The effectiveness of teachers instructional responses to patterns and changes in the KS2 mathematics tests: Problem Solving and Reasoning
Effectiveness of teachers instructional responses

The National Curriculum, as presented in the Mathematics programmes of study key stages 1 and 2 is clear about the role of problem solving and reasoning:

The national curriculum for mathematics aims to ensure that all pupils:

- **become fluent** in the fundamentals of mathematics, including through varied and frequent practice with increasingly complex problems over time, so that pupils develop conceptual understanding and the ability to recall and apply knowledge rapidly and accurately.

- **reason mathematically** by following a line of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language

- **can solve problems** by applying their mathematics to a variety of routine and non-routine problems with increasing sophistication, including breaking down problems into a series of simpler steps and persevering in seeking solutions.
The following comes from the Year 6 Programme of Study on Ratio and Proportion:
Pupils should be taught to:
• solve problems involving the relative sizes of two quantities where missing values can be found by using integer multiplication and division facts
• solve problems involving the calculation of percentages [for example, of measures, and such as 15% of 360] and the use of percentages for comparison
• solve problems involving similar shapes where the scale factor is known or can be found
• solve problems involving unequal sharing and grouping using knowledge of fractions and multiples.
Effectiveness of teachers instructional responses

Looking for a related problem.

Encouraging reflection on looking for similar problem-solving techniques that have been successful; maybe looking for simpler problems. Encourage pupils to interrogate and use their existing knowledge.

There is no evidence that teachers use this approach except in the area of two-step money problems. There were six references to teachers working with children to be confident with one step money problems and then moving backwards and forwards between one step and two step problems.
Practising particular techniques.

To be able to recognise different structures so that they master techniques which become part of a problem-solving tool kit. Organising teaching so that problems with similar structures and different contexts are presented.

There were 33 references to particular ways of approaching a problem. The majority of these related to looking for key words. Instructions to read the question twice were common. Many of the strategies relate to understanding the problem and choosing the appropriate calculation.
Effectiveness of teachers instructional responses

Select problems which are unfamiliar to the children

*Those that do not have well-rehearsed, ready-made methods to solve them.*

The emphasis was on gaining practise with problems that were familiar. The nature of the key stage tests is that contexts are not always familiar.
Encourage children to read the problem thoroughly.

*Identification of words or phrases that are not understood. Ensuring that the children understand the problem.*

There are two aspects to the references. One related to ensuring the children were addressing all parts of the question and not missing out a final part. The other related to talking to and with the children who were not understanding the question.

From above, children are encouraged to read questions and identify key words. It may be that the teacher has strategies to work with those who do not understand the problem; however, there was limited evidence of how this was approached.
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Identifying children who are not engaging but making rash decisions.

First impression can count significantly towards a decision whether to engage with a task. Are children showing uncertainty about methods to use? Are children just picking number to operate on?

There is no direct discussion of this aspect but teachers have identified the need to direct children to ensure they have understood the question. This is likely to have come about because teachers have experienced children not engaging with questions fully.
Encourage the use of visual representation and manipulatives.

Children are presented with and encouraged to use pictures and concrete materials.

The use of visual representations is identified as one of the best approaches to solving a problem. The research identifies that this is the approach used most often when a problem is presented to children. The approach tends to be the teacher drawing a picture to help the children develop an approach to a solution. It was rare for the children to be asked to draw the picture or diagram themselves.

There were also references to using other visual representations, particularly the Singapore Bar Method and the use of tables.

The only reference to concrete materials was for questions involving money. This was usually referred to by teachers working with less confident children. However, there were a few teachers who would use physical materials such as examples of clothes.
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Encourage children to check if an answer is possible.

*Does the answer satisfy the criteria for the question? Is the answer possible in the context of the problem? Make sure the children are checking to make sure an answer makes sense.*

There were nine references to children checking their answers as an important strategy. These often related to consider the solution again if there was a remainder. Points were made that children should relate the answer to any realistic context and consider if it was likely.
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Reflecting on the reasoning and choice of strategy.

*Are the children monitoring and reflecting on their reasoning? Are the children reflecting on their methods? Are they checking their arguments?*

As some children are being asked to check their solutions, it is likely that they will be asked to check the approach they used. However, this is only directly mentioned by two teachers.
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Using whole class or group discussion.

For children to show and discuss solutions. To discuss different strategies that have used. To focus on the importance of understanding the problem. To encourage the writing down of workings so that they can be shared. In explaining, children understand their thinking better.

Whilst it is likely that children will be working in groups for part of the time in the classroom. There were only ten references to children sharing methods or writing questions for each other. This important learning strategy was not identified by the majority of the teachers.
Particular focus on using real or realistic contexts.

*Looking to engage children in different contexts and relating a problem to an experience of the context.*

There were eight examples of teachers focusing on situations rather than particular questions. These included cooking a meal, looking buying items from websites, using coins with a partner when buying items, looking for mathematics in other subjects.
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Thank you for your attention