Early childhood teachers making multiliterate learning environments: The emergence of a spatial design thinking process

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ABSTRACT

Globally, a critical debate about multiliteracies' teaching in early childhood education is intensifying. Teachers and researchers worldwide are rethinking 'multiliteracies pedagogy' and 'multiliterate learning environments' to design innovative and meaningful educational spaces for young children. They pursue to better account for the role (and entanglement) of spaces, places, materiality, bodies, and power in early childhood education pedagogies. Multiliterate learning environments research offers the possibility to reconceptualize early childhood classrooms as real sites of thinking revolution and unique spaces for theorizing new contours of literacy pedagogy. This study explored and elicited early childhood teachers' thinking and making multiliterate learning environments, with an ethnographic approach. We designed a single-case study emplaced in a university's laboratory preschool. The participant observation took place for five months and had two different outspreading moments. First, to explore and familiarize with the preschool culture and to penetrate the learning environment codes, and the second, to produce ethnographic data collaboratively with in-depth interviews. Findings show that teachers' design thinking process is culturally situated and 'child interest- driven,' enabling some child agency in spatial meaning-making as co-authors of the multiliterate learning environments they inhabit. The design thinking process unfolds through an ongoing iterative and collaborative four-phased-cycle. Teachers ideate and reflect on multiliteracies and place-making decisions that materialize learning environments based on the world of children. While making multiliterate environments through this spatial design thinking process, teachers are empowered as designers and as makers of a 'third teacher,' where a wide-ranging diversity of people, texts, practices, meanings, and cultural contexts intersect to build communication.

1. Introduction

Globally, a critical debate about multiliteracies' teaching in ECE -early childhood education- is intensifying, and practitioners within the field are rethinking how to accommodate these changes (Hesterman, 2017) in innovative and meaningful learning environments. ECE teachers and researchers worldwide are rethinking 'multiliteracies pedagogy' (Simon, 2011) and 'multiliterate learning environments' (Hesterman, 2011; Zammit, 2010; Zammit & Callow, 2013) to enable children's full participation in co-constructing societies' knowledge, identity and culture (Dahlberg, Moss, & Pence, 2007; Mills, 2009). As we argue further in this article, the multiliteracies' learning environments perspective emerges from a critical spatial and material turn in literacy studies

(Comber & Nixon, 2008; Robinson & Schulz, 2010). It pursues to better account for the role (and entanglement) of spaces, places, materiality, bodies, and power in ECE pedagogies (Hackett & Somerville, 2017; Jobb, 2019). Multiliterate learning environments research offers the possibility to reconceptualize ECE classrooms as real sites of thinking revolution and unique spaces for theorizing new contours of literacy pedagogy. As Simon posited, it 'cuts against the grain of literacy policy in contexts such as the United States, where legislation continues to restrict rather than invite children's full literate lives into classrooms' (Simon, 2011, p. 363).

In the United States, there is much rhetoric on equipping ECE teachers to implement spaces and classrooms for young children within a globally connected and diverse society (Durden, Escalante, & Blitch, 2015). As Moss, we observe, "ECE is dominated by a strongly positivistic and regulatory discourse" (Moss, 2017, p. 11) and a plethora of instructional recommendations that constrain ECE teachers to fulfill standardized assessments and replace meaningful learning with teaching-to-the-test methods (Simon, 2011). ECE teachers in the United States keep struggling with a focus on reading and writing a tightly confined set of linguistic conventions and print-centric pedagogical practices (2013, Hesterman, 2011; McLachlan, Nicholson, Fielding-Barnsley, Merce, & Ohi, 2012). We contend that this way of thinking ECE literacy has built a technical and controlling narrative in classrooms (Teale, Hoffman, & Paciga, 2010). It not only fails to recognize the complexity of today's communicational landscape (Loerts & Belcher, 2015) but also exclude young children with learning environments that neglect their agency and diverse linguistic resources (Hesterman, 2011).

For more than three decades alternative discourses have come out from different ECE modalities and disciplines to contest this traditional understanding of literacy (Hackett & Somerville, 2017; Hesterman, 2013; Jewitt, 2007; Kuby & Vaughn, 2015) and reconceptualize ECE teachers' literacy roles (Kumpulainen et al., 2018; Yayli, 2009). The Reconceptualist movement of early childhood (Dahlberg et al., 2007; Moss, 2017) and the legacy of grand pedagogues such as Fröebel, Dewey, Montessori, and Malaguzzi, are a basis for ECE practitioners and researchers to reinterpret The New London's Group seminal work (1996 and 2009) and broaden literacy in the ECE field to 'multiliteracies' (Crawford, 2014; Hackett, Pahl, & Pool, 2017; Hesterman, 2013; Kuby & Vaughn, 2015). This critical approach in ECE understands multiliteracies pedagogy as a socio-cultural process were young people learn to communicate in multimodal ways, making meaning of the culture they live. The multiliteracies paradigm in ECE goes beyond the traditional literacy, focused on the acquisition of a clearly defined set of mechanical skills that build up step-by-step for primary education readiness. Following Kumpulainen, multiliteracies in ECE "is the skill of being human and living in an increasingly diverse world, understanding its polyphony" (Kumpulainen et al., 2018). Hence, we agree on multiliterate learning environments for early childhood as interfaces that unfold as children grow up within the intertwine of interactions between human, material, and social contexts, and participate in cultural practices as meaning-makers and influencers of that culture (Hackett, 2015; Hackett & Somerville, 2017).

Our interpretation and research base on a socio-constructivist postmodern premise (Dahlberg & Moss, 2004; Dahlberg, Moss, & Pence, 2005; Moss, 2017) that acknowledges a relational and interdisciplinary construction of the multiliterate learning environments paradigm. From there, we position within the Reconceptualist movement of early childhood (Jobb, 2019; Moss, 2017; Ryan & Grieshaber, 2005; Urban, 2015) that is just one facet of postmodern thinking from which to reconceptualize universal truths of literacy and resist narrow understandings of ECE[1] (Moss, 2017, 2018). Our stance is shared with other perspectives like critical thinking (Kumpulainen et al., 2018), posthumanism (Hackett & Somerville, 2017; Kuby & Rowsell, 2017), critical literacy studies (Hesterman, 2017; Kuby, 2013), post-anthropocene pedagogy (Malone, 2013; Somerville & Powell, 2018, 2019; Wals, 2017) and place-based education or place-conscious pedagogies (Gruenewald, 2008; Theobald, 2018).

We weave together the extended theory of multiliteracies pedagogies from the New London's Group (2017, Hackett, Procter, & Seymour, 2015, 2017; Hesterman, 2013; Kuby & Rowsell, 2017) with theories of space and place in the field of children's critical geographies (Clark, 2007; Gruenewald, 2008; Hackett et al., 2015; Nairn & Kraftl, 2016) and teachers' design thinking in pedagogy (Henriksen, Richardson, & Mehta, 2017; Luka, 2014), to understand 'how do early childhood teachers think and make multiliterate learning environments? We inquire how ECEC teachers permanently engage with children in co-constructing new multiliterate learning environments, less as consumers of designed models or solutions and more as authors of meaningful places. On this track the article contributes by foregrounding the ECE teachers' ample thinking processes, entangled with intuitions, sensitivities, and mindsets, that remain a 'black box' (de Coninck-Smith, 2017; Ingold, 2013) in the rise of prominent ECE learning environments.

We make the case of an ECE teachers' community in a Laboratory Preschool[2] inspired by the Reggio Emilia approach, that manages to mitigate local constrains and unfold a spatial design thinking process to reconceptualize classrooms as situated multiliterate learning environments. From our Reconceptualist standpoint, we highlight how the ECE teachers' spatial design thinking is intuitive, iterative, open to discovery and is embedded in practice, knotted in what they can and are deciding, doing, and making quotidianly with children. Although their spatial thinking does not follow prescribed planning, they share a meaningful narrative and emergent cyclic process about multiliterate learning environments. We show how that collaborative thinking embraces diversity, complexity, and the uncertainty to bring up learning environments that are de-centered of expertise and universal academic or political knowledge necessary for success. (Hackett & Somerville, 2017; Moss, 2018).

