



Figure 1
Developing
sorting and
counting skills
using seeds

Andy Markwick looks at how you can assess mathematics mastery by working scientifically

Working scientifically and assessing mathematics mastery

Exploiting the special synergy between science and mathematics can deepen children's understanding of scientific concepts and ideas and provide a range of contextualised opportunities for children to apply their mathematical knowledge and skills (Markwick and Clark, 2016). With some creative thought and careful planning, science activities can be developed so that they require application of mathematics.

This article explores how a science investigation focused upon grouping (classifying) seeds and observing plant growth can be utilised in the assessment of children's competency in applying place value (partitioning),

addition and subtraction and using appropriate units of measurement in solving problems. Taken together the evidence can support judgements made about a child's mastery of key mathematical areas.

Mathematics in the National Curriculum in England

The mathematics curriculum places great emphasis upon establishing a secure understanding, and ultimately a mastery, of mathematics content in each year (DfE, 2014). Acceleration towards subsequent year content is strongly discouraged. Rather, the intention is that children are exposed to a rich and increasingly sophisticated

range of problems derived from the appropriate age-related content. The key mathematical competencies being developed are:

- **fluency in mathematical ideas, which requires cognitive variation of tasks and consistent practice;**
- **reasoning and problem solving, by arguing, justifying and proving, employing a cognisance of enquiry methodology and application of mathematical knowledge and skills.**

Understanding and assessing mastery

Mastery requires children to have a deep understanding of mathematics and a secure foundation that precludes

Key words: ■ Working scientifically ■ Mathematics ■ Assessment



Figure 2 Sorting and grouping the seeds

Figure 3 (right) Recording the number of each type of seed/bean on a pre-prepared worksheet



- count the number of each seed type accurately;
- partition numbers into tens and units (ones).

Additional challenges might include:

- ask children to display the seeds in order of increasing number;
- introduce inequality symbols $<$ and $>$ by providing some examples such as $7 > 5$ and $3 < 4$; then ask children to choose two types of seed and relate their numbers using the inequality signs, for example from Table 2, mung (24) $>$ corn (18) and corn (18) $<$ cress (47);

the necessity for repeated learning (NCETM, 2015). Furthermore, the NCETM considers mastery to involve an ability to flexibly and fluently apply mathematical knowledge and skills, using well-defined reasoning, to solving problems. It advises that using formative approaches such as teacher–pupil dialogue and well-planned classroom activities, rather than relying solely upon repeated testing, better supports assessment of mastery (NCETM, 2015).

An exemplar activity

Being able to assess mastery of key mathematics knowledge and skills requires their application to solving problems within unfamiliar contexts. This science activity demonstrates how year 2 (age 6–7) children’s mastery of mathematical skills can be confidently assessed. Table 1 summarises the key science and mathematics knowledge and skills being assessed.

Part 1: Grouping and counting

Children are given a jar containing a variety of different seeds. They are asked to group the seeds and then to count them (Figure 2). Once counted children are asked to write

the number of each type of seed into a pre-prepared worksheet (Figure 3). The numbers of each seed can be changed so that appropriate challenge is planned for each group (Table 2).

Part 1 gives pupils the opportunity to demonstrate whether they can:

- group seeds using their appearance;

- provide children with the second worksheet (Figure 4) and ask them to match the seeds/beans to the plants.

Part 2: Measuring, adding and subtracting

The second part of the activity, set out in the third worksheet (Figure 5), provides greater

Table 2 Introducing stages of challenge to the activity

Type of bean/seed	Stage 1	Stage 2	Stage 3
Mung	3	24	121
Haricot	7	31	94
Corn	8	18	37
Coffee	5	13	20
Cress	10	47	140
Broad bean	12	6	4

Table 1 Key science and mathematics knowledge and skills being assessed

Science learning	Mathematics being assessed
<ul style="list-style-type: none"> ● Grouping and classification, learning plant names ● Germination and plant growth ● Working scientifically 	<ul style="list-style-type: none"> ● Number partition ● Addition ● Subtraction ● Linking ‘real’ number to equations

