Conflicts during Science concept formation in early childhood: barriers or turning points?

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Abstract

Young children experience a wide range of conflicts during everyday educational reality. Instead of being intellectual barriers, conflicting situations have a critical role in young children's learning and development in Science. The present study seeks to explore the kind of conflicts that occur during collective science experiences in early childhood settings and how conflicting situations act as turning points in child's science concept formation. Empirical data were collected during a collective science experience centred on the natural phenomenon of cloud formation and cloud movement. One hundred and thirteen kindergarten students, aged 4.5 to 6.5 years old, from seven kindergarten classes in Greece participated in the overall study. Indicative case examples are presented. Methodological choices were determined by the dialectical-interactive method. The Cultural-Historical theory concepts of motives and demands and the interrelation between everyday concepts and scientific concepts were used as the main analytical tools. Three main categories of conflicts were noted: a) collisions, b) impasse situations, and c) provocative situations. The way children engaged with, managed and resolved the conflicting situations influenced the way children developed their thinking about the phenomena. It is argued that diverse conflicting situations opened a new space of thinking, created new learnings and led to new types of activity in science for the children. The study suggests that by highlighting, unpacking and facilitating conflicting situations, early childhood educators can create dynamic learning spaces within a pedagogical framework that respects and builds on each child's perspective.

Keywords

Contradictions, conflicts, turning points, early childhood, science education, motives, demands, everyday concepts, scientific concepts

Résumé

Les jeunes enfants vivent un large éventail de conflits au cours de la réalité éducative quotidienne. Au lieu d'être des barrières intellectuelles, les situations conflictuelles jouent un rôle essentiel dans l'apprentissage et le développement des jeunes enfants en sciences. La présente étude cherche à explorer le type de conflits qui surviennent lors d'expériences scientifiques collectives dans les milieux de la petite enfance et comment les situations conflictuelles agissent comme des points tournants dans la formation du concept scientifique de l'enfant. Des données empiriques ont été collectées lors d'une expérience scientifique collective centrée sur le phénomène naturel de formation et de mouvement des nuages. Cent treize élèves de maternelle, âgés de 4,5 à 6,5 ans, de sept classes de maternelle en Grèce ont participé à l'étude globale. Des exemples de cas indicatifs sont présentés. Les choix méthodologiques ont été déterminés par la méthode dialectique-interactive. Les concepts de motifs et d'exigences de la théorie Culturelle-Historique et l'interrelation entre les concepts quotidiens et les concepts scientifiques ont été utilisés comme principaux outils analytiques. Trois principales catégories de conflits ont été relevées : a) collisions, b) situations d'impasse et c) situations provocatrices. La façon dont les enfants s'y sont engagés, ont géré et résolu les situations conflictuelles, ont influencé la manière dont les enfants ont développé leur procédé de penser aux phénomènes. On soutient que diverses situations conflictuelles ont ouvert un nouvel espace de pensée, créé de nouveaux apprentissages et conduit à de nouveaux types d'activités scientifiques pour les enfants. L'étude suggère qu'en mettant en évidence, en déballant et en facilitant les situations conflictuelles, les enseignants de la petite enfance peuvent créer des espaces d'apprentissage dynamiques dans un cadre pédagogique qui respecte et s'appuie sur le point de vue de chaque enfant.

Mots-Clés

Contradictions, conflits, tournants, petite enfance, éducation scientifique, motifs, exigences, concepts quotidiens, concepts scientifiques

Introduction

The conceptualization of psychological development as a linear process oriented towards a psychological equilibrium has been considered a fundamental concept in the field of classic psychological theories and methodologies (Dafermos, 2014). In that framework, the concepts of stability and balance at the relationship between individual and environment were promoted (Gergen, 1982). Despite progress having been made in the field by studying development as an ongoing and mutated process, this conceptualization led to a narrow understanding of psychological processes.

