

Using and applying mathematics in primary schools



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The first part of this report analyses the progression of problem solving for children between the primary years from years one to six. In the United Kingdom, it is customary for mathematical problems to be treated as contexts in which young learners apply existing knowledge. The National curriculum reflects this fact by using the term ‘using and applying mathematics.’ In the Netherlands, however, problem-solving is viewed somewhat differently. Mathematical strategies and conceptual understandings are developed from the starting point of problem-solving contexts. A delicate balance is required between letting the child have some time and freedom to develop his own approach to strategy to problem solving, and sensitive questioning which develops the child’s thinking. This means that the teacher’s role in this case is quite different from that when teaching different. In such contexts, the teacher’s flexibility and recognition of the likely effect of intervention and non-intervention are critical. The second part of this report gives ideas of teaching strategies that can be employed to promote problem solving and mathematical thinking in the developing children of the United Kingdom.

Part 1: Analysis of the progression of problem solving between the primary years from years 1 to 6

Solving problems is one of the strands in the Using and applying mathematics strand. According to the 1999 Framework for teaching mathematics, numeracy is a proficiency that requires a child to incline to and have an ability to solve problems when given different contexts. This numeracy results in children who are have the confidence to tackle mathematical problems without immediately asking their teachers and

friends to help them. To become problem solvers, children need to solve problems, meaning that children have to be given the space and time to tackle mathematical problems during lessons if they are to become competent and confident problem solvers. In realisation of this, problem solving for the children from primary years one to six has been embedded into mathematics teaching and learning, thereby becoming an integral part of the children's work. The renewed Primary Framework focuses on children solving problems that are set in wider ranging contexts because the children become more confident and skilled. This progression analysis highlights the increasing complexity of the mathematical problems that the children tackle as they move from one year to the next. Through years one to six Block A covers counting, partitioning and calculating. Block B covers securing number facts, understanding shape, Block C covers handling data and measures, Block D covers calculating, measuring and understanding shape and Block E covers securing number facts, relationships and calculating.

Year one

During their first year, children are supposed to solve problems that require them to count, add, subtract, double and halve in the context of numbers, measures and money. In block A of year one, children concentrate on solving problems involving counting and they extend their counting and calculation skills. The children solve problems on estimating the number of objects that they can check when they count. This leads to the children beginning to understand the place value in two-digit numbers, reading and writing numerals to 20 and beyond, relating addition to counting on and to the combination of groups. The children get used to increasing their range of

vocabulary in relation to addition. In block B of year one, children start consolidating their use of patterns and relationships in solving number problems and puzzles. In block C, children get used to taking a greater responsibility in posing and answering questions. In block D, the children compare the length, weight and capacity of two objects without engaging in counting. The children start using uniform non-standard units in estimating, and then measuring length. The children continue working with money as well as continuing in developing the concept of time by ordering the months of the year and reading time. In block E, children continue solving practical problems that involve adding, subtracting, doubling and halving and they record their solutions on a number line or by using a number sentence.

Year two

During their second year, children are gain knowledge in solving problems that involve adding, subtracting, multiplying and dividing in the contexts of numbers, measures and pound and pence. Block A does not cover any problem solving. In block B, children use their knowledge and experience of counting to learn the multiplication facts of 2, 5 and 10. The children learn techniques in solving one and two-step word problems that involve money and measures by using the four operations. In block C, the children learn how solve problems such as they could find out which soft drink is most of the children in the class take, and later making a block graph and explaining what it shows to the others. In block D, children continue to count in ones, twos, fives and tens. These skills come in handy in helping them to tot up a mixed set of 10p, 5p, 2p and 1p coins. The children develop the understanding of number lines to enable them read a range of scales. In

block E, the children build up time-tables from consolidating counting on from zero in steps of 2, 5 and 10. The children describe what they have noticed about numbers in the tables. Using this knowledge, the children predict other numbers that might be in the count. The children understand the multiplication symbol can be used to represent repeated addition. Using a number line, the children support repeated addition and they record the equal jumps on the line and write the repeated addition statement and the multiplication statement that is a match. The children identify the needed operations that can solve a problem and they explain their reasoning.

