Video Observation Research on Preschoolers' Block Play: Identifying Features Associated with the Development of Abstract Thinking

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Understanding and Supporting Block Play: Video Observation Research on Preschoolers' Block Play to Identify Features Associated with the Development of Abstract Thinking

ABSTRACT: This article reports on a study conducted to investigate the development of abstract thinking in preschool children (ages from 3 years to 4 years old) in a nursery school in England. Adopting a social influence approach, the researcher engaged in 'close listening' to document children's ideas expressed in various representations through video observation. The aim was to identify behaviours connected with features of the functional dependency relationship – a cognitive function that connects symbolic representations with abstract thinking. The article presents three episodes to demonstrate three dominating features, which are i) *child/child sharing of thinking* and *adult and child sharing of thinking*; ii) *pause for reflection*; and iii) *satisfaction* as a result of self-directed play. These features were identified as signs of learning, and were highlighted as phenomena that can help practitioners to understand the value of quality play and so provide adequate time and space for young children and plan for a meaningful learning environment. The study has also revealed the importance of block play in promoting abstract thinking.

Keywords: abstract thinking; functional dependency relationship; social influence approach; block play; preschool; video observation; qualitative research

Introduction

This article reports a video study conducted to identify behaviours of preschool children (ages from 3 to 4 years old) connected to the development of abstract thinking during block play. Block play involves use of unit blocks made from hardwood, which are cut into mathematically proportionate dimensions. For this study, the blocks used in this research were manufactured by Community Playthings in the United Kingdom. Given the open-ended nature of the wooden blocks, children were able to use them in any way they liked to fit their play, including stacking, piling, sorting and lining up (see Figures 1 and 2).

The purpose of the study was to explore some of the ways in which children's learning is visible in play. Play is often overlooked in early years settings in favour of teaching approaches that lend

themselves more obviously to assessment and accountability policies. A recent study in the UK found that the best settings did not see teaching as separate from play, but that this ran counter to the prevailing view in the sector that teaching and play are "separate, disconnected endeavours in the early years" (Ofsted, 2015, p.1). This same study concludes that one of the reasons that many early years practitioners fail to see the value of play is that it can be difficult to 'see' the learning that results. The study reported here addresses this issue, by describing features of children's play that may be considered as markers of learning.

The specific aspect of children's learning that we focus on here is the functional dependency relationship (Athey, 1990). 'Functional dependency' is a type of schema – 'schema' being defined by Piaget as a pattern of repeatable behaviour taking place as children learn about the world around them. Schema have been used by a number of researchers to describe the different kinds of actions that precede and lead to symbolic or abstract thought. The functional dependency schema refers to a child's playing out of the fact that some action depends on some other action, or on some state of the world being the case. For example, from Atherton and Nutbrown (2013, p.52), "Henry demonstrated an understanding of functional dependency relationships: in order for him to use the car, it would have to be pulled out and the big bike moved, i.e.: his use of the car was functionally dependent on obstacles being moved out of the way". In this article we focus on the functional dependency as a promising locus for markers of children's transition from concrete to symbolic thought.

The study took a sociocultural approach (Angelillo, Rogoff and Chavajay 2007) to study individual children's thinking as they interacted with the immediate learning context including friends, researcher and the environment. The research placed emphasis on children's representations and ideas by engaging in 'close listening' (Confrey 1995), which will be discussed in detail in this article.

The research question guiding the study was thus:

What are the features that constitute the functional dependency relationship, associated with the development of abstract thinking, in preschool children (3-4 years old) during block play in English nursery school environments?

Theoretical Foundation

Piagetian theory (Piaget 1953; 1962; 1964; 1977; Inhelder, Sinclair & Bovet 1974) has played an

important role in establishing a strong foundation for researching cognitive development. In the context of this article, two aspects of Piagetian theory are key. Firstly, there is the idea that children move through stages of development, beginning with the sensorimotor stage where children begin to make connections between sensory experience and their own actions on the world, through to the formal operational stage where children are capable of abstract logical thought. While some of the detail regarding the ages at which transitions take place, and the idea that progress through stages occurs at the same rate across domains, have not stood the test of time, the idea that children's learning involves transitions from action, through symbolic mediation, to abstract thought, continues to represent a foundation of understanding of children's cognitive development. A second aspect of Piagetian theory that is important for this article is the concept of the 'schema'. A schema is a pattern of actions carried out in a particular context, and so represents the simplest building block of children's thinking. Athey (1990) extended the idea of the schema, following systematic observations of three- and four-year-old children in a nursery setting, and described several kinds of schema that were visible in early years children's behaviours. One particular schema, functional dependency, will be discussed in more detail below.