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[1] We use the acronym ECE -Early Childhood Education- instead of ECEC -Early Childhood Education and Care-, because in coherence with the Reconceptualist standpoint we believe 'care' is at the ethical nature of education and in Moss's words "should not be, confined to services for young children" (Moss, 2017, p. 13).

[2] We use the concept of Laboratory Preschool as equivalent to the Laboratory School John Dewey established at the University of Chicago in 1896. It is an experimental school for children under 5 years within a southwest university in the US. The age span of this ECE center resembles the Froebelian Kindergarten that opened for children between thirty-six months to seven-year-olds.

2. Multiliteracies' relevance in early childhood education

Introducing young children into provoking early learning environments to approach multiple meaningful literacy experiences is a timely topic in ECE worldwide. We argue that this long tradition is not specific to certain pedagogical approaches or methods of early childhood. Instead, we believe it to be a central narrative of what Peter Moss (2018) refers to as a *resistance movement*: a global community that questions and contests dominant discourses in ECE and offers alternative perspectives and narratives concerning the emplacement of literacies for early childhood (Moss, 2018). The multiliteracies perspective in ECE as a socio-cultural process were young people learn to communicate in multimodal ways, making meaning of the culture they live in, is not new in theory and practice. However, it is often assumed, rather than interrogated by research (Duhn, 2012; Jobb, 2019).

More than one century before the critical literacy controversies started, Froebelian kindergarten, the matrix of modern ECE, underlined a pedagogy were children were gently encouraged in play through speech, singing, and by pointing out things found in their social and natural environments. Although the rise of modern ECE did not speak of multiliteracies, it did establish its core for early childhood, pushing as a learning principle making-sense of culture through language and via sensual and physical experiences (Heiland, 2006; Sauerbrey, 2016). Froebelian ECE is the foundation of an influential pedagogical movement ahead of its times, "in the contemporary mood of Piaget and the child-centered educators" (Hewes, 1982). Until today it believes in the natural unfolding of each child's literacy skills by inhabiting a community of mutual love, self-activity, and democracy. Hewes (1982) claims that the Froebelian's movement motto was "come, let us live with our children," which meant that ECE should provide supportive environments with materials and spaces for children to symbolize their ideas and represent the world around them; what we believe later in the 20th century would be the core of ECE multiliteracies pedagogy and multiliterate learning environments.

In 1870 in the United States, there were only 10 or 12 Froebelian kindergartens, and by 1880 they gained strength and spread to over four hundred in thirty-three states and abroad to the Sandwich Isles, Japan, Africa and what was then Palestine. However, several authors (Hewes, 1982; Nordtømme, 2012) describe in their historical research, how during the late 19th-century, though some resistance, ECE 'schoolified' worldwide (Pardo & Opazo, 2019) and early literacy experiences stiffened weakening the Froebelian pedagogical legacy until current ECE. Hewes (1982) explains that in the United States, teachers (trained in Normal Schools) memorized and routinized Mother PlayBook, had children follow dictated lessons, and used material with older students for whom there was no developmental significance. At the same time, manufacturers of school supplies produced the Froebelian resources with instructions for a correct-way-use. Both public and private school systems, built learning environments that increased the numbers of children from Froebel's kindergartens' limit of fifteen to as many as forty or fifty per teacher, and cut the age span of two to seven, exclusively to four and five-year-olds[3] . Within this ECE context, the age of scientism followed and developmental psychology with its deterministic reading and writing habit-training and literacy measurements "became the new gospel" (Hewes, 1982; Lino & Parente, 2018). As Nordtømme (2012) alerted, this focus on the individual child's range of knowledge, dispositions, and skills turned ECE "into more formal and school-look-alike pedagogy" (p.318).

The ECE timeline shows that several child-centered pedagogues contested the schoolified paradigm, pushing a literacy learning perspective through teachers supporting self-activity, meaningful experiences and prepared environments with carefully designed places and materialities. Both Montessori and Dewey are relevant influences of this resistance in the United States, bequeathing alternative literacy learning and democratic learning environments in ECE. Montessori initiated an alternative education in Italy that rapidly spread in North America, advocating for a language environment as a holistic process for skill-building embedded in meaningful contexts (Soundy, 2003). Montessorian classrooms were to follow Fröebels's idea of wooden and natural materialities in prepared environments to provide play and exploration with oral language and ventures into writing and then reading. A core set of materials that included metal insets, sandpaper letters, and grammar boxes for naming games, matching and sorting, and oral reading were the usual pedagogical tools. According to Whitesgarver and Cossentino (2008), in the United States, Montessorian ECE had an intense but short-lived flourishing until 1918, due to a conjunction of influential critics and World War I. It does not resurface until the' 60 s in preschools when a generation of middle-class progressives adopt Montessori's child-centered developmental theories to revive the movement and upraise early childhood education. Despite the rise and fall of specific Montessorian ideas on literacy materials and learning environments in the United States, they have exercised a "strong influence on the American educational establishment even while remaining on the margins of that establishment" (Whitesgarver & Cossentino, 2008).

Surprisingly, the harshest critics of Montessorian literacy pedagogy in the United States derived from Dewey's perspective and one of his most important collaborators, William Killpatrick. Dewey promoted learning environments and literacy based on meaning-making and democratic dialogue considering pedagogical situations as "a universe of experience" that socially and culturally engaged children in meaningful learning (Nordtømme, 2012). From that stance, Kilpatrick accused Montessorian materialities of misunderstanding child self-expression and inhibiting ample literacy experiences when imposing books, reading and writing on children too early, and disconnecting from broader societal concerns. In contrast to the weakening of Montessori, Dewey's view of literacy as an active process and not a transmission of pre-packaged conventions, inspired at the begging of the' 60 s, the pedagogical project of Loris Malaguzzi currently recognized as Reggio Emilia. According to Rinaldi, Reggio Emilia schools embraced Dewey's idea of early literacy learning constructed through children's experiences, situated in practical and emancipated experimentation and participation in activities (Rinaldi, 2004).

In the second half of the 90 s, while the Reggio Emilia project flourished in the United States with a socio-constructivist idea of

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[3] It is upon this phenomenon that Kindergartens today in the US correspond to those lively structured classrooms of pre-primary education within a school, and not a whole institution where children from two and a half were supposed to start formal education and approach multiple literacies.

early literacy, The New London Group questioned the "what" and "how" of traditional literacy instruction. Both perspectives converged and inscribed in a critical epistemology of literacy and advocated for the unvoiced in increasingly multicultural and globalized societies where children should learn and live. Researchers and pedagogues proposed the concept of "multiliteracies" to understand the multiple and integrated modes of learning and meaning-making by relating the textual with the visual, audio, spatial, and socio-cultural dimensions of life. Multiliteracies came to acknowledge the plethora of communicative practices children and teachers can engage with and the relevance of nonlinear and unpredictable multicultural experiences that enable literacies while inhabiting diverse realities and creating new worlds (Hackett & Somerville, 2017; Kuby, Rucker, & Kirchhofer, 2015; Simon, 2011). ECE teachers' role reconceptualized as critical thinkers and makers of learning environments, with multiple modes of representation and meaning-making opportunities beyond language alone (Puteh, Che Ahmad, Mohamed Noh, Adnan, & Ibrahim, 2015; Yayli, 2009).

