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FORUM

The re-theorisation of collective pedagogy and emergent curriculum

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Abstract This essay review of Goulart and Roth's work explores the cultural-historical concepts that they have drawn upon to create a new conception of emergent curriculum in early childhood science education. The pedagogical contexts of Brazilian preschools is discussed in relation to other practices found across cultural communities, with a view to locating the specific research need that has arisen for preschools within Brazil. In the latter part of this article, Davydov's (International perspectives in non-classical psychology, 2008) work on theoretical knowledge and dialectical thinking is discussed in order to further develop Goulart and Roth's conception of early childhood science curriculum.

Keywords Cultural-historical theory · Theoretical knowledge · Dialectical thinking · Early childhood · Science education · Research

> …it is the knowledge systems that dominate the practices children participate in at different ages. If we want to give children conceptual competence that is more oriented toward theoretical knowledge, we must make this part of their everyday practice. So parents and educators should change the practice traditions that the children participate in to change the conceptual competence the child will acquire. (Hedegaard 2007, p. 275)

In the article *Engaging young children in collective curriculum design* by Goulart and Roth (2009), readers are treated to a fresh new approach to the theorization of early childhood curriculum. Goulart and Roth use cultural-historical theory to show contradictions and dialectical relations between passivity and agency as children and teachers interact in a science learning context in Brazil. Dialectical logic is used to frame the analysis of child agency in relation to program structure. In their article, Goulart and Roth introduce the concept of *emergent curriculum* in order to name and theorise the successful pedagogical practice that they claim makes a substantial difference to young children's learning in science in Brazil.

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In order to appreciate the theoretical re-thinking of *emergent curriculum* being proposed in their paper, a more expansive contextual reading of early childhood science learning must be considered. Similarly, an analysis of the basic assumptions about child development that underpin this paper must be contrasted with the assumed views of child development that traditional explanations of emergent curriculum foreground. These discussions are needed if the complexity of the analysis undertaken in this study is to be fully appreciated.

In this review essay, I will examine the cultural-historical concepts being used by Goulart and Roth in order to illustrate the significant differences found between traditional conceptualization of early childhood science curriculum and the pedagogy that is discussed in this paper. I will also focus on what I see as the main theoretical problems that have emerged within early childhood curriculum and pedagogy, and therefore why the empirical and theoretical work of Goulart and Roth is so highly significant. I will contrast this with longstanding beliefs and practices on *emergent curriculum* for early childhood education. The different pedagogical contexts and therefore research needs that arise across cultural communities will be considered in this review, thus taking the response beyond the scope of the article by Goulart and Roth. Finally, I will discuss Davydov's (2008) work on theoretical knowledge and dialectical thinking in order to further develop Goulart and Roth's conception of early childhood science curriculum. This is in keeping with other curricula that have been designed specifically to build theoretical knowledge within the early childhood years (e.g., Aidarova 1982) and within primary schools (e.g., Chaiklin and Hedegaard 2009).

Assumptions about child development shape our conception of *curriculum*

In closely examining the theoretical and empirical material within the article written by Goulart and Roth it is possible to see that a number of important cultural-historical concepts have been drawn upon to show how early childhood children can engage in the curriculum design process. Central to the arguments being put forward by Goulart and Roth is the child's changing relations to their environment, the development of a new conceptual consciousness, and the dialectical relations between sense and meaning. In using these concepts to discuss early childhood science curriculum, Goulart and Roth foreground a cultural-historical view of child development, and not the traditional view of child development that dominates early childhood education. This is important because very few empirical studies within early childhood science education frame their work in relation to a cultural-historical view of development. Most default to a maturational view of development, usually found implicitly (but not usually acknowledged) within their conceptual framing.

Many curriculum models used within early childhood education across Western communities (including that underpinning emergent curriculum) have assumed a maturational view of child development. In line with this conception of child development, 'age' is seen as the central characteristic for signifying curriculum progression. That is, children of a certain age will be expected to meet pre-determined educational milestones (sitting within particular scope and sequence of content). Goulart and Roth argue against this view of child development for framing early childhood science curriculum. They state that

> there appears to be a belief that their age limits what very young children can learn. … In our theorizing, we do not begin with such presuppositions.