Bringing in the social

The Piagetian, cognitive, model provides a useful account of children's learning but leaves some questions unanswered. A key issue relates to the way in which transitions between forms of thinking actually take place; young children's understandings of the world that begin in the form of sensorimotor, and then concrete representations, are *somehow* transformed into abstract representations (Gopnik et al. 2004). The mechanism of this *somehow* part that would describe the process of transformation is still under-researched (Siegler 2000; Taggart & Ridley 2005; Bjorklund 2014). The study presented in this article attempted to investigate the behaviours of young children that support such a transformation between concrete and abstract thinking in order to provide early years practitioners with more effective guidelines for practice to support the development of thinking. To investigate such behaviour, it is also important to understand social constructivist theory and its influence on learning since the attitude of modern constructivist theory acknowledges the importance of the social influence on learning. For instance, the sociocultural theory of Vygotsky (1987) and Wertsch and Stone (1985) has become increasingly more prominent. Essentially, Vygotsky places learning on the social plane, occurring through interaction with peers and with more knowledgeable others. Knowledge on the social plane is then

internalised by individual children. Employing such theory, researchers have come to understand more about the complex interrelationship between cognitive, social and emotional development (Aubrey, Ghent and Kanira 2012; Pascal, Bertram, Mould and Hall 1998). A particular challenge of contemporary child development research consists in the need to develop ways to take account of both cognitive and sociocultural perspectives on learning. Studies inspired by sociocultural theory tend to place focus on aspects of the social and cultural sphere such as words, objects and technologies used during interactions (Sfard 2007).

Rogoff (1998) developed a dynamic sociocultural approach, which complements both traditional sociocultural theory and Piagetian theories (Fleer and Robbins 2003), emphasising the 'sharedness' and 'mutually constituting contribution' of children's learning (Angelillo, Rogoff and Chavajay 2007, p.190), by considering cognitive development as taking place within the full social context in which it occurs. It is Rogoff's approach that has informed the design of the present study. In acknowledging and attending to the social influence on the individual's learning, this study attempted to present results that were as child-centred as possible.

Functional dependency relationship

The functional dependency relationship is a cognitive schema identified by Athey (1997) as she conducted systematic observations of young children at different stages of thinking. Athey's work was influenced by Piaget (1953), who explained that sensorimotor experience provides the foundation for the development of abstract thinking, whereby young children transform real life experience into mental schemata and representations. This occurs via states of cognitive conflict and disequilibration that are resolved through processes of assimilation and accommodation. Assimilation refers to the employment of existing knowledge to solve new problems whereas accommodation is when the knowing subject must alter or construct knowledge in order to tackle a new challenge. Based on this idea, Athey (1990) conducted systematic observations of children's development of thinking, and categorised them into four progressive stages; i) motor, ii) symbolic representation, iii) functional dependency relationship and iv) thought. At the symbolic representation stage, children symbolically represent figurative features of objects existing in their immediate environment or from their memory. For instance, children may pretend a piece of unit block is a piece of cake. At the thought stage, a child is able to describe this piece of cake and explain that it can be cut in half to share with friends without looking at the object. Before this

thought stage, a child would have to observe and understand that slicing a cake in the middle will split it in half to produce two smaller pieces, which was identified as functional dependency relationship. In other words, young children at this transitional stage are practicing making connections between concrete reality and abstract representation. In Athey's study, a total of 4,854 observations of children's behaviour were collected. 22.8% of these observations were categorised as instances of motor action, 66% as symbolic representation, and 11.1% as belonging to the thought category. Motor action was most prominent among children aged around 3 years and 1 month, symbolic representation at 4 years and 1 month old, and the thought level was most common at 4 years and 5 months old (Athey, 1990). The functional dependency relationship category was created as a sub-category of thought level in her study, as she discovered all children manifesting thought level demonstrated conservation of their previous schematic activities. In Athey's study study, there were 225 instances of explicit functional dependency relationship. While this is not a large proportion of the total number of observations, the detailed analysis of observations of these events has shown how each child experimented and internalised what Nutbrown (2011) described, as the cause and effect of their actions. Athey (1990) defined the functional dependency relationship as:

> "...[b]efore thought becomes reversible the child's thinking proceeds by 'functions' in the modern sense of 'mappings' [...] when children observe the effects of action on objects or material" to understand that, for instance, "the distance of a ball depends on the power of the throw" (Athey 1990: p.70).