Year three

During their third year, children are supposed to solve one-step and two-step problems involving numbers, money or measures, including time, choosing and carrying out appropriate calculations. In block A, Children solve problems involving counting, solve number puzzles and organise and explain their written responses to problems and puzzles in a systematic way. The children identify relevant information and select the appropriate operations in order to solve word problems. In block B, the children use patterns, properties and relationships between numbers to solve puzzles. In block C, the Children pose a problem and suggest systematic and appropriate approaches to collecting, organising and representing data in order to solve the problem. In block D, children add or subtract multiples of 10 or 100 and near-multiples to solve word problems and then use practical and informal written methods to solve problems involving multiplication and division. The children recognise that finding fractions of amounts involves division and

find a fifth of a quantity. In block E, the children apply their skills when they solve practical measuring problems.

Year four

During their fourth year, children are supposed to solve one-step and two-step problems involving numbers, money or measures, including time; choose and carry out appropriate calculations, using calculator methods where appropriate. In block A, the children continue to derive and practise recalling multiplication and division facts to 10 – 10. The children consolidate multiplying and dividing numbers to 1000 by 10 and 100. The children develop written methods for multiplying and dividing. In block C, the children evaluate the effect of different scales on interpretation of the data. In block D, Children learn the relationships between familiar units of measurement. Practical activities help children to increase their accuracy of measurement and estimation as well as choosing appropriate instruments and units. In block E, children investigate patterns and relationships. In block E, children count in fractions along a number line from 0 to 1 and establish pairs of numbers that total 1. The children are introduced to the vocabulary of ratio and proportion

Year five

During their fifth year, children are supposed to solve one-step and two-step problems involving whole numbers and decimals and all four operations, choosing and using appropriate calculation strategies, including calculator use. In block C, children test a hypothesis by deciding what data is needed and discussing how they will collect the data. The children use ICT to help them present graphs and charts quickly, and interpret their graphs and

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charts to draw their conclusion. In block D, when the children measure weight, they use a range of scales. In block E, children use multiplication and division to solve problems involving ratio and proportion.

Year six

During their sixth year, children are supposed to solve multi-step problems, and problems involving fractions, decimals and percentages; choose and use appropriate calculation strategies at each stage, including calculator use. In block A, children use a calculator to explore the effect of brackets in calculations. They decide whether or not to use a calculator to solve problems. In block D, children solve practical problems by estimating and measuring using standard metric units from a range of scales. The children draw on a range of mathematics to solve problems involving estimating and measuring. The children communicate clearly how a problem was solved and explain each step and comment on the accuracy of their answer. The children explore area and perimeter of rectilinear shapes. They estimate the size of angles and use a protractor to measure acute and obtuse angles. The children describe the patterns and relationships that they discover. In block E, children solve problems in different contexts, using symbols where appropriate to explain their reasoning. The children identify and record the calculations needed, interpreting the solutions back in the original context and checking the accuracy of their answers.

Part 2: Ideas of teaching strategies to be employed to promote problem solving and mathematical thinking.

Teaching mathematics students how to solve problems is important. These students should be taught how to apply the mathematical problems to

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problems in everyday life. The students should be in a position to do investigational work on the mathematics problem. A problem is a task that does not provide the learner with a clear route to the solution. If the solution to a problem can be arrived at through different approaches, then that problem has some degree of openness. The term ' investigation' is used to describe such an open problem that can be solved through different solutions. An investigation is a good way to enable young learners to use and apply their abilities in mathematical knowledge. There are different levels of openness that are offered by application tasks. Exploratory problem solving is another means by which problems with some degree of openness can be solved. Exploratory problem-solving is a mathematical approach that gives the learner a chance to solve real-life problems. Young learners develop their mathematical thinking by engaging in exploratory and investigative problem-solving. Word problems on the other hand are usually closed problems that have a defined solution and a standard method of calculations is applied. An example of such a problem is: How much change would I receive from a 10 pound note if I bought items costing 2. 59 pounds and 3. 99 pounds? Once the problem has been rewritten using symbols and numbers in a mathematical format, there is usually a standard method carrying out the resulting calculations. Word problems can still offer valuable opportunities for young learners' mathematical thinking.