Drawing upon a dialectical understanding of human development cultural-historical theory captures development as a contradictory process (Dafermos, 2014; Leontiev, 1978; Veresov, 2016; Veresov & Fleer, 2016; Vygotsky, 1989). In real life, contradictory processes mainly exist in a form of *drama* (Veresov & Fleer, 2016; Vygotsky, 1989). That is, emotionally and/or intellectually charged social situations that exist in different forms between people in everyday reality (Veresov & Fleer, 2016). Experiencing dynamic dramatic social situations can lead to critical moments of an individual's development. These moments may, or may not, act as turning points at an individual's development changing the individual's developmental pathway.

In every day educational reality drama is represented as *conflicts*. Young children experience a wide range of *conflicting situations* in early childhood settings. Especially at the transition period when the child enters formal educational settings and joins school life, these *conflicts* are often at an intellectual, affective and enactive level. In the case of child's learning and development in Science, a common *conflict* is the one between everyday experience/knowledge and scientific understanding/thinking (Fleer, 2009; Hedegaard & Chaiklin, 2005; Vygotsky, 1987). That kind of *conflict* can emerge during *collective science experiences* putting important demands on the child, the peers and the educators.

The present study seeks to explore the kind of *conflicts* that can occur during collective science experiences in early childhood settings and how *conflicting situations* act as turning points in child's concept formation in Science. The study focuses on a collective science experience centred on the natural phenomenon of cloud formation and cloud movement. The paper begins with unpacking the concepts of *conflicts* framed in early childhood education and early childhood science education. This is followed by a description of the methodological choices that led the study. Findings are presented through indicative case examples and are analysed through three levels of analysis (a. common sense interpretation, b. situated practice interpretation, and c. analysis in a thematic level) as determined by *dialectic- interactive method* (Hedegaard & Fleer, 2008). An analysis of how diverse *conflicting situations* put new *demands* on young learners and build intellectual bridges between *everyday concepts* and *scientific concepts* follows. The paper concludes with insights into how *conflicting situations* create the conditions for children's development in science. The conclusions inform the practice with suggestions about the pedagogical positioning during collective science experiences in early childhood settings.

Conflicts in everyday educational reality in early childhood settings

As Hedegaard and Fleer argued (2008), *conflicts* can be illustrative of the child's perspective in research allowing the research lens to capture the way the child interacts with the surrounding world and the intentions that guide the child's actions. What is already known from the literature about *conflicts* in early years is mainly that a) conflicts are crucial in early childhood period and act as a moving force to young child's development (Hedegaard, Edwards, & Fleer, 2012) and b) the child is influenced by these *conflicting situations* but, at the same time, contributes to and influences these situations (Hedegaard, 2009, 2012). On the one hand, *conflicts* put *demands* on the child stretching his/her ability to respond to the needs of his/her reality (Hedegaard & Fleer, 2008). On the other hand, the child shapes the *conflicting situations* he/she participates in, by facing the contradictions, transforming the whole experience and creating the conditions for his/her development (Fragkiadaki, 2020).

In everyday educational reality in early childhood settings, *conflicts* between peers, between the child and the educator, between the child's intentions and the institutional practices or even individual's *conflicts* are usual. These types of *conflicts* can be seen throughout everyday life in class such as during educational routines and transitions between activities, during free play as well as during organized tasks and activities. For example, *conflicts* can arise about turn taking and sharing toys and roles in play, about the transition process from home to the kindergarten in the mornings or the transition from outdoors to indoors activities and about shared engagement during team work.

A contradiction between the *demands* of the social situation the child experiences in the institutional settings and the child's *motives* and *motive orientations* usually lays behind these types of *conflicts* (Hedegaard & Fleer, 2008). This contradiction can lead to a *conflicting situation* and proceeds as a crisis in intellectual, social-emotional or embodiment level such as expression of frustration, multiple types of tensions or isolation. Empirical research shows that educators' mediating role and resolutions strategies within *conflicting situations* are critical for supporting young children to manage these types of *conflicts* and the following crises (Arcaro-McPhee, Doppler, & Harkins, 2002; Blunk, Russell, & Armga, 2017).

Although there is an extensive track of empirical studies reflecting various approaches about *conflicts* related to intellectual, social and emotional situations in early years (Chen et al., 2001; Pieng & Okamoto, 2020), less is known about the *conflicts* that occur during collective science experiences and how these *conflicts* influence child's conceptual development about the natural and technical world. The study reported in this paper seeks to address this gap by providing answers to the following research questions:

What kind of conflicts occur during collective science experiences in early childhood settings? and

How conflicting situations act as turning points in a child's concept formation in Science?