It is this stage that this article focuses on to investigate how the practitioners can support such practice in early years settings.

Implications for Early Years Practice: Supporting the Development of Abstract Thinking

Young children seek for patterns that help to generalise their experience when constructing knowledge (Gopnik, Meltzoff, & Kuhl, 1999), and they output the understanding, which is expressed in different forms of representations (Gifford 2004; Carruthers and Worthington 2005). Such patterns occur in interactive play, especially when this is carried out with sensitive response and reinforcement from a more knowledgeable partner. Frequent exposure to such play is crucial in the early years. This was further

emphasised by Van Oers and Poland (2007) who argued that to tackle the problem of formal learning, early years education should focus on bridging the gap between concrete and abstract through play.

With regard to abstract thinking, Van Oers and Poland (2007, p.14) explained that abstraction is "a dialectical process between the concretely given objects and the abstract representations of them", where symbolic representations are constructed as mental object, which sustain "inner relationship" with the concrete world (van Oers 2001, p.287). In Donaldson's (1986) terms, abstract thinking was described as "modes of thought [...] 'disembedded' from the vicissitudes of immediate context" (Grieve and Hughes, 1990, p.5). Both definitions signify that the development of abstract thinking is linked with its detachment from the concrete world, while maintaining connection with it through representations.

So, how should early years practitioners support children's development of abstract thinking? Donaldson (1986, p.94-108) hypothesised that there are five elements required in children's play that supports the development of abstract thinking. They are a) to allow time for reflection, b) to have a feeling of being in control, c) structure, d) to have opportunity to make errors, and e) intrinsic motivation. Yet, observational studies that focused on development of thinking such as Athey (1990) are rare. Employing the social influence approach and Athey's (1990) theory of the functional dependency relationship, this article presents three episodes collected through the study to identify behaviours of young children that suggest transition between concrete and abstract thinking in order to provide practitioners with guidelines for more effective practice.

Methodology

The study presented in this article adopted qualitative methodology that acknowledged the researcher's position within the process of knowledge production (Guba and Lincoln, 1995). To interpret the data, and determine as closely as possible what participating children are thinking, the researcher is required to be as close to children's natural environment as possible. This is a function of the 'close listening' approach used here (Confrey, 1995), where the researcher's role was to understand each child's intention, and to follow and support such intentions without disturbing their flow of play. What was important in taking such an approach was a positive attitude towards respecting young children's voices, ideas and thinking expressed in various forms such as gestures, actions, narrations, constructions and behaviour (Ginsburg 2009; Gifford 2004), and avoiding directing their play.

Such understanding was further expanded to support the children in their decision on how they wanted to participate in the research. Some children silently indicated a desire to not participate in the research, through their body language. Another child directed where to place the voice recorder. Before participating in the study, all children were shown a small picture book showing the purpose of the video recording and how it will be used to "write a story about them". At the end of the story, they were asked if it was alright for the researcher to do so. While formal informed consent was sought and received from participating children's parents, the children's right to express their intention was respected throughout the research process. After the study, all children and their parents had an opportunity to watch the video and listen to how the data was analysed.

Data Collection

The study was conducted in one classroom in an English nursery school, where 30 children from mixed cultural backgrounds, attended three-hour morning sessions for 5 days a week. The children followed a routine of starting a day with a 30-minute adult-led activity, followed by two hours of free-play. The video observation took place during this free-play time when children were accessing the block area freely to start their own play or were invited to join an activity initiated by the researcher.

