

# FACILITATING MATHEMATICAL DISCUSSION THROUGH THE USE OF PICTURE BOOKS IN AN IRISH SENIOR INFANT CLASSROOM

Mary Kearney

St. John's N.S, Drogheda.

*This study explored how mathematical discussion could be facilitated through the use of picture books in a senior infant classroom. A qualitative inquiry was conducted over a three-and-a-half-week period in a large urban disadvantaged junior primary school in Ireland. Data comprised of observations of the children as they engaged in small groups during mathematics lessons. The data was collated by the methods of observations in situ, video recordings and extended fieldnotes. The findings of this research indicated that children's participation in a mathematical discussion can support the development and use of mathematical language and also support their mathematical literacy. Evidence revealed that mathematical discussion also supports children's mathematical thinking through the engagement in mathematical processes such as problem-solving, reasoning and connecting. The findings of this research have implications for early childhood mathematics policy and curriculum which advocate the need for increased opportunities for children to engage in mathematical discussion. One effective pedagogy to facilitate mathematical discussion is the use of picture books which support young children's overall mathematical proficiency.*

## INTRODUCTION

The fundamental aim of mathematics education for young children should be the provision of experiences and opportunities that cultivate their understanding of mathematics in such a way that they can use mathematics "in real-life situations as a meaningful tool to describe their quantitative world" (Hong, 1999, p. 162). According to the National Council for Curriculum and Assessment (NCCA) research report No. 17 on *Mathematics in Early Childhood and Primary Education (3-8 years)*, (Dunphy, Dooley & Shiel, 2014), mathematical proficiency must be considered central in early childhood mathematics.

## Mathematics Education in Ireland

Research indicates that more focus is needed on the development of mathematical language particularly in Irish classrooms (Shiel, Cregan, McGough & Archer, 2012). Following the evaluation of the execution of the *Primary School Curriculum* (GoI, 1999a), the Inspectorate discovered that 25% of teachers did not spend sufficient time on the development of mathematical language during mathematics lessons (DES, 2005a). Additionally, it was highlighted that in cases where teachers spent adequate time teaching mathematical language, the teachers "planned for the teaching of mathematical language, used appropriate terminology, provided opportunities for children to use mathematical language and referred to mathematical words and symbols" (p. 30). *Aistear* (NCCA, 2009) outlines in one of its main themes, *Exploring and Thinking*, that children form understanding of mathematics by interacting with others which enables them to explore, question and refine ideas. A significant factor to consider is that interactions need to be supported by teachers' engagement with children which "builds on children's abilities, interests, experiences, cultures, provides for

their needs and facilitates them to initiate activities” (NCCA, 2009, p. 27). This endeavours to contribute to children’s overall mathematical learning and development and improve their mathematical literacy.

### **Literature Review**

When children engage in a mathematical discussion or *math talk*, they are afforded the opportunity to talk about their mathematical thinking and communicate using mathematical language (Fuson, Kalchman & Bransford, 2005). They are supported in talking about their mathematical thinking which incorporates their formal and informal representations of mathematical ideas and symbols (Dunphy et al., 2014). Cheeseman (2015) noted that a mathematical discussion provides teachers with opportunities to understand children’s thinking but also provides occasions “to challenge children’s thinking to make meaning in the moment and to stimulate new learning right ‘on the edge’ of the child’s thinking” (p. 275). Therefore, during a mathematical discussion, mathematical language development and mathematical vocabulary acquisition can be facilitated because children may be required to express their mathematical thinking, which may enable them to apply problem solving and reasoning skills and so demonstrate their level of mathematical understanding (Anderson, Anderson & Shapiro, 2004).

Nic Mhuiri (2011) notes that the discourse of mathematics lessons which appears to engage children incorporates “patterns of dialogue that involve making conjectures, and examining and justifying one’s own mathematical thinking and the mathematical thinking of others” (p. 320). Nic Mhuiri observed that children were more interested in activities which involved participation in discussion as opposed to traditional mathematics lessons which involved repetition and lower-order questioning. Although young children often lack the essential mathematical language to communicate their understanding, the use of playful practices including a discussion centred on a picture book can enable them to experience correct use of mathematical language (Hong 1999).

During mathematical discussion children are provided with opportunities to talk about their mathematical thinking and ask questions which deepens their understanding and cultivates mathematical language (van den Heuvel-Panhuizen, Elia & Robitzsch, 2014). Evidently, mathematical language development is a vital component of children’s overall mathematical proficiency. At first children talk about their mathematical experiences using everyday informal language but gradually progress to using more mathematical language (Montague-Smith & Price, 2012).