Theoretical concepts framing the study

In order to provide answers to the above research questions, the study is framed by a set of theoretical concepts. During the analysis these concepts are dialectical interrelated in order to provide a deep understanding of the evidence provided by the qualitative data presented in the case examples.

Demands and Motives

As Hedegaard argues (2002, 2009), on living, entering and participating in different societal institutional settings such as home, school and the community, young children face different realities as well as diverse models of practice. These models of practice come in line with institutional goals. Experiencing new practices puts new *demands* on the child such as responsibility for his/her own stuff, collective participation or scientific learning. The new *demands* are communicated to the child by parents, educators or/and caregivers during the child's participation in diverse activity settings across institutions or within institutions. New challenges, opportunities and possibilities for development are created through new *demands* (Fleer, 2014; Hedegaard, 2009). However, it is essential that the child's *motives*, that is what is "meaningful and important" for the child (Hedegaard, 2012), are oriented towards the new *demands* or are generated in order to meet the new *demands*. When *demands* are related to a child's *motives*, they become motivating creating the conditions for the child's development (Hedegaard et al., 2012).

Everyday Concepts and Scientific Concepts

A fundamental *contradiction* that stands behind learning and development in science in early years is the *contradiction* between *everyday concepts* and *scientific concepts* (Fleer, 2009; Fleer & Ridgway, 2007; Hedegaard & Chaiklin, 2005; Vygotsky, 1987). Everyday concepts are conceptualizations simultaneously formed through the child's real-life experiences and everyday routines. *Everyday concepts* are related with specific activities, situations and contexts. For example, the child knows that during the bath time routine the mirror will be blurred and he/she can leave tracks on it. Scientific concepts are conceptualizations that are in line with the scientific model of thinking. These concepts are developed in organized or formal settings such as school settings. Scientific concepts are understood beyond specific activities, situations and contexts. For example, in a well- supported pedagogical environment, the child begins to understand that blurred mirrors are related with temperature and the change in the state of matter. In many cases in early childhood science education literature, everyday concepts are conceptualized as obstacles in young children's learning and development in Science and usually are described as less important, naïve or untutored concepts (Robbins, 2009). However, *everyday concepts* are an essential and the baseline for the development of the *scientific concepts*. Everyday concepts are not alternative to scientific concepts but central and critical for the development of scientific thinking (Fleer & Pramling, 2014). Everyday concepts and scientific concepts are dialectical interrelated as the child plays, learns and develops across diverse settings such as home, school and the community. Scientific concepts make sense for the young child and are organized through everyday knowledge and experience. Everyday knowledge and experience deepen and transform through scientific concepts, thinking and understandings. As a term, "scientific concepts" have got different kinds of interpretations in the empirical research field. In this paper, scientific concepts are conceptualized in a way that reflects forms of thinking about the natural phenomenon of clouds compatible with the scientific model used in early childhood science education (Georgantopoulou, Fragkiadaki & Ravanis, 2016).

Pre-Causal, Causal Thinking and reasoning categories in Science

The study focuses on two natural phenomena observable in a child's everyday life: the phenomenon of cloud creation and the phenomenon of cloud movement. Previous empirical research in that area (Fragkiadaki & Ravanis, 2014, 2015; Fragkiadaki, Fleer, & Ravanis, 2019; Georgantopoulou, Fragkiadaki & Ravanis, 2016; Hansen, 2009; Malleus, Kikas, & Marken, 2017) has shown that young children have a wide range of ideas and representations about the natural phenomenon of cloud and these ideas are complex and well-supported with arguments in children's thinking. In this study, in order to categorize children's thinking about the phenomena, the thinking categories of pre-causal and causal thinking in science and the related reasoning sub-categories, as determined by Laurandeau and Pinard categorization (1972) and as expanded by Fragkiadaki and Ravanis (2015) and Georgantopoulou, Fragkiadaki and Ravanis (2016) were used for the analysis (Table 1).