With technological advancement, video cameras have become more familiar in life allowing more natural integration of video observation into preschool classrooms (Knoblauch and Tuma 2011). The video camera and audio recording devices were set up in such a way that they were documenting children's behaviour, gestures, facial expressions, words, intonations, concentration, persistence and any other signs of the child's cognitive transformation in the light of the functional dependency relationship (Barron 2007; Angelillo, Rogoff and Chavajay 2007). In qualitative research with interpretive analysis, maximum effort has to be exhausted in producing video documentation to allow genuine reproduction of 'semiotic space' between the data and the researcher during the analysis process where meaning can be renegotiated (Wertsch 1991; Fosnot and Perry 2005; Guba and Lincoln 2005). With this approach, the statement by Blumer (1969) below still holds significant relevance in this particular study, which helped to set the protocol during the fieldwork.

> "it signifies immediately that if the scholar wishes to understand the action of people it is necessary for him to see their objects as they see them. Failure to see their objects as they see

them, or a substitution of his meanings of the objects for their meanings, is the gravest kind of error that the social scientist can commit" (1969, p.51).

Ethical Considerations

Gaining access to nursery schools can be a complex process. This particular study involved thorough preparation and coordination with multiple layers of gatekeepers, using emails and meetings to explain the purpose of the study, while allowing sufficient time to develop trust and connections with teachers of the setting. Such negotiation constitutes a key to the success of the research (Lofland et al. 2006). The second stage of gaining access involved gaining informed consent from participating children's parents and guardians, in line with British Educational Research Association ethical guidelines (2011). To ensure the confidentiality and anonymity of participating children, all names in this article are reported using pseudonyms. The Graduate School of Education, University of Bristol, actively promotes ethical mindfulness, which was also adopted throughout the fieldwork by sensitively listening out for unheard voices of young children in their decision towards participation in the research (Aubrey et al. 2000; Dockett and Perry 2011; Alderson 1995; Docket, Einarsdottir and Perry 2011; Bourke and Loveridge 2014). Furthermore, ethical procedures including approval by the lead author's home institution ethics committee, were completed prior to the fieldwork taking place.

Findings and Discussion

In the study, 640 minutes of video recorded data was edited down to 199 minutes for further analysis. 26 events were analysed and organised into three categories as follows;

16 concrete thinking,
7 concrete to abstract thinking,
and 3 abstract thinking.

Three episodes from the concrete to abstract category were chosen to be presented in this article in order to demonstrate the behaviours suggesting transitions between concrete and abstract thinking. Reasons for selecting such episodes were for their clear documentation of behavioural features, facial expressions and verbal representations that suggested the moment of concrete functioning and moment of abstract thinking stage, and the transition in the mode of thinking during the block play. The length of the

recording ranged from 3 minutes to 9 minutes, and they demonstrate insights into what children do in their play when their cognitive stage exhibit functional dependency relationship.

The interpretive analysis was conducted using NVivo, which assisted in organising and highlighting sections of video recordings with the researcher's interpretation of the child's representations. The analysis lead to 8 types of behaviour and 6 types of social interactions. A further 6 categories were created to isolate moments in play that identified either motor action, symbolic functioning or functional dependency relationship.

The context of play was also taken into consideration during the analysis by applying 'rich interpretation', which Ginsburg (1997, p.79) described as "assign[ing] meaning to words or actions on the basis of how they fit into the entire context of the session and what we know about the interviewer and child". This includes speech on the basis of what he or she understands about the environment, the child and what the researcher was thinking and the reasons for the ways the researcher interacted with the child during the event.

Findings: Episodes

This section presents transcripts of the three episodes followed by the researcher's commentary on the episodes and detailed discussions focussing on the features identified.

Episode 1: David's Transformation of Construction

David (age: 3 years 10 months) is building a 2D plain surface using wide slopes, 1/2 and 1/4 blocks. His friend William (age: 4 years 2 months) joins in the construction using different size blocks but David removes them swiftly and replaces with 1/4 block. It appears that David has a "design" in his mind which is not affected by his friend's intervention. Four minutes into the play, William lifts one of the slopes and stands it up vertically. David repeats this and begins lifting all other slopes until their construction is transformed into 2D horizontal enclosure (see figure 1).

Researcher: Look, what you building, David.

David: I building this thing Daniel built.

Researcher: Oh! Daniel built yesterday.

David: [nods]

Researcher: Do you know what this does? [pointing at slopes standing vertically]

David: I don't know [as he tries to fix one of the slope which is not lined up with the rest because its right angle is not facing the same direction.]

