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ARTICLE

Science and imagination in elementary school

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ABSTRACT
Our objective is to investigate how relationships between science and imagination are discursively constructed within a group of children in the first three years of elementary school. Based on Ethnography in Education, articulated with Science Education, we analyze events that demonstrate how references to the non-school context contribute to the teaching of science in a way articulated with imagination/creation activity. The results demonstrate the occurrence of: a science perspective primarily focused on results/products of science and another focused on procedures/processes of knowledge construction/practices; a form of creation activity related to the interaction with materials to investigate phenomena and another mainly related to the creation of imaginary narratives; and greater participation and enhancement of creation activity when talking about the space of the house in the school space.

KEYWORDS
Science Education; elementary school; science; imagination; Ethnography in Education.

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CIÊNCIA E IMAGINAÇÃO NOS ANOS INICIAIS DO ENSINO FUNDAMENTAL

RESUMO

Nosso objetivo é investigar como relações entre ciência e imaginação são discursivamente construídas em uma turma de crianças ao longo dos três primeiros anos do ensino fundamental. Com base na Etnografia em Educação, articulada à Educação em Ciências, analisamos eventos que evidenciam como referências ao contexto não escolar contribuem para o ensino de ciências de forma articulada à imaginação/atividade criadora. Os resultados demostram a ocorrência de: uma perspectiva de ciências prioritariamente voltada para resultados/produtos da ciência e outra focalizada em procedimentos/processos de construção de conhecimento/práticas; uma forma de atividade criadora relacionada à interação com materiais para investigar fenômenos e outra principalmente ligada à criação de narrativas imaginárias; e maior participação e potencialização da atividade criadora quando se fala sobre o espaço da casa no espaço escolar.

PALAVRAS-CHAVE

Educação em Ciências; ensino fundamental; ciencia; imaginação; Etnografia em Educação.

CIENCIA E IMAGINACIÓN EN LA ESCUELA PRIMARIA

RESUMEN

Nuestro objetivo es investigar cómo se construyen discursivamente las relaciones entre ciencia e imaginación en un grupo de niños durante los primeros tres años de la escuela primaria. Con base en la Etnografía en la Educación, articulada con la Educación Científica, analizamos hechos que muestran cómo las referencias al contexto no escolar contribuyen a la enseñanza de la ciencia de una manera articulada con la imaginación/actividad creativa. Los resultados demuestran la ocurrencia de: una perspectiva científica enfocada principalmente en resultados/productos de la ciencia y otra enfocada en procedimientos/procesos de construcción/prácticas del conocimiento; una forma de actividad creativa relacionada con la interacción con materiales para investigar fenómenos y otra principalmente relacionada con la creación de narrativas imaginarias; y mayor participación y potenciación de la actividad creativa al hablar del espacio de la casa en el espacio escolar.

PALABRAS CLAVE

Educación Científica; educación primaria; ciencia; imaginación; Etnografía en Educación.

INTRODUCTION

The main objective of this article is to show how relationships between science and imagination are constructed in a group of children in the early years of Elementary School. For this, we apply the notion of "creation activity" and analyze discursive interactions in Science lessons. We seek to understand the presence of knowledge generated from contexts such as imagination and play (Murphy, 2012) and the way in which children use everyday experiences in the construction of scientific knowledge in the classroom (Sandoval, 2005).

Science Education, from the early years of Elementary Education, is considered important by several academic studies and official documents (Brasil, 1996; Zanon and Cardinal, 1999; Lorenzetti and Delizoicov, 2001; Sasseron and Carvalho, 2008; Mozena and Osterman 2008; Versuti-Stoque and Lopes Júnior, 2009; Brasil, 2013; Monteira and Jiménez-Aleixandre, 2015; Brasil, 2018; among others). In addition, several studies indicate that there is great interest among children aged six to nine years in subjects related to Natural Sciences and that they engage in activities of this subject (Sasseron and Carvalho, 2008; Rodrigues and Teixeira, 2011).

Thus, several authors have raised questions about how the teaching and learning processes of Science take place with children. One perspective that has gained support is that Science learning is a human activity (Vygotski,[1] 2009), constituted in the interactions between the participants, expanding the possibilities of cognitive, affective, social and cultural development of the human being. However, in Brazil, discussions on the implications of children's age range in the process of learning Natural Sciences, and on the notions of childhood that guide these studies are still in their relatively early stages (Colinvaux, 2004; França *et al.*, 2015). Thus, with the present work, we intend to contribute to the deepening of discussions concerning the specificities of childhood, relating them to the teaching of Science in the early years.

In this sense, we seek to investigate, specifically, which aspects are central in this process of constructing relationships between *science and imagination*. Therefore, it becomes necessary to characterize what the members of the classroom need to know, do, predict and interpret in order to participate in events in which the relationship between *science and imagination* is constructed in a 2nd year classroom of Elementary School.

SCIENCE AND IMAGINATION: WHAT DOES ACADEMIC RESEARCH SAY?

To start our investigation, we carried out a search on two of the main Brazilian websites: Capes Periodical Portal (*Portal de Periódicos da Capes*) and Scientific

1 We spelled Vigotski's name with 'i' in the Portuguese text, following the explanation by Prestes (2012, p. 90). In the English version we use the 'y' spelling as it is normally used by English-speaking authors.

Electronic Library Online (SciELO). We selected two articles that analyzed imagination as an important concept in the teaching and learning process. Using the term "*imagination*", we found three international studies that presented important relationships between imagination and Science Education. Below, we present some contributions of the articles found.

Girardello (2011, p. 75, our translation) presents "[…] a brief conceptual discussion about the relationship between imagination and childhood, pointing out some factors considered favorable to children's imagination.". Maheirie *et al.* (2015, p. 49, our translation) approach "[…] imagination as a fundamental psychological process of the human being […]" and present empirical research carried out in an art-education non-governmental organization (NGO) with students aged nine to 14 years. The experiences of young people who participated in percussion workshops, production of musical shows and video production were analyzed. As a result, the authors observed that the "[…] experience (re)signified by the subjects composes memory cores, so that the imaginative activity presents itself as a (re) combining psychological process, objectified in a new product." (Maheirie *et al.*, 2015, p. 49, our translation). The authors concluded that the memory of the young people investigated is being given meaning and re-signified in the experience of the creation process. Thus, the creation activity is recombined into a new product.