The theoretical concepts, as discussed above, are used in the study as analytical tools in order to interpret the children's overall experience of *conflicting situations* in early childhood settings. A presentation of the methodological framework is presented below, followed by the presentation of the findings of the study.

TABLE 1

Categories of pre-causal and causal thinking and reasoning sub- categories in Science for Early Years

Thinking Category	Explanation of the Category	Reasoning Sub- Category	Explanation of the Category
Pre-causal thinking	Non-compatible with the scientific model thinking	*phenomenism*	causal association of separate physical entities
		artificialism	technical factors conceptualised as the cause of cloud creation
		animism	properties of living beings attributed to clouds and to related natural entities
		teleological causality	human consciousness and activity recognised as the cause for cloud creation
		metaphysical causality	divine intervention as the cause of cloud creation
		combination of pre-causal thinking categories	mixed reasoning
		no reasoning	not expressed reasoning
Causal thinking	Compatible with the scientific model thinking	*pre-causal thinking categories combined with compatible with scientific concept*	mixed reasoning
		Compatible with scientific concept	reasoning compatible with scientific model used in early childhood education

Methodological framework

Study Design

Over a period of three weeks, a set of collective science experiences were organized (Fragkiadaki et al., 2019). Following a cultural-historical perspective in studying young children (Hedegaard & Fleer, 2008), the collective science experiences were organized as part of the everyday educational reality in early childhood settings. The research procedure came in line with the educational routines and the overall teaching and learning planning of the kindergartens. The theme of the experiences was the natural phenomena of cloud formation and cloud movement. Children had no previous experience of any teaching- learning experience about the natural phenomena during the school year. During the collective science experiences preschool children were engaged in open-type conversations about the phenomena. The conversations were held between pairs or small groups of four children and educators of each class. Tools and signs free manipulation as well as interaction and co-operation between peers were promoted by the early childhood educator during the experiences. Each child participated in three (3) diverse collective science experiences in three (3) different time phases. The purpose of this methodological choice was to make possible the mapping of the development of the child's thinking regarding the natural phenomena in different social situations. The time that elapsed between each phase varied from three (3) to seven (7) days depending on the feasibility of incorporating the experiences into the daily curriculum of the kindergartens. During the three phases, the same research protocol was used.

Participants and Data Collection

One hundred and thirteen (113) kindergarten students participated in the overall study. Children were aged 4.5 to 6.5 years with an average age of five (5) years and three (3) months. Children were attending seven (7) different kindergarten classes in an urban area in Greece. The seven (7) early childhood educators of the classes were participating in a professional development program promoting science engagement, learning and development in early childhood settings. All children participated in collective science experiences about the natural phenomenon of clouds formation. Indicative case examples of the experiences of eight (8) children are presented in this paper. The conversations during the experiences were recorded and complementary qualitative data were collected through early childhood educators' field notes and children's drawings during the experiences.

Data Analysis

Three different levels of data analysis, as formulated by the *dialectical-interactive method* (Hedegaard, 2012; Hedegaard & Fleer, 2008) were followed. The levels are described below.

1. *Common sense interpretation:* The first level of analysis was based on the researchers' description and comments on each collective science experience. A qualitative conversation micro-analysis of the data sets was held at this level.
2. *Situated practice interpretation:* The second level of analysis involved the emergence

of conceptual links and correlations between the results obtained from the analysis at the first level. Patterns of children's *conflicts* emerged at this level of analysis.

3. *Interpretation in a thematic level:* The third level of analysis was based on the use of a system of theoretical concepts as analytical tools. At this level, a theoretical analysis was carried out in order to give an insight on how different types of *conflicts* transform children's collective science experiences and create the conditions for the formation of the concept of clouds. The theoretical concept of the *interrelation between everyday concepts and scientific concepts* was mainly used as an analytical tool.

