Talking about dialogue

Using talk cue cards to scaffold all children's talk in the primary mathematics classroom

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Abstract

Dialogue and reasoning are central to mathematics. Despite a substantial body of research illustrating the benefit of talk in the classroom, an educational debate remains in schools about how much time and empowerment should be given to children to talk in lessons. For many teachers, particularly post-pandemic, there is a professional concern about the quality of children's communication skills. An example of this is that many children appear to have difficulty in engaging in productive mathematical dialogue, and struggle to articulate their reasoning strategies. This paper explores children's class-based experiences of using talk cue cards as resources intended to support dialogue and hence mathematical reasoning. A case study approach was used to explore the experiences of key stage 2 children. The study showed that talk cue cards could break down some barriers to effective communication and so enhance children's quality of mathematical reasoning, whilst supporting engagement in meta-talk about reasoning. Potential implications for educators are explored in terms of both classroom and mathematical practices such as: co-constructing agreed hallmarks of high-quality talk; teacher and peer modelling; and allotting time for the exploration of the talk cue cards.

Keywords: primary mathematics; children's mathematical experiences; maths reasoning; talk; talk cue cards; stem sentences; sentence frames

Introduction

> 'Um'. 'I know that I got the answer but I am not sure *how* to explain it'.
>
> 'Dunno. I am a bit stuck, miss'.
>
> 'You see. Four times eight is 32, I mean eight times four is … 32. Um. That is the same thing isn't it. Oops. I *think* I am a bit stuck'.

These quotations were spoken by three different key stage 2 children (ages seven-11-years-old) within the last six years of my teaching career as a primary maths specialist teacher. Over the course of time, their words replayed in my mind as I noticed that other children experienced similar challenges. For me, these three children's words

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illustrated a broader and recurring theme of children's difficulties in articulating their mathematical reasoning, particularly when asked to explain, justify or defend their mathematical process. From discussions with other educators, and from class-based observations, I realised that other practitioners had similar classroom-based experiences. Recent literature also suggests that primary children generally find mathematical reasoning challenging.[1] That is not to suggest that removing the challenge element of mathematics benefits learners. Being stuck is an important part of mathematics, as new learning is given time and space to occur.[2] Nevertheless, it was evident to me on various occasions, particularly post-pandemic, that many primary children were unable to engage in productive talk while stuck.

Having considered the formative and summative data associated with these children, I found that children of differing attainment levels had difficulty in articulating their mathematical reasoning in lessons. This was important to investigate as reasoning is recognised as one of the most vital components in children's success in mathematics.[3] This finding formed the basis of a professional desire to understand more about children's dialogue and mathematical reasoning. As I commenced my studies, I became more conscious of a view that I had held for some time: that mathematics ought to be an accessible subject to all learners but that a difficulty in accessing or engaging with productive talk was potentially holding back many. For me mathematics is a subject full of joy and challenge, in which oracy ought to have its place. Mathematics also offers many democratic elements, though as a subject it has not always had this reputation.

In order to better understand children's strengths and challenges in reasoning, it was essential for me to place children's voices at the heart of the research. As Hunter has shown, there is much more literature on teachers' experiences of mathematical dialogue and reasoning than on children's.[4] This is not to negate the vital place of such literature but instead highlights an important gap for investigation. Rather than ignore or limit children's talk, I wanted to understand ways in which we could encourage and develop meaningful talk across the curriculum.

Mathematical reasoning and dialogue

Both dialogue and mathematical reasoning are key parts of mathematical learning.[5] They have the potential to develop systematic and creative thinking, thereby increasing learners' abilities to make creative connections between mathematical facts and topics.[6] As I was completing a selective literature review for my project, I noticed that mathematical reasoning could potentially be categorised in three ways: as a skill, a process and an aim of mathematics. In respective order, it can be first understood as a skill which can be developed in learners and equally also educators, second, as a mathematical process used to arrive at an answer, and third, it can be

interpreted as an outcome.

