Primary mathematics talk: The art of engaging in mathematical discussions

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A core component of mathematical knowledge acquisition is linked to the use of mathematical talk and language (Goos, 2004). The purpose of this observational study is to describe the type of talk (Mercer, 2004) that children use to solve, reason and explain mathematical ideas whilst using manipulatives in mathematics. The setting is an inner city 2 form entry primary school with students engaged in their normal classroom behaviour. Two types of qualitative data are collected for this study: video recording of the mathematics activity within the classroom and audio recordings of the follow up semi-structured stimulated-recall interviews. Disputational, cumulative and exploratory talk types are present to varying amounts when students used manipulatives. This study demonstrates that schools and teachers need to consistently create opportunities for students to demonstrate and explain their thinking and that scaffolding is required to ensure that mathematical reasoning occurs (Mason, 2000).

Disputational, cumulative and exploratory talk; manipulatives, mathematical reasoning.

The aim of this study was to discover how mathematical language is used by students in mixed attainment groups when solving mathematical problems. The importance of the use of mathematical language is underscored by the National Curriculum (2013) in the United Kingdom (UK) for mathematics, which states that schools have a responsibility to ensure that students are able to reason mathematically; solve problems by applying their mathematics to a variety of routine and non-routine problems; and become fluent in the fundamentals of mathematics (DfE, 2013). In 1987, von Glasersfeld suggested that a core component of mathematical knowledge acquisition was linked to the use of mathematical talk and language. Similarly, Rawding and Wills (2012) proposed that when the explanation and use of mathematical language for reasoning purposes was commonplace within students' mathematics lessons, they would become fluent in using the correct mathematical language, including being able to evaluate mathematical concepts (Askew, 2012; Mason et al, 1982; Mason, 2000).

In 1992, Yackel, Cobb and Wood conducted a study investigating solving non-routine mathematical problems. They concluded that when working within groups, students were able to construct their own knowledge through talking about the solutions. Therefore, group work is seen as a viable pedagogical strategy through which students could demonstrate the mastery of mathematics concepts (Askew, 2012; Cobb et al., 1992; Mason, 2000). However, Blatchford, Baines, Rubie-Davies, Bassett, P., & Chowne (2002) suggest that the pedagogic benefits of group work are rarely exploited by teachers as they seldom plan for effective student-student interactions.

In 1980, Galton, Simon and Croll investigated the use of group work in primary schools and revealed that despite being placed in groups, students rarely worked together. Repeated two decades later, Galton, Hargreaves, & Comber, (1999) discovered that while students were still unaware of how to work together in groups, they more readily shared task information and outcomes. Moreover, Galton et al (1999) argued that little evidence was available to demonstrate how the students shared ideas within the groups or what they were talking about (Galton et al, 1999; Blatchford et al, 2002). As an experienced primary school teacher, I often wondered what discussions took place, what the groups' interactions were and whether any of this was focussed on the task at hand.

Talk and Mathematics Pedagogy

Research into the use of language and talk in mathematics classrooms is not a new concept, developing since the 1980s (Hoyles and Forman, 1991; Whitenack & Yackel, 2002). Work conducted by Rojas-Drummond and Zapata in 2004, revealed that the use of subject specific language supported primary aged students to demonstrate and explain their thinking and facilitated their reasoning skills (Mason, 2000; Mercer, 2004; Rojas-Drummond and Mercer, 2003).

In 2007, the Department for Children, Schools and Families (DCSF) described students who were not making expected progress from Key Stage 1 (5-7 year olds) to the end of Key Stage 2 (8-11 year olds) as 'passive' learners (DCSF, 2007). The potential inference being that those not making the expected progress were students not regularly participating in lessons, were reluctant learners in activities or had difficulty in explaining mathematical ideas (DCSF, 2007). Similarly, in the Ofsted 2008 report, it was suggested that students not making expected levels of progress, were students in learning situations that did not emphasise talking within lessons. Furthermore, Ofsted (2008) suggested that when students were not expected to explain their mathematical reasoning, they:

"were generally not confident when faced with unusual or new problems and struggled to express their reasoning" (p.6).

