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Mapping the Relations Between Everyday Concepts and Scientific Concepts Within Playful Learning Environments

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MAPPING THE RELATIONS BETWEEN EVERYDAY CONCEPTS AND SCIENTIFIC CONCEPTS WITHIN PLAYFUL LEARNING CONTEXTS

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Abstract

This paper presents the findings of a study which sought to map the relations between everyday concepts and scientific concepts within situated playful encounters in early childhood settings. Video and transcript data were gathered from one preschool over a four-week period. All free play and organised play activities were captured. The study found that children's investigative probes were mostly random when teacher knowledge of the concepts was limited. The findings add to Vygotsky's theoretical work on complexive thinking and provide new insights into how play-based contexts generate or minimise concept formation in early childhood.

Introduction

Cultural-historical theory originated with the works of Vygotsky and his approach to learning and development was systematized into a new theoretical framework for the Russian context in the 1920's and 1930's (Daniels, 1992). The collected works of Vygotsky, written in opposition to the individualism of behaviourist psychology and the pre-determinism of stages in childhood that have strongly influenced Western conceptions of childhood learning, remain fresh and relevant today, eighty years after his death.

The complexity and multi-faceted nature of Vygotsky's theory has led to many interpretations, summaries and elaborations of his original works by a range of scholars such as, Luria, 1928,1979; Leont'ev, 1978,1997; Davydov, 1988; Ilyenkov, 1977; Veresov, 2006; Newman and Holzman, 1993; John-Steiner and Mahn, 2006; Wertsch, 1985; Cole and Engestrom, 1993; Cole, 1996; Daniels, 1992, 1993; and Blunden, 2006. How social knowledge and abilities became internalised and transformed as proposed by Vygotsky (see his collected works), is still the subject of post-Vygotskian research. For example, Cole and Engestrom (1993) conceptualised internalised learning as being distributed amongst group participants, Chang-

Wells and Wells (1993) used the word interactive and Panofsky (1994) considered such learning as contextual.

Although new directions and insights have been gained from contemporary research, little attention has been directed towards understanding how very young children learn concepts within playful settings. The study reported in this paper, seeks to determine how concept formation occurs in science in preschool settings. In the first part of this paper the theoretical perspective guiding the study is discussed, followed by the study design. In the second and main part of the paper, data is presented and discussed, showing the complexity and fluidity of young children's thinking. A dynamic rather than static presentation of data is given in order to reflect the wholeness of Vygotsky's powerful methodological approach to studying concept formation within a naturalistic context of a preschool setting.

Theoretical Perspective Guiding the Study

According to Vygotsky (1987), concept formation should be thought about at two levels - the everyday and scientific. At the everyday level, concepts are learned as a result of interacting directly with the world – developing intuitive understandings of how to do things. Vygotsky (1987) argued that these everyday concepts lay the foundations for learning scientific (or academic or schooled) concepts. Developing everyday concepts in the context of children's everyday world is important for living. However, everyday concepts cannot be easily transferred to other contexts. Knowing only about everyday conceptions may locate children's thinking into embedded contexts and reduce their opportunities to apply these concepts to new situations.

Vygotsky (1987) also argued that when children simply learn scientific or academic concepts at school away from the context in which they are used, scientific concepts may also be limited to thinking within an abstracted context. Vygotsky argued that everyday concept formation and scientific concept formation are strongly connected to each other. That is, the everyday concepts grounded in the day-to-day life experiences of children and adults, create the potential for the development of scientific concepts in the context of more formal school experiences. Similarly, scientific concepts prepare the structural formations necessary for the strengthening of everyday concepts (Vygotsky 1987). As children bring together their working everyday knowledge with their scientific knowledge, they transform their everyday practice. Vygotsky argued that these embedded or everyday contexts are important pathways toward disembedded or academic thought. This dialectical perspective on everyday concepts and scientific concepts represents a major contribution to concept formation generally, but specifically for science education, since the latter field of enquiry has maintained that everyday concepts get in the way of scientific concepts (Gunstone, 2000; Osborne & Freyberg, 1985). In playful contexts, such as preschools, child care centres and homes, children engage in many everyday activities, such as role playing making cups of tea, making mud pies or swinging and climbing on play equipment. How educators and family members mediate these everyday opportunities for scientific concept formation has generally been under researched in science education and early childhood education. Hedegaard and Chaiklin (2005) offer a way forward for contemporary researchers.

Hedegaard and Chaiklin (2005) suggest that the most powerful learning contexts are those where the professional keeps in mind the 'everyday concepts' and the 'scientific concepts'

when planning for learning. Hedegaard and Chaiklin (2005) have called this the 'double move' in teaching. As early childhood professionals, we create many different types of learning contexts for children – some of these are opportunities for building everyday concepts, and some are contexts which suit the introduction of scientific concepts. What is important here, is the double move on the professional's part – where everyday concepts and scientific concepts are interlaced so that a child's thinking and practice will be transformed. Knowing how everyday concepts and scientific concepts can be interlaced within play-based contexts is important for building pedagogical approaches for early childhood education. This study seeks to determine the nature of the relationships between everyday concepts and scientific concepts within the context of a play-based setting. In order to capture this dynamic process, a complex and intensive study design was necessary, which went beyond the teacher's focus of attention (eg double move), but also captured the child's focus of attention (see Table One).

Vygotsky's (1987) work on concept formation, as shown in Table One, provided a beginning point for examining concept formation in play-based contexts and in particular, categories of thinking in relation to 'unorganised heaps' and 'complexes'. Unorganised heaps represented a range of ways in which children's investigative attempts were organized or the way in which children linked concepts together. For example, children's investigations may be random and not linked in any way or when linked, the linkages may be based on spatial or temporal attributes. Complexive thinking features children's active exploration of attributes where linkages are considered in relation to physical properties, functionality (e.g. cup and saucer), chained (e.g. domino associations), diffuse (where connections are outside of the child's direct experience) or where there is an appearance of full conceptual understanding (pseudo concepts) but the child does not consciously consider the concepts directly. This analytical framework discussed by Vygotsky (1987) is summarized below in Table One.