Ball and Bass define mathematical reasoning as an 'instrument of inquiry' to develop mathematical understanding while 'justifying or proving mathematical claims'.[7] In my view, this definition incorporates the three aforementioned categories: mathematical reasoning as an active process, skill and aim. The term 'instrument ('tool') particularly prompts this. In practical terms, learners may begin with claims and learn to challenge or defend them. By doing so, use of both statements and questions become important features of reasoning. Moreover, reasoning as a skill is important as it is the basis of transferable skills such as justification and explanation.[8] To share their understanding of how and why they have undertaken a process is an important skill for learners which can be developed.

The national curriculum itself makes an important connection between mathematical language and reasoning. It is therefore also important that, as practitioners, we give all children the opportunity to really develop effective use of dialogue.

Turning now to the term 'dialogue', Askew defines mathematical dialogue as the 'words through which ideas are formed'.[9] This is vital because, as Kosko indicates, mathematical discussion is an 'avenue in deepening understanding of concepts through social interaction'. By combining the two definitions there is the potential to understand that learners can show their thinking through dialogue, as well as deepen mutual understanding.[10] However, children's use of and access to high-quality talk can differ greatly, and as such, dialogue – and the ways in which it is either promoted or shut down in the classroom – can act as a gatekeeper to educational engagement and attainment. Marks has identified that despite the positive impact of dialogue on learning, educators can sometimes inadvertently stop mathematical dialogue based on their beliefs of children's capabilities, thereby limiting opportunities for 'rich discussion' and exploration of mathematical concepts.[11] Her work refers to an important association between a teacher's mindset and the potential quality of dialogue that children have opportunities to engage in.

As a mathematics specialist primary teacher, I wanted to explore what I could do to give all learners access to high-quality dialogue, as well as to develop practice more widely.

Talk cue cards

As in many primary school classrooms in the United Kingdom, sentence stems or frames (as commonly referred to in the United States) such as 'I disagree because…' were already a feature in my classroom. I also regularly used sentence stems in my teaching slides. However, these lacked permanence as they were only useful when displayed on screen. My professional reflection led me to consider talk cue cards as

a visible and tangible sentence-based structure aimed to support children's talk and hence their reasoning process.[12]

I concluded from literature that children could potentially develop reasoning skills through interaction with a physical card designed to encourage their dialogue. The practice also had the potential to develop active listening to other children through a series of ready-made questions and statements. Because children are scaffolded in what to say, they can focus on listening rather than trying to quickly manufacture an answer.

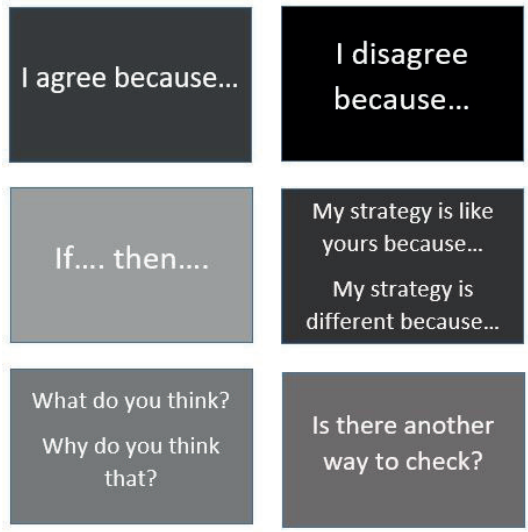

Figure 1: Talk cue card

In my project, I decided to use a combination of statements and questions to encourage mathematical reasoning. An example of potential mathematical reasoning with the 'If ... then...' structure is: 'if 3 x 5 = 15 then 30 x 5 = 150'. Within this structure, learners are able to derive number facts. This structure also supports learners to have an intentional understanding of cause and effect.

I designed my talk cue cards to have six coloured boxes with eight statements, so that children would have the opportunity for depth of practice. Children also had an opportunity to practise some relevant variation in what they asked or said, and thus they could experience how a 'what' question differed from a 'why' question in mathematics. I also colour-coded the cards to assist children in recognising the cards more easily. Red and green were familiar colours to the children and regularly signified disagreement and agreement respectively within the classroom. The other colours (yellow, purple, blue and green) were selected as they were distinct and contrasted with one another.

The project and 'slow listening'

As a practitioner-researcher, I formed my research question by drawing on insight of my working context. Therefore, I wanted to know: what are key stage 2 children's experiences of using talk cue cards to support mathematical reasoning?