Fleer (2011) analyzed situations involving free play with water and earth among 4 and 5 year olds in a preschool in Australia. Based on studies by Vygotsky (1966; 2004),[2] the author discusses the theory of imagination to relate play and learning, and shows how playing, imagining, and learning can act cognitively in activities in Early Childhood Education. The author argues that imagination plays a central role in play, as it acts as a creative reworking of reality, providing relationships with it so that children can play with objects and ideas and, therefore (re)creating new meanings.

Two aspects were of particular interest to us in Fleer's study (2011). The first is the coordination of play with contents of Science Education, which highlights and better characterizes the interest of young students in this subject, already mentioned in several studies (e.g. Versuti-Stoque and Lopes Júnior, 2009; Fagundes and Lima, 2009). Second, there is an emphasis on the teacher's role in supporting students in the construction of meanings, in a process mediated by language, which encourages play. The teacher dialogued with the students, considering their arguments originating from play and imagination. In this way, she seeks to understand the interactions of children and articulate with them some elements that contribute to school learning.

Furthermore, Fleer (2011, p. 254) argues that the "[…] contradiction between imagination and reality creates the dynamic force, which allows theoretical knowledge to be contemplated by young children.". For this author, imagination actively acts in the construction of reality and, therefore, should not be ignored in teaching and learning processes.

2 Vygotsky, L. S. Play and its role in the mental development of the child. Voprosy psikhologii, v. 12, n. 6, p. 62-76, 1966; and Vygotsky, L. S. Imagination and creativity in childhood. Journal of Russian and East European Psychology, v. 42, n. 1, p. 7-97, 2004.

In another study, Heath (2008) presents a theoretical discussion about imagination and its relationship with learning based on Phenomenology and the Philosophy of Education. The author states that imagination has been "marginalized in education" (Heath, 2008, p. 115, our translation). This is despite the fact that there are studies showing its importance in learning processes. Heath highlights the study by Greene (1995)[3] who, like Fleer (2011), argues that imagination is important for creation, as it enables new learning on a given subject, based on previously learned elements.

Heath (2008) proposes two types of imagination. Inventive imagination would be "[…] the cognitive ability to bring to mind an image that is not in the present, but such a view of the imagination can be seen as rather naive by making all sorts of assumptions about reality and subjectivity." (Heath, 2008, p. 117). Radical imagination "[…] can create new experiences or fantasies not represented in any previous experience." (*ibidem*, p. 117). For Heath (2008), this second type of imagination is important for understanding learning, as it involves a process of transforming the learner's consciousness, making it different as a result of this learning. Finally, Heath defends the importance of collectively sharing imagination, recalling that language is fundamental for that. The relationship between imagination and reality is an important notion, as imagination is based on the individual's previous experience and collaborates in the construction of the meaning given to current experience and cultural knowledge, in a process of creative reworking.

Andrée and Lager-Nyqvist (2013), in a study developed in two Swedish preschools, discuss how spontaneous play with scientific guidance is important, as it offers students opportunities to work on epistemic values and norms of science, helping them to create a position in relation to science. The authors also argue that learning Science is socially, culturally, and historically incorporated through play, and can transform and transcend existing classroom practices. Unfortunately, they point out that this type of activity has been underexplored and under-investigated in the classroom context.

The brief review performed here indicates that few works relate science and imagination in the context of teaching and learning. The studies found point to interesting discussions that are still little explored in Science Education. The relationships between imagination and reality, shared through discursive interactions and supported by the different experiences of students and teachers in the classroom, can make an important contribution to Science learning. In the present study, we align ourselves with this research, seeking to investigate these aspects in more depth.

PERSPECTIVES ON IMAGINATION IN HISTORICAL-CULTURAL PSYCHOLOGY

One of the cultural elements present in the classroom, and actively shared among the members of the social group studied, is imagination. Vygotsky (2009)

3 Greene, M. Releasing the imagination. San Francisco: Jossey-Bass, 1995.

shows how imagination is not reduced to daydreaming away from any reality, nor does it have an exclusively individual character. Imagination is seen as a human activity, that is, it is not an innate gift and, therefore, it is constituted by culture and develops from social interactions. "Every work of the imagination is always constructed from elements taken from reality and present in the person's previous experience." (Vygotsky, 2009, p. 20, our translation) and shows an emotional character, expressed in two ways: emotion selects impressions, ideas, images that function as an inner language for feelings and, conversely, imagination can influence feelings.

For Vygotsky (2009), imagination has a strong relationship with creation, becoming important to the extent that these elements are present in teaching and learning situations. In summary, imagination is not an individual daydream — it is linked to *creator activity*. All individuals develop this and it is directly or indirectly related to some kind of experience. Based on these assumptions, we understand that ideas expressed through imagination can reveal the meanings shared in the processes of teaching and learning science.

Cultural-Historical Psychology indicates that "[…] human learning presupposes a specific social nature and a process through which children penetrate the intellectual life of those around them." (Vygotsky, 1989, p. 99, our translation). Vygotsky also emphasizes that social interactions enable both access to, and the process of, appropriation of culture by the child, thus constituting children as unique and social human beings. Furthermore, the child's experiences in the cultural appropriation process give rise to the possibility of transforming both the child and the environment in which he/she is inserted (Vygotsky, 2010). For him, instruction is not development, but properly organized instruction has the possibility of promoting development (Vygotsky, 1989). Such a process is interactive, rather than active, because it presupposes relationships between the subject with other subjects and with social knowledge. Thus, imagination is affected by culture and by the interactions established between children and between them and adults, that is, creation activities are inserted in the collective context (Vygotsky, 2009).

