Mathematical Talk

The importance of communication in mathematics learning

Mathematical language is important in learning and communicating mathematics. In the preschool years, mathematical language has been identified as a strong predictor of future mathematical outcomes (Purpura & Reid 2016). When we consider children's mathematical language, it includes, but is not restricted to, vocabulary (using maths words). It involves all ways of communicating verbally about mathematical ideas, where discussion and interaction are key. There has been a growing amount of research in recent years that has investigated the link between children's mathematical skills and the amount of mathematical talk that they hear from a young age. This includes mathematical language that children hear in the home environment and in educational settings; both with adults and with peers. Purpura, Napoli & King (2019) helpfully separate mathematical talk into *quantitative* language, (e.g. more, fewer, many) and spatial language (e.g. near, above), stating that mathematical talk is far more than simply *number talk* (e.g. relating to counting and cardinality). Having a poor grasp of mathematical language, particularly the language of comparison, will impact on children's early maths skills. For a more detailed breakdown of different numerical skills and the role of mathematical language in their development, see Byrd Hornburg, Schmitt and Purpura (2018). Children bring differing experiences of mathematical language from their homes so the mathematics environment in the home shapes the understanding of mathematical language that children bring to their early childhood education setting.

The Home Maths Environment

Differences in home mathematics environments have been identified in terms of amounts of maths talk in different families, what adults talk about, how they discuss maths with children - both in terms of gender and in terms of other variables such as parenting styles. Differences in the amounts of mathematical talk have been found between families of different socio-economic status (SES) backgrounds (Daubert, Ramani, Rowe, Eason and Leach, 2018) where low SES families were found to use less mathematical talk. When thinking about numeracy, spatial and pattern activities, Zippert, and Rittle Johnson (2018) found that families tend to support children's numeracy more than the other two aspects of mathematical development. It is therefore important for practitioners in early childhood education settings to use maths talk in all areas of mathematics and not just focus on number talk.

Research in the USA by Chang, Sandhofer and Brown (2011) found that mothers tended to use more number terms when interacting with boys compared to interactions with girls. Their study found that with boys, mothers would be more inclined to use cardinal numbers to determine amounts, as opposed to their interactions with girls. Gender differences were also examined by Thippana, Elliott, Gehman, Libertus and Libertus (2020) who found that specifically in activities that were not 'maths related', families were significantly more likely to use mathematical talk with boys than with girls. It is therefore important for practitioners to use and encourage all children to use maths talk, including girls who may have experienced less maths talk at home.

Different parenting styles in combination with mathematical talk are seen to impact on children's mathematical outcomes and the development of executive functioning skills. Clements, LeMahieu, Nelson. Eason and Dearing (2021) identified 'management language' as an important variable. In families where adults use what they termed as 'autonomy supportive language' (i.e. where children are encouraged by the adult to make choices in their play), then this resulted in an increased amount of mathematical talk by the adult. In contrast, more 'directive management language' where adults were more in control of the decision making in the play resulted in less mathematical talk by the adults. It can therefore be helpful for practitioners to encourage families to use maths talk when playing with children who are following their own ideas, helping them to avoid controlling or instructing which may reduce the impact of the maths talk that they engage in.

Supporting families

Differences between children's mathematical understanding are already established by the time they arrive in a preschool or reception class. For example, Levine et al. (2010) claim that the amount of parent number talk between 14 and 30 months predicts children's understanding of number at 46 months. However, the amount of mathematical talk that occurs in the classroom can make a difference regardless of starting points (Klibanoff et al., 2006) and an increase in the amount of mathematical talk in the home can also have a significant impact.

It is worth highlighting to families the things that they are doing well. Fisher (2016) discusses parental intuition in supporting children's development by adjusting their responses according to what they know about their child's current understanding. Some research indicates that mathematical talk aimed just a little beyond children's current understanding can be a very successful strategy (Gibson, Gunderson and Levine, 2020; Elliott, Braham and Libertus, 2017). This is in line with Vygotsky's concept of the Zone of Proximal Development

(1978). Families can also be encouraged to use more questions and choices in their interactions with children rather than more directive methods of communication (Clements et al, 2021) to support executive thinking skills such as self-regulation and problem solving.

When supporting families to increase the amount and quality of mathematical talk in the home, it is important to support understanding of what that talk might entail, e.g. using the vocabulary identified by Purpura et al. (2019) in terms of quantitative and spatial language. Low SES families have been found to use less mathematical talk in activities that are not obviously mathematical (Daubert et al., 2018). Therefore, ideas for activities that might encourage the use of mathematical language can be shared with families, remembering to include activities that support spatial and pattern language as well as numeracy. Families can be supported to understand how mathematical language can be incorporated into non-maths domestic activities such as mealtimes, cooking, shopping and tidying and in activities such as sharing books. It would also be beneficial to discuss the importance of mathematical talk with younger siblings and with all children, regardless of gender.

Mathematical talk in educational settings

Just as mathematics talk at home varies between families, maths talk in educational settings varies considerably depending on the confidence of the practitioners. In a study by Klibanoff et al. (2006) it was found that the variability in the amount of mathematical talk in the classroom by different teachers was significant – between 1 and 104 incidences per hour. If these differences are typical, then the difference over an entire year might be vast. It is interesting to note that no matter what children's starting points were, where teachers used a lot of mathematical talk, their students benefited equally. When children are engaged with continuous provision, without an adult present, maths exploration with peers tends to be more non-verbal. However, where there is more cooperative play, children can be found to engage in more complex mathematical conversations and thinking (Zippert, Eason, Marshall & Ramani, 2019). This has implications for how children might be grouped in play, how children are supported to develop peer relationships and also for how children who play on their own might be supported by adults.

To summarise, mathematical talk is vital for future learning and it is much more than using maths words. Many parents use mathematical talk with children from birth, having meaningful interactions and talking about mathematics around them everyday. In education, we can take account of mathematical talk in the home to ensure that all children are provided with the conditions to support their future success.

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