In 1995, Mercer analysed over 50 hours of primary classroom talk across all subjects and was able to identify three types of talk: disputational, cumulative and exploratory talk (Mercer 1995, 2000). Mercer (1995) developed a classification system for the different types of talk, defining them as follows:

> Disputational talk
> '…is characterised by disagreement and individualised decision-making. There are few attempts to pool resources or to offer constructive criticism of suggestions.' (Mercer 1995, p104)
>
> Cumulative talk
> 'speakers build positively but uncritically on what the other has said. Partners use talk to construct 'common knowledge' by accumulation. Cumulative discourse is characterised by repetitions, confirmations and elaborations.' (Mercer 1995, p104)
>
> Exploratory talk
> 'Exploratory talk is characterised by co-construction of understanding through critical but constructive engagement of learners in each other's ideas and reasoning is apparent in the talk'. (Mercer 1995, p104)

Talk and Manipulatives

MacLellan (1997) suggested that the effective use of manipulatives could enable students to develop a mental image of the mathematics. Through the development of a mental image, the students would then be in a position to engage with and talk about mathematical concepts and ideas (Askew, 2012; Mason et al, 1982; Mason, 2000). However, Anglihileri (2000) cautions against the over use of manipulatives and highlights the risk of children becoming too dependent on the use of concrete objects. Along similar lines, Brown, McNeil & Glenberg, (2009) raises questions about the effectiveness of the types of manipulatives used in mathematics, and questions whether the use of certain types of manipulatives hinder learning. Additionally, she questions if the use of certain manipulatives in mathematics could be distracting for students. Therefore, if group work in mathematics lessons are used as a teaching strategy, and manipulatives represent mathematical ideas, it becomes imperative to understand the language students' use within their groups during mathematics lessons to develop mathematical reasoning skills (DfE, 2013).

Research aim, question and objective

The purpose of this observational study was to describe the type of talk that children use to solve, reason and explain mathematical ideas whilst using manipulatives in mathematics. The aim was to to identify the types of talk students use whilst using manipulatives in a mathematics lessons. This observational research study design involving students engaged in their normal classroom behaviour and subsequently questioned about it on the same day, when reviewing the video recording of the session.

The study took place within an inner city two form entry primary school that I work in. The majority of the students are from minority ethnic groups and speak English as an additional language. The proportion of students on the special needs register is above national average.

Two types of qualitative data were collected for this study, namely: video recording of the mathematics activity within the classroom and audio recordings of the follow up semi-structured stimulated-recall interviews with students. All lessons and interviews that were video recorded were transcribed verbatim. The research was carried out over three phases.

A sociocultural discourse analysis, as described by Mercer (2000), has foundations in language research. Through using social discourse analysis, I would also be in a position to evaluate the development of mathematical reasoning (Askew, 2012, Mason et al, 1982; Mason, 2000) as well as the mathematical outcomes (Moyer, 2001). Through the iterative process of reading the transcripts repeatedly, I found that the manual coding process facilitated me in developing my analytical thinking skills as I became engrossed with the narratives of the episodes (Saldaña, 2015).

Results and discussion of analysis

The aim of the study was to explore the types of talk students engage in within a mathematics lesson. The students explored what the Cuisenaire rods could do mathematically, and applied their previous knowledge of equivalent fractions. To triangulate the data source, I used the semi-structured interview and asked the group why and how they approach the mathematical tasks. The use of video recording and stimulated-recall interview also facilitated the group to reflect on the learning. Only after reviewing the video recording, did they recognise how the types of talk - exploratory, disputational and cumulative – aided them to engage in and make sense of the mathematical ideas (Askew, 2012; Mason et al, 1982; Mason, 2000). Also, the students also recognised how the manipulatives hindered their learning (Brown et al, 2009), identify what mathematical knowledge they used and what learning behaviours (Blatchford et al, 2002; Hunter, 2006, 2007, 2008) they could use in the future. The analysis highlighted that effective group work would occasionally need scaffolding (Hunter and Anthony, 2011).

Disputational, cumulative and exploratory talk types were present to varying amounts when students used manipulatives. However, these talk types were not overtly evident throughout the sessions. Various components of the lesson, as identified through reflection and a deeper exploration of the lesson using semi structured interviews, contributed to this. The choices of manipulatives used within lessons, the tasks the students were set, and the makeup and behaviour of the participants within the group were components identified. Despite the presence of these types of talks, the study highlighted areas that impact teaching and learning.

The manner in which the students approached using the manipulatives to explain their ideas were hindered because they did not understand the limitations of the manipulatives (Brown et al, 2009). This barrier could see students potentially struggling to make sense of the mathematical ideas (Ernest, 1991; von Glasersfeld, 1984). Therefore, research is potentially required to ascertain which manipulatives support the development of reasoning skills in mathematics (Mason et al, 1982; Mason, 2000).

Blatchford et al (2002) suggests that the pedagogic benefits of group work are rarely exploited by teachers as they seldom plan for effective student-student interactions. This study demonstrates that schools and teachers need to consistently create opportunities for students to demonstrate and explain their thinking and that scaffolding is required to ensure that mathematical reasoning occurs (Mason et al, 1982; Mason, 2000; Mercer, 2004). It also highlights the need to ascertain which types of tasks develop disputational, cumulative and exploratory talk.

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