THEORETICAL-METHODOLOGICAL CONTRIBUTION AND RESEARCH CONTEXT [4]

In order to investigate how the relationships between science and imagination are discursively constructed in a class of children in the early years of Elementary School, we apply elements of Ethnography in Education (Green, Dixon, and Zaharlick, 2005; Bloome *et al.*, 2005; 2008; 2012), as well as Science Education literature (Driver *et al.*, 1999; Mortimer and Scott, 2002; Kelly, 2007; 2014). For the construction of the data and discussion of the results, ethnography is understood as the study of cultural practices, based on a contrastive and holistic perspective, as well as on an iterative-responsive process (Green, Dixon and Zaharlick, 2005. See Franco and Munford, 2018, for a discussion related to Science Education).

4 The research was approved by the Research Ethics Committee of the University. We use pseudonyms for participants. Fieldwork was carried out in 2012, 2013 and 2014.

The research was developed in a class with 25 students from a federal public school. This school opened in the 1950s, and has gone through several restructurings. It is noteworthy that, since 2006, nine years of Elementary Education have been implemented. Student admission to this school is carried out through a public lottery, as this is considered democratic, reducing the possibility of favouritism towards any social group. Thus, student diversity is promoted in the classes, both in terms of socio-cultural and economic aspects. The school and the class specifically studied here participate in a broader project that investigated this same class of children from the beginning of the 1st year to the 3rd year of Elementary School.

This project has three axes. The first aims to relate the construction/appropriation of peer culture and school culture. The second is part of the teaching and learning processes related to the school subjects of Portuguese and Natural Sciences. Finally, the third axis seeks to analyze different aspects of teacher education. The present study is directly linked to the second axis of the project, working more specifically with issues related to the teaching of Natural Sciences. However, this investigation is closely intersected with the first axis, since the process of teaching and learning science is constructed insofar as participants become members of the classroom and appropriate the school culture. We observed the Science and Portuguese lessons, both taught by Professor Karina, constituting a database of 107 lessons with an average duration of 2 hours each. The professor has a PhD in Education, a Masters in Linguistic Studies and a degree in Pedagogy and Psychology. Karina has been teacher for 25 years and has established a dialogic and responsive relationship with the class, listening to the children's demands and interests. In this sense, her approach was not just a matter of "giving voice" to children, but of effectively constructing a relationship in which their discourse changed her own positioning as a teacher who takes responsibility for what she teaches (Corsino, 2015). The Science lessons were developed based on an Inquiry Science Teaching approach. Under the teacher's guidance and prompted by scientific questions, the students were required, when answering the questions, to use evidence and formulate explanations, as well as to evaluate, communicate and justify their explanations (Munford and Lima, 2007).

The main data sources were participant observation, video recording and notes taken in field notebooks. In order to examine the discourse constructed in the classroom, we used transcripts developed in a macroscopic and microscopic way. At the macroscopic level, we created maps and event tables (Dixon and Green, 2005) with the intention of characterizing the class history. Through these macroscopic transcripts, we located an event that was considered an "expressive case" (*telling case*, in the original) (Mitchel, 1984). In other words, we identified moments in the history of the class that helped to highlight the relationships between events that took place in the classroom and the phenomenon that we wished to investigate; particular situations involving an *expressive case*, which may bring clarification to previously unknown theoretical relationships. It should be noted that the idea of looking for an event considered to be a *telling case* is not to look for a typical event, but for an event that highlights important aspects of the construction of relationships between science and imagination.

At the microscopic level, we utilized Microethnography (Bloome *et al.*, 2005; 2008) to make word-for-word transcriptions of events considered *telling cases*. After identifying the events, we transcribed the dialogues of the verbal discourse into message units, that is, the smallest unit of meaning that the participants involved use in oral communication (Bloome *et al.*, 2008). Thus, contextual cues were considered, that is, intonation, gestures, facial expressions, rate of speech, pause, etc. (Gumperz, 1982). These clues provided elements to understand, from the participant's perspective, the meanings of the discussions about science and the connection of the discussions with the creation activity that was being created and shared by the group.

For the microscopic analyses, we created tables of discursive interactions with columns to identify the presence of important aspects of these interactions, based on central constructs for our discussion (creation activity, memory and school discourse). We will present four tables in the next section. Chart 1 summarizes the unit that will be analyzed and the next three charts (Charts 2, 3 and 4) are interaction charts for microscopic analysis.

Chart 1 – Brief description of the lessons of the *Misturas* unit.

Lesson	Date (Duration)	Brief description of lesson
1	28/10/13 (01:27:27)	The group discuss, in the classroom, differences between magic and experimentation. The discussion begins at the beginning of the lesson, from one student's spontaneous account.
2	30/10/13 (03:56:42)	Practical lesson in groups, in the classroom, with researcher Danusa. Students mix red cabbage extract with some liquids (vinegar, lemon, boric water etc). The discussion on differences between magic and experimentation continues.
3	05/11/13 (02:01:33)	Lesson in the Science lab. Students test, in groups, the cabbage water with four different materials: soda, vinegar, still water and sparkling water.
4	11/11/13 (01:34:25)	Students do a written report of the activities carried out in lesson 3. They are organized in groups, but the reports are written individually.
5	26/11/13 (02:29:53)	In the classroom, students carry out new tests with the cabbage water in order to discover what caused it to turn pink. At the end of the lesson, they do 'free' mixing using their own materials, with a pink felt-tip pen.
6	27/11/13 (03:09:54)	Students write individual texts, explaining the differences between magic, experimentation, and special effects. After finishing the texts, some students read theirs to Danusa or the teacher's assistant.

Source: Elaboration by the authors.

THE *ÁGUA COLORIDA* (COLORED WATER) EVENT: IDENTIFYING THREE CENTRAL ASPECTS IN CONSTRUCTING RELATIONSHIPS BETWEEN SCIENCE AND IMAGINATION

In Figure 1, we present a timeline of the Science themes developed in the class. We demarcated the temporal location of the lessons in which discussions about

Chart 2 – Teacher and researcher expectations.

