Educator Solutions

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Calculations Guidance

The purpose of this guidance is to support schools in developing and reviewing a calculations policy. Attached is additional guidance from the NCETM, based on the England-China programme that schools may wish to consider.

Key Message
It is essential that all schools have in place a calculations policy that they have written to match the needs of learners in that school. As with all policies this needs to be reviewed regularly and monitored to ensure widespread and consistent implementation.

NCETM Guidance
The guidance produced by the NCETM is useful and reminds us of some of the key ingredients in teaching calculation strategies. For example, the information on developing learners mental calculation fluency reminds us that calculation polices should include reference to both mental and written strategies while the section on understanding the = symbol is also essential. However, we must also remember that the guidance is based on the teaching practice observed in Shanghai schools and in their textbooks.

Norfolk Context
All schools and learners are different. While all calculation polices should have common features there are also choices for schools to make about how they teach calculation strategies, depending on the knowledge and understanding their learners have.

Historically, many learners in Norfolk have struggled to solve subtraction, multiplication and division problems (Borthwick and Harcourt-Heath, 2006). The longitudinal Norfolk research shows that many Y5 and Y8 learners struggle to select an appropriate strategy that leads them to achieve the right answer for their age, particularly for multiplication and division questions.

One of the recurring themes appears to be that too many learners are taught instrumentally, that is they are taught how to solve a question without sufficient understanding (Skemp, 1978). Other reasons include teaching moving on too quickly to different methods, or not building on the progression within a method. The lack of use of mathematical resources is also an issue for some learners who need concrete resources to help support their understanding.

To date we have carried out research with Y5 pupils since 2006 in Norfolk. The evidence shows that the majority of learners who get an answer wrong have often used a ‘formal, vertical

method'. We have compared this to learners who achieve the correct answer, a large proportion of whom use informal methods (e.g. grid method or number lines).

We have also extended the research to Y8 pupils where progress declines in the proportion achieving a correct age related answer, again with high proportions using 'formal, vertical methods'. We have also given Y6 learners from 4 primary schools the Y8 calculation questions and compared them to the answers provided by Y8 pupils. In every case the Y6 pupils out-performed the Y8 students because they employed an informal method.

The Importance of Calculation Strategies Within the Wider Mathematical Context

For the reasons and evidence listed above we have often encouraged schools to delay the teaching of 'formal, vertical methods' until learners are ready, in other words they have the understanding to manipulate numbers and understand the short cuts or 'tricks' of certain methods. We are still mindful to do this.

One of the reasons for this is the success that many schools have found in delaying these methods (or in some cases, not teaching them at all). Results in KS1 and KS2 have risen significantly in those schools that have implemented this and in many schools Ofsted have praised their calculations policies for being applied consistently (e.g. Hillside Avenue Primary School, Norfolk).

The second reason is that informal methods (e.g. partitioning numbers, using number lines, the use of arrays) draw on many of the fundamentals of mathematics needed to solve questions from other areas of the mathematics curriculum. Most questions in mathematics involve some level of calculation. Yet if this is the stumbling block for many of our learners, mathematical progress will be hampered.

One of the new aims of the mathematics curriculum – fluency – requires learners to have number sense, to juggle and play with numbers in order to solve unfamiliar questions. For example, you might know 8 x 5 but not 0.08 x 50. Using your number sense of 8 x 5 learners can see the connections between the numbers and solve the unfamiliar question easily. Formal methods often make it harder for these connections to be seen as numbers are treated as digits, in other words their value is taken away for the purpose of the calculation (e.g. in the question 96 ÷ 6, the formal method requires the learners to ask how many 6's go into 9, not 90).

Cross Phase Cluster Calculation Policies

A recent success in Norfolk has been the development of several cluster calculation polices (e.g. Sheringham Cluster). We very much encourage schools to work together in many different areas and the development of one calculation policy that is used in several different schools within a cluster is a worthwhile project. Mathematics subject leaders have come together to discuss which calculation strategies they know will best suit their learners. A strength in working this way is that all schools from all phases (including the high school) are part of the discussion on which strategies should be included in the policy. Primary schools can discuss with their secondary colleagues the expectations for learners starting Y7 while secondary colleagues benefit from seeing the early stages of development, often needed for some learners in Y7 and beyond.

One of the commonalities we have observed in these cross phase calculation polices is a delay in the teaching of 'formal, vertical methods', sometimes until Y8.

National Curriculum

Previous incarnations of the National Curriculum have not included specific statutory objectives on the methods teachers need to teach. The most recent National Curriculum (DfE, 2013) however, does include specific references to 'formal, vertical methods' from Y3 to Y6. This has caused problems for some schools who already have a calculations policy in place that does not include these methods. It is interesting to note that the KS3 and KS4 mathematics National Curriculum does not include any statutory objectives on the methods learners need to use.