3. Multiliteracies spatial turn and learning environments as the third teacher

Since the 1990s, the critical perspective of multiliteracies (and social sciences in general) made a spatial turn, to focus on how humans and the material world "entangle in the production of realities, knowledge, relationships, and literacies" (Kuby & Rowsell, 2017, p.285). However, historiographic research shows that this profound shift had started in ECE three decades before, in theory and practice, with Loris Malaguzzi's Reggio Emilia project in public early childhood schools of north Italy (Moss, 2018). This encompassing spatial turn brings into ECE a more situated and fluid thinking of power relations in children's spatialities. It reconceptualizes early childhood learning environments as complex interfaces made of both spaces and places, as two necessarily demarcated entities that encounter in classrooms and pedagogy (Jobb, 2019). *Space* is the physical and material world, while *place* emphasizes the connection with the appropriation and meaning making of that materiality (usually adult given). Place-making is the process of "co-constructing meaning and being co-constructed through interactions" (Jobb, 2019, p.213) within space. This crucial distinction in early childhood settings has been extensively studied (De Coninck-Smith & Gutman, 2004; Edwards, Gandini, & Forman, 1998; Jobb, 2019) and there is a growing body of research into place-attuned pedagogies (Hong, Shaffer, & Han, 2017; Miller, 2019; Strong-Wilson & Ellis, 2007) and place-conscious education (2008, Gruenewald, 2003; Mills & Comber, 2013). The last five years research has mainly focused on spatial thinking from the children's views and voices (Hackett et al., 2017; Rinaldi, 2004; Robson & Mastrangelo, 2018; Tarr, 2004), and teachers participatory projects, visible pedagogies and implemented experiences (Adlerstein, Manns, & González, 2016; Kumpulainen et al., 2018; Strong-Wilson & Ellis, 2002). However, leaving as a black box in the field (de Coninck-Smith, 2017; Ingold, 2013) ECE teachers' intuitive and deep spatial thinking, emplaced embrace of uncertainty, and emergent spatial practices as fundamental to construct their knowledge.

Spatial thinking in ECE positions learning environments as what Malaguzzi denominated the "third teacher" -after family and educators- (Hoyuelos, 2009; Hyson, Horn, & Winton, 2013; Malaguzzi, 1981; Rinaldi, 2004). The challenge this concept has taken up is the creation of rich and provocative contexts that enable children to find their own "affordance" through interactions with objects and other people, negotiating the prescribed curriculum (Strong-Wilson & Ellis, 2007). Through this lens, teachers pay close attention to the countless ways in which space can offer provocations that surprise and invite children's explorations and spark discussions for learning. Learning environments as a third teacher is built on listening how young children inhabit spaces in unplanned ways, that is, the emergence of "children's places," in opposition to places thought for children (by adult-centered teaching). Though the third teacher narrative developed in the Italian preschools of Reggio Emilia (Hoyuelos, 2005; Vecchi, 2010) during post-world war II, it accomplished such great international recognition for providing pedagogical power to co-constructed ECE settings, that it became the postmodern paradigm of learning environments in this educational level (Biroli et al., 2017). According to Gandini, the third teacher stance of Reggio Emilia was not intended as a model to imitate, but rather as an incitement to thought and change (Gandini, 2011), requiring forethought, children's voices and interdisciplinary design knowledge (Vukelich, Christie, & Enz, 2011) to materialize in ECE teachers' pedagogies.

We consider this spatial thinking turn relevant for ECE multiliteracies and learning environments in the United States where the typical ECE spaces still reflect what De Gregori called the factory model of classrooms (Gregori, 2011); in ECE, binarized in either a teacher-centered space organized upon group-tables and chairs or a child-centered layout with prescribed learning spaces for different developmental stages. Beyond the different approaches of grand pedagogues, this spatial thinking turn enables reconceptualizing multiliterate learning environments as a hands-on encounter of democratic empowerment in the classroom that acknowledges negotiation, dialogue, and meaning-making within spaces, for multiliterate places to emerge. It disputes the prescribed teacher and child-centered classrooms, promoting learning environments as dynamic socio-spatial assemblages (Dovey & Fisher, 2014), where multiple literacy places are recurrently produced by interconnecting relations and practices for learning to take place (Dudek, 2012). On this basis ECE classrooms welcome uncertainty and wonder, leaving behind prescribed plans and outcomes, on behalf of listening to different voices and embracing singularity, and emergent learning as motor of knowledge (Moss, 2018).

4. Reconceptualizing teachers spatial design thinking within the third teacher

As ECE teachers struggle to create compelling multiliterate learning environments, the field of design through design thinking, advanced to join into ECE pedagogy. Partly, invited by Reggio Emilia's interdisciplinarity to think theoretically and practically, the third teacher in the network's schools (Gandini, 2011; Rinaldi, 2004). And partly, because design professionals pursue to develop

tools for teachers to acknowledge them as designers of multiliteracies. Designers have burst into teacher's thinking and teaching with diverse applications of design thinking structuring and guiding (Rauth, Köppen, Jobst, & Meinel, 2010) the process of reflecting and creating empathic solutions to solve their problems of practice (Henriksen et al., 2017). Design thinking translates ECE teachers' pedagogical knowledge and experience into actionable design practices and mindsets (Koh, Chai, Wong, & Hong, 2015) to frame and reframe problems and solutions (Johansson-Sköldberg, Woodilla, & Çetinkaya, 2013; Maher, Poon, & Boulanger, 1996), and to document, provoke, mediate and co-design children's places and meaningful interactions among human and material worlds (Jordan, 2016).

In ECE pedagogy, design thinking advocates for a bottom up thinking that positions humans (their intertwined bodies and agency) above given space and form making. However, Cortés (Cortés, 2013) charges that prominent models of design thinking for teachers do not consider tacit pedagogical knowledge, unexpected decisions or unique pedagogical systems that unfold when designing multiliterate learning environments. She argues that many valuable pedagogical thoughts, intuitions, ideas and uncertainties around multiliterate learning environments are hard to accommodate into the described phases of prescribed design thinking models offered to ECE teachers. As designers of multiliterate environments, ECE teachers face dynamic, uncertain, complex, and unpredictable challenges were constant thinking, reflecting, decision-making and acting take place. We argue that existing models and their generic nature do not accommodate to ECE teachers' thinking process. Further design thinking understandings of this black box (Koh, Chai, Wong, Hong, Koh et al., 2015; Matthew, Sadiku, Adedamola, & Musa, 2019) will also contribute to reconceptualize the available design thinking models for ECE.

5. Research method

5.1. An ethnographic case study approach

This study explored and elicited ECE teachers' thinking involved in the design of multiliterate learning environments, with an ethnographic case study (Rockwell, 1980, 2011). This qualitative approach to ECE teachers' design thinking is highly relevant in the current context, where quantitative knowledge of cost-benefit studies regarding educational spaces abound (File, 2012), but there is little guidance for creative agency to develop meaningful and engaging learning environments for early childhood (Shonkoff, 2010; Simon, 2011). Following critical (Cummings, Tobin, Wu, & Davidson, 1990; Tobin, Yeh, & Karasawa, 2009) and collaborative ethnographers (Hackett et al., 2017; Lassiter & Campbell, 2010), we understood the research process as an inquiry along with ECE teachers and inside classrooms with a non-participant but dialogic fieldwork. Following the Reconceptualist stance we pursued to "reflexively offset colonial modes of research by engaging research participants as dialogic partners" (Lassiter & Campbell, 2010) along the whole process. A 5-month immersion enabled 'shared walking conversations' through the classroom spaces, self-reported and researchers photographing or visual documentation of children's space appropriation, and audio recordings of teaching meetings for learning environment-making. Ethnographic fieldwork in the case included observation and fieldnote writings of key socio-spatial assemblages and emergent incidents in the classrooms; in-depth interviewing with ECE teachers to collect ideas, feelings, decisions, artifacts and stories of children's engagements in the evolving learning environments.