The use of talk cue cards was designed as whole-class intervention with data collection focused on a case-study group of four pairs of children in my key stage 2

classroom. Pseudonyms are used throughout to refer to the children.

At the start of the project, I gave children time to explore the use of talk cue cards. The whole class discussed collaborative approaches for talk and reflected on what makes a good talker, listener and questioner. There were two major democratic elements to the project. First, I empowered children as a class to discuss and co-construct an agreed approach for dialogue, rather than tell them simply tell them my expectations.

Second, it was important that children felt comfortable to express their authentic views about the talk cue cards, given that the project was centred around their experiences. I was aware that I was the familiar class teacher who had taken on a different identity in the classroom as practitioner-researcher. Therefore, I used a child-centred method of paired interviews rather than a one-to-one structure (child to interviewer) in an attempt to balance the power differential and encourage talk between and with the children. Given my affinity for mathematics and the age differential between myself and the children, it was vital to consider ethics, particularly in relation to power dynamics.

Daily, paired video-elicitation interviews (using short video clips of maths learning in class and asking the children to revisit and talk about classroom moments) were an integral research tool in capturing children's voices. The clips in fact allowed children to talk about dialogue. These interviews allowed me to learn from their experiences, and develop a deeper understanding of the children I teach every day, through what Clark calls 'slow' listening to children's learning experiences: by creating 'a platform for making revisiting possible in an accessible way.'[13]

Stem sentences

The general consensus amongst the children was that the sentence stems were useful to talk about and work through their reasoning ideas; they also expressed that it linked well to existing mathematical vocabulary, such as dividend (a number being divided). Notably, the extent to which mathematical dialogue needs to incorporate technical mathematic vocabulary is contested.[14] My finding is in line with outcomes by the Education Endowment Foundation, which suggests that in oral interventions, regular and meaningful links to vocabulary can assist learners in using that vocabulary more often.[15]

Physical characteristics of talk cue cards

Though discussion often took place in pairs, collectively children expressed that they found it helpful to have an individual (laminated) set of cards which could be wiped clean after each lesson and reused. This illustrated that the tactile nature of the cards assisted them in focusing on a particular question or stem sentence at a time, while developing

their reasoning skills with their partner. It has been suggested that most children benefit from the tactile nature of visual based cue-cards in supporting communication.[16]

All children were able to spot the agreement and disagreement cards most easily amongst the framework of the six cards because they felt the colours used were familiar and recognisable.

Children had access to eight cues spread across six cards. They felt that this was a manageable number:

> Six is a good amount but it's like eight for the price of six because the blue and purple ones have two options, Miss. Eight is a good amount. Not too few, not too many. It is like the three bears with their porridge. (Brooklyn, Pair 2)

Agreement of mathematical ideas

All children said that it was useful to agree about mathematical reasoning if they felt their process was on track. Six of the eight children spoke in detail about how questions can help improve discussions and improve learning from mistakes.

Children thought that agreeing with their partner was an important trait of mathematical reasoning, akin to a study by Wickham.[17] These comments suggested children had an awareness of the benefits and complexity of discussion where agreement and questioning could potentially assist their mathematical reasoning.

Negative aspects of agreement of mathematical ideas

Initially in the project all pairs were using elements of cumulative talk, but not yet exploratory talk. Herrlitz-Biró et al. identify that within cumulative talk 'participants communicate constructively but not critically'.[18] The class rules for talk contained the expectation that children gave reasons for agreement and disagreement in order to encourage exploratory talk. Although children identified agreement as a positive aspect in the project, they also perceived it as having negative elements.

> Agreeing is good but it does not always take you to the next level. Sometimes if I agree with my partner then we might check our answers in the same way. (Knox, Pair 3)

As the project developed, children identified that mathematical reasoning would improve if cumulative talk or quick instances of agreement occurred less often. This shares some resonance with the interesting findings from a project by Reznitskaya and Glina in which most students appreciated that disagreement might extend thinking. One student said that agreement and disagreement 'would help the question come out more'.[19]

Some learners in my early lessons acknowledged that they would agree in order to

'hide' their thinking.

