What impact does the explicit teaching of subject specific vocabulary have on children's use and application of mathematical reasoning?

Southwold Primary School, Lower Phase

Abstract

The purpose of this study was to explore how explicit teaching and modelling of mathematical vocabulary, could impact children's application within mathematical reasoning tasks. Through professional discussions and the sharing of ideas and best practice, teachers sought to change elements of their classroom routines, practice and how they teach and model mathematical reasoning.

All teachers involved reported a positive impact within their individual classes but also for themselves in a professional development capacity. Findings highlight that the process of improvement and development is something that happens over time and would be strengthened by a more targeted and tailored approach depending on individual needs.

Introduction

Southwold School is a two form entry primary school based in Hackney, East London and was recently graded Outstanding following its OFSTED inspection in 2019. There is a higher than average proportion of children eligible for pupil premium. The proportion of pupils from minority ethnic groups and those who speak English as an additional language are much higher than the national average.

The National Curriculum for mathematics is made up of three strands: fluency, reasoning and problem solving. In relation to reasoning it describes its aim being to ensure that all pupils are able "reason mathematically by following a line of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language." (Department for Education, 2014)

Following the introduction of the curriculum, many schools have since adopted a mastery approach to teaching maths whereby teachers teach the same topic to the class addressing the needs for all pupils to enable them to work towards mastering the curriculum, challenging more able children by going deeper rather than accelerating into something new, (National Centre for Excellence in Teaching Mathematics (NCTEM), 2015). In practice this involves starting each unit with a fluency aspect, teaching the mechanics, concepts, and methods of the unit. Once pupils have gained an understanding, they can then apply these acquired skills to reasoning based activities. This helps them to deepen their knowledge and understanding of the unit. This leads to pupils applying knowledge along with other acquired skills to solve maths problems. However, it is important to note that this doesn't mean all children will begin a topic at the fluency stage; they may be able to move straight to the reasoning stage whilst other children further consolidate their knowledge at the fluency stage. Although in order to reason a pupil needs to have the essential skills and known facts to apply to the problem.

The National Curriculum also writes of the importance of spoken language across the whole curriculum including mathematics. The quality and variety of language heard and spoken by pupils are key factors in developing mathematical vocabulary and making their thinking clear, (Department for Education, 2014). Just like writing skills, the foundation begins the ability to verbalise thoughts and ideas before putting them to paper. Evans describes the importance of verbal reasoning and how it allows pupils to demonstrate their understanding, forming an integral part of encouraging children to reason, justify and explain their thinking, (Evans. S, 2017). Giving children opportunities to engage in verbal reasoning through the use of talk partners and the sharing of ideas in class allows children to talk about their maths in a way that allows them to feel comfortable, building up confidence and the language skills to try out ideas and theories. This is something that is embedded in Early Years practice where play based learning lends itself to developing mathematical reasoning and problem solving

through talk and exploring of early maths concepts. He also writes how this is something that is lost as children transition to KS1, (Williams. P, 2008). Although learning becomes more formal in KS1 teachers can still plan for and create opportunities to promote an environment where verbal reasoning is embedded within maths teaching. This is especially important where children's ability to read and write should not limit or restrict their ability to mathematically reason. *'A mastery classroom should never be quiet',* (Evans. S, 2017).

When considering pupils for who English is an additional language, where numbers are in part an international language, pupils are more often able to access the fluency aspect of a maths unit. However mathematical reasoning can be difficult for them; not only does it require the ability to be able to talk or write about maths there is also the added complication of the mathematical language and vocabulary. For example, words like 'power', 'mean' and 'volume' have specific meanings in maths but also very different meanings in everyday language or other subject areas. Making the different meanings explicit will help all learners, not just those with EAL, (Bell Foundation. 2020). The ability to communicate lies at the heart of reasoning and this is something that needs to nurtured and encouraged. This is a particularly important point to consider when taking into the account the demographic of the school the project was carried out in.

It is important to note that mathematical reasoning is tested in separate papers at the end of each key stage. Therefore, in order to give pupils the best possible chance in succeeding, mathematical vocabulary and reasoning skills should be considered an integral part of maths. By enabling pupils to learn and continue to develop these skills as they progress through the key stages they are given plenty of practice in answering reasoning type of questions and see them as part of the normal assessment process, (Bolton. T, 2017).

The school subject improvement plan for maths identifies 'ensuring there is a range of fluency, reasoning and problem solving in all units of work' and 'developing high quality oracy skills in maths as targets for the year 2019-2020, (Southwold, 2019).

With these areas already a focus for maths throughout the school, the project complemented the school wide goal and was supported in a broader context through actions already in place.

Research Process

The project was led by the lower phase leader and involved six teachers from Years 1 to 3. All children within the class were part of the project, however two were selected from each class as target pupils in order to track progress using evidence gathered by monitoring recorded reasoning tasks in books. The project was an agenda item each week in phase meetings so that it was always high profile and staff could discuss and share with one another what was happening in their classes. This enabled staff to share examples of best practice and discuss strategies they had used and results. Early in the project, following feedback from teachers and sharing outcomes in books the evidence did not reflect how verbal reasoning was developing in classes. As a result teachers were asked to make note of any key observations during lessons or focus group work that demonstrated children verbally reasoning and using key vocabulary.