5.2. Case study setting and participants: laboratory preschool & in-service ECE teachers

Our ethnography emplaced in a Laboratory Preschool for two to five-year-old's, within a southwest university of the United States. Following Yin (1981, 2013), the election of this case based on its unique circumstance as an experienced and recognized early childhood education R&D setting for the Faculty members and graduate students of the university. The Laboratory Preschool enrolled 54 children in full-day educational service. Unlike traditional U.S. preschools, our case provided an 'emergent and creative curriculum' based on Reggio Emilia's approach (Hoyuelos, 2005; Malaguzzi, 1981; Vecchi, 2010) and had a strong stance regarding multiliterate learning environments and the educational space as a third teacher. So when deepening in ECE teachers thinking and making multiliterate learning environments, this Laboratory Preschool served for a revelatory purpose (Butvilas & Zygmantas, 2011; Yin, 2006) and can be labeled as an ethnographic case study (Merriam, 1998).

Four female ECE teachers participated as partners of the ethnographic process. While three were classroom practitioners, the fourth who had worked at the preschool for twenty-one years, served as the Principal. They all belonged to different cultural and linguistic backgrounds. Henceforth, per ethical research codes (University IRB requirements), ECE teachers' thoughts, actions, and decisions will appear identified by the number of the classroom they taught in (e.g., T1 corresponds to the ECE teacher in classroom 1, and P to the teacher-principal).

The Laboratory Preschool contained three classrooms, each one with an assigned thematic space subdivided into 'learning centers' with a diverse set of materials for children to use, and one ECE teacher in charge. The distribution of the children in each classroom was an important decision for the staff. Each classroom contained a multi-age group because, as teachers explained, older children are mentors for younger classmates, and because development is not strictly associated with age. This arrangement also gave an opportunity for children without siblings at home to interact with younger and older peers, and to learn important social skills. The children belonged to a wide variety of ethnicities and origins and at least three different mother languages were spoken in each classroom.
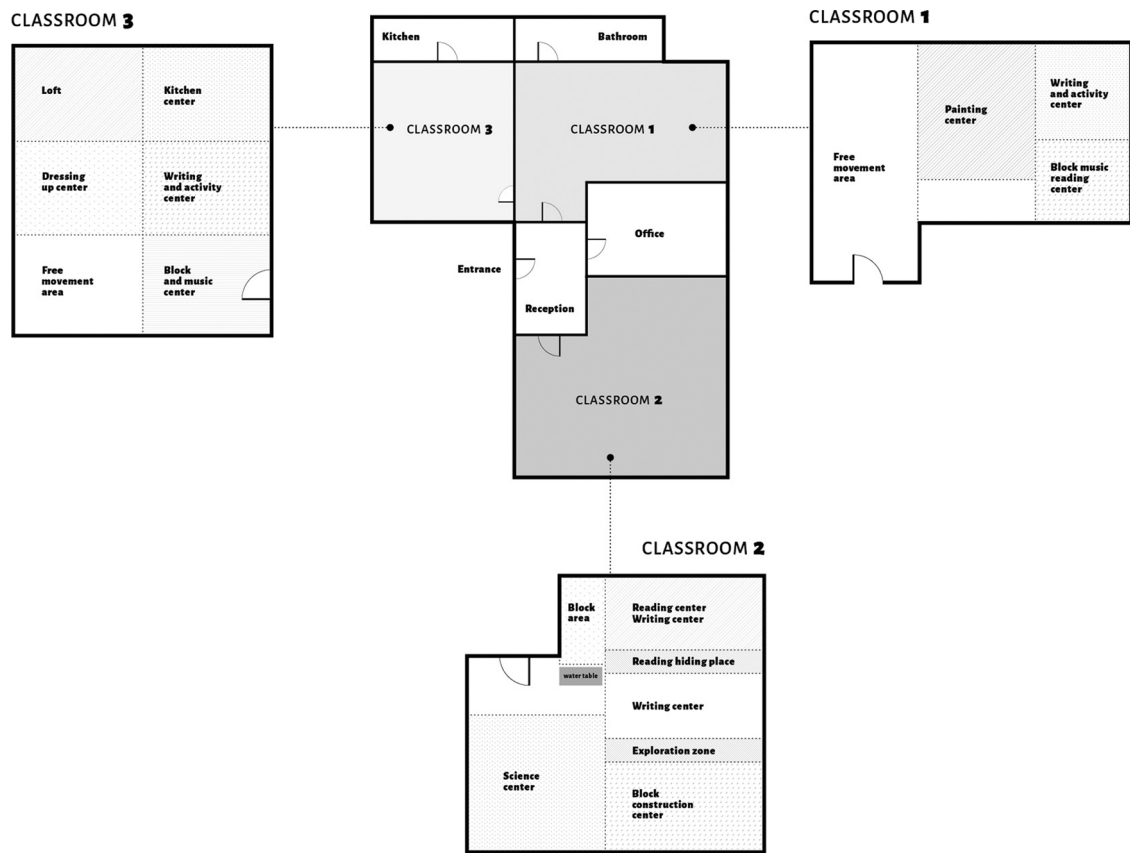
Fig. 1. Plan of the case-study Laboratory Preschool and its learning centers in each classroom.
Researchers' layout based on ethnographic observation (non-formal public plans of the building).

Even when each child was assigned a homeroom, they had the opportunity to move freely within centers during worktime. These micro-environments were thought to foster different multiliterate experiences and pedagogical encounters, as well as organize the uses and affordances of space and place-making. Fig. 1 shows a plan of the Laboratory Preschool and the centers in each classroom (see Appendix B for detailed information).

5.3. Data production and analysis

We produced data with ECE teachers in two iterating phases for five months. The first phase was oriented to experience the multiliterate learning environment planning with ECE teachers, in meetings, and diverse designing conversation-encounters before the school year started. The second moment focused on understanding daily activities and pedagogical experiences that enabled children and ECE teachers in multiliterate learning environment-making. Both ethnographic phases based on participant observation sessions (Atkinson & Hammersley, 1994; DeWalt & DeWalt, 2011) and in-depth interviews with the participants, which were all documented in field notes and audio recordings that were then transcribed (Rockwell, 2006; Rockwell & Anderson-Levitt, 2015). The direct interaction with the children was minimal and reduced mainly to a smile or short answer in response to their calls for attention.

The participant observation had two different outspreading moments. First, to explore and familiarize with the preschool culture (Tobin, Arzubiaga, & Mantovani, 2007) and to penetrate the hidden curriculum (Wood & Hedges, 2016), particularly the learning environment codes (beyond the explicit curricular definitions). Second, as a collaborative ethnographic method (Pink, 2008) to contrast and extend the in-depth interviews. The dimensions that observations considered were: 1) key socio-spatial assemblages (Dovey & Fisher, 2014) and arrangement events in classrooms and centers (Cardellino, Araneda, & García Alvarado, 2017) also understood as multiliterate space flexibility (Vukelich et al., 2011); 2) multiliterate material, things and artifacts that children and/or teachers produced (Ferrare & Apple, 2010); 3) purposes, thoughts and feelings about spaces and place-making (Casey, 1996; Robson, 2011); 4) intentional gestures, languages, and expressions that emerged with multiliterate purposes to communicate something or with someone (Guo, Justice, Kaderavek, & McGinty, 2012). All the participant observations were opened to grasp the production of semiotic resources and multimodal performances (Jewitt, 2007, 2008; Van Leeuwen, 2011) that constituted the multiliterate learning

environments-making. To document observations, we used the Ax4 inventory (used in human centered design methods) which enables to register the observed situations in four categories: actors (participants in the observed situation, their roles, interactions and relations), artifacts (objects used by the actors and objects present in the environment), activities (primary and secondary activities occurring in the observed setting) and atmosphere (ambient in which activities take place, including all the senses). This system enables the observer to separate the aspects being observed and deepen the detail of the documentation.