Researcher: You don't know. [Pause] Try turning this around [twirling the finger to suggest turning the slope around so that the right angle is lined up with the rest of the slopes] turn it around, that's it.

David: [begins to place 1/2 and 1/4 blocks on the opposite side of vertical slopes, transforming the plain surface construction to 2D horizontal enclosure.]

William: [places an orange truck inside the enclosure and nudges the vertical slope with the truck]

David: [begins to lower down one of the slope but pauses briefly, then continues to lower two more slopes, and William drives the truck down the slope.]

Researcher: Ah!

David: If he goes out to get some food... [pause]

Researcher: He's going out to get some food.

Researcher: Did it just open to let the truck out?

David: Yeah, and they close again, and when he (an orange truck) comes back they open again.

Researcher: They open again, do they?

Summary of Episode 1

Figure 1. A series of screen captures from video documentation illustrating the transformation in David's construction.

In this episode, David is building a construction, which is the same as what his friend was building on the

previous day. He uses his memory to reconstruct the building until it begins to look like the same structure until his friend William joins in and alters the structure by lifting up the slopes. Upon the observation of William's action, David begins to imitate the action. Yet, David is still not sure of the function of the structure, and his thinking still remains concretely embedded within what he is experiencing in front of him. However, David's transition in thinking begins as William places an orange truck inside the structure, which David could relate to, allowing David to change his thinking towards the function of the structure. As David watches William using orange truck to nudge the "wall" of the structure as if to say "let me out", David began thinking "what if I lower this..." which triggered his action to slowly lower the slope piece to transform the function of the "wall" into a "ramp" for the truck to drive out. As William continues on to drive the truck out, David begins to tell his story about what his construction can do, at which point his thinking had reached abstract state.

Episode 2: Olivia is Sorting Caterpillar's Food

The block area is quiet, and cylinders have been left out from previous play. Olivia (age: 3 years 9 months) is playing with Eric Carle (1969)'s Hungry Caterpillar display table, which has small pieces of food and a caterpillar. Olivia brings caterpillar's food into block area and hands them to the researcher (see figure 2).

OLIVIA:	Olivia passes the pictures of caterpillar food to the researcher, who is sat next to the cluster of vertical cylinders.
Researcher:	An apple, a plum, a candy, a cupcake, a watermelon, a strawberry, and an ice cream [placing each piece of fruit onto each cylinder. Two cylinders are left without food].
OLIVIA:	We need some more,
Researcher:	We need some more? Okay, go get it.
OLIVIA:	We need two left.
Researcher:	We've got two left.
Researcher:	Let's have a look. Oh, and then you've got a pear, and an orange. Is that enough now?

OLIVIA: Yeah.

Researcher: Yes. We've got everything.

OLIVIA: [8 second pauses] We need some more.

Researcher: We need some more? Okay, go on then.

OLIVIA: [Goes to get one cylinder from block shelf, and places it next to the rest of the cylinders. Olivia then gets one piece of food from the Hungry Caterpillar display table, and gives it to the researcher]

Researcher: And, that's a cherry pie.

OLIVIA: We did it! [Jumps up, takes off her sunglasses and looks at the collection.]

OLIVIA: We need to grab the plate. [Grabs a plate and places all the food onto the plate]

Summary of Episode 2

Episode 2 was initiated by the researcher based on an observation from the previous day in which Olivia was enjoying placing cylinders on a square platform constructed by ¼ blocks. Each cylinder was placed neatly onto each piece of ¼ block suggesting one to one sorting behaviour. In this episode, the researcher begins placing one piece of food onto each cylinder. There are two cylinders left after all the food has been placed, and Olivia announces that she needs two more food to complete the game. The game was started without a set rule, but as Olivia observes the researcher's action, she perceives the sorting as what seems to be a rule, and uses it to extend the activity. She begins to take on the lead and extends furthermore by adding more cylinders. She shows her satisfaction for completion by jumping up.

Figure 2. A screen capture from the video documentation illustrating Olivia's play of sorting food onto each cylinder – a moment when Olivia is extending the play by adding more cylinders.

Researcher: Ah right, what were you building?

POPPY: I building it, around the circle one. [gestures a large circle with her arm]

Researcher: Around the circle?

POPPY: I'm gonna make it very big.

Researcher: You gonna make it very very big.