In arguing against this conception of child development, they begin with the premise that curriculum progression should be based upon 'the problem [of] whether very young children can participate in complex tasks'. This problem is shown as the question that drives their conception of development. Their empirical examples show clearly how 'very young children not only participate competently in designing science curriculum but also that they, in turn, produce resources that enable teachers to improve their pedagogical practice'. The dialectical relations between the child and the teacher are foregrounded in Goulart and Roth's conception of child development.

Goulart and Roth draw upon a range of cultural-historical concepts which can be located within the broader theoretical approach put forward by Vygotsky on child development. In particular, aspects of Vygotsky's revolutionary view of child development can be noted in the theoretical and analytical discussions within their paper. For instance, in Vygotsky's revolutionary theory of child development, he stated that progression was a process of self development framed through the child's changing relations to their environment and their social situation of development. Vygotsky (1997) stated that there exits a 'unique relations of the child to the situation in the sense of his [sic] behavior and his acting within the situation (p. 261). For example, Goulart and Roth in their analysis of video transcripts of science lessons focus on the children's changing relations, and not on some end concept to be learned. In the following extract, taken from their empirical material in the paper, it is possible to notice how the science education curriculum and pedagogy promotes a new self-awareness of children

> Roberto's affirmation that it is the wind who moves the leaves in the trees (turn 02) is evidence of the child's awareness of his own surroundings, and, in this case, is evidence of a significant observation related to his object of study (e.g., air/wind).

Through the teacher, Roberto went outside of his classroom and pondered with the other children about the air/wind. Kravtsova (2005) has argued that in a cultural-historical reading of child development that it is through others, that children gain a new awareness of their environment and build new relations within their social situation of development. A new awareness of the wind was evident for Roberto of the presence of air as a material (even if not visible to the eye). The concept of air as a material was being foregrounded by the teacher. In this context, it is possible to appreciate the view that 'the main purpose of science curriculum in early childhood education is to give young children a new perspective of/on their surroundings,' and through this development is conceptualized as the child's changing relations to their environment and to their social situation.

In traditional approaches to early childhood education within many minority countries, the teacher is almost invisible within the child-teacher relations. That is, the child's interest is put centre stage and the role of the teacher is completely de-emphasised. This is quite a different contextual base than that described by Goulart and Roth, where the teacher tradition in Brazil is to 'predetermine and control' what and how children learn in science education. In this Brazilian context, the teacher's agenda dominates and the child's perspective becomes invisible. Clearly, variability in early childhood context, beliefs about pedagogical approach, and views on child development differ across the global early childhood community. In using a cultural-historical view of child development, the curriculum design used in the paper by Goulart and Roth transcends general practices within Brazil and European heritage/Western communities. Their research findings point to some important concepts for re-theorising early childhood science curriculum across communities.

The cultural-historical concepts of *sense and meaning* are clearly significant for the re-theorisation of early childhood science curriculum being mooted by Goulart and Roth. We now turn to Kravtsova's (2008) conception of *sense*.

Sense

One of the defining features of the early childhood period noted by Vygotsky (1998) related to the concept of *Aufforderungscharakter*, where 'Everything has some affect so arousing that for the child, it acquires a character world of things and objects a kind of force field in which he is always affected by things that attract or repel' (pp. 261–262). Goulart and Roth also draw attention to the alluring nature of objects for children in their paper. Vygotsky (1998) states 'Each object 'draws' the child to touch it, pick it up, to feel it, or, conversely, not to touch it' (pp. 261–262). However, Goulart and Roth do not leave their analysis at this purely sensorial based level. Rather, they examine how the children collectively make conscious what they are exploring, and importantly they theorise how these experiences can be used as the basis for giving new meaning to those experiences. Kravtsova (2008) has shown the significance for young children's psychological development when children pay attention to both the optical field (what they see) and the sense field (the meaning they give to this experience) to create new meanings of their experiences. We see examples of this when Goulart and Roth state that the approach to curriculum being analysed foregrounds 'a new schema that enables them [children] to cognize and re/cognize these same resources—the movement of the leaves in the trees—and thereby move to a new form of understanding that now is incorporating the phenomenon of air.' It is through the children's experiences of their natural world, with guided explorations by the teacher, that children discuss what surrounds them in new ways, that is, through others they develop a new relation to their material world. Davydov (1990) notes, '*only* sensations and perceptions, sensory data, serve as the foundation and the source of all of man's [sic] knowledge about reality. …the result of the activity of the 'senses as theoreticians' are expressed in verbal form, which **carries the experience of other people**' (p. 248; My emphasis).