The in-depth interviews (Kvale, 2011a, 2011b) were 'showing and walking-around conversations'. In an emergent and 'on the move' format, ECE teachers showed us materials, told stories of children's engagements in the evolving learning environments, and gave tangible examples of space arrangements and visible materialization of place-making. The principal's interviews included specific questions related to her position and experience in directing and supporting multiliteracies and patterns of learning environment-making.

We analyzed all the fieldwork data with Thematic Coding Analysis (Robson, 2011) in two levels, first opened and then axial coding (Charmaz, 2017; Strauss & Corbin, 1990) as suggested by mainstream qualitative methodologists (Bryant, Charmaz, & Dey, 2012; Miles & Huberman, 1994; Ridder, Miles, Michael Huberman, & Saldaña, 2014). Interviews were analyzed using meaning interpretation (Kvale, 2011a), and transcripts and observation notes were grouped together under codes with visualization memos. Patterns were classified using a matrix and all interview extracts were organized under each topic distinguishing each of the participants with a color. Themes were grouped according to emerging phases and variables of the observed design process. Analogies were constructed and visualized with the use of a matrix, diagrams, and concept maps.

This process of data reduction, data display, and data conclusion and verification were integrated and contrasted (Fetters, Curry, & Creswell, 2013; Kvale, 2011b; Schoonenboom, 2014) within the research team to identify decision-making moments in the 'design-thinking-making' of multiliterate learning environments. Finally, we grouped and linked patterns and decision-making moments to describe phases and thinking-making milestones of the evolving multiliterate learning environments. Though we show a linear procedure, during the fieldwork, there was a constant back-and-forth iteration between data collection and analysis that included relating to participants, their thoughts, places, and resources they used to make multiliterate learning environments.

6. Findings: thinking and making multiliterate learning environments

Findings show that beyond the prescribed curriculum and regulatory constrains ECE teachers do share a design thinking process that although is not formally defined, works in an intuitive level, based on shared meanings and feelings about children's multiliteracies, that emplace their speaking, thinking, and acting and their relations with materialities and others. The Principal explains that the "*biggest feeling about literacy is that you need to begin to show children why literacy is important to them*" (P). ECE teachers did not use the term "design process" when referring to their spatial decisions in bringing up multiliterate learning environments. They used the word 'design' to describe the "*re-arrangement of elements*", "*their evolving room*", and a "*tweaking here and there*" (P). The staff did not consciously describe a systematic design thinking process to produce multiliterate learning environments. Instead, they recognized a collective effort and flexibility to '*makeover*' the learning environment based on their experience and attunement with the diverse multicultural and linguistic backgrounds of children and families.

ECE teachers' thinking and making multiliterate learning environments occurred in their dialogue where they thought new designs and provocations to foster "encounters", "experimentation" and curiosity embedded in play, pedagogical experiences, and daily life learning. Teachers focused in welcoming children's wonder and unexpected interactions and uses of space, rather than applying specific linear plans for teaching multiliteracies. As the Principal explained, "*[in their] way of thinking, you design an environment that works well for children's play and bring in literacies*" (P). ECE teachers' spatial thinking stands-out for a third teacher understanding of the learning environment, and considers the development of multiliterate individuals as a natural result of focusing on children's initial interests, free play, and meaning-making dialogue. The ECE teachers' design thinking process we unveiled was aware of multimodal communication and the diverse semiotic resources and performances of children, for example "tickets to play." These were identification cards that each child created to move between the classrooms of the preschool freely, as the Principal explained: "*Each child has a ticket to play with their name on it and also the picture that they have chosen. Those two things, staying together, allow them to connect their names. Then as some children are very good with their own name, but they may not be able to read each other's names, they could read each other's pictures*" (P).

Teachers also created signs to communicate by gestures, using songs for certain transition moments and used the walls as a canvas to document and display children´s experiences and processes throughout the classroom space. Children were challenged by the teachers to interpret signs composed by images, symbols, and words to represent materials, activities, and actions. As a system, they trained the children to "read" by interpreting and understanding combined visual codes made up of texts and images.

6.1. The elicited design thinking process

Data analysis revealed an ongoing intuitive and cyclical co-design process between ECE teachers and children. Although design decisions were not directly negotiated with the children through explicit dialogue, listening to their spatial engagements, interests and play were recurrent and based on a deep empathy with children and their backgrounds. We elicited a 4-phase spatial design thinking process differentiated by crucial decision-making moments, that enabled teachers to circumnavigate local constrains. Each
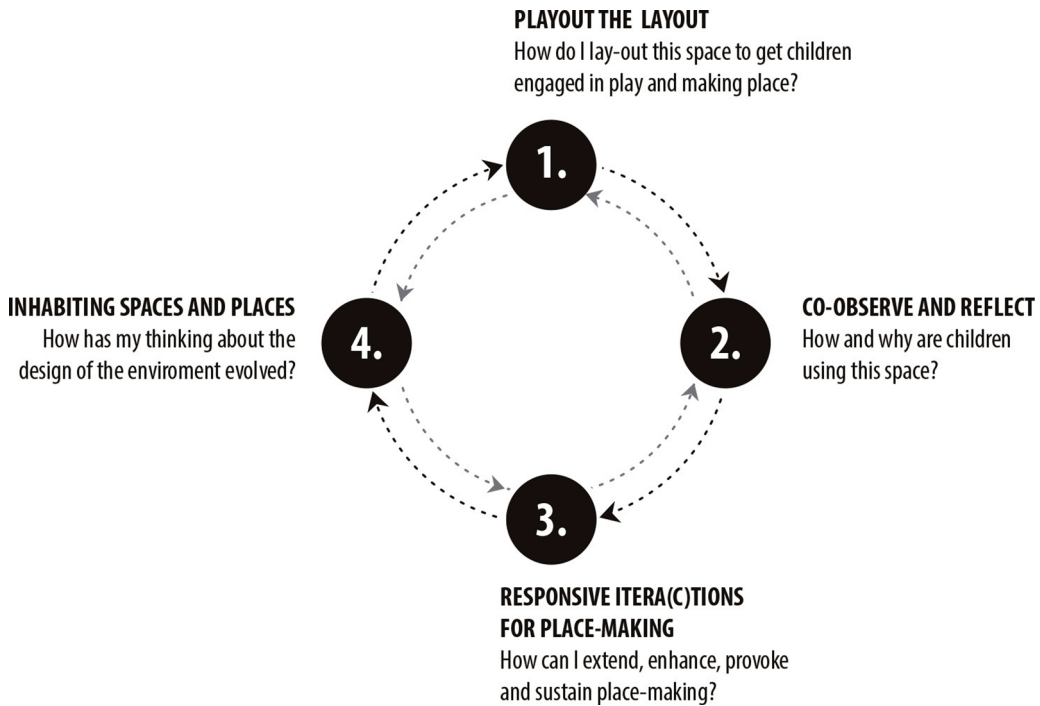
PLAYOUT THE LAYOUT
How do I lay-out this space to get children
engaged in play and making place?

INHABITING SPACES AND PLACES
How has my thinking about the
design of the enviroment evolved?

CO-OBSERVE AND REFLECT
How and why are children
using this space?

**RESPONSIVE ITERA(C)TIONS
FOR PLACE-MAKING**
How can I extend, enhance, provoke
and sustain place-making?

Fig. 2. Model of ECE teachers' Spatial Design Thinking Process.

of these phases condenses a part of the co-design process, revealing the thinking, deciding, and making of ECE teachers to assemble multiliterate learning environments for multiliteracy learning.

Three main defining characteristics guided ECE teachers' design thinking process. First, a 'child-centered' and 'child interest-driven' philosophy based-on observation and reflection as primary values of appropriate design. Thus, space was transformed dynamically in response to the times, interests and learning needs of each specific group of children using it. Second, a cyclical and iterative process completed at different time spans, depending on learning projects and curricular challenges (one day, a week, or year). Iteration was regularly present in the framing and re-framing of problems and solutions (in each cycle), and in the steadiness of design thinking cycles over time. Finally, the process was collaborative, among the staff and including the children as co-constructors and authors in meaning-making through the design of the space. Fig. 2 shows a model of the mapped spatial design thinking process.