Table One: Concepts in action

Unorganised heaps (Subjective - unconnected connectedness)	1. Syncretic image - random separate probes (subjective emotional connections) 2. Spatial distribution - (visual - spatial or temporal encounter) 3. Already united groups in the child's perception are reduced to a single meaning
Formation of complexes (connected and objective)	1. Associative complex - concrete relationship between nucleus and object 2. Complex collections (eg cup and saucer) - functionally associated 3. Chained complex - no structural centre in the chained complex 4. Diffuse complex - units based on things outside child's practical knowledge
Pseudoconcepts	Externally see the conceptual connection. Internally, it is still a complex. Apply concept in practice, but no conscious awareness of concept.

Vygotsky believed that the categories were not hierarchical, but rather should be thought of as sedimentary layers – that is, they co-exist. He suggested that as thinking evolved or was stimulated in a particular category, then other layers would also be influenced. Vygotsky (1987) argued that '[r]ather than involving a simple isolation of similar features from a series of concrete objects, the process of concept formation came to be understood as *a complex process involving the movement of thinking through the pyramid of concepts*, a process involving constant movement from the general to the particular and from the particular to the general' (Original emphasis; p. 162).

Table One illustrates the way conceptual connectedness may be possible as children actively explore core concepts in science. In drawing upon the double move in teaching, the teacher has in mind the everyday context and experience and at the same time the scientific concept. The children's engagement within this dialectical framework created by the teacher provides opportunities for children to make connections with, or pay attention to, different dimensions of the core concept being explored. That is, they may through randomly probing, further generate or add to their 'unorganised heaps' or they may note patterns or connections and begin to make associations which develop into complexive thinking, pseudo-concepts or concept formation.

The dialectical relations between everyday and scientific concepts can be thought about in relation to the double move (teacher's focus of attention) and to the child's probing (child's focus of attention, as shown in Table One). These theoretical tools allow researchers to investigate concept formation within dynamic and playful naturalistic contexts, such as preschools.

Research Design

Research Question:

The overall study aimed to examine the dialectical nature of everyday concepts and scientific concepts (Vygotksy, 1987) in playful contexts such as early childhood centres. In particular, the study sought to determine how children develop core science concepts (Hedegaard, 1995) during play.

Sample:

A group of twenty-four preschool children (14 boys and 10 girls) aged between four and five years participated in the study (age range from 4 years 4 months to 5 years 5 months; Mean age of 4 years 11 months). All the children were from European heritage families. The children lived in a rural community where fishing and market gardening were the main source of employment. The children attended the preschool for four days per week, where an extended day program was offered (Monday 9-1.00; Tuesday and Wednesday 9-2.00; Friday 9-12.00). The centre had one qualified teacher (4 year university degree) and an assistant who had no formal

teaching qualifications, but held a fine arts degree. She had worked in the centre for approximately 18 years. Both staff were briefed on the aims of the research and were introduced to cultural-historical theory by the chief investigator.

Video Recordings of children at play

The children were video taped over four weeks during their free play time. A total of ten preschool sessions were video recorded. Five focus children were predominantly followed and recorded. Focus children and their families were given disposable cameras and asked to photograph their science play at home. Families were interviewed about their photographs. Staff were shown both video clips of the children playing in their centre and photographs taken by families, and interviewed about their intentional (double move) practices and other aspects of the program deemed important for concept formation in science.

Analysis

In this study, the analysis required a complex mapping of children's movement in thinking through experimentation, supported by children's situated play scripts. Through this dynamic myriad of 'concepts in action', actions, thoughts and words were categorised in relation to Vygotsky's everyday and scientific thinking. We sought to map concept formation in relation to the core concepts that were evolving for children through the investigative work enacted by individuals/groups. Analysing children's knowledge generation through play was a complex task. We used Hedegaard's (1995) work on core concepts to assist us with mapping the concepts, and Vygotsky's work on everyday and scientific concept formation (Table One) to determine the overall types of thinking being promoted in the particular interactions.

Hedegaard (1995) in drawing upon the work of Davydov (1977) Engestrom and Hedegaard (1986) and Ilyenkov (1977) discusses the model of a germ cell or core concept. She argues that models can be important tools for acquiring theoretical knowledge. A core concept or germ cell can be characterized by its capacity to '*depict the basic relations in the subject area or problem area studied so that if one aspect changes, the influence of this change can be traced in the other aspects depicted in the germ cell'* (p. 300). A core concept illuminates the 'basic relations' in the concrete surrounding phenomena. A core concept model provided us with a useful framework for analyzing the probes (random or otherwise) of children's scientific investigations during play sessions. The core concept model we used on the particular data set is shown below in Figure One and related to the science unit in the teacher's program (she called 'potions').

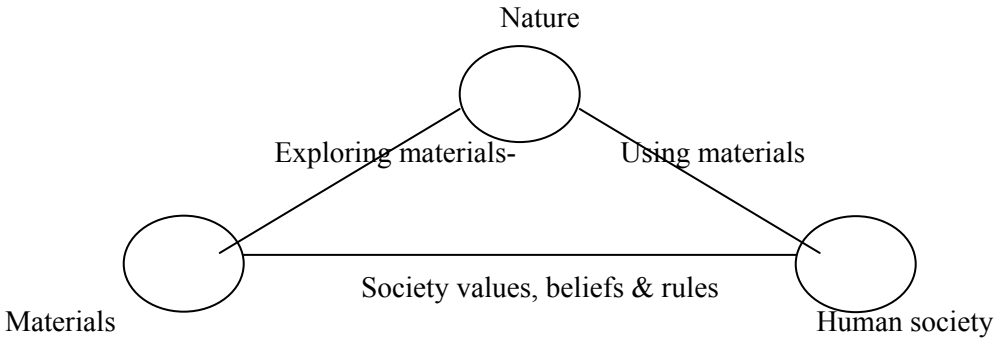

Figure One: Core concept for understanding materials and their properties

The core concept for materials and their properties highlights the relations between materials and nature, materials and human society, and human society and nature.