We would like to remind schools that the introduction to the mathematics National Curriculum does make reference to ensuring that teachers follow the statutory guidance as long as it is appropriate for their learners. It is also important to remember that objectives do not need to be covered until the end of a key stage, so while an objective may sit in Y3, it does not have to be covered until the end of Y6.

As we all know and want, the most important goal for learners is that they make progress and achieve age appropriate outcomes. The ability to calculate efficiently and accurately is essential, and yet we know that there are still many learners in Norfolk who are still not able to solve a division or multiplication question accurately (Borthwick and Harcourt-Heath, 2014). Schools need to make sensible decisions on the most appropriate methods they need to teach their learners to achieve mathematical success.

KS2 National Tests

The arrival of the draft KS2 SAT paper has also caused some discussion. This is mainly due to the arithmetic paper, which contains 36 questions to be completed in 30 minutes. It would appear that this draft paper is suggesting that 4 questions (2 for multiplication and 2 for division) will be presented in a formal layout (vertical for multiplication, the bus stop for division). Marking guidance attached to this draft paper is clear that if learners attain the correct answer, the full two marks will be awarded (regardless of the strategy employed). If an incorrect answer is submitted learners will only be awarded a mark if the formal designated method has been used and if only one (not more) mistake has been made that is a place value error.

We understand that schools are worried. However, there is a potential loss of four marks and while every mark is essential and necessary, schools must consider if it is worth teaching learners these strategies (if they are not currently within the schools calculation policy) purely in case learners make a mistake. We would rather encourage schools to strive for their learners to gain both marks in getting the answer right through whichever method is most suitable for their learners.

Paper 2 and Paper 3 may contain questions that appear to be vertical in layout, but our evidence shows if learners have used manipulatives such as digit cards and Dienes equipment they are able to solve them accurately without having been taught a formal, vertical method.

It will be necessary for schools to show learners the different ways that calculations can be presented, but the layout of a question does not determine the way it should be solved. An example is included below:

1022 ÷ 23

1022

23

$23\overline{)1022}$

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Developing Or Reviewing Your Calculation Policy

We suggest the following steps:

1. Carry out a calculations audit across the school. It is important to find out what your learners can and cannot do before making any decisions about the methods you want to teach. Audit questions are available from the Norfolk Mathematics Team. Alternatively, choose an age related question for addition, subtraction, multiplication and division and present it to learners abstractly (i.e. not in a problem). This is important to do whether individual schools or a cluster of schools are writing a policy.
2. Collate and evaluate the evidence, noting in particular the strategies used for correct and incorrect questions. You may like to base this on the grid used in the Norfolk Calculations Research.
3. Whether you are writing the policy as one school or a cluster of schools, gather as many people together to go through each calculation method and discuss the strengths and barriers to using each method. Make sure that you always go beyond the key stage of your learners so that progression is addressed fully.
4. Write a draft policy. Some of the sections in the attached NCETM guidance may help to scaffold the policy (e.g. remember to include mental calculation, algebra, manipulatives, ICT links etc).
5. Include examples of the methods. This will help anyone who may use the policy (all teaching staff, parents, governors). Schools often use real life examples from learners in their school.
6. Ensure everyone has a chance to review and comment on the policy.
7. If the policy is new consider holding a launch event. This may be just for staff within your school, or cluster of schools, or you may wish to invite parents and governors. Some schools have launched the new policy by organizing a PD day.
8. Remember to review your policy regularly and the outcomes for learners. Is it fit for purpose? Are learners in your school making progress in solving calculations?

Concluding Remarks

Historically the Mathematics Team have always encouraged schools and teachers to question the methods they teach, to ensure they are fit for purpose and not habitual or only pertinent to them. Evidence which spans over 16 years shows that this is an area that Norfolk children have struggled with, seemingly because they were taught formal, vertical methods without understanding.

We would like to emphasize that there are primary schools in Norfolk who are teaching formal, vertical methods very successfully. These schools scaffold the learning with conceptual understanding and show learners why these methods work using appropriate models and images. However, when the learners move to Year 7 often the secondary school reports a drop in progress (e.g. Borthwick, Harcourt-Heath and Keating, 2014) and pupils who were successfully completing formal methods in primary school are unable to transfer these skills to more challenging problems.

We hope this guidance has offered some critical and reflective advice that will help you either write a calculations policy or review your current one.

Please do contact the Educator Solutions Mathematics Team if you would like any further support with your calculations policy.

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