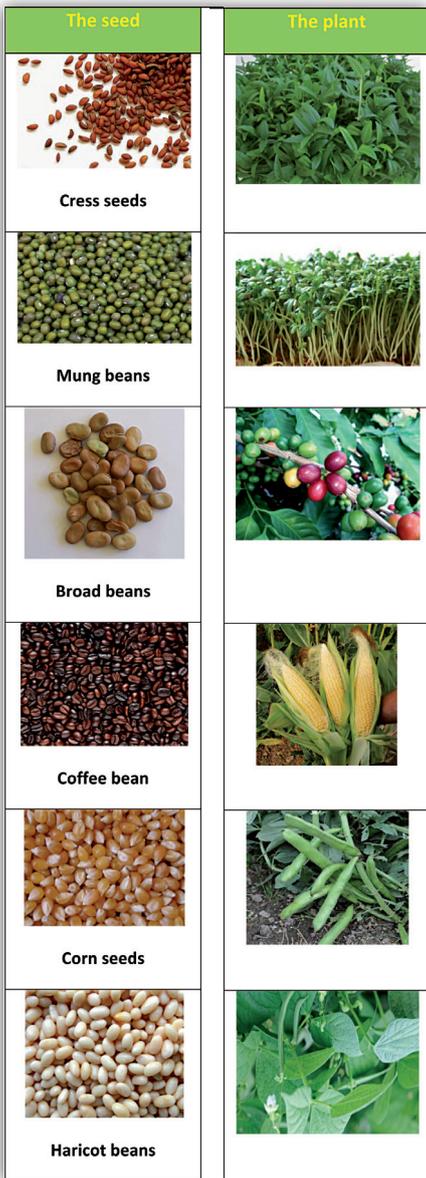


Figure 4 The worksheet exercise for matching seeds/beans and plants

challenges for the children by providing opportunities for them to demonstrate whether they can:

- measure in mm;
- add and subtract numbers.

Part 3: Seed germination and growth

Part 3 focuses upon seed germination and growth. Children are introduced to a problem using a story. The story asks children to plan and carry out an investigation on the rate of plant growth and, from their results, determine which seed/plant would be best to solve the problem. Not only does this investigation teach children about germination of seeds and subsequent plant growth, but it also provides opportunities for them to measure the rates of growth of different plants.

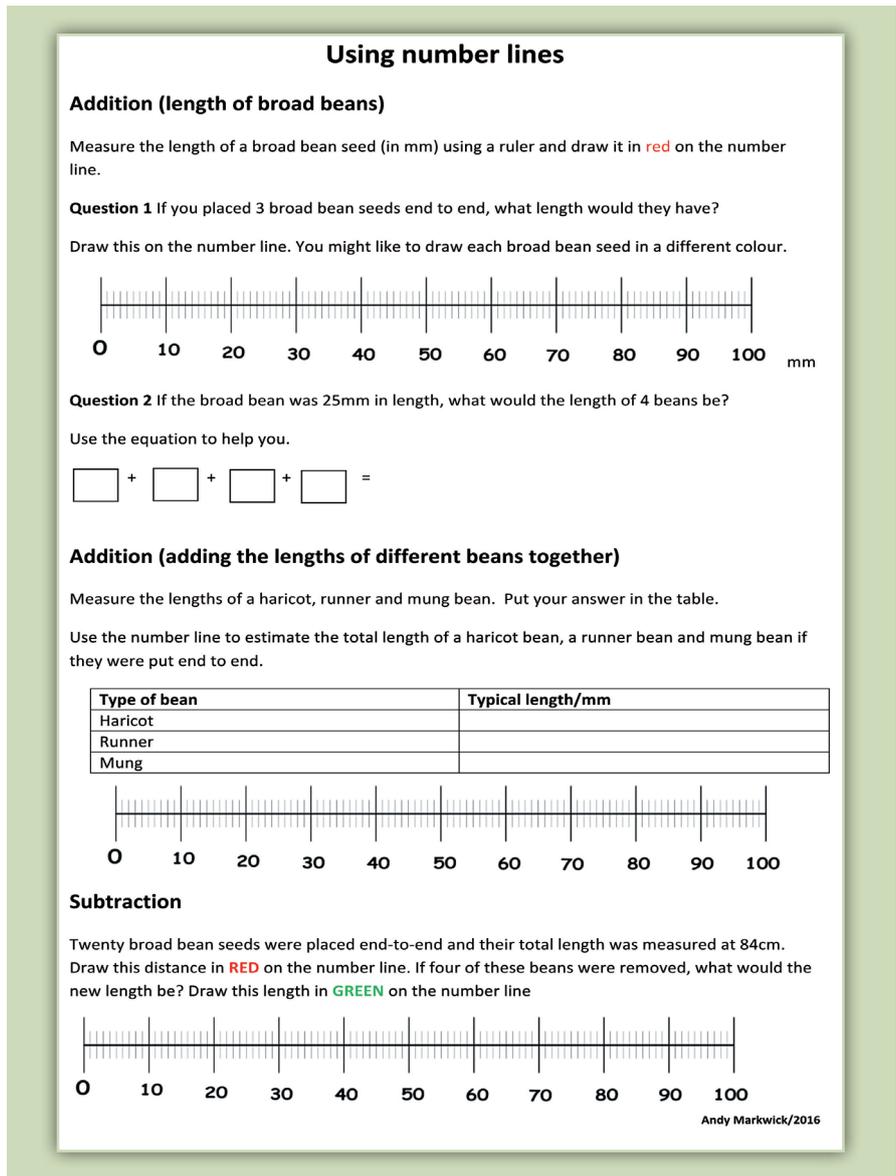


Figure 5 Worksheet for assessing measuring, adding and subtracting skills

Conclusion

These activities demonstrate that children's experience of learning science can be enriched when application of mathematics is built into lessons. It also shows how such activities can be used to assess competencies in mathematical knowledge and skills and so establish an understanding of children's levels

of mastery in mathematics. The final activity shows how English can be integrated with science and mathematics.

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References

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