*Mathematization* is a crucial factor in supporting children’s understanding of mathematical processes and content and developing their overall mathematical proficiency (NRC, 2009). Dunphy (2015) argues that in order to sufficiently accommodate for mathematization in early childhood mathematics there is a need for “the intervention of the teacher who not only recognises opportunities to encourage and support mathematization but who proactively seeks to engage children with mathematization processes” (p. 3). One effective means of facilitating mathematization is through mathematical discussion where children are challenged to

mathematize. Children engaged in mathematical discussion are “collaborating and building upon each other’s contributions” (Suggate, Davis & Goulding, 2010, p. 25).

Children’s literature, such as picture books, can act as a catalyst to support children’s ability to participate in mathematical discussion where they can interact, mathematize and make learning connections. From a socio-cultural perspective, children’s mathematical language and discussion is enriched when children share their individual connections to the story (Whitin, 1992).

## **METHOD**

### **Participants**

Some groups in society are “known to struggle with general language acquisition, including children living in disadvantaged circumstances, children who speak a language other than the language of instruction at home, and children who have a language impairment” (Dunphy et al., 2014, p. 65). This statement is a true depiction of my research setting which consists of children with a range of abilities that come from diverse backgrounds. The Delivering Equality of Opportunity in Schools (DEIS) action plan states that every child should be afforded the opportunity to access, share in and reap the benefits from education regardless of their circumstances (DES, 2005b). Hence, this study endeavoured to attend to the needs of 5-6 year old children in senior infants, the second year of their formal education, by providing them with a context that they can connect with, enabling them to build on their prior mathematical experiences through a mathematical discussion.

I participated in team-teaching with this class every day in my role as a learning support teacher. The class who were my sample consist of twenty children, twelve boys and eight girls who come from diverse backgrounds. Six children are non-Irish Nationals whose second language is English, two children are from the Travelling Community and one child has special educational needs.

### **Qualitative Research Methodology**

A qualitative research design was deemed most appropriate as this study proposed to gain an understanding of children’s overall mathematical proficiency during mathematical discussion based on picture books. Therefore, the investigative and descriptive characteristics of a qualitative study (Maykut & Morehouse, 1994) suited this particular research and facilitated the inquiry into how children participated in mathematical discussion using three picture books. As well as this, the research was conducted in the “natural setting” (Creswell, 2007, p. 37) of the children’s own classroom which involved gathering multiple sources of data and subsequent inductive data analysis (Creswell, 2007).

In conducting this qualitative inquiry, triangulation of data collection was used to check whether the responses from each method were consistent and to ensure the credibility and validity of the data (Cohen, Manion & Morrison, 2011). Within the interpretivist paradigm the methods of data collection that were used were observations on situ, video recordings and extended fieldnotes based on the video recordings. They were selected in order to facilitate the investigation of children’s understandings through an interactive process. Through

continuous analysis of the data the following recurring themes emerged: mathematical language, mathematical processes and mathematical content.

## FINDINGS AND DISCUSSION

### Mathematical Language

The picture books presented extensive opportunities to model correct use of mathematical language through a meaningful context. The following extract from a discussion on *Oliver's Milkshake* (French, 2000) supports this claim. We discussed an image where Lily and Oliver were peering over the half-door at the goats with Auntie Jen. The children engaged in a discussion about their height and Deon used the comparative language “bigger” (Transcript, Thursday 2<sup>nd</sup> February 2016) on one occasion during the interaction. The content area of measures was being developed here. There is also evidence of teacher modelling where both comparative and superlative mathematical language was used.

- MK: Have a look... what are Lily and Oliver doing, Jill?
- Jill: Points at Lily and Oliver
- MK: Ok...they are looking at the goats. They have to go up on their tippees I'd say.
- Derek: Or maybe...or maybe Oliver is a bit bigger?
- MK: Maybe Oliver is just a little bit taller. I think you are right. I can see more of Oliver's head than Lily's head so I think Oliver is taller. Do you think Oliver is taller Deon?
- Dn: Yes
- MK: Who is the tallest out of everyone?
- Deon: Points to Auntie Jen
- MK: Auntie...
- Deon: Jen
- MK: Auntie Jen is the tallest. Who is the smallest Jill?
- Jill: Points to Lily
- MK: Lily is the smallest and they are peeping over the door to see the goats.

It is clear from the above extract that the children did not have the appropriate mathematical language to engage in the discussion. The children showed their understanding of measurement in relation to height by pointing to the images and were supported by teacher modelling the correct use of mathematical language.

### Mathematical Processes

It was found that the picture books contained ample opportunities to enhance children's engagement in mathematical processes such as reasoning. The following extract from video footage of a discussion on *The Runaway Dinner* (Ahlberg, 2006) illustrates this. They were

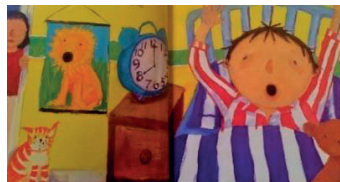
presented with the problem that there were not enough chairs for all of the chips. Some of the chips were sitting on chairs but others were standing up.