Line	Speaker	Dialogue	Dialogue	Explicit memory / Reference to context		Science/ School dialogue
				School	Non-school	
1.	Student	Start I				
2.	Danusa	And then I				
3.	Danusa Teacher	Do you remember what I did in that I First I We did what ↑		■—	—	—■
4.	Karla	We did that thing I		•		
5.		To make water turn pink I		•		•
6.	Teacher	To make water turn pink I		■—	—	—■
7.	Students	I Many students talk at the same time				
8.	Danusa	What did we use ↑		■—	—	—■
9.		People ↑				
10.	Students	Cabbage I Some students talk together		•		•
11.	Maurício	Teacher I	•			•
12.		How do you do this experiment I	•—	—	—	—•
13.		With that cabbage there ↑	•			•
14.	Maurício Jonas	We took this cabbage to I Some students talk together I took the cabbage I Livia raises her hand In the water I And it changed I	• •— •—	• • —• —•	

The symbols on the board: ■ (teacher's dialogue); ● (students' dialogue); I (pause); III (long pause); ↑ (increased intonation at end of speech); ↓ (decreased intonation); emphasis; ▲; Non-verbal behavior in italics. The dash indicates the relationship between school discourse and the type of memory used.
Source: Elaboration by the authors.

the nature of scientific knowledge and/or its production process were highlighted by the observers in the field notebook. In the highlighted events, the class engaged in discussions on, for example, the characteristics of science or the differences between what could or could not be considered science.

Chart 3 – What was done at home?

Line	Speaker	Dialogue	Creation activity	Explicit memory/ Reference to context		Science/ School dialogue
				School	Non-school	
1.	Teacher	Here are various things I				
2.	Danusa	And ↑			■	■
3.		Then you mixed the water in it ↑ *looking at Jonas. He said no with a shake of his head.*			■—	—■
4.	Danusa	Ah and so ▲			■	■
5.		Just looked I			■	■
6.	Teacher	Who mixed it ↑			■	
7.	Danusa	People I				
8.		Ah I				
9.	Danusa	Who took the cabbage home I			■	
10.	Breno	I put the cabbage I	●		●—	—●
11.		There in water I	●		●—	—●
12.		It went brown I	●		●—	—●
13.	Teacher	It went brown ↑ *nods his head.*			■—	—■
14.	Karla	Mine went green I			●—	—●

Source: Elaboration by the authors.

For our analyses, we selected the *Misturas* (Mixtures) unit, as it involves several lessons in which there were discussions on science. Such discussions refer to the term "mixtures", frequently used, over the three years, as representative of what science is. In addition, the unit had six lessons, and was able to be analyzed in an integral way, in order to better understand the flow of events and the relationships between events. The *Misturas* unit involved different activities, distributed in six lessons that totaled 14 hours 39 minutes of video recordings. Chart 1 summarizes this unit.

In a broader study, nine events were examined in the *Misturas* unit which took place in four different lessons. In this paper we present analyses of the *Água colorida* event, which occurred in lesson 3. We selected this event because it reveals how the classroom members constructed relationships between science and imagination. In addition, it made it possible to locate other events, in the same

Chart 4 – Procedures performed by Karla.

Line	Speaker	Dialogue	Creation activity	Explicit memory/ Reference to context		Science/ School dialogue
				School	Non-school	
34.	Danusa	Karla I			■—	—■
35.		Yours went green I			■—	—■
36.		Only in the III			■—	—■
37.		In the water I			■—	—■
38.		Or did you put anything else in ↑			■—	—■
39.	Karla	What ↑				
40.	Danusa	When you mixed in the water I			■—	—■
41.		Did it go green I			■—	—■
42.		Or ↑			■—	—■
43.	Karla	No I			•	
44.		I put it in I			•	
45.		And then it went green I			•	
46.	Danusa	But you didn't get to put it in I			■—	—■
47.	Karla	I put a part of it in III *Makes a face of someone trying to remember.*			●—	—●
48.	Evandro	Peroxide water I			●—	—●
49.	Karla	It's not that ▲			•	
50.		It´s a part of it I			•	

Source: Elaboration by the authors.

unit, which contributed to an in-depth analysis of central aspects in this process of constructing relationships.

Three important moments stood out in the event in question, signaling breaks in expectations (*frame clash*, Agar, 1994; Gumperz, 2002) which are fundamental for accessing the participants' perspective. Green and collaborators (2012, p. 310) explain that *frame clashes* are moments in which the researcher is "[…] confronted with a surprise or something that does not turn out as expected […]", making some meanings and practices more visible in understanding the group from the perspective of the group itself. At the beginning of the lesson, before going to the Science laboratory, the teacher and one of the researchers talked to the students about what

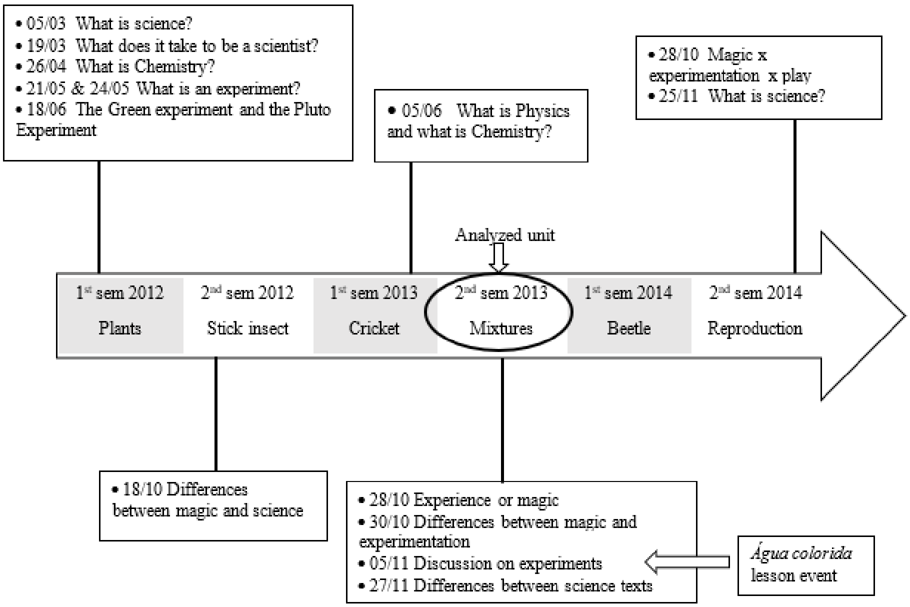

Figure 1 – Timeline: lessons with epistemological discussions on science.
Source: Elaboration by the authors.