Findings

Context of centre: Located on a major highway this pre-school is in the centre of a small coastal village (population 800). The sounds of gulls, pelicans, boats, machinery and traffic surrounded the children as they played. Data on home experiences showed family participation in water sports, fishing, vegetable and cattle farming, football and everyday life practices in a rural village community. Two staff (a teacher and assistant) provided a sessional kindergarten service. Two very large outdoor yards characterised the nature of this centre. The backyard was a place for teacher directed organised games with space to run and chase. The front yard included a boat and bird hide, provided through the efforts of the committee. In addition, a productive garden, large sand pit, mature trees, water tank and real tools such as adult size watering cans, metal spades, buckets, wheelbarrows, taps, hoses and reels, ropes and trolleys, were used to make this yard a place of real work. The community based parent committee worked with staff to support the centre and the children's program.

Unit of work within the whole centre program: Potion play was introduced by the assistant teacher and arose spontaneously outdoors through the provision of a large box of clean plastic bottles and buckets of coloured water. Staff considered that the mixing of potions and actions surrounding this play might have scientific potential for this project. Language surrounding the actions of funnelling, siphoning, mixing, pouring, water dispersal, evaporation, and gravity was expected to arise. The children's play was free flowing and spontaneous. The teacher wanted to see what the children might do with the materials in their own way without interference so she could 'observe children's potential'. The assistant teacher was explicit in her support of potion play by providing materials, conversations and print resources that extended the children's ideas as play moved all over the yard in the form of random separate probes and explorations. Over a four week period, children re-presented their ideas in many forms each associating potion play activity with their own spectrum of experiences.

Operationalisation of the program – outside and inside the centre: In practice, two staff (with a rostered parent) worked together in a routine called indoor and outdoor program flow during each five hour long session. Children were able to play for uninterrupted periods of time choosing to use materials, equipment, spontaneous and pre-planned activities either indoors or out. It was agreed daily where each staff member would work and at the start and end of each session children were gathered together with the assistant teacher, for home news sharing time of ideas or story reading. Throughout the session, children often rotated in small groups through a set task such as making a birthday card, drawing from an excursion experience or painting a fund raising plate. Staff communicated closely with one another to maintain the flow of activity and routine. Specific task oriented small group instruction occurred within this framework. One example was an indoor group demonstration of the mixing of fragrant leaves and water with a pestle and mortar, which later gave rise to the idea of perfume making outdoors. In another example, demonstrations by staff on mixing bi-carbonate of soda with vinegar and later vinegar with oil, led to children experimenting in the sand pit area with cooking and siphoning mixtures, generally referred to as potions. Potions were being variously transformed into foods, poison, perfumes, medicine, shampoo, beer, bottles to count and store, and were also thought to create magical change. Potion play offered rich potential for everyday and scientific concept development in this particular setting.

Data Presentation and Discussion

An analysis of the data gathered over the four weeks, demonstrate that children's scientific investigations could be categorised in two quite distinct ways (Unorganised heaps; Complexive thinking). In this first section, the children's interactions with the materials and each other during free play, tended to be both *random* and *unconnected*. The children appeared to be experiencing the materials physically rather than conceptually. The teachers supported the children's random investigations – even when the directions taken were different to those planned by the staff. The random probes are exemplified in the observations: Writing and potions; Siphoning; and Potions and perfume. These data and their analysis are presented in this part of the paper.

Random probes – 'Unorganised heaps'

Observation 23.8.05: Writing and potions

A small group of children are assembled at a table outside. There are bottles of coloured water on the table. Pens, sticky labels and hard covered books with lined paper are available for the children. The teacher is close by supporting the children with their writing (field notes).

The teacher frames this potion experience by actively encouraging the children to label their potion bottles. In this example, the children's focus is mostly on the physical act of filling the bottles. The children do engage with the teacher's request to label the bottles, but the children are much more interested in filling the bottles.

> Jacob: This is, how do you write ah, umm, how do you write ah, (pause) handle? (holding blue pen in one hand and feeling something in a tray).

Teacher: (listening).

Another young boy is trying to write on funnel that's in a white plastic bottle and another young boy is pouring coloured water into funnel into bottle.

Teacher: 'Handle' okay (takes blue pen from Jacob and writes in a book) I'll write it how I think you would write it. (TA puts it in front of Jacob)

Jacob: I need some help with that. (TA holds bottles up to show Jacob another boy goes to pour coloured water from red bottle into small white plastic bottle, realises it won't work he then finds a funnel on the table. He puts the funnel in the white plastic bottle and then pours coloured water into it)

Jacob takes his book over to another part of the playground and shows it to another child.

Jacob: I'm going to make, I'm going to make more potions than that. Look how many potions I'm going to make. That many, that many, more than you (walks away from children and puts book down on table and walks away with two white plastic bottles filled with coloured water)

Teacher: Do you want me to write number 2 for you or do you know how that looks? (Jacob looks at teacher)

Jacob: Ah, you need to write number 2 (Jacob then returns to the bottles and continues filling them with coloured water).

This group of children is intently focussed on filling the bottles with liquid (potion) and preparing as many filled bottles of potion as possible. Being able to represent the number of bottles prepared supported the direction of their play with the materials provided in the free play context for these preschool children. A related 'physically active response' to the materials was also noted by the group filling large buckets with coloured water (data not shown here) and siphoning (see next section).

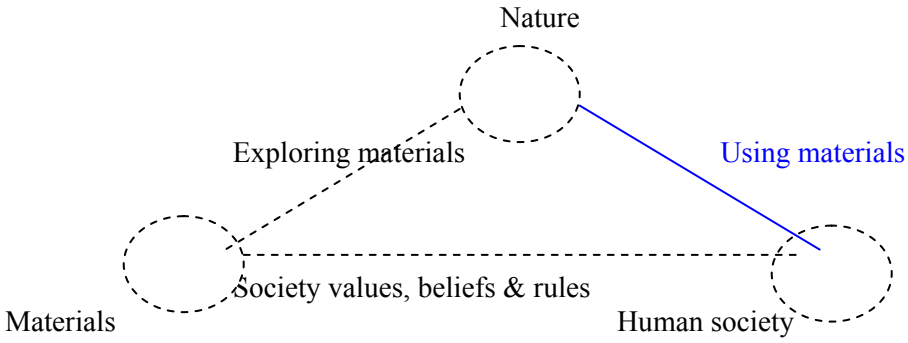

Figure Two: Preparing bottles of potion

In this analysis, the focus is on using materials – that is, the relations between human society and the environment (as shown above in the diagram above with the full line shown). What is important here for the children is participation in the experience of 'making potions' and in doing so, filling as many bottles as possible. There are no discussions about the materials or their properties– as represented in the core concept model. No other parts of the core concept illustrated above are investigated by the children (this potential is shown in the dotted lines in Figure Two). This example is shown, as many of the children spent long periods of time engaged in this type of play. The adult sought to broaden the children's experience by introducing the idea of writing labels for their potion bottles. However, the focus for the children was mostly on filling up the containers and having as many bottles of potion as possible. In the next example, the physical act of siphoning – important for the children, but also for the teacher – is shown.