6.1.1. Phase 1: playout the layout

The first phase of the design process focused on reflecting and deciding the initial layout of the classroom, considering space organization and materialities' display. The layout displayed the pedagogical intention of ECE teachers and the free and creative play environment they wanted to provoke with children. The layout also pursued enabling children's agency to transform through play, the given spaces into places for living and learning. Decisions about the layout design were based on prior experience and knowledge that practitioners had gained over the years individually, and through planned or spontaneous collaborative discussion meetings held throughout the school year. Following the Reggio Emilia approach, ECE teachers thrived to create hybrid environments where given space had a provoking shape and identity that invited diverse relations within it. The question that initiated this first phase was: "How do I lay-out this space to get children engaged in play and making place?". ECE teachers reported that their main driver to think about new layouts was to create flexible and intuitive spaces that *'communicate their use to children,'* encouraging them to *'become the major leading force of the play.'* They thrived on producing spaces that enhanced a sense of belonging in the children: *"Everything in your classroom, in the design and the setup of it influences people. Just like walking in somebody's house"* (T2). ECE teachers defined their role as *'mediators partnering with children'* to support their exploration. As the principal described: *"If we become a true partner in play and yet not the major person, not the fireman but perhaps the person with the house that's on fire (…) then the children carry their play"* (P).

ECE teachers considered the creation of 'centers of interest' and the definition of circulation as key space features of the initial layout. They created centers by placing furniture strategically to divide the total space allowing children to focus on an experience according to their interests while offering multiple choices. Teachers described the group of children as a *'beehive moving and exploring together', and thus planned circulation in the space carefully*. They controlled constant movement by locating physical boundaries that divided the total space to limit running, and by placing related centers close to each other. On the other hand, ECE teachers took special care of enhancing visibility by separating centers considering children's eye-level visible limits, and at the same time, ensuring

Image 1. Children interacting and producing texts in the kitchen center in Classroom 3.

exceptional visibility for both teachers and children from different points of the classroom. Tagging materials with their name and an icon or drawing was also used to support clarity and autonomy.

Teachers were deeply interested in bringing in and combining various types and complexity of materialities into the classrooms to fulfill their pedagogical objectives (for multi-aged children). They displayed the materials at a reachable, visible, and accessible position for the children to invite them to explore. For example, Teacher 1 described one of her past observations about the use of art materials, which she had carefully set in a counter for the children to use freely: *"I think, how it's laid out, and how it's presented. If the children see it, I think they'll play with it. For example, last year in this room, there were these containers that had different colored papers with cut different colored shapes, but they had lids on them, so they weren't being used. The kids would never even take them out and see what's inside. But this year, I've opened them and let the kids see inside, and they've been utilizing them more"* (T1).

ECE teachers brought in materialities to the environment with two primary purposes: to motivate and challenge the children, and to support meaning-making dialogue. For example, the kitchen in Classroom 3 was laid out as a real kitchen area, with appliances and objects that children used to play 'pretend cook' while they talked and invited each other to dinner, wrote and read recipes, discussed dishes, and wrote them down in little menus (Image 1).

ECE teachers felt enthusiastic about open-ended materials, specially the Froebelian wooden blocks. "Blocks are certainly the most open-ended thing you could almost work with (…) That's why children are instinctively drawn to that because they are the masters of what happens there (…) But blocks can stimulate literacy too. You can talk about what you are building. You can talk to somebody else about how to plan things. You can make signs" (T2). They provoked endless place-making experiences with children and allowed rearrangement of the layout to extend their engagement with the space. ECE teachers and children used blocks to build bridges, dramatic play areas, and improvised furniture to spontaneously sit and read together. For example, in classroom 3, we observed girls dressed up as mothers in high heels, caring for baby dolls "sleeping" on wooden blocks (wrapped in pieces of fabric). While they read a picture book to younger peers ECE teachers distributed printed materials (books, handouts, letters, etc.) throughout the classroom and used their computers to search for information, show videos or images, and play music accordingly. Technology appeared as a resource to search for new languages and enrich the multiliterate environment, but not as a lesson to be learned, a tool to master or a learning outcome itself.

After some time using the initial layout, teachers acknowledged challenges and opportunities arising from children's interactions and their ways of inhabiting spaces and making them meaningful. This spatial pedagogical awareness initiated a second phase in the design process.

6.1.2. Phase 2: co-observation and reflection

The second phase of ECE teachers spatial design process was a time destined to observe the interactions taking place between the children and space, and among their peers. It was also an opportunity to document those observations. ECE teachers described observation as a tool that helped them acknowledge the effects, reactions and engagements of the designed space on a specific group of children and reflect on the diverse motivations, understandings, and agencies implied in these interactions: How and why are children using this space?

ECE teachers positioned as 'outsiders' of children's places and considered children the native inhabitants of designed spaces. They performed the first approach through profound and non-participant observation, as an attempt to understand the use of the space from children's perspective: *"I observe too, see what's happening (…) You always have to observe to see what their activity is because you want to keep it open for them"* (T3). On the other hand, observation served as a tool to assess the design of space is a critical way: *"I'm the kind of person that constantly wanders around, seeing how things are going. When I walk into a room, then I see it as an outsider looking in. It's a pretty good chance for me to see how the room is being used"* (P).

ECE teachers made many spatial and place-making observations but did not document them with a formal method or tool (as we expected, considering the Reggio Emilia curriculum). The few notes that teachers saved were related mainly to individual child assessment, sometimes concerning multiliteracies, but not associated with meaning-making observations in the designed learning areas. They described their interpretations and spatial findings as pure mental activity. Teacher 1 explained she used _'mental notes'_ as a way to reflect on her observations and outline design challenges that required attention: _"I don't really say I would take notes, maybe mental notes (…) I just want to make sure, if it's not being used, why not? Is there something that I need to change? Is there something I need to add? Is there something I need to take away? I mean, I do, mentally take notes of an area that's in use"_ (T1). Another teacher (T3) mentioned using notepads to register some of her observations but not keeping them for further documentation, even when she believed they were fundamental: _"That's why note-taking is really important because you need to know what their plan is and how the languages of socialization in playing go with that. Note-taking and observations, you are doing that all the time, whether you are aware of it or not"_.

This phase was also characterized by moments of collective thoughtful insights production as a result of children's lives understanding. For example, T2 explained her conclusions after observing the children play in a space with peers: _"Children, at this age, are attracted to explore things and to clever stuff, as opposed to 'I like that person because we laugh together.' They are usually drawn to materials first. Then, they tend to play with the same children. Children, at this age, don't think, 'I want to expand my horizons with my friend"_ (T2). The profound understanding and appreciation of children's motivations in materialities by the teacher opened-up learning possibilities, as she provoked and extended play by displaying materials according to children's interests.

The phase's core is ECE teachers' listening and questioning children's various actions, thoughts and expressions in space. In this second phase, teachers' observation goes beyond looking, and is transformed in a pedagogical resource that defines space design. It produces critical understandings about how children inhabit adult-designed spaces and metalinguistic challenges to elaborate innovative opportunities to develop as multiliterate citizens.

6.1.3. Phase 3: responsive itera(c)tions for place-making

The third phase of ECE teacher's' spatial design process emerged for crucial decision-making and enacting collaboratively the multiliterate learning environments. ECE teachers iterated possible solutions for the challenges and opportunities detected in the previous phase. As the principal explained: _"The proof of the pudding is in the eating, not how the pudding looks. It's true with food. It's also true with the classroom design"_ (P). Sometimes the staff introduced substantial modifications, and others performed minimal changes. Depending on the situation, decisions were taken individually or discussed collectively by the team usually during lunchtime. Their thinking in this phase was led mainly by asking themselves: How can I extend, enhance, provoke and sustain place-making? They answered themselves by adjusting or re-designing the initial layout and building it with children, being open and embracing serendipity and improvisation, and responding to emerging place-making interests of the children.