It is not that the material world has changed, but rather *what has changed is the relationship that the child has with the material world*. As Vygotsky (1998) noted 'there is no neutral or "disinterested" relation to the things around' the child (p. 262). Through the teacher, the child gives new meaning to these experiences. That is, the child gives a new sense to the objects in their world. Kravtsova (2008) nicely conceptualizes this as a model.

In the work of Goulart and Roth in science education, Kravtsova's model is helpful, as it makes visible the relations between sense and meaning that are being worked through by the children as they experience (and discuss with the teacher) the wind in relation to a 'material named as air'. In Kravtsova' (2008) model (Fig. 1) this relationship is expressed

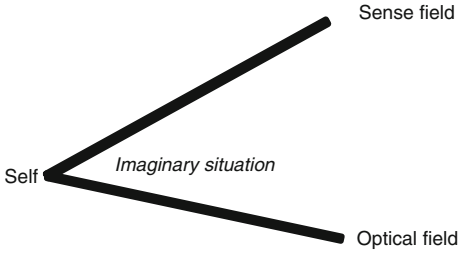

Fig. 1 Kravtsova's (2008) Model of the optical and the sense field

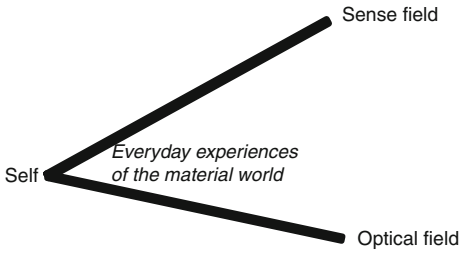

Fig. 2 Giving new meaning to everyday experiences in the material world

through an imaginary situation. However, the curriculum context in Goulart and Roth's study is a real world situation that the child gives new meaning to. The child consciously considers these everyday experiences, and conceptualizes them within a scientific framework. Figure 2 shows this amendment.

A further refinement of this kind of conceptualization of giving new meaning to the everyday experiences of children in science education is possible if we draw upon Vygotsky's (1966) writings on play. For instance, if we re-examine the pedagogical practice of naming and classifying objects in the material world that were initiated and facilitated by the teacher in Goulart and Roth's study, we can conceptualise this as an object-meaning relation.

The object (in this case the card representing the ideal of the material world—e.g., sun, wind, etc.) is what dominates the child's thinking (Fig. 3). For young children, meaning may be less dominant that the physical and obvious presence or sensation of the object. However, through the activity of discussing the object's existence (e.g., wind, as a material property, not just a sensation) and its relations to other objects in the material world (e.g., animal/plant etc.) through some conceptual framing (e.g., sorting and classifying according to Western scientific system), meaning begins to dominate. For instance, Goulart and Roth state

> In this description, we articulate how the schemas|resources and the agency|passivity dialectic plays out in the design of a curriculum with and for the student, as the emergence of a new schema (conceptual order) gives the students and the teacher opportunities to make sense of and organize the ideas that the children have previously brought forth and continue to bring forth as part of and constituting this living and lived science curriculum. **The emergence of the two-fold water-land categorization results in the establishment of an order that affords new forms of action, as it allows other cards to be categorized and constrains the placement of these cards** (My emphasis).

The children, through the teacher, moved from naming objects to sorting and classifying them in relation to Western scientific classification system that the teacher was using. *Meaning* was inverted in the fraction Object/Meaning and *meaning* came to dominate the children's discussions.

Another cultural-historical concept that appears to be embedded within Goulart and Roth's paper is *motives.* A discussion of this concept in the context of Goulart and Roth's

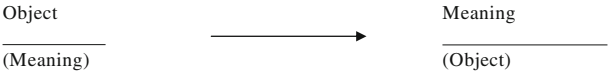

Fig. 3 The object–meaning relations (Vygotsky 1966)

study will make visible important elements of the re-theorisation of early childhood science curriculum being promoted.

