Toys as dual pivots for imaginative play and mathematics

Marie Therese Farrugia

Toys as dual pivots for imaginative play and mathematics

Marie Therese Farrugia

University of Malta, Faculty of Education, Malta

marie.t.farrugia@um.edu.mt

Presently in Malta there is a move towards an informal pedagogy in kindergarten (ages 3 – 5), through which the teacher is expected to support the learning of mathematics by interacting with children as they play. Taking the role of teacher-researcher, I carried out a small scale study wherein I first observed children play on their own, then later interacted with them as they played. Drawing on Vygotsky (1967), Walkerdine (1988) and Sfard (2008), I considered 'learning mathematics' as a shift from a play discourse to a mathematical discourse. In particular, play items were considered to serve as 'dual pivots' for new meanings. In this paper I focus on one child, using the empirical data to articulate a theory with which one can discuss children's learning of mathematics in play settings.

Keywords: Early Years education; mathematics discourse; pivots; chains of signification

Introduction

The present direction in early childhood education in Malta is to move away from structured pedagogy. Teachers are now expected to act as 'responsive' adults, engaging in "authentic conversations" with children (Stacey, 2009, p.14), to support learning through play. In this regard, I wished to theorize about what it means to 'learn mathematics through play'. I wished to present a theoretical approach through which one might consider a child's play as 'mathematical' or otherwise. I also wished to investigate if children attended spontaneously to mathematical ideas when playing on their own, and then see how an adult's interaction (mine) might influence their talk/actions. I undertook a small scale study in which I took the role of teacher-researcher with four 4-year olds, and explored their talk and action in a context of play initiated by the children themselves. The play items presented were 'loose parts' e.g. pebbles, blocks, connecting camels, and so on. The main subject of the present paper is one of the children, Mario. The mathematics in focus is counting and foundational aspects of measurement (length); while I had taken *a priori* decision to focus on counting, due to the countable nature of the loose parts, the element of measurement emerged from Mario's play itself.

Although young children are sensitive to quantity, counting is socially constructed and can only be learnt through interaction with others (Montague-Smith, Cotton, Hansen, & Price, 2018). According to Gelman and Gallistel (1986) learning to count involves an appreciation of five principles of how to count, namely one-to-one, stable order and cardinality, order irrelevance and abstraction. Measurement involves assigning numbers to physical quantities such as length (Smith, 2013). As discussed by the Early Math Collaborative (2014), the idea that counting can be used to compare not only sets but also the length of objects is an important revelation for young children. Indeed, it is this non-obvious application of counting to the comparison of attributes of size that creates the concept of the repeated or iterated 'unit, which is a key idea of measuring length (Clements & Stephan, 2004).

Theoretical framework

Vygotsky (1967) believes that imaginary play had an enormous role in a child's development, in that it is a transitional stage through which a child can 'sever thought from an object' (p.12). The liberating

of thought and meaning from their origin in the perceptual field provides the foundation for the further development of speech and its role in advanced forms of thinking. This liberation of meaning from object is facilitated by means of what Vygotsky referred to as 'pivots'. For example, if a child uses a stick as a horse, the stick acts as a pivot to transition of the child from a real situation to an imaginary one. Vygotsky (1978) further explains that when using a stick as a horse, the child retains the property of the thing, but changes its meaning. It is the meaning, in play, that now becomes the central point and objects are moved from a dominant to a subordinate position.

Hodge and Kress (1988) define discourses as sets of practices within which spoken or written language are embedded. Play situations provide contexts for the intersection of multiple discourses (Wagner and Andersson, 2018). For example, in the kindergarten classroom, one discourse may relate to how children are expected to play around a table (e.g. by taking turns), another discourse relates to how the student-adult relationship is articulated. The imaginative narrative of the play may be an enactment of discourses learnt outside school. For example, when children enact a birthday party, the discourse is that of the social practice of preparing cakes, decorating the environment and inviting guests. In this paper, I use the expression 'play discourse' in an encompassing sense in order to distinguish 'non-mathematical' discourse from mathematical discourse. Sfard (2008) identifies four characteristics that render a discourse 'mathematical': (1) Word use that is responsible for what the user is able to say about (and thus to see in) the world; (2) visual mediators, especially symbolic artefacts that are operated upon as part of the communication; (3) endorsed narratives, or established constructs such as definitions, proofs and theorems; (4) Routines, or repetitive patterns, e.g. regularities in forms of categorizing. Applying these characteristics to the kindergarten play context, I conceptualize the characteristics as follows.

