Early Years Teachers' Perspectives on Teaching through Multiple Metaphors and Multimodality

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Recent research findings indicate that using multiple metaphors in multimodal learning experiences are effective teaching approaches in early years mathematics. Using a social semiotic lens this paper reports on eight early years teachers' perceptions of this approach whilst engaging in a small collaborative professional learning group. This group focussed on observing video footage of one teacher implementing multiple metaphors such as the number line and using multimodalities such as gesture, drawings and concrete materials in her classroom. Analysis of the data revealed variations in the teachers' perceptions of this particular teaching approach.

In 2013 the researcher and author of this paper conducted a small scale study to explore a West Australian teacher's use of multiple metaphors in an early years classroom. In that study, with careful scaffolding by the teacher and in paired learning experiences, the teacher facilitated the children to engage with multiple metaphors such as motion on a path (number line) and parts of a whole (ten frames) (Mildenhall, 2014). This study is a sequel to the 2013 research; it involved the researcher gathering perceptions of the 2013 research from the teacher researcher, 6 pre-primary teachers (teaching children aged 5-6) and 2 kindergarten teachers (teaching children aged 4-5), 2 numeracy coordinators and 1 primary principal, who comprised a collaborative research group. The researcher's purpose in this study was to explore how the members of the research group perceived this teaching approach and whether they thought it would be appropriate in their particular context.

Conceptual Framework

The researcher used social semiotic theory as a theoretical lens as this research is focussing on how teachers use these various multimodal representational forms, such as language, gesture, symbols and objects, as semiotic resources from which students could generate meaning (Lemke, 1990). Multimodality can be defined as the modes of learning that are intertwined across sensory modalities (O'Halleron, 2011). Although semiotics was traditionally associated with linguistics (Lemke, 1990), mathematics education has broadened its definition to encompass the complexity and inherent multimodality of the classrooms (Arzarello 2006; Lakoff & Núñez, 2000; O'Halloran, 2005; Radford, 2003). It is now becoming apparent that modalities such as bodily movement and gesture are integral parts of the learning process (Radford, 2003).

Multiple Metaphors

Recently the value of metaphor as an important mathematical learning tool has also been observed (Lakoff & Núñez, 2000). In order to understand what a metaphor is, it is useful to consider the following statement "these metaphors, which map inferential structure of a source domain on to a target domain, allow us to conceive abstract concepts in terms of more concrete concepts" (Núñez, Motz, & Teuscher, 2006, p. 133). Lakoff and Nunez (2000) claimed that there are four main metaphors used when teaching number and arithmetic which "allow us to ground our understanding of arithmetic in our prior

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understanding of extremely commonplace physical activities" p. 54. Young children need to be engaged in learning experiences that use metaphors such as the number line as this metaphor does not appear to be intuitive to children (Edmonds-Wathan, 2012).

Using multiple representations and metaphors has been suggested as an effective strategy by Griffin (2004). Griffin stated that by exposing children to multiple representations of a number in one activity children can gradually come to the ways that they are equivalent. Bills (2003) found that often children talked about mathematics using the metaphors they are familiar with and he asserted that children could be impeded if they have not been exposed to multiple metaphors. Ainsworth, Bibby and Wood (2009) do point out that as multi representational environments can be difficult for children and a single representation can result in more successful outcomes. They concede that this success is only possible "if the design of the represented world ensures that this one representation encapsulates all the necessary information" (2009, p. 59). As it is more likely that each mathematical metaphor would have limits and it logically leads to the perspective that there is value in providing students with multiple metaphors in order to develop their mathematics.

Purpose and Research Questions

As noted above the researcher's purpose in this study was to gather and analyse teachers' perceptions of the research (including trialling it in their own contexts) conducted by the researcher in 2013. The researcher approached several schools to recruit members for a small evaluation teacher professional learning community. These recorded perceptions would inform mathematics educators if it was possible to replicate the 2013 findings in a different context and inform the researchers' future research. The research question for this study was:

- What are the early years teachers' perceptions of a teaching approach that focuses on the pre-primary teachers using a multi- semiotic approach?