had been developed in the previous lesson. At that moment, the students made reports about experiments carried out at home. Then, the teacher gave some guidelines for the activity that would be carried out in the laboratory. The class went to the laboratory and there, while the researcher prepared the red cabbage extract for the practical activity, they talked again about experiments they had previously carried out at home and about the objectives of the lesson that would be held. After this conversation, which involved the whole class, the students, organized into groups, received test tubes with the cabbage extract. Each group chose 4 materials to mix with the extract and answered the following question: "How can cabbage water be made pink?". The materials available for the tests were: lemon, boric water, hydrogen peroxide, detergent, lemon soda, ammonia and citric acid. After the tests carried out by the groups, the researcher summarized the results obtained on the board.

The *Água colorida* event took place at the beginning of the class, when the teacher and the researcher asked the students to remember what they had done in the previous class. Student Karla answered the question and then student Maurício asked how to do the experiment. In this event, we noticed three moments (whose transcripts are presented in Charts 2, 3 and 4) that signal a breach of expectation among the participants (*frame clash*, Gumperz, 2002).

The charts have six columns: the first indicates the line number, the second the participant's pseudonym, and the third indicates the discourse. The column "creation activity" focuses on interactions in which participants bring aspects of imagination when discussing a given topic. The column "reference to the school or non-school context" indicates moments in which the participants remember previous experiences, considering that the creation activity may be based on these experiences and where they happen (Vygotsky, 2009). The last column explains those message units in which the participants bring elements of science lessons or even the interactions of elements that refer us to a broader context of school culture. The dash is utilized to join columns when they are directly related to each other.

As already mentioned, the teacher and researcher start the lesson by talking about the different color changes in the substances in cabbage extract that the class had observed in the previous lesson. Thus, they ask students to remember and talk about this activity. Karla replies: "*We did that thing* to *turn the water pink*" (lines 4 and 5). The student refers to what was produced with the activity in a descriptive way and as if it were a pre-established objective or purpose, without dwelling on *how* this product/result was reached and *how* the work in her group was. The teacher, by repeating (*revoicing*) Karla's last message unit (line 6), reveals one of the aspects that make up the student's memory: the result of the experiment, that is, the change in water color. The researcher, in turn, asks: "*What did we use*?" (line 8). Thus, instead of contributing to the characterization of the "product" of the activity, the researcher takes a different position and focuses on the process of producing that result. The different actions of the teacher and the researcher when talking about the experiment indicate a first breach of expectation (*frame clash*), considering that one highlights issues related to the result of the experiment, while the other offers the opportunity to talk about the procedures, evidencing different conceptions of what might be Science Education with this class.

The researcher asks the students to remember the materials used in the experiment carried out in the previous lesson, inviting an opportunity to talk about *how* the activity was performed. Some students cite one of the materials used (line 10) and Maurício takes his turn to ask for an explanation on how to do the experiment at home: "*Hey teacher, how do you do this experiment with that cabbage there?*" (lines 11, 12 and 13). The answers indicated that there is a recognition (or *taken up*) that, at that moment, the discussion about *how* the "experience" was performed (or how it is performed) is significant for the participants. Shortly after Maurício's dialogue (line 14), we identified a transition to establish relationships with non-school memories and the discourse of science/about science. Jonas begins to say that he tried to do the experiment at home: "*I put the cabbage in the water*" (line 14). With the discussion moving to the non-school context, the researcher reiterates the ways to produce results and the students participate even more actively, with new reports and debates.

In this context, we identified a second breach of expectation (*frame clash*), as the main discussion focuses on the experiments carried out by the students in their homes and not on the experiments performed in the classroom, as expected by the researcher and the teacher. The initial question is related to the experiment carried out in the previous lesson by the whole class — a shared experience — and only Karla gives a brief answer that does not receive feedback from her colleagues.

In contrast, several students want to talk about the experiments they did at home (Chart 3), as is clear in the Breno's (lines 24–26) and Karla's dialogue (line 28). We noticed that both the teacher (line 20) and the researcher (line 23) welcome the change in direction pointed out by the class and guide their dialogues towards the non-school context.

The discussion taken to the non-school context results in interactions between the researcher, the teacher and two students who carried out experiments at home. Breno, at this point, talks only about the result of the experiment, as part of what, for us, seems to be a narrative constructed predominantly from imagination. Breno says: "*I put the cabbage there in the water and it turned brown*" (lines 24, 25 and 26). He then recounts pranks he played with colleagues mixing yogurt and recalls an episode of a cartoon, watched at home, in which the main character melts a lasagne in the microwave. In other words, Breno creatively reworks what he experienced at school and at home, relating the two contexts.[5] This is the third breach of expectations: the researcher positions herself as a scientist looking for evidence of the experiment, while Breno relies on his imagination to narrate what happened. On the other hand, Karla assures "*Mine turned green*" (line 28) and, when responding to the researcher, gives details about the materials and procedures performed (Chart 4).

Karla's report[6] shows that the child was aligned with the researcher's perspective and helps us to understand the events in this class. Although different, the two children's reports gain attention in the classroom, and are discussed by the group.

In summary, we identified three *frame clashes* in the *Água colorida* event that were important to reveal aspects of the construction of relationships between imagination and science in this classroom. An overview of these analyses is presented in Figure 2[7] in the next section. First, the teacher's dialogue, which refers to Karla's answer about the result of the experiment, and the researcher's dialogue, which asks for a description of how the result was achieved, that is, a description of the process. The process and result highlighted in the dialogues emphasize different ways of doing and talking about science. Second, something unexpected happens, from an instructional point of view: in the previous lesson, several experiments were carried out with the material, but when the researcher requests that these events be reported, student" participation only increases when they talk about experiments that they did at home. These reports are more detailed, with greater student participation, establishing a conversation around the process rather than the result. Finally, Karla and Breno present two perspectives of creation activity, one more centered on their action on the concrete world and the other more focused on the construction of imaginative narratives based on games with colleagues and cartoons watched on television. Our analyses indicate, however, that the aspect highlighted in the second *frame clash* is particularly important, as continuities and tensions between the school and the non-school contexts permeate the process of constructing relationships between imagination and science. Further, they create

5 For reasons of space, we will not present here the details of Breno's discourse. Such details can be found in França (2017).