THOMAS: beep beep.

POPPY: That could be your broken down truck. [continue to play with loading and unloading trucks, and transporting blocks]

POPPY: [to Thomas] Excuse me, could I borrow a brick, please?

THOMAS: No.

POPPY: These bricks, please.

Researcher: Did you just borrow the bricks?

POPPY: I need the bricks to... I think I need another... [looking for blocks to construct parking]

POPPY: Truck has to go in first, [drives the truck into the half enclosed space and places 1/2 sticks around the truck to surround it] and then the truck goes out that way. [pointing at a small gap made between the blocks, which is not big enough for the truck]

Researcher: Ah, I see. That's the entrance.

POPPY: [pauses and looks at her construction] But I take it off because I don't need it. [removes one block to open enough space for the truck to drive out]

Researcher: You take it off because you don't need it.

POPPY: Just put it here. [places the removed block out of the way, then drives the truck

out]

Researcher: So what does this space do? What is this?

POPPY: It's a parking place.

Summary of Episode 3

In the episode 3, Poppy (age: 4 years 8 months) is constructing a "parking" space for a truck, which she has been playing with. She begins by describing her design as "a circle" thing excitedly. She uses a truck to guide her with the construction to build an enclosure around it. At this point her play is described as concrete thinking as her verbal representation is figurative which is embedded within the experience. Poppy's thinking begins to advance further towards abstract thinking when she pauses for a reflection and notices that the gap was not big enough for the truck to go through. Her thinking has demonstrated functional dependency relationship as she acquires the concept that a complete circle will obstruct the truck from driving out, therefore she needs to remove a piece a block to open up a space required for the truck to go through. This episode is illustrating the early development of abstract thinking with an assistance from concrete experience as Poppy begins to apply her understanding of her acquired concept to alter her construction to meet the function of the "parking place".

General discussion of the three episodes

The interpretive analysis revealed three dominant features, depicted in the presented episodes. They are i) *sharing of thinking between child and child*, and *sharing of thinking between adult and child*; ii) intrinsically driven *pause for reflection*; and iii) the demonstration of *satisfaction* as a result of their self-directed play. This section discusses each feature in detail.

1) Sharing of Thinking - Child/Child Sharing of Thinking

In episode 1, David had completed constructing an enclosed space. His friend William placed a truck inside and nudged the wall. In this particular sequence of play, William saw the feature of the construction, i.e. the enclosed space created by upright slopes and other surrounding blocks. Placing the truck inside this space demonstrated that William had internalised the containing schema, which focuses on *in and out* state of an object (Athey 1990). Although David was the one who built this construction, it is only until observing William's behaviour and letting the truck out by lowering the slope that it can be

concluded that David had internalised the containing schema. Here, the outcome of this sequence of play is a sharing of thinking which led to David's learning.

Child/child sharing of thinking involved unintentional sharing of thinking. The focus is the *unintentional* nature of event, which is distinguished from 'tutoring' as seen in scaffolding (Wood et al., 1976) or active delivery of problem solving strategies as seen in zone of proximal development (Gifford, 2004). Rather, the sharing is regarded as the outcome of the action when a child observes an incidence or operation that interests him or her, internalises it and turns it into his or her own knowledge (Edwards, 2014).

Sharing of thinking - Adult/Child Sharing of Thinking

In contrast to Child/Child Sharing of Thinking is Adult/Child Sharing of Thinking, where an adult takes on an active role to pose relevant question to extend child's thinking. For instance, in episode 1, the researcher asked David "did it just open to let the truck out?". David then explained that it can open and close, demonstrating David's thinking represented the functional dependency relationship. It indicated that his understanding on the functional capability of his block construction had developed during this block play by observing his friend placing a truck inside the enclosure to pretend that it was trapped.

Adult/child sharing of thinking involved the researcher's active involvement in their play to extend the child's thinking through the use of appropriate observations and judgements on what the child might be interested in. Adopting such pedagogical approach stimulates the implementation of a curriculum of thinking. It demonstrates that teaching thinking can be employed at young ages with appropriate approach. The style of such curriculum is described as 'infusion' style (Aubrey et. al. 2012) where development of thinking skills are embedded within spontaneous play. Asking appropriate questions involves practitioners to engage in the play and gain deeper understanding of what the child is focused on.