Motives

In a maturational view of motives, teachers focus on 'children's interests and children's needs,' positioning these attributes as something that arises internally within the child. However, a cultural-historical view of motives focuses on the object-motive generated through collective activity within the material and social world and the child's relations to this. Leontiev (1978) suggested that in Vygotsky's general collective meaning of activity, that researchers must consider specific activities 'each of which answers a definite need of the subject, is directed toward an object of this need, is extinguished as a result of its satisfaction, and is produced again perhaps in other, altogether changed conditions' (p. 62). The central idea in Leontiev's theory is that every activity is driven by distinct motives and these motives do not arise from within, but rather are the objects of the material world. Stetsenko and Arievitch (2004) argue that what Leontiev 'wanted to achieve by introducing the notion of object-motive was to convey the idea that human activities are always driven by something objectively existing in the world, rather than by some event and occurrence in the hidden realm of mental processes or human souls' (p. 482). As such, motives are socially produced within the human world and 'an individual activity bears the birthmarks of and reflects these collaborative practices, never becoming completely isolated from the social processes that give rise to it' (Stetsenko and Arievitch 2004, p. 487). Stetsenko and Arievitch (2004) suggest that although the positioning of motives outside of individuals seems counter intuitive, it is nevertheless a central and important concept in cultural-historical theory. As children grow they 'increasingly enter into connection with historically established human experience, and come to know objective reality with increasing breadth and depth' (Leontiev and Luria 2005, p. 47).

Goulart and Roth explicitly draw upon the cultural-historical concept of motives when they state that 'The process of making the emergent curriculum suggests that participants work towards something that they want to investigate (both actively and passively), the arising motive being oriented to a certain object. This object/motive then becomes the orienting moment (the 'object/motive') in subsequent activity (Leontiev 1978).' In their analysis they specifically examine how the cards are used by the teacher to generate a motive for creating a schema of the sun, land, planets, animals etc. The activity of attempting to generate a schema with the whole group of five-year-old children, not only orients the children, but it creates uncertainty and the need for undertaking investigations. The cards act as an important link between lessons, constituting 'a physical memory of what has been done on the day before, and they constitute materializations of the students' ideas to be manipulated to create a curriculum plan.' In drawing upon a cultural-historical concept of motives, Goulart and Roth are able to show how collective curriculum design between teacher and children is possible. For example

> In using the plural personal pronoun 'we,' she does not just invite the children to participate, but she also opens a real sharing space, accepting the resources that five-year-old children have to participate in this kind of activity. Indeed, Denise's invitation subsequently will be taken in a literal sense by one of the students, Bela, who is sitting on a chair outside the circle. Bela approaches and starts gesticulating toward the cards.

"Motives" is a powerful concept because it foregrounds for teachers the significance of the activity setting that they organize for supporting science learning. It also pays attention to the child's perspective in the activity setting. The relations between the teacher's perspective and the child's perspective can be better understood if the education system in Brazil is examined. We now turn to the societal perspective (see Hedegaard 2007) as an important dimension in shaping curriculum design in Brazil.

Curriculum design within a global context

According to Goulart and Roth the Brazilian *education system* is teacher centered and the 'process of increasing child participation in classroom events has been a challenge for these teachers because it requires them to manage more exploratory work on the part of the children (Quinteiro and Carvalho 2007).' They argue that teachers feel constrained by the educational structures which group children by age and which define learning in terms of indoor lessons and outdoor activities. This change from a teacher-centered view of learning to a child-centered view has also been noted in other countries such as, Hong Kong China and Taiwan, where curriculum reform by Government has actively worked towards building a more child-centred curriculum (see Fleer et al. 2009). Similar political imperatives have also been promoted by non-government organizations (NGOs) working in some regions of Africa, Bangladesh, India, South America, and Vietnam. For example, Plan International promotes the concept of 'active learning' within a child-centred philosophy for curriculum and pedagogy in schools and early childhood care and development (ECCD) programs (see PlanInternational.org.au).