> In the first session, I actually used to say I agree when I did not disagree or agree. When I said 'I agree because', I didn't actually know what to say after. I feel I've improved. It is good to have a partner for maths, so it makes it like you are explaining to someone else and yourself. (Ursula, Pair 1)

This finding is particularly significant because in many instances the major focus in primary classrooms is about working in harmony together. It could be possible that, by emphasising this, we inadvertently set children up to not want to disagree. Yet disagreement in this context is not personal but expressed rather to further the ideas, learning and the quality of reasoning.

Talk cue cards in relation to mathematical topics

Whilst recognising the small sample size, seven out of the eight children found the use of the talk cue cards useful across the range of mathematical topics (multiplication, division, mass, volume, word problems).

One child did not find it as useful in topics such as time and mass but found it much more useful in multiplication or division.

> I didn't use the cards as much today to challenge ideas. If it were say something connected to a calculation then it would make sense to reason more about it. Because we were just reading the scales for mass, I could see the answers straight away. But Joanna reminded me that you could check by counting in multiples of 10. (Stephen, Pair 1)

This seemingly peripheral comment is of interest and has some resonance with findings by Herritz-Biro et al., in that high-quality talk can be limited or non-existent when a task is deemed to be straightforward.[20]

Classroom rules for talk

Although my project involved a small sample, all children felt that it was beneficial to have 'class rules for talk' in their own words, or 'ground rules' as they are commonly known in literature.[21] Underpinning this is the position that children need to be explicitly taught and exposed to what exploratory talk looks like, rather than assuming they are already aware of what is required.[22]

Children said that:

> You can still be BFFs [best friends forever] and disagree, even outside of maths. The class rules remind us of expectations and also that challenging ideas is good. (Brooklyn, Pair 2)

> I am beginning to talk more because of the rules. At the beginning I would say I agree but now I make more effort to look at different ways to do it. (Ben, Pair 4)

> It is good to take turns, and listen to your partner. Otherwise you could be talking all the way into breaktime. Yaba yaba yaba. You have got to listen to some reasoning too. (Knox, Pair 3)

Children's discussion of reasoning strategies in paired interviews

A key finding was that children found it beneficial to engage in dialogue with one another in order to reason, rather than reasoning being perceived as an individual process. Children commonly referred to their interactions through terms such as 'talking and 'listening', in preference to using the term 'dialogue', as often found in literature. Children's comments about their shared reasoning process included some transferable comments which contain elements of meta-thinking, as well as lesson-related instances which refer to both questions and statements as useful elements:

> When I talk to my partner I share reasoning ideas and it puts it out there. When they ask a question [it] makes me think about how I got there and that helps us and then later the class. (Knox, Pair 3)

Conclusion

The children's experiences were at the centre of the research. In order to attempt to support children's processes in talk and mathematical reasoning, I selected talk cue cards as these are recognised as a tool to support dialogue.[23] Perhaps the most striking and unanticipated non-mathematical finding was that all children positively referred to the colour and tactile nature of the talk cue cards. Within video-elicitation interviews, children regularly referred to the coloured design of the laminated talk cue cards as 'helpful' and 'useful' since they each had a laminated personal copy of the stem sentences and questions which they could point to, tick or circle while using in discussion. Children had the opportunity to share their first-hand experiences of using talk cue cards, as well as to reflect on and improve their talk and mathematical reasoning skills. We may take it for granted that children just 'know' how to talk, yet this project suggested that this is not the case. All children can benefit – individually and collectively – from being supported to develop a broad range of talk skills.

Although the stem sentences did not magically reveal answers to the children, they appear to have contributed towards supporting learners in starting reasoning strategies through dialogue. It was apparent that children were assisted in mathematical reasoning by sentence stems, something which aligns with findings by Buffington et al., suggesting that sentence stems assist in preparing children to engage in discussion.[24]

Initially, most children thought agreement could only be positive as 'it shows that your answer is on track'. As the study progressed, some children said that agreement was less useful as sometimes disagreement helped 'unlock' a question in a different way. This allowed for 'sense-making of their own and others' ideas'.[25] As suggested by Black and Varley, teachers need to be conscious of their questioning techniques in addressing misconceptions so that within paired talk children perceive disagreement or a differing answer as a positive opportunity.[26]

As the children's experience of using the talk cue cards increased, they developed in their ability to engage in meta-talk. This included reflecting on mistakes in lessons. This process of reflection did not happen in isolation. Children were supported by teacher and peer modelling. It appears that this combination led to quick change in the classroom.