The decision to have three thematic rooms (each with particular centers) opened the opportunity of free play and transitioning between rooms during work-time, but it also challenged children to identify learning experiences offered by the centers in each room. T2 had observed that children needed to visualize connections between the different centers to naturally use them and move between them: _"If you have a self-contained classroom and everything is there, eventually they will make those connections"_ (T2). Through her long years working at the preschool she had developed an empathetic and responsive approach to intuitively design the space for multiliteracies: _"Children, if they don't see it, they don't make those connections (…) it requires a certain degree of sophistication that most children don't have here. That is the thing that I have to deal with"_. Her way to manage the need for a visible connection was to locate a '_writing center_' between the '_reading hiding place_' (created by the children), and the '_exploration zone_' to provoke spontaneous writing or drawing (which she had observed to be an instinctive impulse in children) motivated by reading or by exploring with natural materials. Thus, she facilitated connections between activities in an actionable way by rearranging the initial layout of the centers in her classroom following children's motivations (Image 2).

Image 2. 'reading hiding place' and 'exploration zone' in Classroom 2.

Image 3. An example of '*multiliteracy flow*' observed in Classroom 2.

Concerning the usability and appropriation of the space by the children, teachers dealt with a variety of situations during this phase. On occasions, the use of the space by the children was very different from the intended purpose of the teachers' layout. T3 explained: *"We tend to look at what they are interested in and pick up on that."* Children's appropriation of the space produced what ECE teachers defined as "*new literacy places*." For example, in Classroom 3, children brought fabrics and cushions to the loft and made beds where they read to each other. The space under the stairs of the loft was also a favorite '*secret reading spot*' created by them. Teachers observed that children had conquered this space as a private place to hide and comfort themselves when they were sad or upset, and often brought in books to read. As a way to acknowledge and legitimize children's agency in place-making, teacher 3 hung a poster in front of the entrance to enhance the privacy of the space. In classroom 2, children read under the aquarium table and sometimes hung a piece of fabric (as a door) to hide. ECE teachers extended children's place-making sustaining them in time and acknowledging them as a new feature of the layout. We defined these actions as generators of '*multiliteracy flow.*'

Another issue that teachers dealt with were underutilized areas that sometimes seemed 'invisible for the children.' To manage underutilized spots, teachers modeled possible uses of specific materials or areas: *"If there's an area that's not being used, I may sit down in that area and make myself a seat or sit and see what happens. I would do this as a teacher, and sometimes as the principal, and just see if kids wander over"* (P). In this way, children could explore spontaneously and discover new opportunities for play.

As teachers followed and legitimized children's preferences, curiosity and interests, life in the learning environment became comfortable and fluid both for the teachers and the children. A spark of novelty and creativity could be sensed in every corner and a multiplicity of interactions unfolded naturally, giving way to the last phase of the design process.

6.1.4. Phase 4: inhabiting spaces & developing places for multiliteracies

The last phase of ECE teachers' spatial design process became visible when the multiliterate design of the learning environment enabled a natural flow of children, a sense of belonging to the spaces, and created new places though diversified languages. Also, in this phase, the teachers and principal reflected individually or collectively, confirmed or dismissed their initial assumptions, and concluded about relevant aspects to consider in the design of the literacy environment. The main question that leads the thinking in this phase is: How has my thinking about the design of the learning environment evolved?

An example of '*multiliteracy flow*' was observed in classroom 2, were the reading center included a library at the reach of the children as well as musical instruments, wooden blocks, fabrics, and cushions in a carpeted area. A group of girls was observed using blocks to construct beds, covering themselves with textiles like blankets, and pretending to read to each other, playing a bedtime

story situation between a mother and son. After a while of story-reading, they used musical instruments to sing and dance in the same space. The teacher explained her intended purpose to incorporate musical instruments close to the classroom library and the writing center: *"Sometimes we do music, but that also involves some literacy too even though you move. There are things that you listen to, words you listen to or words you repeat (…) You can emphasize repeating words because I think music and literacy are intertwined like everything. You can have them count out beats, which could be interpreted as a math activity, but it also could be a phonetic thing too"* (T2). Children understood the possibilities that the space offered and produced their own places by spontaneously inhabiting the learning environment brought-up by them and their teachers (Image 3).

ECE teachers shared two main principles that contributed to producing 'multiliteracy flow' for the children. First, the idea of 'reading everywhere' based on the belief that reading is fundamental to develop thinking skills: *"It's so important to me because that's their vocabulary, that's their language, that's what makes them think. That's going to be their writing later, how they foresee this, and how they will write it down after they read this book. It's going to be their book reports, later, their research papers later-on"* (T3). Reading was therefore incorporated in every play activity naturally and was not restricted only to quiet or 'reading areas' or solely to books as reading materials.

Secondly, teachers emphasized their conviction to motivate kids to 'write for a purpose.' Children used writing to express their intentions, appropriate themselves of the space, and communicate. The writing was enhanced initially by motivating children to write their names: *"We don't push, 'This is the letter 'A', and this is the letter 'B', this is the letter 'C'.' We really go with their name at first, and then we kind of branch off from there (…) That way, they want to do it, and they're more open to doing it"* (T1). The writing was also used by each child to plan their daily activities. They wrote, scribbled or dictated to the teacher their plan for the day, using handwriting as a resource to choose, autonomously, the purpose of their daily activities. They also wrote letters to their classmates and placed them in their cubbies, which had the same identification system as the "tickets to play" described in the layout phase.

Although ECE teachers discussed their problems and challenges about the design of their classrooms during staff meetings or informally, many valuable insights stayed undocumented. T2 was the only ECE teacher to register some decisions in fast sketches to plan future disposition of furniture, materials, and sleeping spots for the children. Nevertheless, the general absence of visible data obstructed future recall and inhibited systematic collaboration. Novel ECE teachers (as T1) and teaching assistants, could not access the background knowledge of their colleagues who had been working at the preschool for a more extended time.

With time and due to diverse reasons, the *'multiliteracy flow'* that ECE teachers felt was interrupted with new classmates from abroad and different linguistic backgrounds, a research study going on in one of the classrooms, and the natural development and changing interests of the children, to name a few. All these factors configured original opportunities to rebuild the learning environment and begin another design thinking cycle able to drain a new multiliterate empowering layout.

7. Discussion and conclusions

Teaching multiliteracies in early childhood education requires a broadened definition of learning environments and teachers' roles as designers and makers in 21 st Century education. In this ethnographic case study, we find that ECE teachers accommodate these new understandings engaging in a shared and intuitive experience-based design thinking process, to make multiliterate learning environments possible. Beyond the different pedagogical approaches of multiliteracies and learning environments, ECE teachers manage to share a spatial design thinking process.

ECE teacher's design thinking process is culturally situated and 'child interest-driven,' enabling child agency and power in spatial meaning-making as co-authors of the multiliterate learning environments they inhabit. The ECE teachers' intuitive design thinking unfolds through an ongoing iterative and collaborative process as described in recognized existing models (Dorst & Cross, 2001; Henriksen et al., 2017; Kolko, 2011). The four-phased-cycle we elicited, entangle ideas about multiliteracies and place-making decisions that materialize learning environments as interfaces that unfold based on the world of Children, the world of Others and Things (Rinaldi, 2012). While making multiliterate environments, ECE teachers develop a spatial design thinking process that empowers them as designers (Simon, 1996) and as makers of a 'third teacher' where a wide-ranging diversity of people, texts, practices, meanings, and cultural contexts intersect to build communication (Gruenewald, 2008; Yang et al., 2014) and belonging to a multiliterate community.

