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Improving mathematics in the early years and key stage 1

Introduction and background

Early mathematical understanding for young children is strongly associated with later school achievement. However, not all children learn the skills they need to succeed. In 2018, just 66 per cent of disadvantaged children achieved at least the expected level of development for number at the end of the Early Years Foundation Stage compared to 82 per cent of their peers. Once children fall behind, it is hard for them to catch up and they are likely to fall further behind throughout school.
This is why the Education Endowment Foundation (EEF) have produced this guidance report. It follows on from an earlier report on teaching mathematics at Key Stage 2 and 3, which was published in 2017. It offers 5 practical recommendations to support the learning of children aged 3 to 7 in the early years and Key Stage 1. The recommendations are based on the best available international research and consultation with experts. In the full report, they are illustrated with examples to help practitioners put the evidence to good use. The EEF emphasises that the recommendations do not provide a 'one size fits all' solution and that they must be considered within a school's particular context with sound professional judgement.
The EEF will also produce a number of additional resources that will sit alongside this guidance report to support practitioners to build on these recommendations and put them into practice.

Key points

Recommendation 1: develop practitioners' understanding

- Effective mathematics teaching requires knowledge of mathematics pedagogy and learning as well as of mathematics itself. This includes knowledge of how children learn mathematical concepts, connections between mathematical concepts, likely difficulties children may have, and different approaches to solving problems or tasks.
- Professional development should therefore focus on the integration of three areas: mathematics itself, children's mathematical development, and effective mathematical pedagogy.
- Teachers need to be aware that mathematical development involves acquiring skills, conceptual understanding, and factual knowledge across a range of topic areas, including quantity and number, operations, shape, and space. It involves forming connections between concepts, such as understanding that addition is the inverse of subtraction.
- The rate of mathematical progression relies not only on knowledge, but also on a range of skills such as working memory, language skills and motor skills. Children's attitudes and interests must also be taken into account.
- It is important that teachers are aware of the key role of metacognition (the ability to reflect on one's own learning processes) and self-regulation (the ability to manage one's emotions and behaviour). Teachers can support children to develop these skills by describing the child's strategies and approaches linked to thinking and learning. For example: 'I can see that you are thinking really carefully about where the corners are on the jigsaw pieces—that could help you to find the right place for it'.
- Teachers need a sound understanding of children's 'developmental progressions', i.e. the paths which children follow in developing an understanding of a mathematical concept. They also need to understand that there is considerable overlap in development and that children may develop several skills in parallel. Development is not linear, but rather follows a spiral pathway. The full report includes examples of spiral models related to number, operations development and geometry.

Recommendation 2: dedicated time for mathematics

- Practitioners should dedicate time each day for purposeful mathematics activity. In the early years, activities are likely to be short and active. Mathematics can be explored through a range of contexts, including books, puzzles, songs, rhymes, puppet play and games.
- Using storybooks to teach mathematics can be particularly effective, through providing an opportunity for mathematical talk and questioning. Development and Research in Early Math Education (DREME), a research network, provides evidence-informed guidance for practitioners on choosing books with appropriate mathematical content along with 'Storybook Guides'.
- Games can be an engaging way to practise and extend skills. There is some evidence that board games with linearly arranged, consecutively numbered, and equal-sized spaces, such as Snakes and Ladders, may be particularly beneficial to numerical understanding.
- An example from the Mathematical Reasoning project, evaluated by the EEF is the caterpillar game. In this game, the teacher projects a slide on the board with 2 number caterpillars and the class plays as two teams racing to reach the end of the caterpillar. Each team throws the dice and pupils work out where their mark will be by counting on

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from where the marker is. In order to finish and win the game, the team must end exactly on the last square, requiring them to work out what number they need to finish.
- In an evaluation, the EEF found that children who experienced the Mathematical Reasoning approach made an additional 3 months' progress in mathematics compared to a control group.
- Practitioners should reinforce mathematical vocabulary—for example by making a comment about which child is standing 'first', 'second', or 'fourth' in line, which child has 'more than' or 'fewer' objects than another child, or helping children rephrase statements that use ambiguous, non-mathematical language, such as refining 'big' when the child means 'tall'.
- Mathematical language can be integrated into other areas of the curriculum. For example, children in a Y2 PE lesson worked out ways of recording progress after playing a game in which they did rallies of throws and catches.