Methodology

A case study was selected as the methodological approach for this study because it was ideally suited for collecting multiple sources of data in a rich context (Yin, 2009). A case study is a bounded system (Yin, 2009) and the case was the professional learning community. In qualitative research it is important that participant voices are prominent (Hatch, 2002; Patton, 2002). As this study focussed on teacher perceptions it was important to design the study so that the teachers' voices were heard (Patton, 2002) but acknowledge that these voices were perceptions of the subject matter. The main method for the data collection was a focus group discussion (Kruger, 2009). This method is appropriate for providing insights into the matter under investigation: the teachers' perceptions of the multi-semiotic approach in regards to their own personal context (Rabiee, 2004). It is important to declare that the researcher had a bias in that she believed in the value of a multi-semiotic approach to teaching.

Research Participants

Purposeful sampling was used to recruit early years teachers (teaching children aged 4 to 6) from schools that were from a variety of socio-economic backgrounds. The invitations, using email, were to government and non-government schools. From the school teachers who replied, stating that they were interested, two were from independent

schools and one worked in a government school (the same school as the teacher/researcher). Two of the schools had previously worked with the researcher using multiple metaphors and multimodalities and one interested contact, who was the school numeracy coordinator, had no previous contact with the university.

These teachers then invited other early years teachers from their own schools and together they formed this community. At the first community meeting, members examined the findings from the previous research project "Semiotic resources in the kindergarten classroom" and particularly the highlights video package.

The highlights video package from the 2013 study showed a teacher in a low socioeconomic school using multiple metaphors where she focused on the use of the ten frame and the number line and discrete objects to teach effective counting, more or less than 5, and the addition of two single digit numbers. After this initial meeting the teachers implemented the use of the ten frame and number line in their own classrooms and reflected on this. The group then met regularly to share their reflections on their teaching.

Because the data gathering technique employed in this research study was dependent on a manageable group discussion, the ideal number of participants for the study was considered to be approximately 8-10 (Kruger, 2009). As it happened, the research group comprised of 11 participants, but during the four meetings there were some absences due to illness or other commitments so the attendance at the meetings ranged from 8 participants to 11.

Data Gathering Techniques

Data gathered in this study included: 1) teacher journals and work samples, 2) research field notes from regular meetings, including the research participants' own notes made whilst trialling the suggested approach, and 3) full transcripts from the audio recordings of the focus group meetings. The researcher was the facilitator of the research group and she explicitly assured participants that her aim in the research was to trial and develop this multiple metaphor and multimodal approach in different contexts, and therefore, everyone's opinion was to be respected.

Data Analysis

In line with the research question, the reflections of the participants were focussed on their perceptions of a multi-metaphor and multimodal teaching approach. Using NVivo10, the researcher entered all of the data into the software package. Although the study had a particular focus and was therefore somewhat deductive (Bitektine, 2008), at this stage a grounded theory approach was used to explore what the data revealed about teacher perceptions. The researcher conducted initial coding (Charmaz, 2014; Glaser, 1978), which involved reading the full transcripts from the focus group interviews, teacher journals and student work samples, and looking for the participants' viewpoints from a sentence, a paragraph or a picture (De Wever, Schellens, Valke, & Van Keer, 2006). In this way the researcher aimed to understand and represent the participants stand points.

After this was completed, the researcher commenced the second phase in the coding process: focussed coding (Charmaz, 2014). This involved recoding the initial codes to identify important themes pertaining to the teachers' perception of this particular approach to teaching early years mathematics and these are shown in the findings as focussed code/theme.

Findings and Discussion

The analysis and coding of the comments offered by each of the participants in the study revealed three major themes that were specifically focused on how the teachers perceived a multi-metaphoric and multi-semiotic approach.