Observation 23.8.05: Siphoning

Three children are in the sandpit. Two children hold one end of a plastic tube. One end is positioned lower and is attached to a bottle which is held in the sand. The other child is holding the other end of the tube which has a cup funnel attached to it. Child with red shirt is packing the sand around the bottle. Another boy is watching. He then looks at the cup and turns and puts coloured water in it. The red shirt boy stands up and walks over to the other boy who is holding the cup with coloured water.

Red Boy: Put it in that one cause there's lots of potions (yellow sleeve boy turns and puts more water into cup and looks in cup. Red shirt boy goes and gets another white plastic bottle and takes the plastic tube out of the bottle and puts it into the new bottle, Yellow sleeve boy turns and puts more water into the cup. Red shirt boy takes the other bottle out of the sand and puts the new bottle in it's place and packs the sand around the bottle, yellow sleeve boy watches and then looks inside his cup. Red shirt boy then gets the bottle that was filled first and tips it into the spare bottle which is in the sand next to the bottle being filled by plastic tube.

The two children who were involved in this play event focussed their attention on the siphoning action. Siphoning was also evident in other areas of the centre's outdoor environment. A parent helper and a small group of children move the siphoning equipment to many different parts of the outdoor area, including the fort and climbing equipment in order to siphon from higher and higher points in the environment (transcript not shown here). Although the intention of the teacher's program is to see how the children explore the mixing of substances, the assistant teacher has provided an additional range of equipment, including siphoning equipment to extend children's play.

The siphoning equipment led one child to focus his attention on siphoning liquid onto plants (cuttings) that he had dug into the sandpit.

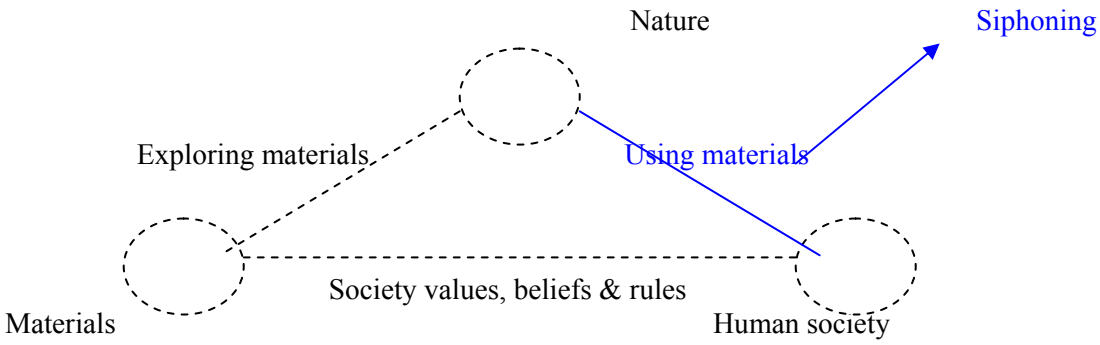

Figure Three: Siphoning potion

In this play event, the focus is again on using the equipment to move the potion. The relations between human society and the environment are featured. No other element of the core concept is examined by the children (as is evident by the dotted lines). This type of physical, rather than conceptual play was prevalent in the play activities of many children. This was a type of play that dominated how the boys tended to play. However, connections with human experience were also evident in the boys' play. An important example is shown later (potion poisons).

Making Perfume

The teachers also provided explicit links between the potion activity and children's real world environments by introducing the play activity of 'making perfume'. The assistant teacher introduced the herbs, mortar and pestle, and aromatic oils to the children to support their explorations and to help them think more explicitly about materials and their properties (see interview with teacher). This was a delightful sensory experience for the children. However, it did not conceptually progress.

Transcript: Making Perfume

> Jacob: I'm going to ah, (stands up) all the flowers into the water (gets another branch with leaves whilst looking at what another boy (red shirt) is doing. Teacher and red shirt boy each with a mortar and pestle. Jacob takes leaves off branch and puts them in the bowl) Yeah
>
> Teacher: … flowers (T looks at Jacob) yeah? (Jacob leaves the table and gets another branch and then comes back close to the table) Jacob lifts his bowl up to teacher's nose.
>
> Teacher: Mmm.

Jacob comes back to table and puts leaves into his bowl of water.

Many of the children participated in the experience of grinding fragrant leaves using a mortar and pestle, adding water, or mixing aromatic oils to water (eg peppermint). These experiences were keenly participated in by the children but limited discussion around the experience resulted.

Everyday understandings of perfume were generated through this experience. Some of the children carried these activities over into their home context, as was evident during interviews with families:

> Yeah um Breanna especially I think they've been doing potions at kinder and she loves getting outside and getting her water out and (AVIS – mixing) mixing up grass or stuff in a bowl so she does bring that home, like some experience you mentioned with that sort of thing (Parent interview).

The concepts that the teacher foregrounded related to fostering everyday experiences of mixing through the sandpit and through water play with coloured water. The teacher's assistant introduced the perfume making. However, the teacher's comments tended to focus on the traditional activities found in preschools, and she did not discuss the introduction of making perfume, as is shown below:

> I mean obviously we've had our, dye and potions play and that's been a continual thing like the children are constantly looking at colour mixing and there's constantly been um you know like not… not constantly but like throughout the year there's been, um, colour mixing and… and water with um colour in it um and it's even being like Ibis group where they've had that, they've had different things to paint the boat and paint the shed and things (teacher interview).