As indicated by Coles and Copeland: 'Discussion helps children to master the language of mathematics and to clarify their conceptions of the subject'.[27] As the children became more aware of their ability to reason, they discovered that agreement did not allow for an exchange of differing ideas. Children desired to move away from cumulative talk and engage in exploratory talk. This aligns with literature by Mercer suggesting that exploratory talk was the most productive category of talk as it gave more opportunity for reasoning.[28] Children in my study, exemplifying Hunter's reasoning project, also identified that their reasoning was improving and becoming more sophisticated as they engaged in the project.[29] By the end of this study, all children were able to engage in a combination of step 4 or 5 of the NRICH progression in reasoning framework.[30] Children's arguments were much more watertight, drawing on strong connections to other areas of mathematics. They used mathematical and linking words such as 'if' and 'then'. Ben (Pair 4) said that:

> When William asked me if there was another way, I got the same product of 80 by using 'if' and 'then' too. I ended up flipping it so four times 20 is eighty. I used my base 10 to show him. Then I said we are super sure.

When justifying, children used phrases such as 'because' or 'then' within their mathematical reasoning. All pairs demonstrated elements of mathematical proof and engaged much more securely in making generalisations as per national curriculum expectations. Formerly, Ursula (Pair 1) would often say 'don't know' within her reasoning process and progress. The talk cue cards provided her with a sentence structure which consequently improved the quality of reasoning in the pair.

Finally, there is also potential to investigate the use of talk cue cards beyond mathematics. It would be interesting to explore which areas of the curriculum might benefit from their use with a consideration of how they would need to be adapted to be used in other subjects.

Implications

Underpinning the successful use of talk cue cards in my classroom was a supportive classroom climate for children's ideas to form in. Askew reminds us that children form ideas through mathematical dialogue, and paired talk is an important opportunity for them to engage in dialogue.[31] Teachers can sometimes be the ones to stop mathematical dialogue based on their beliefs about children's capabilities, thereby limiting opportunities for 'rich discussion' and exploration of mathematical concepts.[32] Addressing conscious and unconscious preconceived ideas of children's capabilities can help educators create a much more inclusive environment for children to engage in and with dialogue.

I am conscious that the overall success of the study did not solely reside in the use of talk cue cards, since they are a mathematical tool. It is important for educators to note that they were employed in tandem with agreed hallmarks for high-quality dialogue, peer and teacher modelling and a classroom climate in which mistakes are welcome. All children said that knowing everyone had access to the talk cue cards was beneficial, as was the expectation to talk to your partner and not 'accept the first answer'.

Despite various pressures on teachers such as workload and lack of time, it is important that teachers invest in time to discuss an agreed approach for dialogue and expectations of the use of talk cue cards. This allows children to understand some hallmarks of reasoning such as using 'if … then', as well as shared expectations for lessons.

Final word

Mathematical reasoning can be categorised in three ways as a powerful skill, process and aim. Developing reasoning can be challenging for many children and teachers alike. The talk cue cards were designed to potentially provide an inclusive and democratic approach in supporting mathematical talk and hence reasoning. In this research paper, key stage 2 children's overall experiences of using talk cue cards appear positive. The children's voices in the research made clear that the success of talk cue cards was contingent on multiple factors. These include their tactile and colourful design, stem sentences, classroom rules for dialogue, and teacher and peer modelling. All these factors operated in a classroom environment in which I actively taught the children and modelled that mistakes were welcome. As suggested by one of the children, simple mathematical tasks could also have an impact on their initial perception about whether there is any value in engaging in mathematical reasoning in the first place. Sometimes this requires educators to further adapt tasks before the lesson in order to provoke deeper dialogue, rather than fostering what appear to be quick, straightforward answers that may only encourage agreement. Certainly, in the

realm of research there is much we can learn if only we take the time to slow down and really listen to what children have to say.

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