6 Karla brings some 'evidence' to her account when trying to answer the researcher. She doesn't know the name of the product, but she knows it makes a difference.

7 Details of the analyses and tables can be found in França (2017).

conditions for the emergence and/or or consolidation of other elements, such as different forms of creation activity and also results and procedures of school science. Next, we delve deeper into this issue, adding other evidence.

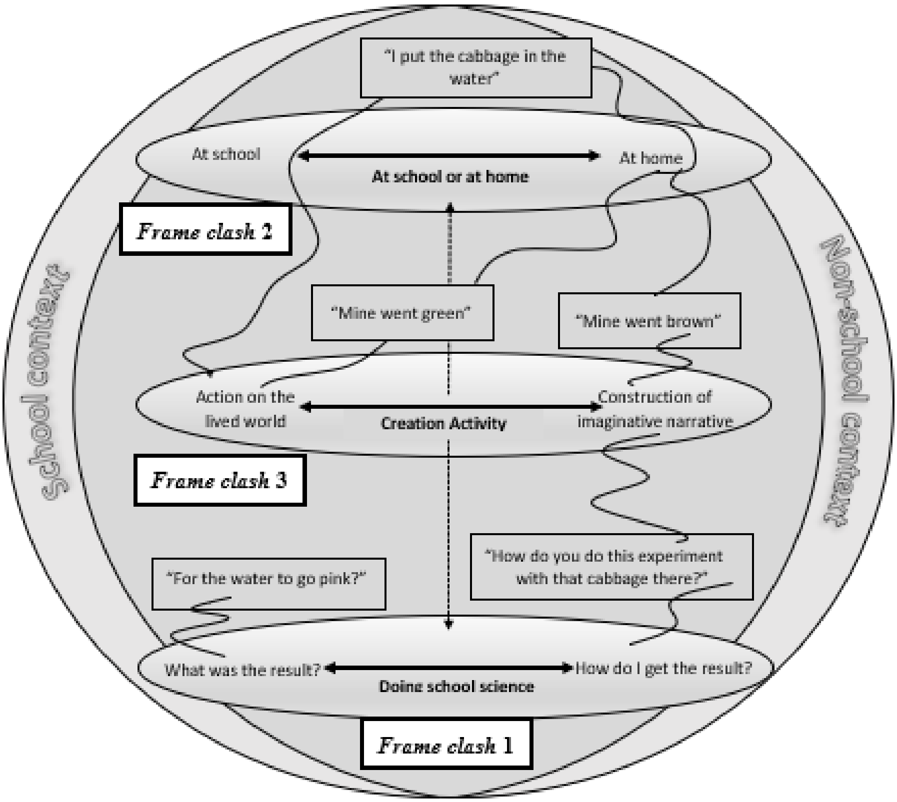

Figure 2 – Representation of the *Água colorida* event.
Source: Elaboration by the authors.

THE NON-SCHOOL CONTEXT AND THE CONSTRUCTION OF RELATIONSHIPS BETWEEN CREATION ACTIVITY AND SCIENCE

The analysis of the *Água colorida* event (Figure 2) showed that creation activity, science and the non-school context are closely related: the house plays a central role in constructing a relationship between science and creation activity. There was a preference to narrate and converse about activities carried out at home to remember, as suggested by the teacher and the researcher — activities shared in the classroom in the previous lesson. Breno and Karla's narratives were constructed in two ways: one more detailed and with evidence of having happened more effectively; and the other without many details, and bringing characteristics mentioned previously in another lesson, such as the brown color of the mixture that was obtained. In this sense, we see that the group discussed different experimental situations and engaged in a discussion about how a result was achieved, that is, not only the results themselves were mentioned, but a search was also initiated for an explanation for them.

Talking about procedures brings home the interactions. When using the non-school context, the home itself, student participation increases, expanding discussion on the procedures of the experiment in question. In other words, an important relationship between imagination and science was observed in the *Água colorida* event, which referred to the children's home. Therefore, we revisited all the unit's lessons and identified eight new events in which the same occurred (Figure 3).