Findings

A qualitative analysis of the data generated from the *collective science experiences* demonstrated multiple *conflicts* as children were elaborating, expressing and developing their thinking about the phenomena. The *conflicts* became obvious through the conversations between a small group of children (see Case example 1) or between pairs of children (see Case example 2 and 3). These *conflicts* were dynamic intellectually charged situations expressed as a mismatch between children's ideas, as well as socially-emotionally charged situations expressed as tensions in social relations. The kinds of *conflicts* that emerged through the data sets analysis were organized into the following main categories:

a) *collisions:* situations when children expressed sharply opposing ideas about the natural phenomena,
b) *impasse situations:* situations when children's diverse ideas about the phenomena led their thinking to a standstill, and
c) *provocative situations:* situations when participatory thinking challenged children's thinking about the phenomena.

The analysis also gave evidence about the way the diverse forms of *conflicts* acted as turning points in the individuals' concept formation trajectories about the natural phenomena. A set of three indicative case examples, each one related with the above categories, is presented, analysed and discussed below.

a) A collision as a turning point at the process of cloud concept formation

In this case example, four children, Harry, Lucas, Kenneth and Ben, are discussing how clouds are formed. Two days ago, the children had discussed the same issue in couples participating at the first phase of the *collective science experience.* During that phase, Harry had suggested that clouds are made of sheepskin (i.e. *"Clouds are made of the sheep's fur")*. In this phase, the early childhood educator enhances the four children to think collectively and reflect on Harry's idea (i.e. *"The idea Harry has can be happening for real? What are your thoughts on that?")*. All the children, except for Harry, say at the same time *"No!"*. The conversation continues as presented in the following extract (Extract 1).

> ***Extract 1.*** A collision as a turning point at the process of the concept formation by Harry.
>
> Ben: *But clouds are transparent, like white….*
> Kenneth: *We can't climb on them!*
> Ben*: How can fur fly? How can this happen? The fur will fall down. That can't be happening?*
> Harry: *It's just an idea!*
> Kenneth: *Maybe clouds are flying because there is no oxygen in the sky…*
> Lucas: *When we throw something in the air, it doesn't stay there and just flies… It falls down again.*

After this dialogue, the early childhood educator suggests thinking about all this information collectively as a team. Lucas says *"Maybe we can think something by having a look at our drawings* (meaning the drawings about clouds that they had drawn a couple of days ago participating at the first phase of the research procedure). The educator provides the time for the children to think on and discuss that. Then, the three children, Lucas, Kenneth and Ben start talking about their ideas while Harry remains silent, hearing carefully to the conversation. A few minutes later he says *"Maybe it is made of dust and soil*".

At the above extract (Extract 1), the four children faced a *conflict* formed as a collision. Harry's idea seemed opposed to the ideas of his peers. However, the whole team considered his idea struggling with this *conflict*. The three children, Lucas, Kenneth and Ben, expressed an extended argumentation trying not to turn down their peer's view but analyze and discuss his idea. Their argumentation was based on science concepts relevant to the natural phenomenon of cloud formation such as gravity, lack of oxygen and transparency. This framework created the conditions for Harry to reflect on his initial explanation that based on an imaginary situation such as a flying sheep skin. At the end of the conversation, Harry expressed a more advanced explanatory scheme about the natural phenomenon based on phenomenism (Laurandeau & Pinard, 1972). Despite his explanation not being compatible with the scientific model, it is indicative of a qualitative shift in his thinking since he started forming an explanation related with classical elements related with matter rather than animals' biological characteristics.

What is important here is that the collision advanced children's *collective science experience* in a twofold way. On the one hand, the collision caused a qualitative change in Harry's thinking about the phenomenon. On the other hand, the collision oriented the three children to create a narrative, negotiate and pose arguments based on ideas compatible with the scientific model about cloud formation. This process was critical for children's thinking about the phenomenon since they started conceptualizing the phenomenon in a more advanced and systematic way.

b) An impasse situation as a turning point at the process of cloud concept formation

In this case example, two children, Felix and Anna, are discussing how clouds are formed. Anna has the idea that clouds are made by rain. However, Felix insists that this cannot be happening because while raining clouds become bigger (i.e. *"Clouds cannot be made of rain. When rain falls clouds are inflated"*). Felix suggests making a drawing in order to better understand how clouds are formed. He introduces the idea of clouds being made of air. However, the two children appear to be unsatisfied with this explanation too. They both remain silent for a while. Then, Felix says *"Ah, how can I know… Maybe Anna knows..."*. The educator asks Anna if she has any ideas. Anna hesitates to answer *"Clouds are…"*. Then, Felix says *"Probably you don't know either… (refers to Anna)"*. Again, the two children remained silent for a while. After a while, Felix starts to express and elaborate the idea that clouds are bits of bread (i.e. *"White small bread bits fall down and then are raised up to the sky"*).