Recommendation 3: using manipulatives and representations

- A manipulative is an object which children can use to represent mathematical ideas. Manipulatives can include everyday objects such as pinecones, buttons, and small toys as well as resources like interlocking cubes. A 'representation' is a particular form in which mathematics is presented such as drawings, symbols, diagrams or graphs.
- There is some evidence that physical movement and gestures may support the learning of mathematics, for example, moving along a physical number line, or jumping and clapping while counting. Fingers can also be important manipulatives and practitioners should encourage children to use them.
- It is important to ensure that children understand the links between the manipulatives and the mathematical ideas they represent. For example, a child may be confident using Dienes blocks to add but be unable to connect this to a written addition.
- Practitioners should support children to become familiar with a repertoire of strategies to use to represent mathematical ideas, including their fingers, drawings, and marks such as tallies and arrows. Children should be free to invent and explore their own representations.
- Teachers should ensure that there is a clear rationale for using a particular manipulative or representation to teach a specific mathematical concept.
- As their understanding develops, children should be encouraged to represent problems in their own way, for example with drawings and marks. They can also work in pairs and small groups using manipulatives to solve problems and ask each other questions about strategies and reasoning.
- Evidence demonstrates the importance of showing children different representations of number and then helping them to make connections between them. For example, understanding that the numeral '3', a 3 on a dice face, 3 cubes, and a 3-step on a number line all represent aspects of 'three'.

Recommendation 4: building on what children already know

- Since children have different starting points and experiences, teachers need to assess what children already know. They should take opportunities throughout the day to do this, for example through observation as children play games or engage in block play or counting. The questions which teachers ask should be open, for example, 'How did you know?' or 'What did you do first?' This type of questioning will also help teachers to better understand why a child has made a particular error.
- When planning a task or activity to collect information, it is important for practitioners to plan exactly what information they want to get out of the activity and what they will do with the information.
- There are some well-researched common errors that children typically tend to make when learning to count. An effective method of checking children's understanding of counting can be to ask a child to judge if a puppet is counting correctly. Under these conditions, children can often detect counting errors better than they can perform the counting task themselves.

Recommendation 5: high quality targeted support for all children

- Settings should focus on mathematics planning and pedagogy, which supports all children. When this is effective, there should be less need for extra support.
- In order to make the most of targeted support, teachers should: use more experienced staff to support the children with the greatest needs; provide training and support for staff using targeted activities, including structured resources or activity plans; provide brief regular sessions, prioritising quality over quantity; and make explicit connections between targeted support and everyday activities or teaching with discussions between teachers and practitioners delivering additional support.
- There is evidence that interventions delivered through computers or apps can have a positive effect on children's attainment in mathematics. However, simply delivering an intervention through a computer doesn't make it effective; the intervention must be based on strong pedagogy. The EEF's 'Using Digital Technology to Improve Learning' report provides more guidance on the use of digital technology.
- Resources like the EEF's Promising Projects list and the Evidence 4 Impact database provide guidance on the existing evidence for different programmes. Using a programme that has been evaluated and found, on average, to be effective is a good starting point.
- One example of an effective intervention is one billion - an app-based mathematics learning programme for 3-6 year-olds. A 'virtual teacher' provides oral explanations and visual demonstration of each topic, and then the child works through a number of activities for each topic before completing an end of the topic quiz. Feedback is given after the child's answer. Children at their own pace with sessions supervised by an adult (usually a TA). should have time to discuss this work with their colleagues.
- A randomised controlled trial of the programme with Y1 pupils found that those using it made an additional 3 months progress in mathematics.