Word use. The adult can use introduce terminology into talk with young children, while s/he notes whether the child uses words that might be considered 'mathematical'. While some words may easily be identified as 'mathematical' (e.g. *seven, subtract*), Walkerdine (1988) draws our attention to instances when the use of a word needs further reflection in order to draw conclusions about whether it is used in a mathematical sense or not. In her observations of parent-child conversations, Walkerdine noted how the 'everyday' word "*more*" was used in relation to the consumption of food and was contrasted with "*no more [food*]" or "*not as much [food]*". Thus, the relational pair in use was *more/no more*. On the other hand, in mathematical discourse, "*more*" is contrasted with "*less*", and this particular contrast sets up a different relation.

Endorsed narratives. Young children begin to gain experience of simple definitions and conventions, such as names of shapes and the appropriate way of writing numbers and so on. They might bring the ideas into their play, or an adult might make reference to established conventions.

Routines. For the young child, this might include the activity of counting to establish 'how many', measuring length using units, using instruments to establish weight, using simple graphical representations to show information, thinking of shapes in terms of their properties and so on.

Visual mediators. In a play situation, the adult may prompt the child to attend to, and to use, certain words or to engage in a narrative or routine that the adult knows to be established norms for the discipline. For example, suppose a child is building a dragon's tower with pebbles and is focusing on

the smoothness and colour of the pebbles, creating a doorway for the dragon. At this stage, the pebbles - originally river related objects – serve as what Vygotsky (1967) calls 'pivots' for imaginative thought. If an adult draws the child's attention to the *number* of pebbles being used, or their weight, or relative size, then the pebbles come to serve as a pivot for a mathematical meaning. Hence I consider that the pebbles in this play situation can serve as a *dual pivot.*

As explained by Walkerdine (1988), one way of achieving a shift is through chains of signification. During the parent-child conversations that she observed, Walkerdine noted the mother and child talking about inviting friends to a party. In the ensuing interaction, the friends were first represented by their names (*Mark, Michelle, Kirstie*); these names were then represented by fingers, and finally the fingers were referred to by numerals ("*one, two, three*"). In my study I aimed to investigate the process of shifting discourse in a particular play context, that of playing with 'loose parts'. In my own study, I was interested in the children's verbal interaction between themselves and /or with an adult (myself) in relation to play items - it was the combination of talk and action that realized the discourse.

Research Design and overview of children's play

Wagner and Andersson (2018) note that children can develop proficiency in mathematical language practices by drawing on their repertoires of language practices in other discourses. In this study, my intention was to use the play context and conversation ('play discourse') as the basis for a shift to a mathematical discourse. The four children (pseudonyms) who participated in my study were Mario and Sarah who were Maltese, Dorina who was Hungarian and Ling who was Chinese. They were suggested by their teacher as being comfortable to play together; parental and child consent was also sought. The children were presented with various sets of loose parts to play as they wished. For Sessions 1 - 5, I took the children together and allowed them to play with minimal interaction from my part. For Sessions 6 – 8, I intended to pair the children since I planned to interact much more with them. However, Dorina stopped attending school and hence Mario, the subject of this paper, was taken alone, since I had already paired up Sarah and Ling. The language used during the study was English, which was the *lingua franca* of the class due to the large number of language groups represented in the class. All four children could understand English and they appeared comfortable using the language to communicate with me and with each other as they played. Throughout these sessions, a recurrent theme was birthday parties and cakes. The children also made crowns and necklaces with small coloured camels (of three sizes) that connect as shown in Figure 1. Mario was particularly drawn to the camels, and it is his play with these items that are the subject of this paper. (See Farrugia, forthcoming, for a discussion of Sarah and Ling's discourses).

Figure 1. Connecting camels

The 25-minute sessions were video-recorded to allow for later transcription. Analysis was done by first viewing the videos and noting the children's conversations as they played without my intervention, and then noting the development of the conversation and actions when I *did* interact with them. I kept Sfard's (2008) discourse characteristics in mind in order to select excerpts for discussion. My main *a priori* interest was counting but, as a result of the direction of the play, I was also able to link counting with size, thus touching on the foundations of measurement.

