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The impact of pupil voice and the social nature of learning on mathematical thinking and problem solving: Stories from a Year 5 Primary classroom

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This article articulates the challenges faced when considering the pedagogical potential of turning mathematical thinking into a co-dependent cognitive practice within a primary classroom. It studies the importance of oracy in supporting every pupil's ability to think and reason mathematically.

Teaching mastery

The Teaching for Mastery Five Big Ideas (Figure 1) encompasses maths pedagogy in the U.K (Boylan, et al., 2019). It is heralded as an approach that promotes skills within the cognitive domain including responsibility, perseverance, grit, self-regulation and co-dependent cognitive thinking (NCETM, 2016). The aim is to equip pupils with mathematical skills, which ensure they have the confidence, meta-cognition and competencies required to succeed and solve problems (DfE, 2014).

Mathematical thinking

This article focuses on the potential of one of the Five Big Ideas: Mathematical Thinking. It demands the deepest levels of thinking and links directly to the National Curriculum aims of reasoning and problem solving. This has perpetuated some misconceptions in its application. It can be easy to misunderstand or underestimate the application of mathematical thinking and reasoning as only relevant to the context of developing pupil's mathematical explanations (Hunter, 2017). Often this can translate in practice into something formulated in isolation, depicted simply by recorded words or images. However, Hasanah, et al., (2019) challenge this notion. They describe good practice as encompassing co-dependent cognitive experiences that are developed through rich opportunities to collaborate, converse and critically evaluate the complexities of the problem-solving process, in partnership with peers. It is therefore important to give pupils both the time and space to think creatively together.

Link to Theory

Vygotsky's (1978) theory on the social nature of learning is at the heart of understanding how to unlock the potential of pupil voice within the mechanisms of mathematical thinking. First and foremost, is the belief that learning is a social experience. Herein lies the importance in why engagement

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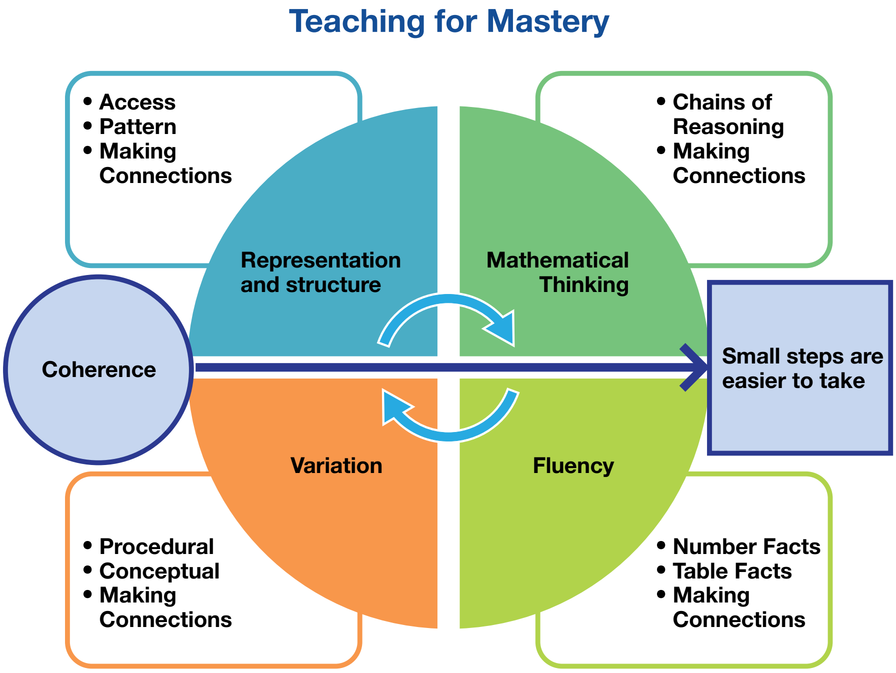

in collaborative interaction (most importantly our pupil's dialogues) facilitates this shift away from the traditional perception that problem solving is a personal experience, and pupil's mathematical thinking is received passively through teacher instruction.

Pupil Voice and mathematical thinking

The shift towards using pupil voice as a vehicle for collaboration within mathematical thinking is not without contention. Hunter (2017) argues that it requires creating a safe space in the classroom, for pupils to express their thinking, irrespective of whether their 'thinking' be the solution, or in the direction of it. However, when successful, it transforms pupils into both active and critical contributors within our classroom communities. In the context of mathematical thinking, and in particular problem solving, Vygotsky's theory affirms a direct link between the potential of a pupil's success founded on whether they have worked in collaboration with peers (Smagorinsky, 2007). Purposeful planning for good collaborative thus creates space for pupils to talk, share ideas and listen to each other's views, prompting reflection and listening to others (Hunter, 2017).

However, difficulties arise in the form of the misconception that mathematics and mathematical reasoning are two separate entities (Hasanah, *et al.,* 2019). One possible consequence for this is evidenced in research by McCray, *et al.,* (2019), who report on the problematic concept of pupil voice and mathematical talk being at the heart of the earliest disparities which are unearthed and witnessed when observing pupils. Their findings depicted that, when pupils in the Early Years Foundation stage problem-solve mathematically using materials, or manipulatives, the ability gap remains narrow and barely noticeable. However, once mathematical thinking is begun to be evoked and applied in practice, with pupils beginning to voice their reasoning, the difference in ability becomes significantly more apparent. This perpetuates the beginning of a misconception that mathematical reasoning is for the gifted pupil, segregating this fundamental component – namely, mathematical thinking – from the teaching and learning of mathematics. It creates a culture that pupil voice in mathematical thinking is a platform, left only for those who have the right answers and can provide eloquent explanations, or even worse, for those who can provide coherent written responses. This belief that mathematical reasoning is for those who can do maths defies the philosophy from the NCETM (2016) and all the mastery approach stands for; the belief that everyone is a mathematician.