Social implications observed in the episodes include child/child observations and 'sustained shared thinking' between adult and child. Siraj-Blatchford (2009) derived the term sustained shared thinking through the Effective Provision of Pre-School Education (EPPE) Project as "sharing of thinking, and [...] sustained nature of some of the interactions". The emphasis is placed upon the extended period of activity intentionally prolonged by the supporting adults through participation in the activity and sharing their interests, and organising a timely provision of suitable learning environment in order to develop their critical thinking. Similar notions include scaffolding (Wood et al., 1976) and zone of proximal

development (Vygotsky, 1978). However, unlike scaffolding or zone of proximal development, the intention is not to deliver knowledge or strategies to the child. The intention of sustained shared thinking assumes the child as powerful learner who is capable of constructing knowledge themselves, with relevant social support. Holding such assumptions at the heart of the early years practice leads to the formation of pedagogical structure that incorporates 'interactionist' approach. The interactionist approach, as described by Gura and Bruce (1992), constantly searches for a child's interests that can be used to extend learning opportunities. Especially for children as young as pre-school age, skills to think abstractly is still developing which makes teaching of mathematical concepts, skills and strategies through direct method difficult. In such cases, mathematical concepts can be conveyed indirectly through play, where concept is concretely embedded. The demonstration of such procedure can be seen through this research, where the researcher actively sought for learning opportunity as a child played with unit blocks, and either initiated, extended, or asked open-ended questions that would extend critical thinking. Such approach coincides with Claxton and Carr's (2004) arguments that teaching in early years should be about supporting the development of learning disposition.

2) Pause for Reflection

In episode 1, David was lowering the slope to let William's truck out. He lowered the slope halfway and paused briefly as if to think whether what he was doing was the right thing. Then he continued to lower two more slopes. In episode 2, Olivia had an 8 second pause between the moment she said that she has enough caterpillar food and the moment she decided to get some more. Poppy in episode 3 also had a brief pause after she had constructed her 'parking space', when she looked at the construction and made an alteration by taking a piece of block out to make enough space for the truck to drive out.

These preschool children's behaviour of pausing for reflection resonated with the development of awareness. Donaldson (1986) described such development occurs when " something gives us pause and when consequently, instead of just acting, we stop to consider the possibilities of acting which are before us" (Donaldson 1986, p.94). This is also another feature identified to be emerging at this functional dependency relationship where children's thinking transformed between concrete and abstract. These children in the presented episodes demonstrated their abilities to reflect on their actions while eliminating irrelevant factors around them and giving considerations towards the product of their actions. Such

behaviour is the process of "turn[ing] language and thought in upon themselves" (Hughes 1990, p.123), and continuous practice of such behaviour will help children to develop abstract thinking.

These episodes also demonstrated that reflective pauses occurred intrinsically. While, a further investigation is required to determine what triggers effective reflection in young children, it is suggested that ability to reflect is linked with possessing a feeling of being in control (Donaldson 1986; Hughes 1990). It is argued that the act of stopping and pausing to think about one's own thinking and to actively "choose to direct our thinking" is "relevant to the development of intellectual self-control, with incalculable consequences for the development of the kinds of thinking which are characteristic of logic, mathematics and the sciences." (Donaldson, 1986, p.94-95). Although the children referred to in Donaldson's (1986) text are at school age and capable of writing, (i.e. turning their thought into visual form) it is also evident in these episodes that young children are beginning to apply a form of reflection when they witness their achievement concretely. Since this reflective action has to be initiated intrinsically, the practitioners should understand the value of time and space required by children to complete their play and assist them to look back their action by using the products of their play. This will support the children to practice the process of running through their cognitive process.

It is uncertain if the child held any explicit theory or a plan in mind before the reflection that linked with what their block construction can do. It may be that the young children whose form of thinking is at this functional dependency relationship stage, have ability to remain open-ended allowing them to scan through the world for relevant and interesting information.

3) Satisfaction

The third sign of learning at this transitional stage of functional dependency relationship is satisfaction, which is connected with reflection. Olivia in episode 2 jumped up with joy, took off her sunglasses to take a closer look, and said "we did it!". Satisfaction from David in episode 1 was very clear when his energy in speech changed as he began explaining his achievement and what his construction can do.

