of 27 children ages 3 to 5 years old. In this group, only the teacher conducts the pedagogical work. On the dates of the activities with the Meli-Melo, the teacher was assisted by a researcher (the second author of the present text) who helped in organizing the records.

In this class, to start using the Meli-Melo, the teacher made a few large puzzles from poster paper of various colors, fixed a few figures formed with the large pieces on the blackboard, and left other sets available to be handled later. She also made smaller-size sets of the material, which would be used in other activities.

As they entered the classroom, the children were invited to check whether there was anything different in the environment, and they quickly noticed the figures and started to question what they were. This first moment allowed proceeding to the following activities:

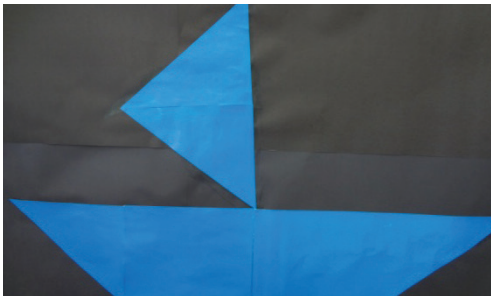
1. Introduction and dialogue about the Meli-Melo puzzle in circle.

• While observing and handling the puzzle pieces, the children talked about the similarities and differences between the pieces and what they were similar to.

• They named the geometric figures of shapes already known, such as triangular and quadrangular figures, and were introduced to the trapezoidal shape.

• They talked about the number of sides of each piece, and the number of corners (vertex) in each of them.

Figure 4: A boat built with the Meli-Melo, exposed on the blackboard



Source: the authors archive

2. Free elaboration and assembling of figures based on the outline of images.

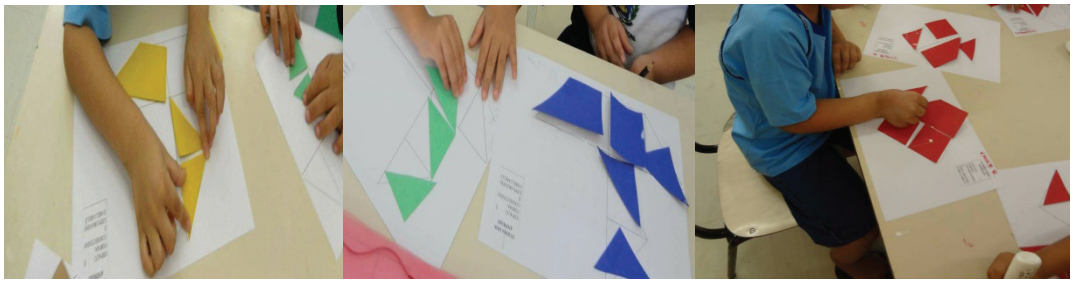
• By observing and handling the pieces, the children made compositions of figures and named what they had made.

• The children got to choose one of the figures to fill up with the Meli-Melo pieces.

• They compared the size of the pieces and the outlines in order to superpose the pieces.

• They handled and superposed pieces in order to fill up the figure chosen.

Figure 5: Children superposing pieces



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3. From the presentation of two images (boat and fish) made with Meli-Melo pieces, the teacher proposed the collective creation of a text.

• Based on the boat and fish figures fixed on the blackboard, the teacher proposed the collective creation of a text involving these elements.

• The children created a text and the teacher worked as a scribe to record the production.

Figure 6: Fish made with Meli-Melo pieces and fixed on the blackboard

Source: the authors' archive

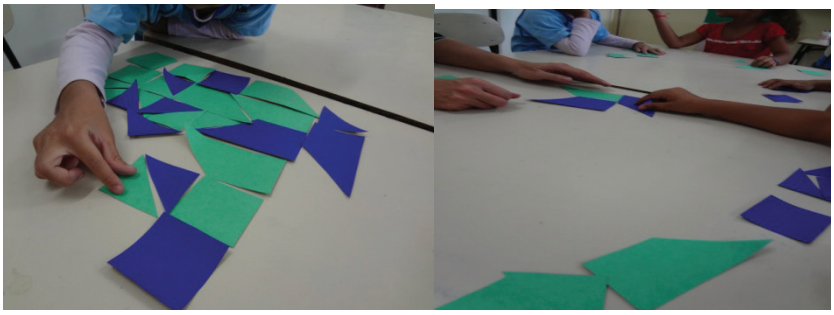
4. Playing the Measure Game.

Organized in a group, the children are given a complete Meli-Melo set of the same size. It is necessary to choose the player who will start. This player must choose one piece to put on the table; the next – each in turn, respectively – must choose the piece to be used, considering the length of the side of the piece on the table and that of his own piece.