This philosophical orientation contrasts with other early childhood contexts across the global community, where a child-centred approach has dominated for some time, and where the role of the teacher has been completely de-emphasized (due in part to teacher philosophy inspired by Piagetian theory for matching curriculum content to age related developmental milestones). In countries such as the Denmark, Sweden, US, Canada, Australia, New Zealand, and the UK there has been a strong tradition for play-based programs where curriculum emerges from the child's interests, and where curriculum content is weighted towards social outcomes, rather than discipline based concepts, such as science. For example in Nordic countries, there is an emphasis on 'democracy, equality, freedom and emancipation, solidarity through cooperation and compromise, and a general concept of the 'good childhood,' or what life should be like for all children…' (Wagner and Einarsdottir 2006, p. 4). However, in some of these countries there has been a recent push for curriculum which where there is 'increasing emphasis on academic learning (which many Nordic scholars and practitioners view as an 'invasion' from other countries)' (Wagner and Einarsdottir 2006, p. 4).

Although a continuum in approaches to curriculum formality is reported by the OECD (2006), growing concern for improving learning outcomes in discipline areas has been observed. These developments have generated research interest in how concept formation can be supported within traditional play-based programs, where social outcomes feature (see Fleer 2010). Goulart and Roth are also concerned with the relations between structure and agency whilst ensuring science learning. They note, 'The main purpose has been to improve the conditions for children's development by increasingly making room for their participation. This movement has created opportunities for shifting early childhood education practice, theory, and research.' Hedegaard (2001) has shown that it is important to 'use a teaching approach that motivates the pupils to plan and participate in research

activities with the object of creating a link between the pupils' own questions and the problems that are central for the subject begin taught' (p. 81).

The approach adopted by Goulart and Roth contrasts with those countries where the role of the teacher has been de-emphasized, and where governments are seeking to create room for a more conceptually active role for the teacher in the curriculum development process. Consequently, the research undertaken by Goulart and Roth is very important as it makes visible a very different context in which dialectical approach to science curriculum planning and implementation is being researched. Goulart and Roth have rightly foregrounded the societal expectations as noted through the pedagogical approaches advocated within Brazil's education system.

As Hedegaard (2002) reminds us, 'knowledge is not a mirror of the world, but rather collective experiences that are created through solving pressing societal problems connected to specific way of living' (Hedegaard 2002, p. 26). As such, particular forms of knowledge will prevail within communities for supporting their specific needs. Although there are clearly different knowledge traditions across communities, both subject matter knowledge, and social pedagogical knowledge require scrutiny. This is the site of most contestation. As Goulart and Roth point out the discussion should centre 'on the enhancement of the quality of the learning environments for young children and the role adults should take in those settings.' Learning environments are contextualized and research must take account of these situated pedagogical beliefs and practices.

Conceptualising *emergent curriculum* within early childhood education practice

The term *emergent curriculum* as discussed by Goulart and Roth is theorised differently to what is commonly seen within the literature for early childhood education for many Western communities. The re-theorisation of emergent curriculum by Goulart and Roth is centred on the notion of contextualization. They state that the 'main purpose of a contextual curriculum is to sustain… competencies and to open up spaces for children's manifestations of the sense they make in the process of a dialectical production (i.e., reproduction and transformation) of the curriculum.' They argue that the perspective of the teacher and the perspectives of the children must be foregrounded within an emergent curriculum. They state

> Precisely because the children and the teacher have different backgrounds, different experiences, and different ways of perceiving the ongoing class events, their worlds meet allowing both to move beyond the evident limits of their respective current horizons.

In the emergent curriculum model outlined by Goulart and Roth, the collective construction of curriculum must dominate, and pedagogical techniques which give voice and agency to children, must be found. Importantly, Goulart and Roth state

> Collective design expands not only the control of the community as a whole but also of each member, who, by contributing to the collective endeavor of curriculum design, also expands his/her individual control over the learning environment.