Each design thinking phase draws upon a singular purpose and opens to shared 'thinking with place' (Jobb, 2019) between teachers and children to create a multiliterate environment by reimagining layouts, exploring materials, posing place-making questions, and facing crucial decision moments. Phases reveal the thinking, deciding and acting of teachers as enablers of socio-spatial assemblages that foster multiliteracy learning (Dovey & Fisher, 2014). ECE teachers' design thinking is dynamic, and its iterating cycles are fast.

The first phase brings up spatial ideas, thoughts, and 'place-drafts' and materializes possible layouts that recognize children's playing interests, learning needs and teachers' spatial teaching knowledge to empower multiliterate learning environments (Rinaldi, 2006). The second phase observes and reflects about how children inhabit the given space and co-author multiliteracies pedagogies. The exceptional responsiveness of ECE teachers to challenging spatial demands and emerging place-making interests of children define the third phase. Teachers thrive to open up possibilities to position children as the protagonists of the learning experience, embracing serendipity and improvisation (Hackett et al., 2018), and giving children's spatial decisions value and meaning. In the fourth phase, when children achieve a natural flow in space and inhabit places as multiliterate individuals, ECE teachers reflect upon

their initial spatial assumptions and acknowledge relevant and creative aspects of the multiliterate learning environment making.

Though ECE teachers making multiliterate learning environments are experience-based and intuition-guided in their design thinking process, they flow with children producing multiliterate places as authentic, emergent, and transcendent ongoing experiences. We borrow this term as defined by Csikszentmihalyi (1990) to highlight the design thinking process as a positive human experience of joy, total involvement, and creativity. ECE teachers' design thinking process emerges as a state of flow where thinking evolves as they deploy their role as designers and makers of multiliterate learning environments.

Findings support the need for valuing ECE teachers' pedagogical intuitions, knowledge, and experience to enact their potential as designers, as opposed to being only recipients of generic design thinking models (Laurillard, 2012). Along the spatial design thinking process ECE teachers express place-based thinking that constitutes relevant decisional capital (Hargreaves & OöConnor, 2017; Pearson, 2013) in making multiliterate learning environments and a critical stance regarding children as co-authors of the physical and socio-cultural spaces where they live.

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CRediT authorship contribution statement

Catalina Cortés Loyola: Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft, Writing - review & editing. **Cynthia Adlerstein Grimberg:** Methodology, Formal analysis, Writing - original draft, Writing - review & editing. **Úrsula Bravo Colomer:** Writing - original draft, Visualization.

Declaration of Competing Interest

None.

Appendix A

Interview guide

ECE Teachers as designers of learning environments for multiliteracies.

Introduction

Research Purpose: The purpose of this research is to study the processes that teachers use to design their learning environments in preschool settings. As designers and educators, we want to understand and analyze the tools that teachers use and how they apply their knowledge and experience in the designs they create.

Confidentiality: Your names and any other identifying detail will remain confidential.

Background

1) How long have you been a preschool teacher?
2) How long have you worked at this preschool?
3) What rooms have you used at the preschool?
4) How many children do you have in your room today and what are their ages?
5) How many different languages do children speak in your classroom?

Materials and literacy

1) Where do the materials that you use in the room come from?
2) Do you participate in the election of materials?
3) Do you follow any specific curriculum for the selection and use of materials?
4) What kind of materials do you use to engage children in literacy activities?
5) What can be done to stimulate children's interest in literacy activities?
6) How do you organize the different type of materials in your classroom?

Classroom design and literacy

1) How do you design your classroom?
2) What aspects are the most important for you to consider when organizing the space?
3) Do you follow any process during the year to assess the use of the space by the children?
4) How does the design of the space influence the use of the classroom by the children?
5) Do you notice differences between the same children in different rooms?

Process

1) Do you keep records of the interactions happening in your classroom?
2) Do you think classroom design affects children's interests?
3) Do you change your design during the school year? If you do, how do you do it?
4) Do you work with other professionals when designing your classroom?
5) Do you know about any design process you could apply when designing your classroom?

Wrap-up

1) What suggestions would you have for re-designing your classroom today?

Appendix B. Centers, activities and materials available in each classroom

See Tables B1–B3 and Images B1–B3.

Table B1
Centers, activities and materials present in classroom 1

Classroom 1 / Art Activities (T1)		
CENTERS	**RELATED ACTIVITIES**	**OBJECTS AND MATERIALS**
Block, Music and Reading Center	Construction, pretend play, dancing, reading, building with blocks, playing with cars, playing music, talking, group discussions.	Big blocks, music instruments, books, cds, radio, stuffed animals, puzzles, alphabet and numbers posters, mirror, blackboard, chalk, scarves, legos.
Painting Center	Painting, drawing, writing, cutting, experimenting, talking, collaborating.	Paint, brushes, stamps, glitter, paper, feathers, paper shapes, glue, scissors.
Free Movement Areas	Dancing, running, jumping, using cubbies, playing with cars, sitting in the floor, laughing, stretching.	Cubbies, aprons, water table, hangers, books, wooden xylophone, cars.
Writing and Activity Center	Drawing, writing, stapling, reading, Play-Doh exploration, eating, talking.	Pencils, markers, crayons. glue, paper, scissors, alphabet stamps, Play-Doh, beads, pipe cleaners, stickers, books, alphabet poster.

Table B2
Centers, activities and materials present in classroom 2

Classroom 2 /Science and Math Activities (T2)		
CENTERS	**RELATED ACTIVITIES**	**OBJECTS AND MATERIALS**
Block Construction Center	Construction, pretend play, sorting objects by size and shape, collaborative building projects.	Variety of small blocks, trains, cars, people, traffic signs, plastic ramps, tree branches, animals, dinosaurs.
Science Center	Experimenting, predicting, measuring, material exploration, Play-Doh experiments.	Microscopes, natural material samples, sample containers, plants, scale, body parts, markers, paper, teacher's personal objects.
Reading Center	Reading, building, dancing, pretend play, playing music, jumping, gross motor exploration, balancing, writing.	Books, musical instruments, fabric, cushions, blackboard, chalk, erasers, alphabet wooden box, big blocks, radio, wall alphabet.
Writing Center	Drawing, writing, stapling, reading, puzzles, hiding, pretend play, resting.	Pencils, markers, crayons. glue, paper, cushions, puzzles, scissors.
Exploration Zone	Observation, feeding the fish, touching objects, arranging objects.	Fish tank, sea shells, unit blocks, abacus, nuts & bolts, plants, seeds, pumpkins.
Water Table	Touching water, moving water, using funnels, group explorations, pretend play.	Aprons, cups, funnels, water toys, sand.

Table B3

Centers, activities and materials present in classroom 3

Classroom 3 / Dramatic Play Activities (T3)

CENTERS	RELATED ACTIVITIES	OBJECTS AND MATERIALS
Block and Music Center	Construction, pretend play, dancing, reading, building with magnets, talking, group discussions.	Big blocks, music instruments, books, CDs, radio, stuffed animals, puzzles, alphabet and numbers posters, boxes, mirror.
Kitchen Center	Pretend play, writing, material experimentation, drawing, reading, talking, group planning, measuring.	Kitchen furniture, kitchen utensils, pretend play, food, Play-Doh, books, menus, table cloth, writing materials.
Loft	Reading, playing with dolls, going up and down the stairs, sitting, observing, hiding, pretend play.	Books, dolls, stuffed animals, plant, poster, cushions, fabric, alphabet poster.
Writing and Activity Center	Drawing, writing, stapling, reading, puzzles, hiding, pretend play, resting.	Pencils, markers, crayons, glue, paper, cushions, puzzles, scissors.
Dressing Up Center	Pretend play, dressing up, talking, dancing, reading.	Costumes, shoes, dresses, hats, books, fabrics, note pads, treasure box, register toy machine, mirror.

Image B1. General views of classroom 1.

Image B2. General views of classroom 2.

Image B3. General views of classroom 3.

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