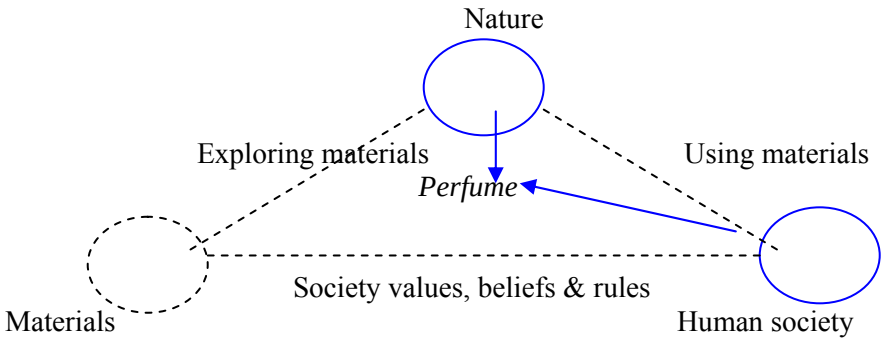

Figure Four: Potion as Perfume

Although this particular play event drew upon two areas within the core concept (nature and human society), there was no active scientific connection between these two areas. Rather the connections were tied to human everyday experiences of crushing the herbs or mixing the oils

and smelling the results. It is not the say these experiences are not valuable, but rather, the play events privileged physical and fantasy activity, rather than scientific learning. What is important here is acknowledging the type of learning that is featured during these play events, and the particular category of conceptual thinking being privileged.

In this section, it was shown that the children who participated in the range of experiences set up by the staff in the preschool mostly made associations between the resource in relation to the physical attributes of the materials (eg siphoning, coloured water for filling containers and picking and crushing fragrant leaves/petals in the mortar and pestle). Their probes were mostly random, spatial or suggested by the resources themselves. Mostly the children's activity in relation to concept formation was focussed on what Vygotsky termed 'Unorganised heaps' (see Table One).

Complexive Thinking – Humanising Science Experiments

The second categorisation of conceptual activity that emerged in this study was 'complexive thinking'. The children's cognitive connection to potions was directly linked to things known to them, such as medicine, poisons and cooking. The children role-played with the materials in ways that did not relate to core scientific concepts, but rather to 'playing out the things in the children's world'. Examples of data, which demonstrate complexive thinking are presented and discussed in this section of the paper.

Observation 23.8.05: Siphoning to Kill Plants

M is holding a bottle. He is standing in the outdoor area of the preschool.

M: Kill all the plants. No they're our plants (Points to leaves that a child has just picked up). They're the ones that are gonna get killed (points to plant on ground other child picks up bucket with plants in hand and moves to where another bucket is and tips something in it).

This child has brought to the planned activity of mixing coloured water, his own experience of poisoning plants. His focus is on the materials but in relation to the plants that are in abundance in the outside area within the preschool grounds. Other children in the centre bring different experiences, and their construction of the materials provided for mixing are different, as is evident in the following observation (Potion poison).

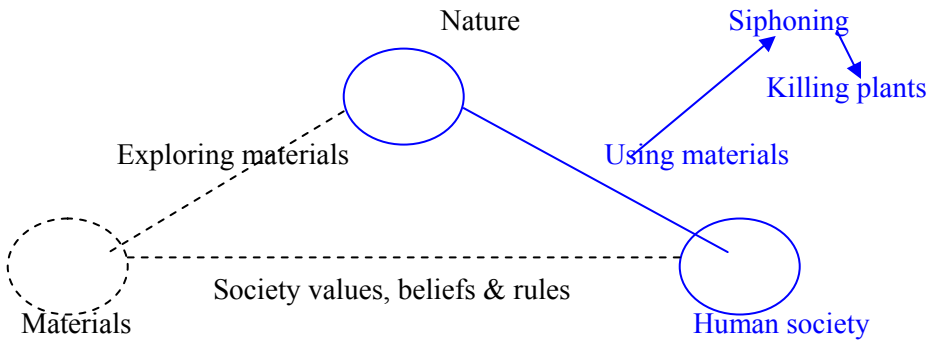

Figure Five: Siphoning poison

In this example, the focus is on using materials. However, the connections between the environment and human society are much stronger, as the child has actively linked the play materials to what he knows about 'poisoning plants'. No other dimensions of the core concept shown in figure five were examined by the child. Thinking about the exploration of materials and their properties, was not considered by the children. The child made sense of the play activity through fantasy rather than through the actual materials he was encouraged to investigate. This was also noted on subsequent days and in play events by the children (see below).

Observation 26.8.05: Potion Poison

A group of children are assembled outside under a fort, where they are filling up plastic bottles with coloured water from a bucket.

Teacher: What potion is this?
Child: It's poison
Teacher: The potion is poison?
Child: Puts funnel down by feet and starts spraying at the bottom of the tree.
Picks up funnel and moves around to potted plants in a tray.
Teacher: The potion is poison. How does it work?
Child: Puts down funnel and starts spraying plants in pots.

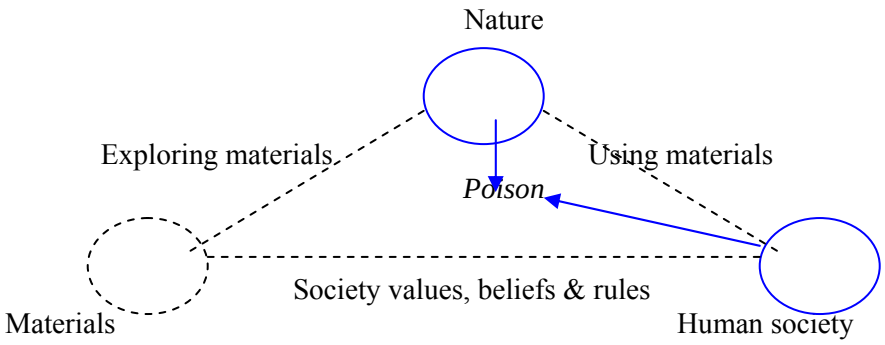

Figure Six: Potion poison use

This child has made sense of the coloured water and containers by constructing the potion as poison. This was also evident in the previous observation. In terms of the core concept that is being developed here, this child has focused primarily on a human society and the act of killing plants (a common experience for children living on local vegetable farms). In this particular play event, the fantasy dimension was more prevalent than the physical experience of moving the plunger on the bottle to poison the plants.