While not all children displays satisfaction in such an obvious manner, each activity that is completed fully will have an ending point. Bennett et al. (1997, p.13) described that "children's self-directed activities often reveal powerful evidence of children effectively directing their own learning, particularly

if supported in the process by an adult". Yet the argument goes that the degree of child-centred approach which ensures children's rights to choose can sometimes cause conflicts with the curriculum objectives where teachers attempt to facilitate for children to "experience breadth, balance and progression" (Bennett et al., 1997, p.13).

Some nursery schools in England appear to have introduced literacy hours for 0 to 5 years old since the revision of the Early Years Foundation Stages in 2014 with the aim for young children to enter school with pre-equipped literacy skills. The practitioners' interpretation of Communication and Language in certain settings were to teach vocabulary through repeating and reciting. Since these activities were far from children's interests, signs of learning as seen in this research were not observed. Similarly, a recent report from the UK's All Party Parliamentary Group for Maths and Numeracy criticised Early Years settings for an excessive focus on rote learning of number facts at the expense of approaches that help children develop number sense through play (APPG for Maths and Numeracy, 2014). For early years curricula such as the EYFS, which dictates learning areas, practitioners are required to understand how young children learn and have practical skills to apply topics of teaching agenda appropriately. Appropriate methods of teaching will incorporate holistic approach that fully engages children's play as directed by themselves. The teachers' job is to introduce any relevant academic concepts into their play without interrupting the flow of their play. In such approach, these three signs of learning as identified in this study will become useful in guiding the teachers about children's learning.

Conclusion

The study presented in this article was driven by its aim to identify behaviours of preschool children that would indicate a transformation between concrete and abstract thinking in order to allow early years practitioners to better understand importance of effective scaffolds. The main focus was on Athey's functional dependency relationship, and it was crucial not to guide children in this study other than to support their intentions through effective communication. For this reason, the data collection stage was underpinned by the act of "close listening", which allowed children to express their ideas in various forms of representations. It was important to establish such methodology, since this was a study of young children's thinking and learning in their natural context (Angelillo, Rogoff and Chavajay 2007; Schoenfeld 2002; Ginsburg 1997).

For the purpose of this paper, the number of reported episodes was reduced down from 26 to 3 focusing on the ones which the young children had demonstrated the transformation from concrete to abstract thinking. The analysis of these "concrete to abstract" episodes demonstrated that children's thinking was continuously transforming back and forth between concrete and abstract. Furthermore, the transformation was supported by a complex interplay of young children's cognitive development and their social interaction. When young children observed other children, they memorise and imitate any features that interest them. Through the act of imitation, children internalises various concepts that helps them to understand the world around them. It is difficult to judge when such sharing of thinking occurs between children, and what features are presented to them. The best support the practitioners can give to allow development of concepts through child/child sharing of thinking is by organising varieties of activities over a long period of time; observing their play from a distance and allowing space for the children to negotiate their play without having the practitioners to intervene. This requires practitioners' sensitivity and knowledge and understanding of what children are doing in their play, in order to know when *NOT* to step in.

The research has also identified the importance of a pause for reflection in young children, as a feature that may suggest the development of abstract thinking. After the young children paused to think about their action, their block construction became more complex and more refined, suggesting that their spontaneous reflection is connected with the development of abstract thinking (Aubrey, Ghent and Kanira 2012; Chatzipanteli, Grammatikopoulos and Gregoriadis 2013; Taggart and Ridley 2005). As in the case of these young children, they require time and space to complete their play, and to feel that they have been in control of their own play. To support development of abstract thinking, the practitioners need to plan adequate space and time for such activities, and understand what reflective questions or props to use to support such development. For this, the practitioners should be prepared to be with the children during the play to understand their intentions, and understand what reflective questions or props to use if required. It important to reiterate that playing together with young children is not about guiding them with a curriculum, but it is about organising various environments in which their exposure to various concepts is maximised for them to experience and discover.

While more early years settings are feeling a pressure to conduct formal teaching to young children, it is important for the practitioners to understand that the young children are able to retain such concept more effectively once their abstract thinking has developed. Until their abstract thinking skill is

fully developed, the early years practitioners can provide the best environment the young children can have to practice thinking skills by exposing them to different types of play using open-ended equipment, and allow opportunities to physically experience the concepts before giving didactic instructions.

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