Word problems can be solved by either a horizontal or vertical mathematising process (reference). The horizontal mathematising process is the easier of the two and is a strategy commonly used by children to solve word problems. Horizontal mathematising is whereby symbols are used to

represent items in a mathematical word problem. Vertical mathematising is whereby the model created in vertical mathematising needs to be adapted in order for the answer to the mathematical word problem to be figured out. Askew gives two questions that are used to demonstrate the complexities surrounding word problems. The first question is: Mrs. Chang bought five video tapes that cost the same amount. If she spent 35 pounds, how much did each tape cost? The second question is: Mr. Chang bought some tapes that cost 7 ponds each. How many tapes did he buy? The first question is easier for children to solve because they can use fingers as a symbol of the number of tapes. The use of symbols supports the children's thinking within the purely mathematical context and enables them to arrive at an answer by trial-and-improvement techniques (reference).

Research findings show that children solve word problems by making use of a wide range of informal strategies (reference). The mere use of models, however, is not adequate enough for many children who are trying solve a word problem. This is because word problems require that the children translate to and fro between the real world context and the mathematical world. Switching between the physical world and the mathematical world is difficult because there exists a mismatch between these two worlds. When the teacher is made aware of this issue it provides a way forward. In the example of Mr. And Mrs. Chang, children should be asked to compare the problems. This will help the children appreciate the complexities of solving such mathematical problems. Children should also be helped to categorize word problems in order to help them appreciate similarities and differences in the structure of mathematical problems. The children's reasoning skills will

be put into use if they were to have a simplified approach and solution strategy on how to solve particular classes of mathematical problems.

A different approach to problem-solving known as Realistic Mathematics Education is used in the Netherlands. This approach is based on the belief that children should reinvent mathematics by being given guided opportunities to tackle mathematical problems. Thus, the intention of realistic mathematics education is helping the children's mathematise contexts which they find meaningful to them. Through the children's participation in the learning process, they develop mathematical understanding and strategies to solving problems. In England, problem-solving is used as a means by which children can solve context-based problems. However, in the Netherlands, context problems are used by Realistic Mathematics Education as a basis for the learning process. The context of a city bus is a good example of a context building up mathematical knowledge. The children are faced with a real life situation where they act as the bus driver. Bus passengers get into and off the bus at designated bus stops, and the children count the new number of passengers in the bus. When they go back to class, the students show the findings from the bus in their books. Without the teacher having to tell the children to write down their findings while they are in the bus, the children develop a need to keep track of the number of passengers in the bus at a given time. At first, the children develop a mathematical language that is closely connected to the context. This knowledge is later used in describing other situations. This way, children's conceptual understanding of related strategies from within

the contexts of the problem is developed from the realistic mathematics education principle.

Conclusion

When different approaches to teaching problem-solving are put into consideration, then the purpose of teaching problem-solving will be re-evaluated. A problem-solving approach helps pupils in approaching all kinds of mathematical problems in a more structured way. Transferable skills such as practice in looking for strategies and relationships in a problem-solving situation, and identifying the important features of a problem and ignoring the redundant information, can be used in all area of mathematics. The challenge is to determine a way to ensure that when children learn mathematics, they are able to transfer the skills, knowledge and understanding learnt from one context to another. A teacher's role in supporting children's learning is of crucial importance.