• The children play the game in small groups.

During the game, the children must compare the pieces and think about the measures of the sides of the pieces.

Figure 7: The length game with the Meli-Melo



Source: the authors' archive

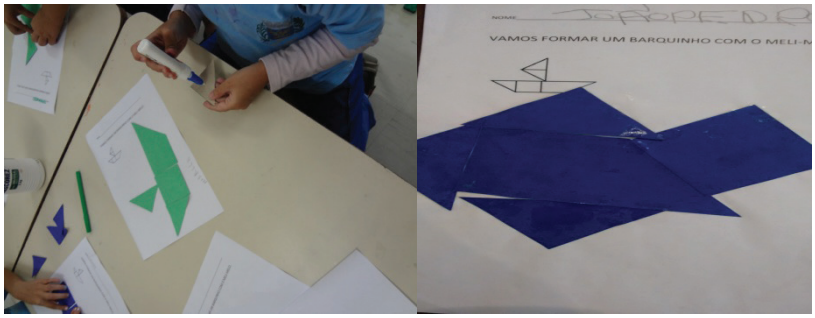
5. Making figures from observing a small model, without superposing the pieces.

• The children observed a model smaller than the pieces of the game, which was printed on a white paper sheet.

• They tried to assemble the figure from observation.

• They glued the pieces on a sheet, after organizing them.

Figure 8: Making figures from observing a small model, without using superpositions



Source: the authors' archive

It is worth stressing that the activities with both classes occurred on different days of the week, respecting the classrooms' routine and the children's interest in them.

Learnings Observed in the Educational Context

In this study, our goal was to promote the children's spatial and geometric skills and allow measuring actions, promoting also dialogue and group activities. During

the activities, the teachers questioned the children to learn their ideas about geometry as they classified and characterized figures, in addition to introducing other words which were not in their vocabulary, without demanding their use. This procedure favored the children's experience with the geometric figures present in the Meli-Melo; it also provided an opportunity to hear their previous ideas and allowed them to reason about what they thought.

Conducting these activities with the Meli-Melo in two classes allowed a dynamic and ludic approach to geometry and an opportunity for children to think about and seek different alternatives to perform them, particularly in the proposals that required filling up an outline or assembling a figure without superposing the pieces. The activities also allowed the children opportunities to develop important skills in building spatial perception, such as visual differentiation and visual decomposition (LORENZATO, 2006).

As they attributed similarities and differences between the figures, remembered everyday objects, and related them with the game's figures, they exercised visual differentiation, which is an important skill for various activities. As to field decomposition, which is the ability to perceive parts in a whole, it was used as they focused on the Meli-Melo pieces, identifying triangles and the square from the images formed.

Below we present a few learnings, focusing on each of the classes we conducted our geometry approach with. We will start this analysis with class 1, formed by the younger children.

At first, the children in this group explored the puzzle pieces and soon turned it all into a big game. Sommerhalder says that:

> [...] by playing 'as if', the child ties past, present and future together in an attempt to give meaning to what it experiences in reality, i.e., as it plays, the child invents and builds a scenery where it sets its desire moving around and gives meaning to what it experiences in life (SOMMERHALDER; ALVES, 2011, p. 19).

During the activities, the young children could be seen demonstrating curiosity about and engagement in exploring the geometric puzzle. When gathered in the large group, they ventured to name the geometric figures in formats they already knew, such as triangles and squares; however, dialogues and games became richer when they gathered in small groups and started to pay attention to the names of the figures as they explored. This analysis demonstrates the importance of allowing different learning situations based on various groups in the reference classroom (now same-age groups, now different-age ones); it still points to skills that, according with Lorenzato (2010), favor spatial perception, such as visual differentiation and visual-motor coordination, in addition to term-to-term correspondence and comparing figures.

Another interesting aspect was to offer them a more rigid material. Through their exploration, the children showed that using a Styrofoam Meli-Melo expanded their exploration possibilities and allowed them to build, in nearly every attempt, objects, animals or people, using the properties of depth, width and height, which characterize tridimensional elements. The observation of the children's actions showed

that the material that is offered to younger children requires attention. They are also able to learn and discover things, but they need adequate material that can endure their handling and curiosity (for this reason, poster paper was glued onto the Styrofoam). A more rigid material made their exploration easier.