- MK: Were there enough chairs for all the chips?  
May: No  
MK: How many more chairs would we need for those chips Matt?  
Matt: 2  
MK: 2 more chairs  
Evelyn: No 4!  
MK: 4 more chairs?  
Evelyn: For those 2 there (pointed to two more chips in the boat on the other page). They are going to sail back and stop.  
MK: Oh yes! Because there are 2 here and 2 there and that makes 4. Well done.  
Evelyn: And they are sailing back to the path

The use of comparative language can be seen in the above extract as well as evidence of the counting principle of one-to-one correspondence where the children had to determine how many more chairs were needed so that each chip would have one. Evelyn noticed that there were two more chips in the picture and justified why she thought four more chairs were needed. The language of addition was modelled to illustrate that two and two makes four. During this discussion the children co-constructed knowledge when Evelyn extended Matt's response to determine that four more chairs were needed (Suggate et al., 2010).

### Mathematical Content

Over the course of the research the children began to make connections between the content that they had discussed in the different picture books and this supported their understanding of algebra. *Oliver's Milkshake* (French, 2000) contained ample opportunities to develop the concept of recognising patterns. When the children looked at the image of Oliver's bedroom, they noticed many different patterns (Figure 1.). Savine (5 years 8 months) noticed a red and white pattern "On his pyjamas", Hayden (6 years 5 months) commented that the pattern on the duvet was "Indigo, white, indigo, white" and Matt (5 years 8 months) observed that the pattern on the cat was "White, orange, white, orange" (Transcript, Friday 5th February 2016).



*Figure 1. An image of the patterns in Oliver's bedroom from the story Oliver's Milkshake (French, 2000)*

The picture books presented abundant opportunities to explore number and supported the children in making estimations. The following extract displays how they engaged in a discussion about the relationship between the number of fruits in the basket and the number of

people. They discussed whether there would be enough fruit for the fifteen people in the picture (Figure 2.).

- MK: Could you guess how many tangerines are in that basket Polly?
- Polly: A million!
- MK: You think a million!
- Hayden: I think a million hundred
- MK: Do you remember we were estimating during the week? ...we were making guesses. I'm just looking at that and I think there could be about 150..?
- Evan: I think there's 100
- MK: ...how many do you think Victor?
- Victor: I think 145
- MK: Well done...Hayden do you think there are enough tangerines in the basket for everyone to get one?
- Hayden: yes
- MK: ...now we have 15 people
- Evan: But there's more tangerines
- MK: So do you think some people might get 2 tangerines
- Hayden: No a lot of them
- MK: Some people could even get 3 tangerines
- Polly: or 4?
- Hayden: or 6!

This extract showed that the children had an awareness of large numbers when they commented on the basket over-flowing with tangerines. During this discussion they engaged in approximation and estimation of number. I suggested that each person could get two or three tangerines each but Evan (6 years 3 months) and Hayden (6 years 5 months) disagreed and used comparative language when justifying how many tangerines each person could get. Polly (5 years 11 months) suggested that each person could get four tangerines each which demonstrated her understanding of the stable-order principle of counting. This example shows the range of mathematical processes and mathematical concepts that can be developed when children engage in a discussion about an image that is meaningful to them.



**Figure 2.** Handa's basket full of tangerines at the end of the story *Handa's Surprise*, (Browne, 1995)

## CONCLUSION

The findings of this research indicate the use of picture books is an effective approach to support mathematical discussion and to support children's overall mathematical proficiency in a senior infant classroom. This study also revealed that mathematical discussion supports children's engagement in mathematization and in key mathematical processes such as problem-solving, reasoning, connecting and communicating. Moreover, a range of mathematical content areas such as number, measures and algebra were addressed and it was observed that the children made links between content areas. Within these content areas mathematical concepts were addressed.

## Implications for Policy and Curriculum

While the *Primary School Curriculum* (GoI, 1999a) alludes to the importance of mathematical language and the development of mathematical concepts, it does not place the same emphasis on the importance of developing mathematical processes through mathematical discussion. Furthermore, mathematical discussion is not a prominent feature of the *Primary School Curriculum: Teacher Guidelines* (GoI, 1999b) as it does not elaborate on how mathematical discussion can be developed nor does it recommend various pedagogical approaches. This research has depicted one effective pedagogical means of facilitating mathematical discussion. As previously noted, *Aistear* (NCCA, 2009) recommends that teachers and children engage in interactions to develop language which includes mathematical language. This guidance can be adhered to through the use of picture books.

To conclude, the findings clearly establish the fundamental role that mathematical discussion plays in supporting young children's mathematical proficiency. This study highlights the effectiveness of facilitating mathematical discussion in a senior infant classroom through the use of picture books which provides opportunities to develop mathematical language, engage in mathematical processes and support mathematical thinking.

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