Because Goulart and Roth foreground sorting the questions posed by the children as a way of beginning a dialogue with children about their scientific thinking, they centre thinking on a Western scientific classification system for organizing their questions. If we draw upon Davydov's (2008) work on knowledge construction and thinking, it can be argued

that the knowledge being employed in this kind of logic is empirical and the thinking paradigmatic. Davydov (2008) states that empirical knowledge and paradigmatic thinking assume that the world can be represented accurately and measured correctly. Hedegaard (1999) suggests that 'Knowledge in this [empirical] tradition is conceptualised as mental building blocks that can be stacked up or conceptualized as puzzle pieces which can be collected …knowledge does not change unless the information is wrong.' As Davydov (1999) contends, this view of knowledge transforms into discrete subject stacking, in which different 'blocks of knowledge' are built for different 'subject areas' resulting in empirical knowledge in which 'the child ends up with concepts and skills from different subject domains which are difficult to relate to each other' or to their everyday lives outside of school. Hedegaard (1999) further states that 'Empirical knowledge influences a great deal of the everyday life of people in Western industrialised societies. The argument is not to dismiss this kind of knowledge but to subordinate it to theoretical knowledge' (p. 28). As such Goulart and Roth's research is highly significant because their curriculum theorisation begins to move in this important direction. The implementation of the emergent curriculum that is researched by Goulart and Roth, foregrounds empirical knowledge and paradigmatic thinking, but the data are analysed from a cultural-historical perspective. An analysis of theoretical knowledge and thinking as theorized by Davydov (2008) has the potential to add value to the findings of Goulart and Roth's important cultural-historical science education article. We now turn to a discussion of Davydov's writings on theoretical knowledge and dialectical thinking.

Building theoretical knowledge in early childhood science education

> A beautiful formula: Not merely an abstract universal, but a universal which comprises in itself the wealth of the particular, the individual, the single (all the wealth of the particular and the single!)!! (Collected works, vol. 38, p. 99) (Lenin 1963, cited in Davydov 1984, p. 12)

The essence or formula of theoretical knowledge and dialectical thinking are captured in this quotation by Lenin (1963). The dialectical relations between individual and particular are foregrounded, and this relation forms the basis of the concept of *rising to the concrete*. In this section space is devoted to explicating what Davydov (e.g., 2008) meant by these concepts, followed by a discussion of how these concepts may be used to expand upon the re-theorising of early childhood science curriculum by Goulart and Roth.

Whilst children building empirical knowledge and engaging in paradigmatic thinking are both important for helping them to make sense of their immediate environment, it is theoretical knowledge and thinking which allow children to think and act differently across a broader range of contexts. Theoretical knowledge and dialectical thinking support children in building mental models, engaging in thought experiments, and in ascertaining relational connections between many different elements within a system. Davydov (1990) argues that 'mental experimentation forms the basis of theoretical thought, which operates by *scientific* concept' (p. 249).

A concept can both represent a material object and be used to reflect on the material object. The concept allows for a particular mental action to occur. To do this, a child must first be aware of the material object, as a conscious mental representation. For example, when Goulart and Roth discuss the children's discussions of wind with their teacher, they make conscious a concrete representation of wind as a material—air—to be contemplated.

It is through this conscious reflection of the material object, that the child can discover its essence.

Davydov (1990) suggests that verbally expressed forms of activity become the subject matter for the 'senses of theoreticians' (p. 246). That is, the children discuss the sensorial perceived feeling of wind in their hair, on their faces, as moving the leaves of trees, etc. These begin in the first instance as 'flashing impressions,' where elements of significance are singled out or are conceptualized as the 'essence of the thing' being observed. That is, wind generates a physical force, and wind can be thought about as air. Air then has a physical presence that can be observed and actively contemplated. Air as a material is an important concept in Western science. Without this concept, it is difficult for children to give thought to 'air resistance' as a force that is acting upon children's everyday life events (e.g., such as when they are riding their bicycles or when they throw a ball). Having a concept of air as physical material helps children make sense of many different aspects of their material world. 'A *concept* functions here as a form of mental activity by means of which an idealized object and the system of its connections, which reflect in their unity the *generality* or *essence of movement of the material object'* (Davydov 1990, p. 249).

What is important about theoretical knowledge and dialectical thinking is the relational dimensions that are foregrounded. Davydov (1990) in drawing upon Davydova has argued that theoretical knowledge 'always pertains to a *system of interaction,* the realm of successively connected phenomena that, in their totality, make up an organized whole' (p. 254). Children considering air as a material property can only think about this as concept if they understand a system of relations concepts which together make up the universal concept of 'materials and their properties,' as is detailed in many science curriculum documents. In its broadest sense, Western science is also a knowledge system that has been created by humans as one form of thinking epistemology designed to support the needs and problems found within particular societies. Subject-matter knowledge is one form of societal knowledge that has been generated in Western Society to support its communities. Theoretical knowledge methods allow children to explore the relational concepts that make up particular knowledge system—such as 'mathematics' or 'Darwin's theory of evolution.' Theoretical knowledge generates for children symbolic tools 'that they can use to analyse and understand the complex and changing world' (Hedegaard 2002, p. 36).

