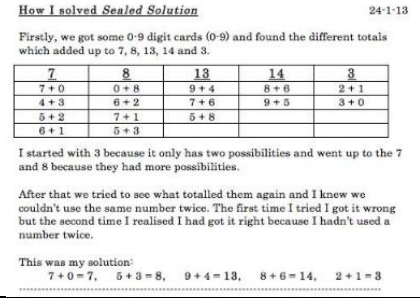
Coates Primary School

The progression of skills for problem solving at Coates Primary School. Progression of skills adapted from Nrich and developed in conjunction with NCETM progression documents.

Step One	Step Two	Step Three	Step Four
Getting started	**Working on the problem**	**Digging deeper**	**Concluding**
Offering them strategies to help them engage with the problem. These could be prompts such as:	*Involve using one or several problem-solving skills such as:*	*When the problem has been explored and then it is possible to look for generalisations and proof.*	*The problem-solving process where we support the children to learn to explain their findings both verbally and in writing.*
• Tell me/a partner what you think the problem is about. • What would help you understand the problem? • You might like to draw a diagram, act it out or represent it with a model. • What other problems have you seen that are 'a bit like' this one? • What mathematical skills have you got that could be helpful here? • Try making a simpler case to get an idea of how the problem works.	• Trial and improvement • Working systematically (and remember there will be more that one way of doing this: not just the one that is obvious to you!) • Pattern spotting • Working backwards • Reasoning logically • Visualising • Conjecturing.	Here is an example of generalisation and proof from N rich activity "Make 37" This problem is not possible because with an even number of odd numbers you cannot make an odd number. You can make 36 and 38 using 10 numbers but not 37. You can make 37, but by using 9 numbers. Here are some examples: 36 (10 numbers): 5 + 5 + 5 + 5 + 5 + 3 + 3 + 3 + 1 + 1 38 (10 numbers): 1 + 1 + 1 + 3 + 3 + 5 + 5 + 5 + 7 + 7 37 (9 numbers): 5 + 5 + 5 + 5 + 5 + 5 + 5 + 1 + 1 Or from the "sealed solution": We started off by thinking of all the possible ways of making the totals. This took a long time. We thought that it would be best to make the biggest totals first, using the bigger numbers to make them: 14 = 9 + 5, 13 = 6 + 7, 1 + 2 = 3, 4 + 3 = 7 and 8 + 0 = 8. Some of us did it the other way round, making the smallest totals first, with the smallest numbers: 1 + 2 = 3, 4 + 3 = 7, 8 + 0 = 8, 7 + 6 = 13 and 9 + 5 = 14. We could also come up with pairs randomly but it's quicker to use a strategy. 7 + 0 = 7, 5 + 3 = 8, 9 + 4 = 13, 6 + 8 = 14 and 1 + 2 = 3. Or:  How I solved *Sealed Solution* 24-1-13 Firstly, we got some 0-9 digit cards (0-9) and found the different totals which added up to 7, 8, 13, 14 and 3. 7: 7 + 0, 4 + 3, 5 + 2, 6 + 1 8: 0 + 8, 6 + 2, 7 + 1, 5 + 3 13: 9 + 4, 7 + 6, 5 + 8 14: 8 + 6, 9 + 5 3: 2 + 1, 3 + 0 I started with 3 because it only has two possibilities and went up to the 7 and 8 because they had more possibilities. After that we tried to see what totalled them again and I knew we couldn't use the same number twice. The first time I tried I got it wrong but the second time I realised I had got it right because I hadn't used a number twice. This was my solution: 7 + 0 = 7, 5 + 3 = 8, 9 + 4 = 13, 8 + 6 = 14, 2 + 1 = 3	Written recording could be in the form of a photograph, Presentation of ideas, Drawing/jottings diagram or written explanation. *See Reasoning progression document.*

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Trial and Improvement	Working systematically	Patterns	Working backwards	Logical reasoning	Visualising	Conjecturing and generalising
Trial and Improvement at KS1 Trial and Improvement at KS2	Working Systematically at KS1 Working Systematically at KS2	Number Patterns Feature	Working Backwards at KS1 Working Backwards at KS2	Reasoning and Convincing at KS1 Reasoning and Convincing at KS2	Visualising at KS1 Visualising at KS2	Conjecturing and Generalising at KS1 Conjecturing and Generalising at KS2
Trial and improvement is perhaps an undervalued skill. Children can be reluctant to use trial and improvement as they sometimes feel they are only using it because they do not know the 'right' way to solve the problem in hand. In reality, trial and improvement involves trying something out, which will always give more insight into the context and therefore gives the solver a better idea of what to try next. Trial and improvement is often the start of working systematically.	In the context of problem solving, working systematically could be thought of as working in a methodical and efficient way which could clearly show others that a pattern or system is being used. This is important, for example, when a task entails finding all possibilities, or when it is helpful to structure a method for solving a problem. More details about what it means to work systematically can be found in the article Encouraging Primary Children to Work Systematically	During the problem-solving process, being able to identify patterns can save time. However it is by then asking why the pattern occurs, and by trying to answer this question, that learners gain greater insight into mathematical structures and therefore deepen their conceptual understanding.	Starting from the end might sound counterintuitive, but it can be an efficient way of solving a problem.	Reasoning logically as a problem-solving skill is, however, just a small part of reasoning and involves connecting information together in a sequence of steps.	Picturing what is happening in your mind's eye, or imagining what is happening or what might happen, is a skill which is perhaps not talked about very much in the classroom. Specifically drawing attention to instances when it might be used will raise learners' awareness of this skill so that they might use choose to use it themselves.	Conjecturing, or asking "What if..?" questions, is an important problem-solving skill. Knowing what to ask means that you understand something about the structure of the problem, and being able to see similarities and differences means you are starting to generalise. Caleb Gattegno once said, "If it's not shot through with infinity it's not mathematics". In other words, there must be generality for it to be mathematics.

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