Does the implementation of agreed core strategies in daily reasoning lessons impact the precision of pupil outcomes in mathematics?

Southwold School, KS2 Phase

Abstract

The purpose of this study was to explore whether the implementation of core strategies, fundamental to reasoning, in daily maths lessons had impact on the precision of pupil outcomes. 'Southwold's Maths Action Plan' outlines the development of reasoning as a key point of action because reasoning questions were often used as an 'extension' to fluency and not considered a skill in of itself. Often, this led to lessons being stopped to 'model' reasoning question meaning that pupils were not given the tools to reason with independence. Providing pupils with and embedding strategies integral to cultivating accurate and independent reasoning was essential to the foundation of developing Southwold outcomes.

Introduction

The ability to reason independently is widely considered integral to development within maths. For example, research by T. Nunes in her 2009 paper, recognises ability to mathematically reason as the most important aspect in a pupil's success in mathematics. Providing pupils with the ability to make connections in mathematics is central to this and cannot be done without integrating these skills fully into the curriculum. Furthermore, the Mathematics National Curriculum points out in its second aim that pupils can '*reason mathematically by following a line of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language*'.

For this study, it was necessary that KS2 teachers involved in the process agreed upon the strategies that they were going to embed within their lessons. Not only did this allow for ownership over the skills but also helped maintain consistency across the phase. The strategies were broken down into four sections; talk partners, modelling, questioning and extending. These areas were then expanded upon to provide detail and a clear expectation of how strategies were practically applied, (Fig 1).

Talk-partners	Modelling	Questioning	Extending
Explaining the process. **Sharing and defining the necessary vocabulary.** **Finding the errors.** **Pattern seeking (tts?)**	**Teacher error 'Thinking aloud' the process/steps.** **Continually rehearsing us of the vocabulary.** **Working backwards – starting with an answer and working back to the question.** **Making links to other learning.**	**Can you explain the steps?** **Where did I/you go wrong?** **What would have made... easier/harder?** **What would happen if...?** **What vocabulary have we used?** **Where else is it used?** **Was there another way to solve...?** **How could we check we are correct?**	**Explain/prove/true or false reasoning extentions.** **Plenaries with a reasoning focus.**

Fig 1. Agreed upon strategies to be embedded in input

The key aims of integrating these strategies were to provide pupils with opportunities to practise the skills throughout teacher input. Consequently, providing pupils with the skills to answer their reasoning questions independently.

A potential limitation identified was the ability to conclusively measure the impact of our agreed upon strategies, from the general teaching of reasoning and mathematics throughout the year.

Research Process

The research process was carried out by the phase leader and involved a total of six teachers and classes (Year 3 – 5). The decision was made not to include Year 6 in the research due to the set specific revision ahead of their SATs exams.

Utilising the agreed upon strategies, it was then necessary to develop methods for consistent practical application. Within the teacher's planning and preparation for their Maths lessons, a slide was added to the flipchart that focussed on one of the strategies. The strategy chosen was reflective of the type of reasoning questions they may encounter during the specific lesson. For example, when understanding multiplication patterns, the reasoning question required them to use a similar skill, (Figure 4).

No time was set aside during the lesson for strategy application, rather it was up to teacher judgement when it would be most beneficial. Strategies were implemented at various points throughout lessons, such as during a mental oral starter, mini plenary, plenary, or during main input. However, it was the expectation that a range of strategies were chosen weekly to expose the pupils to a wider possibility of questioning, (Figure 2, 3 and 4).