The three areas of focus for the project was to improve planning, implement strategies within the classroom to improve the use and application of mathematical vocabulary and to develop teachers modelling of reasoning. The maths subject leader supported planning by encouraging the introduction of reasoning lessons, so teachers could focus on and explicitly teach the skill of reasoning. This was also important to encourage teachers to move away from the idea that reasoning tasks were something to 'move onto' in a lesson after completing set fluency tasks. These lessons and resources were differentiated to meet the needs of all abilities, even those that may have still been at the fluency stage. This was in order to allow them to have exposure to mathematical reasoning and practice using specific vocabulary for this. By enabling teachers to specifically focus on teaching 'reasoning skills' through modelling and class discussion there could be a larger focus on the use of the subject specific vocabulary. This was done in both a whole class context and in focus groups.

Various strategies were introduced and implemented to improve the use of mathematical vocabulary in the classroom and throughout lessons. Key vocabulary for topics were displayed in central areas of the classroom for children to refer to. Table top vocabulary cards related to the particular topic were made using the Communication in Print (CIP) program and were placed on tables during maths lessons as visual aids to support and encourage children to use them when recording their reasoning tasks. In some classes the same key words with CIP visuals were used within the flip charts and as resources in books (Appendix 2) to ensure consistency and repetition.

Findings

When this project was first introduced it was positively received by the teachers who agreed with and supported the projects aim. The impact of targeted support in planning sessions resulted in teachers gaining confidence to teach lessons with a specific focus on reasoning. Further support helped teachers to create and develop reasoning tasks that allowed them to see evidence of application of fluency skills along with evidence of a deeper understanding. This was a process that was slow to start as it required teachers to feel confident in not only teaching reasoning but making the shift to accepting that all children regardless of ability could in fact reason. The regular discussions at phase meetings also helped teachers to discuss and share ideas and best practice. These reasoning lessons were best placed towards the end of a unit, and helped teachers to not only extend the more able children to achieve a deeper level of understanding, but to see which students really understood the topic and who didn't. One teacher commented "when they are able to reason about something that was taught last week I feel I can assess them as secure."

Through the project it became apparent that some topics were more suited to reasoning type questions than others, especially within the lower phase where new areas of maths are being introduced. Teachers in Year One raised concerns about children independently accessing questions and being able to record responses. It was suggested that in Year One reasoning activities would be carried out in adult focus groups to begin with as this would enable small group discussions and teacher modelling to be clearer. Children in Year Two and three who struggled with reading and writing were also supported by adult led focus groups to access questions and record written responses. This led to all children regardless of ability gaining exposure and experience in mathematical reasoning and using the appropriate vocabulary.

Maths vocabulary related to the topics were introduced at the start of the unit and displayed around the interactive whiteboard and on a slide at the start of each maths lesson. Some teachers were of the opinion that this was too many words to give children at once, especially as the learning was often also something new to them. One teacher added each word to the display as it was used making the introduction of the vocabulary more gradual. It was agreed that the gradual introduction of words would be more effective. This resulted in a routine where by each day was a recap of previously introduced words and their meanings along with a slower introduction of new ones. For example, during a Year Two lesson, the introductory lesson to shape allowed for children to be introduced to all the maths vocabulary at the beginning of a unit through a practical lesson. This enabled them to explore and use the words in a practical way, without committing to writing them. The class teachers commented on how this benefitted them by allowing them to discuss ideas and make statements, building on their verbal reasoning skills but applying in a practical way.

Teachers commented on how the table top frames supported children to independently access the mathematical vocabulary keywords and transfer these to their books. Children used them as prompts and also to help with the spelling of words. These key words were also used by some teachers who created vocabulary stickers in books further supporting children's application of mathematical vocabulary in their responses and explanations.

When discussing with teachers how they modelled reasoning tasks, it became clear that 'explicit modelling' meant different things for different teachers. Results in books were of better quality in classes where teachers had heavily modelled the use of vocabulary when modelling reasoning questions. The same was the case for teachers that allowed time for children to use carpet sessions as opportunities to talk about their maths and discuss ideas before setting off to tables. One teacher in particular after using talk partners, invited pupils to stand up and present their response to the class, they then commented on how well they had answered and explained why, referring to the specific vocabulary the student had used.

Marking and feedback by teachers showed how children can be helped to deepen their reasoning skills and use of language. This is valuable because this helps able to discuss this with the pupil and explore their thoughts and ideas further. Evidence in books showed examples of how teacher marking helped to move children in in their reasoning responses.

Impact and Conclusion

This project concludes that a specific focus on the use of mathematical vocabulary and its application through reasoning, can result in an improvement in children's outcomes. Children were more confident in using mathematical vocabulary, verbally and in written responses, and those that were able to, independently used the resources available to them. Teachers became more confident in planning lessons and teaching reasoning and using it to assess children's understanding.

The resources created to help scaffold and support children using the CIP program, proved to be effective and easy for both children to access and for staff to create. Using a consistent approach across classes would be beneficial for students and also help to build a bank of resources that can be accessed when revising and consolidating topics.

This project was something of a gradual process and whilst evidence shows improvements, this varied from class to class. To achieve a more sustained impact, support that is more tailored to the individual need of teachers, would allow for the targeting of specific areas of development. This could be in the form of team teaching and observing more experienced teachers, which would help teachers that were less confident and peer observations within year groups would help teachers to support and develop one another.

The outcomes in books highlighted the importance of using marking and feedback as a tool to encourage and support children in extending their reasoning responses. This could be implemented through collating some best examples and sharing with staff.

In conclusion to develop reasoning skills and the use of vocabulary further, reasoning needs to be embedded with the teaching of mathematics. It needs to be something that teachers not only completely understand but are confident in teaching, so that they can support and develop these skills in children.

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