Using the Meli-Melo also allowed the children to build a square-shaped figure using two triangular pieces, as well as to build a trapezoid-shaped figure using a square piece and a triangular piece. Lorenzato (2010) calls this ability to assemble a whole by starting from its parts field composition. The children showed satisfaction in making and commenting on their constructions and discoveries, and even more in being able to help their friends move the pieces to fill up the outlines they had chosen. We believe that using the Meli-Melo with the children in class 1 provided challenges and presented significant situations that made the understanding of geometric figures dynamic, particularly with tridimensional figures.

In class 2, most children showed no difficulties in creating figures with the Meli-Melo pieces, although some showed greater or smaller facility. Characteristics of the figures were reexamined, such as similarities and differences, names, number of sides and "corners"; in addition, other spatial perception skills were essential in assembling the figures, such as: visual differentiation, field decomposition, motor-visual coordination, and equivalence through movement (LORENZATO, 2006). To him, these skills are necessary to understand the study of figures, as well as in other activities, such as: reading, writing, drawing, walking, playing, among others.

In the proposal of writing a text from the images of a boat and a fish formed with the puzzle pieces fixed on the blackboard, the children created each part of the story, which was recorded and read so the class could approve or change it. This activity, conducted in the larger group, allowed the children's interaction and engagement, as well as their attention to aspects such as the structure of the written text.

The composition of images with the Meli-Melo pieces from observation of a smaller outline than the figures given to the children was more complex, as it required visual differentiation, field decomposition, form and size conservation, and visual-motor coordination skills (LORENZATO, 2006). As expected, this activity proved more difficult for children this age. Therefore, most of them could not perform it according with the proposal. Different figure compositions were made, some closer to and others very different from what had been proposed.

In the length game, we observed that a few children had difficulties perceiving the measures of sides and identifying a figure that fitted that space. Therefore, they were instructed to try with the pieces they had until they could find a piece that fitted properly. In the group of five-year-olds, the relationship between the measures of the sides and the figures occurred more easily. The children in this age group engaged better in the activity, they had fun looking for the pieces, and manifested satisfaction as they managed to fit the pieces properly. We believe this was an important activity which allowed a differentiated work with geometric figures and a few notions related with the sense of measure, such as horizontality, verticality, length between the pieces disposed on the table and the pieces the children had to play with. In addition, the children also needed to understand the equivalence of the lengths of figures by rotating them when necessary.

Like in class 1, the activities involving geometry that were conducted with class 2 allowed exploring mathematics in a ludic perspective which involved games and problem solving in different situations. In this respect, we agree with Lorenzato (2006) when he says that mathematic exploration can favor a child's intellectual, social and emotional knowledge, so it is important that early childhood education institutions offer opportunities for children to play, experiment, conjecture, talk, and learn in the educational environment.

Final Considerations

It is worth stressing that early childhood education is the first phase of basic education; however, the curriculum to be taught cannot be focused on transmission of knowledge, demand of contents from children, and discipline structure rigidity, nor is it only a place of care and conduction of actions without planning or intentionality.

The proposals presented in this text were conducted over the course of several days, which allowed enough time for children to interact with the Meli-Melo puzzle, and were very profitable. The children showed themselves motivated and engaged, and we believe a good initial contact with geometry was successfully provided.

During the activities, the teachers raised different questions, allowing children to reflect about what they were doing; they were also encouraged to comment on their ideas, raise hypotheses and seek different ways of fulfilling the proposals. The intervention of other children in the group was also fundamental for the more insecure ones to venture into constructions, elaborations and justifications in the small groups.

The activities proposed to the younger children, like freely exploring the Meli-Melo, talking about and observing the similarities and differences, their contact with a new figure (trapezoid), and the possibility to create with Styrofoam pieces, expanded the construction repertoire, considering the sides, heights and angles of the pieces, without directly discussing about these aspects.

For the five-year-olds, the challenge to assemble figures from observing an outline without superposing pieces, and the length game, which required observing similarities and differences between the figures' sides to put the pieces, favored children's creation and reasoning about the situation, as well as the pursuit of solutions for the problems proposed.

We believe that the practices conducted in childhood education and reported in this article allowed different mathematics learning opportunities, taking into account children's curiosity and interest, the articulation of different languages, respect for each one's specificities, and the theoretical premises that found our actions. We believe we were able to overcome the idea that mathematics in early childhood education occurs only in the numbers-quantities relationship. We can say that the work conducted opened possibilities for other practices involving this subject on this educational phase.

The constant dialogue with the other teachers participating in GEProMAI was essential to conduct this work, as the studies and discussions about the activities conducted, as well as verbalizations and expressions in the group, among other actions

collaboratively carried out, provided the teachers with learnings that reverberate in their teaching.

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