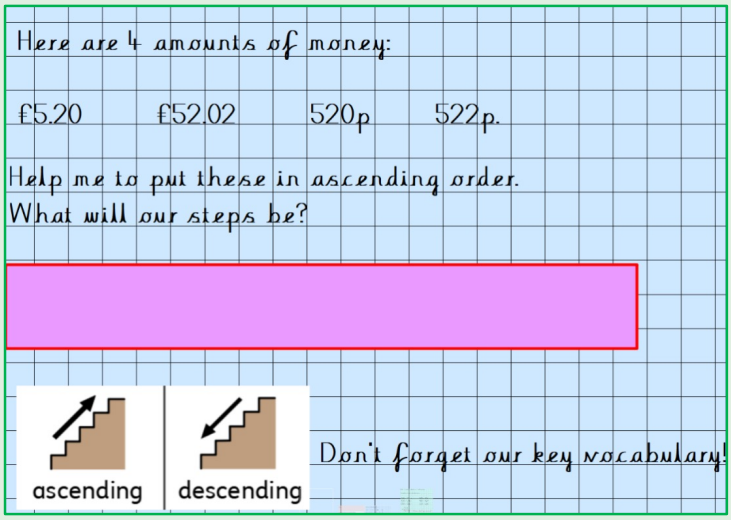
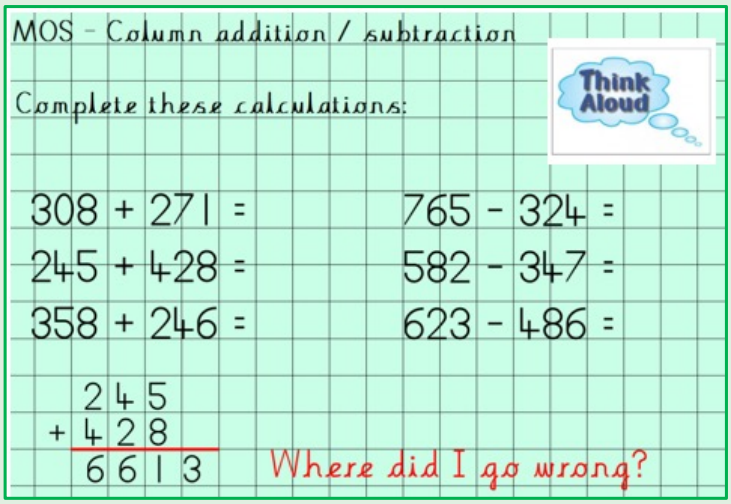
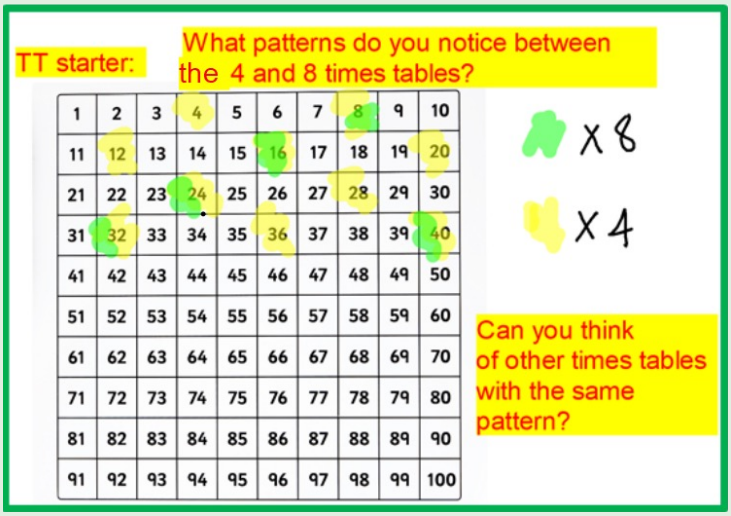


Fig 2. Example of slide used to embed continued rehearsal of vocabulary, explaining the process/steps and possible opportunity for teacher error and teacher think aloud.

Fig 3 (right). Example of teacher think aloud, pupils to explain process and spotting errors

Fig 4 (right below). Example of a pattern seeking times table starter





Consistency is imperative when implementing these new taught approaches regarding the tools needed to reason with independence and confidence. To help facilitate application support staff and class teachers received training and CPD in which they were given examples of what the implementation would look like in practice as well as how to facilitate and foster a culture of reasoning through questioning and discussion. Progress was monitored through interviews with pupils and teachers and lessons observations in order to evidence a 'culture' of reasoning and oral outcomes.

To further measure progress the outcomes in selected pupils books were compared from September to the end of spring term. For consistency, teachers were asked to pick three pupils per year of differing abilities (LA, MA, HA) to ensure that when comparing outcomes there was measurable progress. The outcomes would then be measured against the reasoning checklist used to help scaffold responses in class i.e. clear statement, key vocabulary, explanation focusing on taught skills and/or calculation (see appendix 2).

To further ensure that teachers felt confident in the research process time was set aside in weekly phase meetings where they were able to feedback successes or potential barriers within the process.

Findings

Initial findings, and arguably the most important, was the increased confidence in which pupils spoke about the process and tools they used to reason. In pupil interviews there was a noticeable increase in the precise use of key vocabulary and pupils had an awareness of the different strategies they used to reason with confidence.

In addition to this, teachers and support staff said they felt the process provided them with a clear and purposeful structure to help embed reasoning strategies and they felt more confident ingraining them within mathematical input.

When observing maths lessons it was evident that there were greater opportunities within the input for pupils to practise chosen core strategies and pupils' oral outcomes demonstrated a greater understanding of reasoning concepts. Additionally, it was evident that the embedding of these strategies worked well in practice and didn't disrupt the fluidity of the lesson.

When comparing outcomes in books reasoning outcomes were more refined, and there was a clearer focus on using correct mathematical vocabulary as well as including an explanation focusing on taught skill (see appendix 1 for scrutiny of outcomes before and after the process).

Conclusion

On reflection, impact would have been more reliable and measurable if these core strategies had been applied to smaller target groups such as specific classes or an intervention group and then compared with the outcomes of pupils who were not part of the process.

However, this research has shown that the consistent use of agreed upon core strategies in daily lessons have significant impact in pupil oral and written outcomes. Not only did it influence the precision of pupils' written outcomes and the use of key vocabulary but there was also increased confidence in their oral reasoning skills and ability to talk through their thought process. Furthermore, the structure of having these strategies in place had a positive impact on teacher confidence when embedding them into their practise.

Next steps would be to ensure that all teachers and members of support staff are confident in the implementation of reasoning specific strategies and to make sure they are used consistently and effectively within the school. For the pupils to be regularly exposed and modelled to the range of skills needed to reason within a context through which to apply it will allow for them to develop in to independent, confident and eloquent mathematicians who are critical thinkers.

References

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Appendices

Appendix 1: scrutiny of outcomes in books before and after process

Year 3 (HA)	before process	after process
Clear statement		
Correct use of key vocabulary		
Explanation focusing on taught skills and/or calculation		

Year 3 (LA)	before process	after process
Clear statement		
Correct use of key vocabulary		
Explanation focusing on taught skills and/or calculation		