A further example of how the children were making sense of the potions materials through fantasy is shown below in the next three examples. The play examples shown here were mostly enacted by the girls in the centre. In the first example, the children make sense of the oil and then the vinegar (introduced by the teacher), by re-framing the context as a cooking experience (rather than a science experience).

Observation 26.8.05: Mixing Oil in Sandpit

Section One: Oil Lana and Molly

> Teacher: Um it's it's Lana's oil experiment. (Lana pouring oil into a bowl, puts oil down, makes sure the lids on and then turns the oil container so that the label is facing her)
>
> Lana: There. (picks up oil container and looks at the label) Baking(?) oil experiment. (puts oil container down and picks up container with mixture and walks to another area where Molly is playing. Lana puts sand into her container and swishes it around. Molly then gets up and goes to where Lana was. The child then brings the oil back and starts pouring it into another container) Oh this is working babe (Lana looks up as she speaks walking back to where she started from).

Section Two: Oil shake

Molly takes an oil bottle over to her teacher and asks her to close the lid.
Teacher: Ah that is hard to shut isn't it? (Molly tries to push lid down)

Molly: Hard to shut
Teacher: So what are you going to do with it?
Molly: Shake it

Child is mixing ingredients in a bowl.
Lana: I'm going to mix this (Teacher: hm-hm) all the way to the bottom, to the end.

Teacher: What does it smell like?
Lana: Um, cause I'm making meat
Teacher: You're making?
Lana: Meat
Teacher: Meat okay (Lana stops mixing and pours oil in) More oil?
…

Teacher: What can you see Molly what can you see? (tilts container)
Molly: Oh water and oil
Teacher: What's this at the top? (Molly looking) Can you see how something's at the top and there's other stuff at the bottom and then

Molly: There's oil (points to top) there's um water (points in middle) (TA-yep) and there's sand (points to bottom)
Teacher: Why do you think it does that?
Molly: Cause I put it in there I put them all in there.
Teacher: Yeah but why do they all stay layered I thought you shook it? (Molly starts shaking)

Molly: I couldn't shake it properly
Teacher: You can't shake it properly well how about we shake it together (shaking together) here we go. We're doing really well together aren't we?
Lana: Yeah we make some more different oil
Teacher: Okay let's have a look at it
Lana: I make some more different oil
Teacher: See we shook that didn't we Molly but it's still the same
Lana: I make some more (comes over to Molly and TA and observes)
Molly: Yeah but it ? (pushes on lid)
Lana: I make some different oil
Teacher: Okay you made some different oil (Lana pours oil into bowl and Molly looks on)

The teacher works hard to re-direct the children's attention from making meat to looking at the mixing of the oil, water and sand. The children take note, but focus on 'making different oils'. The activity does not support scientific thinking, but rather provides the children with a

playful event in which they expand their experiences of playing with cooking oil. Later the teacher asks the children to comment again on the materials in the mixture, but the response from the children indicates that the children have reframed the experience in relation to cooking once more:

> Lana: Put a little bit, a little bit more sand (grabs a handful of sand and puts it into bowl) little bit, mix it all around. (picks up handful of sand with other hand and puts it into the bowl) Lots of sand. (mixes then picks up oil and pours it into bowl)
> Teacher: A different type of oil.
> Lana: (puts oil down and grabs something else and puts it down next to the oil. Opens up oil and stands up)
> Teacher: How come there's all these spots of it? (pointing in bowl Lana leans forward and looks into bowl)
> Lana: Oh cause that's my meat (stands up and walks away with oil)

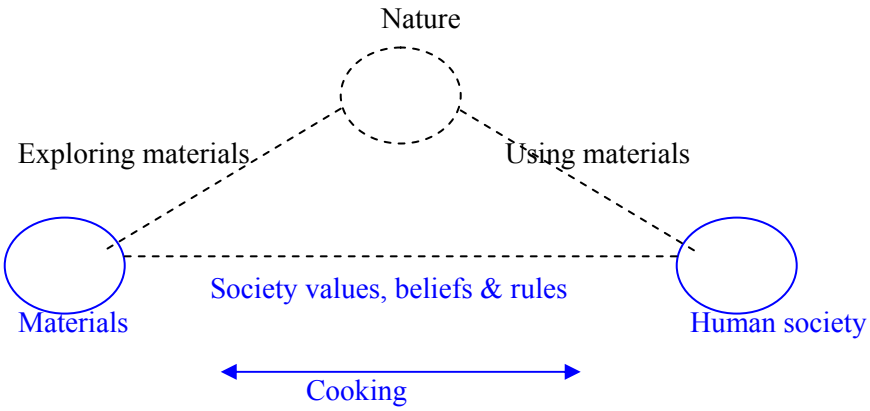

Figure Seven: Potion as Cooking Meat

These observations and transcript reveal an interesting context. The children have framed the activity of mixing sand, water and oil within the context of cooking meat. Although the sandpit was embellished with additives, such as water bottles, a peanut oil bottle and also a bottle of vinegar, this child has tied these disparate materials together and generated a 'play event' of cooking.

The teacher draws the children's attention to the mixing process, commenting on the particular substances that are being combined. In the following section, the teacher's scientific knowledge about mixing substances is foregrounded. In the next example, the teacher tries again to turn the activity into a science experience.

Observation 26.8.05: Mixing Vinegar and Oil in the Sandpit

> Teacher: So you don't want to use the vinegar Lana?
> Lana: Yeah. Where's the vinegar? (Lana stops mixing)

Teacher: It's over there (Lana turns and goes and gets a 2litre plastic container)
Lana: Vinegar, vinegar.
Teacher: Hope this doesn't explode. (Lana brings 2l plastic container back to mixing bowl and tries to take the lid off) I don't know what happens with oil and vinegar (laughs).