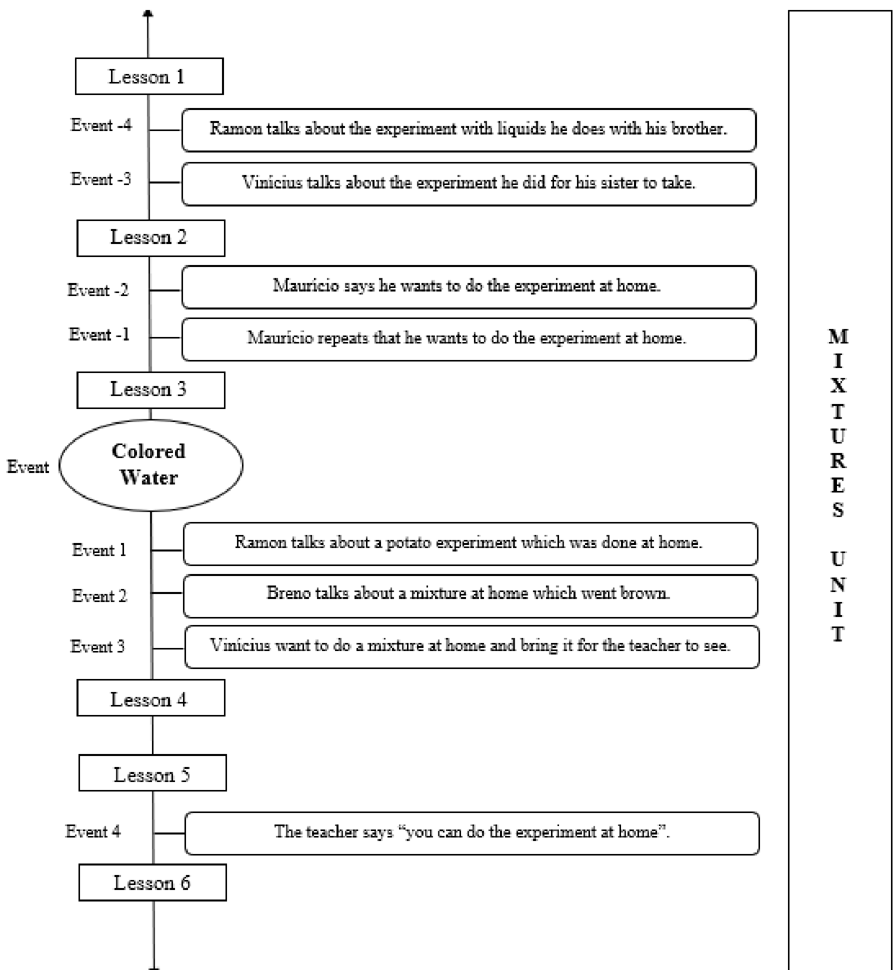

Figure 3 – The home in different events throughout the *Misturas* unit.
Source: Elaboration by the authors.

In the analyses, it was noteworthy that the home appeared at different moments, being utilized by both students, the teacher and researcher, and with important consequences for the teaching and learning of science. In the -3 event, the teacher mentions the home in an attempt to help students talk about experiments that have no mixtures. In the -2 event, the researcher asks Maurício what he will do at home with the cabbage water. In the +1 event, Ramon reports an experiment he did at home and the teacher talks to the class, asking what he could have done differently in his experiment. In the +4 event, the teacher suggests that the students do at home exactly what they are currently doing in class.

Therefore, the relationship between the school context and the non-school context occurs in both directions, enhancing science teaching and learning. The school context is present in the non-school context, as actions reported in the classroom about the non-school context are directly related to actions/activities in the school context. In their reports of experiments at home, the students talk about actions that were previously carried out in the school context. For example, in the *Água colorida* event, students report how they "replicated" the experiment from the previous lesson at home. They do not talk about varied "mixtures" or without intentionality as they did at other moments in the history of the class.

In addition, it is noteworthy how, during discussions about experiments carried out at home, possibilities arise to change the result that has been obtained in the classroom. In this sense, discussions do not revolve around predictions about "what would happen if I did this?", but around reported results that differ from those observed in the classroom. Thus, the home experiment is discussed as "real". This process is also evident in relation to Brun"s account of the *Água colorida* event. Later, in the +3 event, Maurício does something similar, saying that, at home, his experiment did not turn green, but became transparent again. Reacting to this report, the teacher, the researcher and the monitor discuss objectives and results of experiments.

Finally, another interesting aspect of these relationships between the two contexts is that, in the events analyzed, there was a recurring request to carry out the experiments at home or report what was done at home. This "do it at home" is not a totally free or uncommitted action with recognition of results and also of procedures (how to do it) at school. In the *Água colorida* event, Karla reports that she repeated the experiment at home and observed a similar result to that found in the classroom. Other students narrate experiments differently: sometimes they talk about the same materials used in school or the same procedures, but with different results. Later, Vinícius, in the +3 event, for example, wants to make a mixture at home, but then he wants to bring the experiment for the researcher to see. This indicates that, even while having a certain freedom to do an experiment at home, there is an expectation that it will be the object of discussion and analysis by the peers and the teacher in the classroom.

Thus, the creation activity supported by the imaginary narrative enabled discussions on the procedures of experiments carried out at home, playing an important role in this class, allowing the group to discuss, do science and construct an understanding of natural phenomena. In this way, the activity promoted interactions with greater participation of students, giving them an active role in the construction of knowledge in different ways. We realize then that, in the early years of Elementary School, students engage in meaningful discussions on science and construct school science from their school and non-school routines.

DISCUSSION

When examining a sequence of lessons, we observed that the narrative brought by the students played an important role in the class discussions. The non-school context, that is, the house space, appeared in the stories presented by different students in the events under analysis: the narratives engaged the class in discussions on experiments in different ways, but with significant similarities in several cases. This is precisely what makes these narratives a creation activity that deserves to be examined in more detail, as they are significant for learning Science in this classroom.

The creation activity played an important role, relating the opportunities for learning Science in the classroom and the imaginary narratives brought by the students. The students extract elements of the reality experienced in the class, showing their imagination based on the group's own memories. Imagination, as a creation activity, becomes a resource used by the group to discuss, do and interpret the experiments carried out in the classroom and generates resources for new discussions on experiments. It is important to highlight that this becomes possible because the teacher listens to and values these narratives.

The teacher's role as a mediator who creates conditions for children's participation has been highlighted by other authors (Fleer, Fragkiadaki, and Rai, 2020). Based on a historical-cultural conception of play, Fleer (2019a) discusses research results developed with young children. For the author, "[…] the narrative and the imaginary situation create new conditions for the child's development." (Fleer, 2019b, p. 11). In this perspective, Fleer (2019b) developed what she called the Conceptual PlayWorld. This universe is an evidence-based model of intentional teaching, which values play and stories to teach concepts related to science, technology, engineering and mathematics. It was developed considering the interaction of preschool children (zero to five years old) with adults (parents and teachers) to face and solve challenges and also learn concepts using imagination while playing. It can be inspired by a children's book or a fairy tale and can be developed in a classroom or at home. The idea of the model is to create imaginary scientific situations, collectively constructing scientific problem situations and imagining the relationships between observable contexts and unobservable concepts, transforming everyday practices into a scientific narrative and promoting children's engagement. This imaginary world allows educators and families to offer imaginary situations to young children in which they can experience concepts that would otherwise be difficult to explain. Fleer (2019a) argues that the adult will play an important role in the sense of:

1. giving a more collective nature to children's participation, as they support them to enter, participate and leave a collective narrative;

2. indicating that it is a learning situation, contrasting this type of play with other games they develop and, thus, introducing children to ways of participating in learning activities, which are central to preschool; and
3. introducing conceptual aspects (including concepts of natural sciences) into play.