Focused Code /Theme 1: Perception that Using a Multi-Metaphoric Approach was Valuable

Four of the teachers chose to incorporate multiple metaphors into their teaching. Three of those teachers, Polly, Diane and Brenda were able to explain how they had used all three metaphors of parts of a whole (the ten frame), points on a line (the number line) and the discrete objects in one activity (Figure 1). These teachers appeared to understand the importance of exploring the concepts deeply and perceived it to be a successful approach. They were able to identify that, just because children could articulate a mathematical idea using one metaphor, this didn't necessarily mean that they could articulate it in another. The fourth teacher, Toni, incorporated all three initially but this adoption slightly waned as time progressed (the reason for this will be discussed later). The four teachers also had mentoring support in the school, such as the teacher/researcher in the 2013, or a numeracy support teacher who had worked as a research assistant on the 2013 research and this appeared to support the implementation as Toni stated "When I watched the videos because we watched them with Natalie (the mentor) I got a bit excited because I thought I've been doing some of this" (Figure 1).

Two of the strong adopters of the multiple metaphors also began to consider how their teaching could be multi-modal using gestures. Donna stated she used "hands to show bigger than/ smaller than" (Figure 1).

Initial codes	Samples of quotes
Teachers found value in teaching across three metaphors	So we had the sock we had to count with and we used the ten frames and on the number line we used a frog. They had four different items in ice cream containers … and I showed them how to use the other hand to scoop into the cup …We used the ten frame … and they quite liked it. I would just say "so what is 7" and they would say back "it is five and two" and we used the number line.
Mentoring in school supported multi-metaphor approach	I did the same as Julie … I set it up very much the way Julie set it up That's alright I'm Toni, forgot my bits for this. When I watched the videos because we watched them with Natalie (the mentor) I got a bit excited because I thought I've been doing some of this
Children found it a challenge to transfer from one metaphor to another	It's funny the children that I thought had got it when they'd drawn these beautiful tens frames because they were getting it and then when I was talking about it on the number line they weren't getting it. So he scooped out approximately 12 counters. He then counted 1 to 1 correspondence up to 12 … then asked could he find that same number on a number line … So I had a number line, so he then pointed to the 1 and the 2 on the number line at the start so I praised him for finding the two numbers and then I said that was number 1 and 2 not number 12 which I'm sure was very confusing.
Metaphorical gestures were used in a multi-modal approach	Sweeping my finger along the ten frame to show direction I was more aware of the language I was using, how I used my body language and gestures to communicate Hands to show bigger than/ smaller than

Figure 1. Example of codes in focussed code/theme 1.

Theme 2: Factors that Impeded the Adoption of Using Multiple Metaphors in Early Years Teaching

Five of the teachers, Caris, Elle, Gemma, Lucy and Toni had some reservations about using multiple metaphors. Whereas all of the teachers perceived that the use of these tools separately had some value, and Toni was initially very enthusiastic about multiple metaphors, in their reflections four of the teachers (Caris, Elle, Lucy, and Toni) appeared to view that if children could solve the problem using one metaphor there was no reason to explore the same problem using a different metaphor (three of those teachers came from the school without the strong mentoring support). Interestingly, it did appear that in one class, even when the teacher (Lucy) focused on just using the ten frame, which "really came in handy as a different way of explaining the addition process "(Figure 2), some children chose to seek the number line out and use it as well as the ten frame suggested to them. The biggest factor that appeared to impede the adoption of this approach by three of the teachers was the use of a mathematics textbook scheme in their pre-primary classroom.

Lucy outlined that the textbook led the teachers' pedagogical approaches rather than allowing them to make independent pedagogical decisions (Figure 2). One of the teacher's planning documents indicated that their text book scheme did not incorporate any multi-semiotic approaches and it may have encouraged the pencil and paper activities to be done quite separately from other more concrete activities.