Theoretical knowledge and theoretical thought allows children to think about a whole system of relational ideas or concepts. Theoretical thought is very useful to children for making sense of their world and for contributing to activities in very thoughtful ways. Vygotsky (1987) argued that when children learn concepts, they need to learn them as part of a system and not as isolated pieces.

Davydov (1990) states that there are conditions for the activity of theoretical thought, one of which is the wholeness of the object under investigation. For a universal connection to be established, the learning context must work with the wholeness of the object, and the interdependence of its elements.

> In principle, the view that thought is needed where our 'eyes' cannot glance, either because of external space–time obstacles (for example, the opposite side of the moon was such for a certain time), or because of the exceptionally small or large dimensions of the objects being studied (the atom or the galaxy), also amounts down to this point of view. (Davydov 1990, p. 268)

Davydov (1999) argues that theoretical thinking supports children in orienting themselves to the general relationships found within materials and phenomena. Through theoretical thinking, children develop theoretical consciousness. Davydov (1999) writes that people in

society frequently meet demands that require a system analysis where it is necessary to distinguish between main and second order elements, basic and derived components of general and particular dimensions, and the essence and the phenomenon itself. It is important to not only determine the characteristics of the system, but to also find the links between them. In this way, linkages are made visible. In theoretical thinking, it is also possible to determine a phenomenon derived from the core characteristics and to notice or construct particular features from a general characteristic. In this way it is possible to see that a general and a particular (phenomenon and core) of a system may not be similar. Davydov (1999) suggests that they are often contradictory to each other. He sites the example of an electric globe as a concrete and particular object (physically observable globe) where the essence is a system of movement of electrical power that is not visible to the human eye (p. 132). Determining the essence of the globe (electrical movement) helps the learner to understand the general phenomenon of electricity. In theoretical thinking, the task of the child is to determine the essence of something (particular object such as a globe) and then trace it back to a general phenomenon (movement of electrical power). Davydov (1999) states that the learner's thought moves 'from the general to the particular within a material' (p. 135), and then from the particular to the general. Davydov (1999) suggests that

> Humans solve all these tasks by means of dialectical/theoretical thinking within which contradictions can be handled in objective systems, to find mutual relationships and transitions in such holistic systems. (p. 132)

We see a close approximation of this kind of thinking beginning to emerge in the work of Goulart and Roth, when they state that

> We observe evidence here for something that might be explained by a psychological schema—i.e., an *ideal* (in contrast to material) structure associated with an aspect of the material world.
> We use the term 'ideal' in its cultural-historical activity theoretic sense, that is, as the dialectical complement to its material equivalent. The ideal|material dialectic maps a similar terrain as that invoked in saying that the *material senses* are at the source of *sense making*, i.e., having *ideas* about some aspect of the *material* world.

Whilst this kind of theorization is important for making sense of the data that they seek to analyse, a more expansive analysis is possible when Davydov's work on theoretical knowledge and dialectical thinking is used.

Davydov (2008) further argues that 'The task of theoretical thinking is to rework the data of contemplation and conceptions in the form of a concept, and thereby to fully reproduce the system of internal connections that give rise to the given concreteness and reveal its essence' (p. 100). To establish the core elements or the essence of the concept, children need to reproduce the concrete into some form of abstraction (e.g., as a model). In order to reveal the essence of the concept within the concrete in the form of an abstraction, such as a model, Davydov (2008) argues that the content being explored should include elements of the history of the development of the particular concept as a holistic system. In the context of the research by Goulart and Roth, it can be argued that the classification system of land and water being used by teachers if their study is situated within a framework that employs Western science for understanding the material world. Different classification schemes would be evident if a traditional Australian Indigenous classification was used, such as the relational classification of food sources and the seasonal activity of

organisms (reproducing/growing/moving), and how deliberate contradictions may become evident between these relations if the weather conditions change (e.g., climate change).