At the above event, the two children faced a *conflict* formed as an impasse situation. They both wondered about the phenomenon struggling to provide an explanation based on their everyday knowledge. However, no progress was made regarding their thinking about clouds. This conceptual standstill forced Felix to start thinking in a new way about the phenomenon that led to a new explanatory scheme.

What is important here is that till this point in time Felix has not expressed any ideas about the phenomenon. In the previous phase of the research procedure he has mentioned that *"These answers are really tough"*. However, in this social situation he expressed an extended explanatory scheme and afterwards, he tried to convince his peer about the validity of his explanation using multiple arguments. The explanatory scheme he formed about the natural phenomenon was based on phenomenism (Laurandeau & Pinard, 1972). Although his explanation was not compatible with the scientific model, this has been a critical moment in Felix thinking about the phenomenon since he managed for the first time to express an idea about how clouds are formed.

c) A provocative situation as a turning point at the process of cloud concept formation

In this case example, two children, Patrick and Brian, are discussing how clouds can move. Brian expresses the idea that clouds are moving because of the wind. Patrick has a different idea. He mentions that clouds are moving because there is wiring in them. Brian disagreed with this idea (i.e. *"Clouds do not have wiring in them. I told you that!")*. Patrick tries then to provoke his peer (i.e. "*How do they move then? Ah….? By wire in a plug?*"). Patrick stays silent for a while and afterwards he says "*Let's say that wind is doing that….*". At that moment, Brian says to his peer that he is confused. The conversation continued as presented in the following extract (Extract 2).

> ***Extract 2.*** A provocative situation as a turning point at the process of the concept formation by Brian and Patrick.
>
> Brian: *You confused me a little bit!*
> Patrick: *Ok, I don't want to confuse you…*
> Brian: (Frustrated) *I told you! Wind is pushing the clouds! The wind that it is outside…*
> Patrick: *Yes, but maybe there is a big cloud outside or at t.v. …*
> Brian: *If there is a big and heavy cloud then it can't be moved because there is gravity, a little bit, inside and outside of it.*
> Patrick: *Listen to me… gravity is inside… but then, if wind blows gravity runs out… Then, wind is moving the cloud.*

At the above extract (Extract 2), the two children faced a *conflict* formed as a *provocative situation*. Patrick and Brian seemed to challenge each other by posing questions, doubting the following answers and expressing their explanation about the cloud's movement. This challenging situation stimulated Brian to advance his argumentation and, at the same time, oriented Patrick to build his own arguments, rethink about the validity of his answer and start thinking on the new idea of wind moving clouds. Through this process Patrick's thinking made a transition from an explanation based on artificial causes towards explanations based on natural causality (Laurandeau & Pinard, 1972).

What is important here is that during this procedure the two children were engaged in a process of constructing and reconstructing arguments advancing their argumentation characteristics. This was a critical moment in children's thinking about the phenomenon since they both started conceptualizing the phenomenon in a more systematic way.

Forming the science concepts through the conflicting situations

The overall case examples outlined that the interactions between the children during the *collective science experiences* generated multiple *conflicts*. The *conflicts* arose between children's different understandings about the phenomenon. The *conflicts* proceed differently in diverse social situations in each *collective science experience* (i.e. collision, impasse situation, provocative situation). However, in all cases, *conflicting situations* put a new *demand* on children. That is, how to manage and resolve the *conflicts* so they would come up with an explanation about the phenomena collectively as a team. Trying to respond to this *demand*, children were motivated towards a) conceptualizing their peers' perspective about the phenomena, b) reflecting on the rationale behind these perspectives, c) wondering, negotiating and rethinking about their rationale, and d) providing a response to their peers. Responding to these new *demands* and developing a motive orientation towards finding a resolution key to the *conflicts*, children deepened their thinking about the phenomena and developed a wide range of methodological skills required for scientific thinking such as a) argumentation (e.g. *"When we throw something in the air, it doesn't stay there and just flies… It falls down again"*), b) use of rudimentary scientific language (e.g. gravity), c) wondering and posing questions (e.g. *"How can fur flights?"*), d) use everyday knowledge and experience (e.g. "*When rain falls clouds are inflated"*), and e) to use cultural tools such as drawings (e.g. *Felix suggests making a drawing in order to better understand how clouds are formed*).