Codes	Samples of quotes
Focus on solving problems	The ten frame really came in handy as a different way of explaining the addition process. In terms of the number line I basically just used that more again as a tool to assist with reversals. So we did it on the number line and they ended up actually not using the number line and they were quite enamoured with using the lines to count.
Textbook approach followed	Yeah yep so some of them are reversing their numbers still and stuff but yeah I mean the tally bit is hard and we were talking about that because with our i maths program we don't really focus on that until term 3/4. I think that I think I mentioned before we do the iMaths program in pre-primary and in particular this term the ten frames have really assisted us because obviously like, you get the text book and we always go through the text book

Figure 2. Example of codes in focussed code/theme 2.

Theme 3: Using Multiple Metaphors to Develop an Awareness of Pattern and Structure of Computational Strategies

Using the resources of the ten frame, the number line and the discrete objects, some of the teachers commented that the children were able to reason mathematically and use the resources to match their thinking. Some students were at the foundational stage of the Australian Curriculum (Australian Curriculum Assessment and Reporting Authority, 2011) and were using counting discrete objects as their only strategy. As children developed, and began to identify the concept that the number could be partitioned, the teachers reported that the children began to use different computational strategies. Toni noticed that her children used "counting on" as the first strategy the children implemented (Figure 3) which corresponded with the literature (Sarama & Clements, 2004).

The pre-primary teachers who did not use this multiple metaphor perspective did not mention this type of interaction with their children. Their main focus was on the concept of "*altogether"* which was limiting children to only think of addition as "counting all". They used a textbook "iMaths" that was aligned to the Australian Curriculum and at the "Foundation" stage there is only a requirement to model addition, which the teachers had implemented. This suggests that following the Australian Curriculum too prescriptively may prevent the children's potential from being realised.

Codes	Samples of quotes
Learning to count effectively	Then they had a strategy if they don't know what it looks like, everybody knows what 1 looks like, so they start at 1 and then they count on and when they get to 8 oh that's what it looks like and then they record the number. Toni: And then what I did with a few kids was get them to put it on the number line 5 and then adding 4 I get this number here. Paula: Oh great yeah so you did actually count on on the number line. Toni: And they were doing the back to zero, and going 1,2,3,4,5;
Developed mental strategies such as counting on, doubles	We added them together - one used the counting on method the other used the number line We'd used this tens frame. I had to demonstrate that you fill the top in first and I said, because we've got two colours red and yellow, and I said you have to use the same colour at the top so I explained that first and it was funny how some children, especially with 6 they want to do 3 and 3 ah, number line and counting on and my way of being able to identify ... count on when she did the others she said I used the counting on strategy, tally marks, drawing a picture and then writing the number sentence
Partitioning	Understand that numbers are made up of 2 or more parts, reinforcing the concept of part, part , whole.

Figure 3. Example of codes in focussed code/theme 3.

Conclusions

It is not possible to generalise from this small scale study. In this study and particular context, three of the teachers were strong adopters of a multiple metaphor approach (using the ten frame and number line in the same learning experience) into their practice and these were the teachers who also had the mentoring support in their individual school. The teachers who only had access to the focus group sessions, without mentoring support in school, had the lowest level of adoption. The latter group of teachers also used a school textbook scheme and this, which did not include a multiple metaphor approach in its texts, appeared to impede the implementation of the approach.

The four teachers who were reluctant to use multiple metaphors did mention that once children could solve the mathematical problems using one metaphor i.e., the ten frame, they did not extend the learning experience by exploring the same mathematical concept using a different metaphor. This approach was the one recommended by the text book that they followed. In a climate where there is not one clear approach to teaching mathematics, it is understandable that teachers rely on published textbooks and their suggested approaches (Shoenfeld, 2004). Future research is now planned by the researcher to create a collaborative research study with a Year 2 teacher to explore how to implement this multiple metaphor and multi-modal approach with slightly older primary school children and this will be reported on at a later date.

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