In this kind of theorisation the content of the abstraction should be simple but allow for the essential relations of the system to be noticed, such as in the relatively independent components of habitat (including climatic conditions), species-food source, which will enable children to determine the essential relations between differentiated parts within the system, for instance, changing weather conditions change the habitat, which has a direct relationship on which species will be in abundance, and therefore what food sources will be available. These relational links hold the independent parts of the concrete system together.

Davydov (2008) notes that through contemplation about the real relations within a holistic system, abstraction of the concrete is possible. He argues that initial abstraction can be named as *concrete abstraction*, *the concretely universal relation*, *the objective cell of the whole being studied* or simply *cell* (Davydov 2008).

> The abstract and the concrete are moments of the differentiation of the object itself, of reality itself, as reflected in consciousness, and already for this reason they are derivative of the process of thinking activity. Asserting the objectivity of both of these moments is an important feature of dialectics as logic. (p. 101)

In essence, the system is perceived as a cell of its concreteness, that is, the concrete cell is both individual and real, and universal and abstract. The system of ecological knowledge held by a community is both concrete—direct evidence of food source, and at the same time, it holds the essence of the classification system—seasonal weather, animal and plant activity, and what organisms will be available to eat (e.g., if the ants are moving, wet season is approaching, and a harvest of particular indigenous plants will be plentiful, and together these hold the essence of the classification of peoples' material world).

The essence of the concrete is revealed as a universal concept. The concreteness of food sources is obvious, real and external, while the essence 'is usually characterised as mediated, as internal, as the basis of phenomena,' and the phenomena or concrete 'lie on the surface of things, as it were, while essence is hidden from direct observation' (e.g., world view on the classification system being used) (p. 103). Davydov (2008) states

> Thus, essence is an internal connection, which, as the single source, as the genetic basis, determines all the other particular features of the whole. These are objective connections, which, in their differentiation and manifestation, provide for the unity of all aspects of the whole—i.e. they give the object its concreteness. In this sense, essence is the universal determination of the object. (p. 103)

Davydov (2008) argues that in theoretical thinking, the concrete appears twice. The dialectical nature of concreteness can be seen as the concrete context begins and ends the process of contemplation, while the essence of the concept is revealed as concurrently universal and particular.

Rising to the concrete encompasses the pedagogical principle of initially examining a holistic system and mentally ascending to this system in order to determine its specific nature. Through establishing the individual relations it is possible to observe its universal character. Through this kind of contemplation, children discover a general law. Consequently, a concept must reflect the process of its historical and scientific development. Significantly, 'Empirical thinking solves the task of cataloguing or classifying objects and phenomena' as was noted by Goulart and Roth. However, 'Theoretical thinking sets itself the goal of reproducing the essence of the object of study' (Davydov 2008, p. 107). Ascent is the leading and primary thinking activity. It is through these forms of thinking and

knowledge generation processes that social consciousness arises and historically formed universals become available for individuals to use within society.

Conclusion

Theoretical knowledge and dialectical thinking as discussed in this paper provide another reading of early childhood science curriculum to that theorized by Goulart and Roth. However, this conception is in keeping with the potential pedagogical directions that as readers we did not learn about. We were tantalized by the following comments made by Goulart and Roth when they explained what was to occur after the sorting and classifying of questions

> After that day, they [children] will choose one of the three emerging topics to be studied in depth, which means that they will go to the next step: enacting the designed child-centered curriculum that has emerged from the enactment of a child-centered curriculum.

Presumably due to space constraints, the researchers do not show 'what happens next' as children move from full engagement with sorting their questions into water and land, to undertaking investigations to answer their questions. It is possible though, that the teacher in Goulart and Roth's study positioned the children in the centre to generate theoretical knowledge. However, we will need to wait for their next research paper, to know what kinds of knowledge and thinking were promoted by the teacher in the Brazilian early childhood centre. What is known though, is that Goulart and Roth have systematically shown how a cultural-historical analysis can be applied to early childhood science learning in a traditionally teacher dominated curriculum context. As such, their paper makes a valuable, and much needed contribution to understanding how early childhood science curriculum can be conceptualized from a cultural-historical approach.

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