In this section, the children are using the materials introduced by the teacher in the sandpit. The teacher has provided these materials in order to extend the range of substances available for the children to mix. She has knowingly provided substances which react with each other in particular ways. The everyday mixing experiences are extended within the context of using sand. The teacher has no particular scientific concept formation agenda about the particular nature of the substances being mixed, but rather seeks to draw their attention to the way the substances react with each other during mixing. The children have used their everyday concepts of these substances, through seeing them used in cooking, in order to contextualise their experimentation. Their probes used in these playful events focus on mixing through pretending to be cooking meat. Combining oil and vinegar with sand provided no conceptual connection for the children. In the next play event, the children's focus of attention for using the potion pump bottles is also social rather than scientific.

Transcript: Medicine for Humpty Dumpty (23.8.05)

Three girls at a table outside, they have two plastic bottles one has a spoon in it the other has a pump action dispenser. There is a Humpty Dumpty soft toy nearby.

Jayde: He fell off the wall again and this is a girl Humpty
Lana: Humpty fell off the wall again
Grey Girl: Wait I'll spray it I have to spray it. (takes spoon out and puts it under the dispenser and fills spoon)
Jayde: Oh hi ah Humpty Dumpty
Lana: Hello
Grey Girl: Here you go (passes spoon to Jayde)
Jayde: Hello how are you today (Another child wearing cream jacket joins)
Cream Girl: Ah let me see. (Comes over to table, is holding a mobile phone in one hand and touches Humpty Dumpty's arm) touch it here.
Green Girl: Yes he's dead, he's dead I knew he he's dead. (climbs onto table, little girl with black jumper leaves).

In this particular event the group of children use the narrative of Humpty Dumpty and bring their everyday understandings of medicine together with their understandings of healing Humpty Dumpty who has fallen off the wall. Potions for these children are not about materials and their properties to be gleaned through mixing, but rather it is about medicine and caring for people in the community.

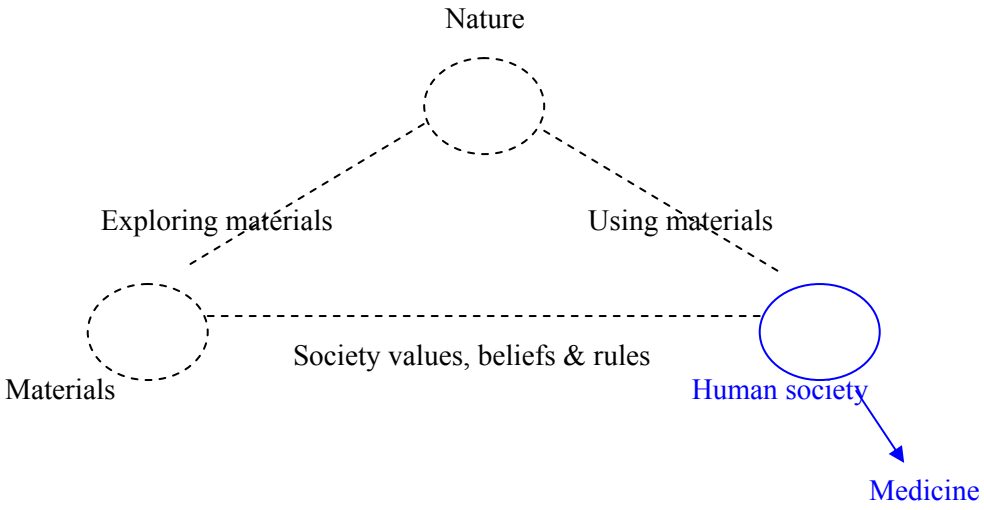

Figure Eight: Medicine for Humpty Dumpty

The element of the core concept that is explored by the children is 'human society', as shown in Figure Eight. There were no investigative probes, but rather the children focused on human connections between potions and what they knew about potions in everyday life. In this instance, the children associated potions with medicine. Their Humpty character provided the physical link with an imaginary world.

Complexive thinking was evident only when children connected the materials with other everyday activities they had observed in their environment, such as potions representing medicine or poison. The conceptual connections were functionally associated through cooking. For instance, oil was combined with sand and water to simulate the cooking of meat. Children only demonstrated complexive thinking when given opportunities to combine substances used in cooking by pretending to be cooking in the sandpit. However, concepts associated with materials and properties were worked only at the everyday concept level. Scientific concepts were not introduced to the children during the playful events observed in the preschool. It is not the intention of this analysis to suggest that the play events were not rich. But rather, the analysis is to make clear what kinds of categories of scientific learning are occurring in these play events. The analysis has shown how important it is for children that play events introduced to support scientific learning be meaningful to children. It has also shown that when conceptual intentions on the part of the adults are not clear to children, or when the core concepts being considered by the teacher are not well understood or thought through, that the play events will be re-framed by the children in ways that suit their interests and connect in meaningful ways to their experiences. However, the latter does not necessarily equate with conceptual development.

Conclusion

The data and the findings present evidence of a broad range of everyday concepts being fostered in the preschool context. The children had at their disposal many everyday materials. The

teachers provided concrete experiences that expanded the children's everyday concepts of water, colour and mixing. The addition of oil and vinegar into the sandpit, and the introduction of fragrant plants and petals, fragrant oils, and a mortar and pestle into the outdoor area, provided many new experiences that could build the children's everyday understandings.

In line with the deliberate expansion of everyday experiences in the centre, was a concentration on the children's random probing and also noticeable complex connections being made between the materials and life events (e.g. poisons, cooking, medicine). As such, two types of thinking processes were being privileged in the centre – 'unorganised heaps' and 'complex collective' (Vygotsky, 1987).

Over time, the children expanded their everyday concepts. The children made sense of the materials provided to them through connecting them with their previous experiences of cooking, poisoning plants, and administering medicine. What was particularly noticeable in the data and the findings was the focus on building more everyday concepts, rather than introducing scientific concepts to the children. This is not surprising, as most early childhood professionals who have developed their programs on the interpretations of Piagetian theory, will concentrate upon concrete materials when building an experiential base (everyday concepts) for the children. Less time has traditionally been devoted to introducing scientific concepts, particularly in ways that interlace everyday and scientific concepts. The perfume experience had the potential for interlacing everyday concepts and scientific concepts. During data gathering, no discussions, reading of books or introduced experiments or expert knowledge (apart from naming of fragrant plants lemon verbena and lavender) was offered to the children on materials and their properties.