Mario's play with connecting camels - from play to mathematical discourse

When the children played without my intervention, it was rare that an instance could be classified as 'mathematical discourse' in terms of the characteristics identified by Sfard (2008). Examples of Mario's talk/actions during these sessions are the following (the reader is reminded that English was not Mario's home language). During the first session, Mario was taken up playing with blocks and shells and an excerpt of his talk is: "Miss, I'm going to play with the shells. I need the 'carrot' one. It looks like a carrot. I don't know where it is." Mario's first use of the camels came in the second session, when he made a four-camel circle declaring to me "Miss, look! This is a crown". On the third day, I did not take the camels along with me, in order to vary the items presented, so there was no reference to them by Mario. On the fourth day, Mario scoffed the girls for making 'cakes' yet again and he preferred to play with the camels on the carpet; he used language to express what his creations 'looked' like, naming them as traffic, crowns and so on. For example:

> Miss, I'm going to make a crown (*he makes two rings of camels, then wears one on his head*). *He then takes it off, opens out both crowns).* Sarah, now I'll make a big one, so we'll have a big crown for us. (*He makes a circuit of 18 camels – see Figure 3*). Wow, a big crown! It's a bit [like] tracks … like, like a[n] escalator. Escalator! Escalator!

Figure 2. Mario's big crown / tracks / escalator

On the fifth day, I added various sets of numerals to the play items. Mario initially showed a brief interest in the set of large plastic numerals. However, he quickly turned his attention to the camels and made a crown, which he wore, and then a necklace. I concluded that up to this point in Mario's play, his talk appeared to focus mainly on describing his creations. In terms of Sfard's characteristics, there was only a brief instance of naming of some of the plastic numerals ("two, three …"), which can be considered as an endorsed narrative. No routines normally associated with mathematics were observed. There were a few words that I examined more closely in order to evaluate whether they formed part of a *mathematical* discourse but concluded that they did not, as explained below.

- *Big*. Mario attended to size three times, for example "Sarah, now I'll make a big one, so we'll have a big crown for us … wow, a big crown. Mario's use of the word *big* confirmed the suggestion by Montague-Smith et al. (2018) that children aged 3 to 4 years use one of three standards to judge size: perceptual (what the object looks or feels like), normative (comparing it with a mental image of what is 'normal') and functional (comparing it with what it is used for). The crowns were too large to sit on a head and would fall onto one's chest like a necklace; the party was 'big' in the sense that several cakes were to be made and placed on the couch. Hence, bigness was not quantified, nor was it compared - both key aspects of measurement.
- *More*. The word *more* was used once when the focus of play was on creating decorations ("I'm bringing more"). However, the play context allowed me to conclude that *more* was not contrasted with *less* , but appeared to be used in the sense of '*further items to add to the play'*.
- *Some*. On two occasions, Mario used the word '*some'* as an expression of the need for play items; one instance was when the girls had monopolized the shells ("Give me some!") and another was when he couldn't find the camels ("I'm going to need some camels. Where ARE

these camels?!"). Hence, *some* was used in the sense not of a specific quantity but in the sense of 'something to play with' implying that *some* was contrasted with *none* or *no play items*.

Given this picture of Mario's play, I concluded that the play items, in particular the toy camels, served only as pivots for imaginative play.

At the end of the fifth session, Mario joined up four camels and tried to wear the circuit as a bracelet. It was too small to pass over his hand and as he tried to force it, two camels disconnected. He tried to close the bracelet again. The end camels touched, but could not connect. He addressed me for help ("Miss, can you close this?"). I did manage – just – but the camels disconnected again.

MTF I think you need an extra one. I think you need another one.

Mario (*The string of camels falls into a box. Mario picks up another camel and adds it to the string, thus closing the bracelet. He wears it around his wrist. Then he makes another similar bracelet, by using camels of similar colours. He wears the second bracelet on the other wrist*). Miss! Have a look at my bracelets!

MTF Now nice! They're the same.

My contribution to the discourse here was to introduce the words *extra/another one* thus introducing the idea of *more* [implied] in the sense of an exact quantity: *one* more. By following my suggestion, Mario managed to create a bracelet that fitted him. Following this, he made another bracelet of similar length. Although at this point it appeared that Mario's attention was on creating a similar-coloured bracelet, this episode formed a link to further interaction on the following days as will be explained.

During Sessions 6-8, Mario was taken alone and I interacted with him with the intention of directing his attention to aspects of quantity. I started off by asking Mario to make a bracelet again, with the excuse that the photo taken the previous day had not turned out well. Thus, I went along with the child's interests in order to address cardinality and introduce the notion of unit iteration.