At the same time, longitudinal quantitative studies involving elementary and high school students also indicate that creative imagination is more present when the teacher adopts student-centered strategies, with group work and a more cooperative approach (Ren *et al.*, 2012).

Vygotsky (2008) believes that creation activity can point the way to the development of abstract thinking. Students discuss by talking about actions (supposedly) performed at home, without directly discussing the ideas they are applying to understand the experiment. In this sense, Colinvaux (2004, p. 107, our translation), when discussing the abstract character of scientific activity and the common-sense conceptions that the child is concrete, questions "[…] the view that the child is not ready to learn something so abstract, complex and difficult.". The author states that the development of abstract thinking does not start in adolescence and that young children can learn Science by relying on abstract thinking in the full developmental process.

Play, carried out through creation activity, allowed the creation of an important link between science and imagination, in the sense of enabling a broad discussion about the experiments that were carried out in the classroom. This play was performed (or imagined) in the house space and entered the classroom through the students' narratives. We believe, therefore, that it was from the stories that the students told about their experiments carried out at home that they engaged in the discussion about their observations and their hypotheses regarding the experiments performed in the classroom. Fleer's research (2011, 2019a, 2019b, 2020) evidences the centrality of narratives for the construction of knowledge in the classroom through a coordination between home and school. In our work with older children and without the methodological systematization of the Conceptual PlayWorld developed by Fleer (2019b), which involves pedagogical planning and family mediation, the children themselves take the school home and also bring their home to the school, in a complex, fluid and continuous movement that still needs to be better understood, as Fleer herself points out in a previous text (Fleer, Fragkiadaki, and Rai, 2020).

What children share from their peer cultures actively contributes to social change. This change was clearly noticed in the *Água colorida* event. The fact that the children bring up what they have done at home reorganizes and changes the course of the class at that moment. It is observed, then, that the children contributed to the lesson and their own learning. On the other hand, the teacher and researcher rely on what the children bring in order to organize teaching processes. Thus, the children transform themselves and the context in which they are inserted. They are not just "consuming" the adult world, but they take the discussion home and produce something new through play that was then narrated in the classroom.

The home-school dialogue is established without necessarily having a direction established by the school.

Therefore, the present work describes resources that are present and can be used to consolidate this dialogue. We understand that older children do not depend so much on interaction with adults in the family, allowing a contrary movement to bring things from home to school. In fact, quantitative studies have indicated that there is an increase in creative imagination in older children (Ren *et al.*, 2012), which would indicate that the active role of children can be further enhanced if we appropriate some discussions of these works from preschool, considering the specificities of this later stage of schooling.

We understand children's participation from the perspective of creative reworking (Vygotsky, 2009). In this way, their contributions became fundamental for the appropriation of the discussions of the experiments carried out. If their stories or dialogues about the imaginary experiments performed at home were understood from the "deficit perspective", this could be seen as "misbehavior" and would limit the rich discussions brought by the children, contradicting perspectives of Science Education itself that show the value of this type of experiment in the construction of scientific knowledge (Gilbert and Reiner, 2000). Imaginary experiments, both imaginary narratives and other elements of peer culture, such as play, have an important role in science learning. In this classroom, the teacher created the opportunity to negotiate with these elements, respecting children and their cultures in a dialogic and responsive way. Thus, opportunities were created for the appropriation of school science.

FINAL CONSIDERATIONS

By enabling classroom discussion on the experiments carried out at home (and "imaginary" experiments), the students had the opportunity to discuss why the results obtained were not what had been expected. What was intuitive was discussed in a different way than specialist teachers might have expected. The students did not directly ask why, but created stories to (re)interpret the unexpected results. Therefore, in this situation, the class was not participating in an activity of inventing a story, but rather discussing and seeking a scientific explanation for that which did not match what was expected, that is, what was counterintuitive. The student Karla, in this sense, brings precisely the counterintuitive result, allowing the class to participate in discussions that generated opportunities for appropriation of ways of talking about Science. This was an important way of talking, formulating hypotheses and discussing explanations, which are essential skills for Science Education. Thus, we are faced with a situation in which children develop experiments that follow "rules" that are adopted by their own will and, at the same time, reflect on school science norms, indicating a way of appropriating these norms. A fundamental aspect in such appropriation involves participation in the discursive practices of the community, that is, what Duschl (2008) calls the social dimension in Science learning and which is closely related to the conceptual and epistemic dimensions. Therefore, understanding Science is more than merely grasping scientific explanations, but knowing how to use and interpret such explanations, generating and evaluating evidence, in addition to participating in scientific practices and discourses.

In addition, the role of the teacher is highlighted once again. Fleer (2019b) applies the concept of "peer pedagogy" (Kravtsov and Kravtsova, 2010)[8] to point out the importance of having two teachers in the classroom: one who investigates together with the children (who is present as an equal), while the other can suggest ways to find out how to solve the problem of play (the model for children). Mortimer and Scott (2002) have already shown the importance of a dialogic perspective in Science Education, even pointing out what a single teacher can bring to the classroom. Our results indicate that the presence of the two teachers in the early years (the class teacher and a researcher), who oppose each other and have different roles, although not planned, was also fundamental for the children to understand the contrast of ideas as part of participation in social science learning practices, insofar as it generated learning opportunities in this sense.

In conclusion, we emphasize that it is important to realize that children bring experiences from other contexts to the classroom. Some studies on imagination focus on characteristics of the school context or, at most, on the contact of students with extracurricular activities, such as visiting museums and participating in competitions (Ren *et al.*, 2012), ignoring the issue of less directly related everyday contexts to Science Education, such as home. Such contexts play an important role in learning, enabling a more active participation and also actions of creation activity, which are more in line with the views of school science held in our research community. Even studies that focus on this home-school interface show that little is known about how understanding concepts might be related to imagination (Fleer, Fragkiadaki, and Rai, 2020). In this sense, the present study makes a significant contribution. These aspects need to be considered in the initial and continuing education of Science teachers and also in Science Education research.

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