Through advancing children's thinking and skills, *conflicts* created the conditions for qualitative changes in children's concept formation about the phenomena of cloud formation and cloud movement. A transition course of thinking was mapped starting from a conflicting point, moving towards a dynamic transforming situation, leading to qualitative changes and development. These qualitative changes were expressed through transitions towards an explanatory model more expanded or more compatible with the scientific model used at early childhood science education.

The mediating role of the early childhood educators supported children's interaction and contributed to the advancement of children's thinking about the phenomena. Posing questions, giving children the time to think and reflect but, importantly, giving children the leadership in handling the *conflicting situations*, educators gave children the opportunity to create a new conceptual space and at the same time oriented them towards a more scientific understanding.

Taken together, the above findings illustrated a dialectic interrelation between the *everyday concepts* and the *scientific concepts* during the *conflicting situations* the children experienced. As expected, given the lack of any kind of teaching intervention, the findings demonstrated that children did not reach a level of thinking compatible with the scientific model. However, the evidence has shown that *conflicting situations* allowed children to frame their real-life experience about clouds in a more systematic way. In the *conflicting situations*, children started making sense as well as expanding their everyday knowledge about clouds. Through more advanced forms of scientific engagement such as the concept of gravity or scientific methodology such as reasoning on the basis of concrete criteria, everyday knowledge and understandings were transformed (see case example 1), stimulated (see case example 2) or deepened (see case example 3). The initial *conflicts* oriented children towards this interrelation stretching their thinking.

Conclusions

The present study sought to explore the diverse kinds of *conflicts* that occur during *collective science experiences* in early childhood settings and how *conflicting situations* can act as turning points in child's science concept formation. It was found that *collective science experience* generated multiple and dynamic *conflicts*. These conflicts were critical moments at child's concept formation about the natural phenomenon of cloud examined in this study. The overall findings showed that although *conflicting situations* caused tension and a temporal loss of equilibrium at children's interactions, a kind of narrow crisis, they also acted as turning points at the process of science concept formation. Qualitative changes at children's thinking about the phenomenon were noted.

The findings come in line with the theoretical framing of the study about the importance of *conflicts* in young children developmental pathways (Hedegaard & Fleer, 2008; Hedegaard et al., 2012) as well as about the conceptualization of development as a contradictory process (Dafermos, 2014; Leontiev, 1978; Veresov, 2016; Veresov & Fleer, 2016; Vygotsky, 1989). What appears to be new here is the critical role of *conflicts* in young children's science learning and development as well as the capacity of young children to manage and resolve *conflicts* during collective science experiences. The way children engaged with, participated in, reflected on and shaped the *conflicting situations* influenced children's cloud concept formation. The *conflicting situations* created the conditions for children's development in science opening a new space of thinking, creating new learnings and leading to new types of activity in science for the children.

The findings of the study also point towards a reconceptualization of early childhood educators' pedagogical positioning within *conflicting situations*. Rather than intellectual and social-emotional barriers in young children's learning and development in science, *conflicts* can be understood as challenging teaching opportunities. Highlighting, unpacking and facilitating *conflicting situations* early childhood educators can create dynamic learning spaces and a pedagogical framework that respects and builds on each child's perspective.

Conceptualizing *conflicting situations* as critical moments in early childhood science education give new insights in understanding science teaching, learning and development as a social activity in group settings. This aspect takes an important meaning in the light of the need to establish a new Science Education Pedagogy in early years that supports and promotes science as part of the child' everyday educational reality in early childhood settings.

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