The core concept of 'materials and their properties' was explored in relation to children's everyday concepts. Because concept formation tended to be related to children's everyday concepts and not their scientific concepts, the core concept that was mapped was both incomplete and lacked real depth. However, it should be noted that the data gathered on this preschool site was broadly expansive, concentrating upon many events that focused on materials and properties, rather than drilling down to just a few children and their thinking. As such, it is possible that private interactions between individuals may have taken place which foregrounded the introduction of scientific knowledge.

This study has shown that when Vygotsky's (1987) theoretical writings on everyday and scientific concept formation are used for examining play-based programs, it is possible to map the investigative probes of children in relation to potential scientific concepts.

Vygotsky (1966) argued that 'As play develops, we see a movement toward the conscious realization of its purpose' (p.16). The study reported in this paper, illustrates to us the importance of making clear the purpose for play in early childhood education. If, as noted by Siraj-Blatchford (2004) and the recent review by the OECD (2006, Starting Strong II), the early childhood education community is increasingly relying upon play as an important pedagogical approach for supporting cognition in the early years, then further research is urgently needed if we are to fully understand how concept formation occurs within play-based contexts.

References

Blunden, A. Vygotsky and the Dialectical Method. www accessed 2.06.06
http://webpages.charter.net/schmolzel/vygotsky/dialectical.html

Chang-Wells, G.L., & Wells, G. (1993). Dynamics of discourse: Literacy and the construction of knowledge. In E.A. Forman, N. Minick, & C.A. Stone (Eds.), *Contexts for learning: Socio-cultural dynamics in children's development (pp.58-90)*. New York: Oxford University Press.

Cole, M. (1996) *Cultural psychology: A once and future discipline*, Cambridge, Mass: Harvard University Press.

Cole, M. and Engestrom, Y. (1993) A Cultural-historical approach to distributed cognition. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp 1- 46). New York: Cambridge University Press.

Daniels, H. (1992) Vygotskian Theory and Special Education Practice in Russia. *Education Studies Mar.93, Vol.19 Issue 1, p79*. www accessed 2.06.06
http://webpages.charter.net/schmolzel/vygotsky/daniels.html

Daniels, H. (1993) *Charting the Agenda: educational activity after Vygotsky.* London: Routledge

Davydov,V.V.(1988) Learning activity. *Multidisciplinary Newsletter for Activity theory,* 1 / 2 (pp.29-36).

Gunstone, R.F. (2000) Constructivism in the classroom. In D.C. Philips (ed) *Constructivism in education: Opinions and second opinions on controversial issues* (Ninety-ninth Yearbook of the National Society for the Study of Education Part 1). (pp. 254-280). Chicago: University of Chicago Press.

Hedegaard, M. (1995) The qualitative analysis of the development of a child's theoretical knowledge and thinking. In Martin, L.M. W., Nelson, K. and Tobach, E. (eds.), *Sociocultural psychology. Theory and practice of doing and knowing.* (pp. 293-325). USA: Cambridge University Press.

Hedegaard, M. and Chaiklin, S. (2005) *Radical-Local Teaching and Learning A Cultural-Historical Approach.* Denmark, Aarhus University Press.

Ilyenkov, E. (1977) Dialectical Logic*, Moscow: Progress.*

John-Steiner, V. and Mahn, H. (2006) Sociocultural Approaches to Learning and Development: A Vygotskian Framework. University of New Mexico. (Paper submitted for a special issue of *Educational Psychologist*.)

Refereed proceedings from Learning and Socio-cultural theory: Exploring modern Vygotskian perspectives workshop, 2007, Wollongong University

Leont'ev, A. (1978) *Activity, consciousness and personality*. Englewood Cliffs, NJ: Prentice Hall.

Leont'ev, A. (1997) *The psychology of social interaction*. Moscow:Smysl
www:webpages.charter.net/schmozel/vygotsky/toolssi.html
accessed 2.06.2006

Luria, A.R. (1928) The problem of the cultural behaviour of the child. *Journal of Genetic Psychology, 35, pp493-506.*

Luria, A.R. (1979) *The Making of Mind*. Cambridge, MA: Harvard University Press.

Newman, F. and Holzman, L**.** (1993) Lev Vygotsky: *Revolutionary Scientist. Chapter 3: Practice- Vygotsky's tool-and-result methodology and psychology.* www accessed 2.06.06
http://webpages.charter.net/schmolzel/vygotsky/practice.html

OECD (2006), Starting Strong II, OECD Paris, France.

Osborne, R. and Freyberg, P. (1985) (eds.) *Learning in science. The implications of children's science.* Auckland, New Zealand: Heinemann.

Panofsky, C.P. (1994) Developing the representational functions of language: The role of parent-child book reading activity. In V. John -Steiner, C.P. Panofsky and L.W. Smith (Eds.), *Socio-cultural approaches to language and literacy: An interactionist perspective* (pp.223-242). New York: Cambridge University Press.

Siraj-Blatchford, I. (2004) Quality teaching in the early years, In A Anning, J. Cullen, and M. Fleer (Eds.), *Early Childhood Education. Society and Culture.* (pp. 137-148). London, UK : SAGE Publications.

Veresov, N. Vygotsky Before Vygotsky: The Path to the Cultural-Historical Theory of Human Consciousness (1917-1927) Historical and methodological analysis. www accessed 2.06.06
http://webpages.charter.net/schmolzel/vygotsky/Veresov.html

Vygotsky, L., (1966) *Play and its role in the mental development of the child.* Voprosy psikhologii, 12 (6), 62-76.

Vygotsky, L.S. (1987) Thinking and speech. In L.S. Vygotsky, *The collected works of L.S. Vygotsky, Vol. 1, Problems of general psychology.* (pp.39-285). R.W. Rieber and A.S. Carton (eds.), N. Minick (Trans.) New York: Plenum Press.

Vygotsky, L.S. (1998) *The collected works of L.S. Vygotsky, Vol. 5, Child psychology.* R.W. Rieber (ed); MJ Hall (Trans.) New York: Plenum Press.

Wertsch, J. W. (1985) The social formation of mind: A Vygotskian approach (pp.7-18). Cambridge, MA: Harvard University Press.

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