Establishing cardinality. At several points in the three sessions, I asked Mario "*How many*"-type questions, for example: "*How many camels did you use to make it*?" Each time, Mario counted willingly, albeit not always applying accurately the one-to-one and stable-order principles (Gelman & Gallistel, 1986). Furthermore, he did not seem to know all numbers. A typical example of his counting beyond ten was: "… eleven, twelve, fourteen, sixteen, nineteen, twenty-two, twenty-three, twenty-four, twenty-one, twenty-two, twenty-zero, twenty!" *Twenty* was often the last number Mario stated, and a number he used when he wished to indicate a large quantity. Despite inaccuracies, it was clear that Mario was aware of the social purpose of counting to establish quantity ("I can count them very easy!" [sic]). Through my use of the expression *how many*, and Mario's socially appropriate response to it, the play discourse shifted to a mathematical one as indicated below:

- *Words*: How many? One, two … twenty etc., count.
- *Endorsed narrative*: the social activity to count to establish quantity
- *Routine*: the actual recitation of numbers by tagging items by pointing/touching (a routine still being developed by Mario)

As a result of these aspects now included in the interaction, the camels' meaning changed. Originally they had been interpreted as coloured components of a crown, necklace or decoration, and the action

carried out was connecting them mouth to tail. Hence, the items served as a pivot for the imaginative narrative. Then the camels came to serve as a visual mediator for quantification; the action carried out was tagging with the pointer finger and referring to quantity: "one, two, three…twenty". Here the items served as a pivot for mathematical abstraction. Hence, the play items served as 'dual pivots'.

Linking number with size (unit iteration). Following the incident when Mario asked me to help him connect his bracelet, the ensuing play in the following days offered an opportunity to link quantity with size. For example, the following excerpt is taken from Session 6.

(Mario has just made a small circuit of camels).

MTF So how many camels did you have to use to make it?

Mario (*Mario counts the camels touching one camel at a time*). "One, two, three, four, five, SIX".

MTF Six camels! I wonder if you can make it a bit bigger, to fit ME.

Mario Yes. (*Starts connecting camels*)

MTF What shall we do to make it a bit bigger?

Mario MORE camels. We can make different colours (*continues connecting*)…

MTF That's fine. Do you think that will fit me? How many camels did you have to use to make one for me?

Mario (*Counts, touching one camel at a time*). One, two, three, four, five, six, seven, EIGHT.

MTF Eight! Let's see! Does it fit me? (*Puts out her wrist*).

Mario *(He slides the bracelet over MTF's hand. The bracelet hangs loose over MTF's wrist).*

MTF Oh! (*They both laugh, then Mario takes off the bracelet*).

van Oers' (2010) states that if a spontaneous, action/utterance by a child is be taken as a cultural form [e.g. mathematics] by an adult, who reacts accordingly, then in time, through participation in such interactions, the child him/herself may acknowledge the [mathematical] meaning of the adult reaction, and finally, of his/her own actions as well. Indeed, over the three sessions in which I interacted with him, Mario himself began to relate quantity with size. For example, towards the end of the 7th session Mario was making a long circuit of camels on the carpet under the table and I was preparing short strings of camels to save Mario some time.

MTF I'll join them up and you can put them around the table...Oh! I don't know how many. How many shall I join up?

Mario Many.

MTF D' you know how many?

Mario Yes.

MTF Hmm… maybe five?

Mario No, twenty! (*By now Mario has a line of camels going around two legs of the play table*).

MTF Ah, twenty.

Mario Twenty's a LOT.

MTF Here. (*Hands Mario a string of camels – seven or eight, not clear from video*). Can you put those? Do you think we've got twenty up to now?

Mario No. It needs longer.

MTF OK.

Mario (*He has taken the new string of camels and goes to attach it to the developing line on the carpet*). Look, we have to make it a bit longer.

MTF I wonder if I need a hundred.

Mario Yes, we need big of hundred…up to orange.

MTF Oh how nice. (*Passes another string of camels*). Here you are, look, what a long one!

Mario (*Takes the string*). Now I'll make the red one up to… up to the orange. Almost there, Miss.

In terms of characteristics for mathematical discourse

- *Words*: make bigger, fit, more, twenty's a lot, needs longer, bit longer, big of hundred, up to, one, two …
- *Endorsed narrative*: quantifying length (unit iteration for measurement)
- *Routine*: recitation of number sequence

Once again the camels served as pivots twice over – firstly the line of camels was a decoration for the party, then they were counted and hence given a new, mathematical meaning. Furthermore, the similar toys attached in a line now served as visual mediators for the notion of unit iteration which, as stated by Clements and Stephan (2004) is a key idea of measuring length.