Evidence in Action- stories from a Year 5 primary classroom

Mathematical thinking, in our opinion, is the cornerstone of the teaching for mastery pedagogy; without it everything else wanes. Following a term of remote education due to the pandemic, for a third of their academic year many pupils had worked independently and in isolation. As a consequence of asynchronous maths lessons, their voices had been mostly silent, and the impact of this resonated within maths lessons upon our return to the classroom in March. Re-establishing a culture of social collaborative learning with pupil voice being at the heart of mathematical thinking and

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reasoning proved more difficult than expected. However, as this study later evidences, a pursuit worthwhile.

Research approach

Due to the nature of the relationship with the pupils, a participatory action research methodology was adopted to interrogate the current classroom culture in terms of how mathematical thinking was evoked. Cook (2018) advocates this methodology, as it challenges and changes practice. The role of teacher thus becomes crucial in facilitating learning.

Findings and Analysis

Initial observations demonstrated how pupils were in the habit of writing their reasoning down, and problem solving mostly independently. In line with the research from MCCray, et al., (2019), there was evidence in how this had caused disparities for pupils in terms of how their literate ability was impacting expression of their mathematical thinking. Observations highlighted how, at worst, some pupils were unable to evidence it at all. In the initial phases, some pupils spoke about their difficulties in knowing how to 'record' their mathematical thinking. Acting upon this initial finding, it was decided to establish deliberate opportunities to encourage pupils to both share and discuss new mathematical experiences together, bringing in the use of social learning and insisting pupils 'think aloud' through their problem-solving experiences together. Pupils enjoyed voicing their mathematical thinking together. From the analysis, two emerging themes were noticed: a) enjoyment within teamwork and b) making mathematical cognitive connections. Quotations from pupil's and examples from practice have been chosen to illustrate these themes.

A) Teamwork

Pupils spoke fondly about working together to solve mathematical problems. The quotations below illustrate this:

'I enjoy working in a group. It makes it easier to try new things out and we can talk through the problems together.'

'Sometimes my friends give me ideas I might not have thought about. We all have ideas and I don't worry about making mistakes anymore because we are learning together.'

These extracts provide good examples that show learning is a social experience and, that through encouraging pupils to voice their ideas in a collaborative environment, they felt better equipped to think mathematically to solve problems.

B) Making connections

Secondly, evidence suggested that when pupils voiced their mathematical thinking in a social construct of learning, they unlocked the ability to make connections to each other's ideas. When pupils talked through their sequence of problem solving, it became evident as to how they had connected ideas to that of their peers; evidencing the shared cognitive experiences they were encountering.

This short extract below depicts an example where pupils built upon each other's mathematical thinking. Follow up discussions with pupils highlighted how they had collectively discussed the problems and made connections to each other's thinking to arrive at a solution. The journey of these mathematical connections as illustrated in figure 2 is described below:

Figure 2: The pupils were using 10 counters trying to make a shape with 5 lines

'When we made the first shape, which had 5 rows, the number of counters was too many'

'Next, we wondered what would happen if we tried a 5-sided shape, like a pentagon, however we were still using too many counters'

'I suggested we try crossing over the lines and this made me think about a star. We tried this out and realised we were right!'

Here, the connections the children were making to each other's thinking built coherence into this particular problem-solving experience. This short extract demonstrated the journey the pupils went on in building upon their peers' mathematical thinking collectively to solve the problem.

Discussion

We discovered the reality that, when pupil talk is a well-rehearsed and habitual component of mathematical thinking and reasoning, they develop a method of connecting, building upon, exploring and deepening each other's ideas. This process is underpinned by a positive and social learning experience. From this small-scale research into what has been witnessed inside this Year 5 classroom, it is evident that a profound and positive problem-solving experience was created for all.

This article is here to celebrate the power of oracy and social learning as part of mathematical thinking, not to absolve other means of recording or experiencing it. However, the impact is very clear. Once pupils have had opportunity to collaborate, converse and critically evaluate the complexities of the problem-solving process, in partnership with peers, they begin to takeaway these experiences and apply them to new contexts. This was particularly prevalent in how all pupils began to speak mathematically, using key terminologies correctly and reasoning - verbally - in full mathematical stem sentences. Eventually, this translated into their written evidence, when pupils began to deploy, flexibly, familiar pictorial representations (even creating their own), with all children finding ways to share their thinking. It empowered the notion of inclusive mastery practices, enabling all pupils to succeed, triumphing together.

Implications

Our conclusion is simple; invest time to create space for pupil voice as part of your mathematical thinking practices. Avoid saving reasoning and problem-solving experiences as part of a differentiated process and thus the right of passage for only the most able. Remember and celebrate the ambition of the teaching for mastery pedagogy; the belief that every pupil can and will succeed in mathematics (Boylan, et al., 2019). It is time to fully consider the theory posed as part of the social nature of learning and not be deterred by a journey of getting this right in practice for your pupils; it is a worthwhile pursuit.

Pen Portrait

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Feedback

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