Conclusion

An informal pedagogy in Early Childhood settings presents a challenge with regard to how mathematics is actually learnt through play. In my study, I observed that children did not engage spontaneously in talk and action that might be described as 'mathematical', but it was evident that the 'responsive' adult can have a significant impact on shifting the discourse from a 'play' to a 'mathematical' discourse. The chain of signification occurring is shown in Figure 3.

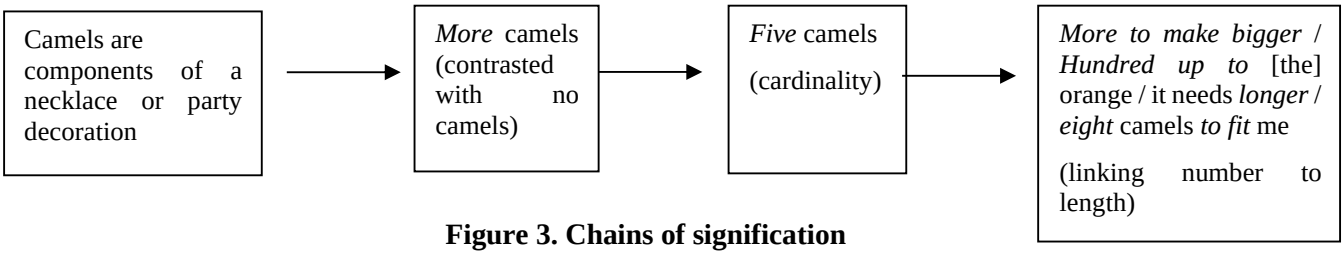

Figure 3. Chains of signification

Affording the play items a new interpretation implies that the items serve as dual pivots – first for imaginary play and then for mathematics. My key observation is that through the introduction of words, narrative and endorsed routines, the play items are rendered visual mediators for mathematics. Thus, I suggest that the shift in discourse to a mathematical one centres on establishing the play items as visual mediators, that is, on introducing children to the key mathematical aspect of representation.

References

Clements, D. H., & Stephan, M. (2004). Measurement in pre-K to grade 2 mathematics. In D.H. Clements & J. Sarama (Eds.), *Engaging young children in mathematics* (pp. 299–317). Mahwah, NJ: Lawrence Erlbaum Associates.

Farrugia, M. T. (in press). 'Mathematics through play': The influence of adult intervention on young children's shifts between play and mathematical discourses. In N. Planas, C. Morgan, & M. Schütte (Eds.), *Classroom research on mathematics and language*. London: Routledge.

Gelman, R., & Gallistel, C.R. (1986). *The child's understanding of number*. Cambridge, MA: Harvard University Press.

Hodge, R., & Kress, G. (1988). *Social semiotics*. Cambridge, UK: Polity Press.

Montague-Smith, A., Cotton, T., Hansen, A., & Price, A. J. (2018). *Mathematics in early years' education* (4th ed.). London, UK: Routledge.

Sfard, A. (2008). *Thinking as communicating: Human development, the growth of discourses, and mathematizing*. Cambridge, UK: Cambridge University Press.

Smith, S. S. (2013). *Early childhood mathematics* (5th ed.). Boston, MA: Pearson.

Stacey, S. (2009). *Emergent curriculum in early childhood settings: From theory to practice*. St. Paul, MN: Redleaf Press.

The Early Math Collaborative. (2014). *Big ideas of early mathematics*. Boston, MA: Pearson.

Van Oers, B. (2010). Emergent mathematical thinking in the context of play. *Educational Studies in Mathematics, 74*, 23–37.

Vygotsky, L.V. (1967). Play and its role in the mental development of the child. *Soviet Psychology*, *5*(3), 6–18.

Vygotsky, L.V. (1978). *Mind in society: The development of higher psychological processes* (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.). Cambridge, MA: Harvard University Press.

Wagner, D., & Andersson, A. (2018). Intersecting language repertoires when 4-year-olds count. In J. N. Moschkovich, D. Wagner, A. Bose, H. Rodrigues Mendes, & M. Schütte (Eds.), *Language and communication in mathematics education* (pp. 105–118). Cham, Switzerland: Springer.

Walkerdine, V. (1988). *The mastery of reason*. London, UK: Routledge.