Progress in the first year at school

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Introduction

Children normally start school at the age of four in state-maintained schools in England. This year is known as the Reception Year. In the time up to their starting school children will have had a wide range of learning experiences, and a good teacher will want to find out as quickly as possible what new pupils know and can do. It is also important to the teacher and other teachers within the school to know what progress they make in the first year at school. This paper draws upon an analysis of data produced by a computer-based assessment (BASE – not an acronym) that teachers carried out with their pupils shortly after the children entered full-time education in the Reception class, and that was repeated at the end of the year. The paper describes what children could typically do when they started school and the progress children typically made in their first year at school.

Background to the BASE assessment

In 2015, the Department for Education (DfE) introduced the idea of a statutory baseline assessment for use in the Reception Year in state-funded schools. In response to this requirement, the Centre for Evaluation and Monitoring (CEM) created a new baseline assessment named BASE which was accepted as one of three assessments that schools could use to fulfil their statutory duties. The assessment was offered to all CEM schools currently using an earlier baseline assessment and to new schools that chose to use BASE from the three options available. The first year of assessment was the academic year beginning in September 2015.

The DfE's decision to introduce baseline assessment was not without its opponents. Critics of early assessment (Bradbury, 2019) frequently argue that testing children results in them being "labelled". The BASE assessment was never designed to "label" children, but was constructed to allow teachers to discover the skills and knowledge already possessed by children and to help them to build upon these.

Following the pilot year, a small number of items in the BASE assessment were reviewed and replaced in response to user feedback, making the first stable year for BASE the academic year starting in September 2016. Since its inception, the BASE assessment has also been offered to other CEM assessment users, such as those in independent schools, international schools, and schools in Scotland. As the number of state-maintained schools using the assessment has diminished, the rise in other schools taking up the assessment has changed the demographic representation of the sampled population. Despite the changing composition of schools and pupils taking the BASE assessment, it has remained popular, being taken by an average of 26 000 pupils each year since 2016.

The BASE assessment

BASE is administered within the first few weeks of the child starting in the Reception class. It is taken on a computer on a 1:1 basis with a teacher or other suitable adult. A cartoon character on the computer screen asks questions and the child answers, either verbally or by pointing to an object on the screen. The response is then marked on screen by the teacher.

The assessment is not fully computer adaptive but uses a simple "three wrong and move on" algorithm, ensuring that if questions get too hard, further questions of greater difficulty are not asked. Once a child's level of ability is reached in a particular section the assessment moves on to the next topic. Reports are then generated showing which questions the child answered correctly and a score showing where they stand in the overall ability range for the national BASE cohort starting in that year. The child is then assessed again at the end of the year and measures of progress can be established.

The BASE assessment consists of over 200 questions in 13 sections. The difficulty of these questions ranges from questions appropriate for typical 3-year-olds up to questions appropriate for typical 6-year-olds. Due to the adaptive nature of the assessment, only the most able children will see all the questions in each section. When the children are assessed again in the end-of-year assessment (EOY), typically children will not see questions they have already answered correctly in the start-of-year assessment (SOY) but will be moved on to questions they have not yet seen. The questions chosen for analysis in this investigation were drawn from the initial section in each assessment area (maths, literacy etc.,), ensuring that most of the children would be offered these questions.

Table 1: The sections of the BASE assessment analysed.

Section name	Number of questions
Concepts about Print	10
Repeating Words	9
Vocabulary	14
Letter Recognition	26
Word Recognition	6
Shapes	5
Counting and Numerosity	6
Numbers	23
Numeracy 1	9
Total	**108**

What do 4-year-olds typically learn in school?

When children start school, it may be the first time that they have been in an academic environment. Some, though, may have attended a nursery, playgroup or kindergarten where there was some formal teaching occurring. For others, the child's parents or siblings may have involved themselves in the child's learning. Every Early Years programme is designed to teach children the basic skills they need to make sense of the world around them and to access formal education as they grow up. To this end, Early Years education concentrates on early number and literacy work. The sections of the BASE assessment are grounded in educational research to provide teachers with important information about the children they teach.

Mathematics

The development of a sense of number is the foundation of all mathematics. Psychologists have found that children are born with a basic concept of numerosity, and that very young children will show surprise or concern when one toy is surreptitiously removed from a small number of toys they have been looking at (Feigenson et al., 2002; Langer et al., 2003). It follows then, that learning mathematical concepts does not start at school and some children have been introduced to single digits and even to numbers with two or three digits, so there are BASE questions to cover that area. Two things are being addressed here; firstly, that the child can distinguish between the single digits by their shape, but secondly, that they know a name for that digit. This part of the assessment does not assess the concept of number itself, but digit recognition can form the groundwork for understanding place value and how number systems work.

Counting is also an area where children can develop an early sense of number. Counting combines digit identification with the concept of cardinality, that is, the number of items in a set. Children begin to understand that counting involves visiting each element in a set and assigning a number to it. The final number they reach is also the size of the set (Schaeffer et al., 1974; Nunes & Bryant, 2009). This is by no means simple, and as the size of the set increases, children develop strategies to keep track of the elements they have counted and those they have yet to count. Once they have established strategies for counting groups of objects, children normally move on to problems involving 'counting on' or counting back', that is, they are beginning to understand the concepts of addition (counting on) and subtraction (counting back) (Nunes & Bryant, 2009). These skills lead on directly to sharing (division) and counting groups (multiplication).

The ability to recognise shapes is an important precursor to the understanding of geometry and there are subtleties to a child's learning in this area. Young children can often distinguish between a square and a triangle but understanding that a square rotated through 45° is still a square, can often be too hard for them (Tall, 2013). At first, children are distinguishing shapes by their gross morphology, but as they learn more about shapes, they start to understand the nomenclature based on the number of sides (hexagon, pentagon etc.).

Reading

Learning to read is a complex process which is initiated by the child developing an understanding that print conveys information. By reading to young children and observing where their attention lies it is possible to capture some fundamental behaviours relating to visual perception, mental processing and motor development. Asking children to point to parts of the story uses a combination of these basic behaviours to make sense of the text being shared. This is the basis of Concepts About Print developed by Marie Clay in New Zealand (Clay, 1989). Clay established some fundamental skills that young readers (and pre-readers) develop. Among these are the correspondence between each word they read and the word on the page, directionality (in Western texts, pages are read from left to right) and the relationship between letters, words and sentences. These ideas are shared, along with the recognising and naming of individual letters and ultimately words, in the concept of 'Emergent Literacy' advocated by Whitehurst and Lonigan (1998) but based on Marie Clay's doctoral dissertation entitled 'Emergent Reading Behaviour' (Clay, 1966). Emergent literacy is seen as a continuum which starts with pre-reading. The concept also considers the interdependence of reading, writing and oral language in the development of literacy.

The ability to recognise individual letters and associate them with specific sounds is fundamental to learning to read. Most schools use a specific phonics scheme to teach children the sounds of individual letters and how they are modified when they appear together. A pilot of the synthetic phonics approach in schools in Clackmannanshire, Scotland, (Johnston & Watson, 2005) showed a promising result and, following a review by Sir Jim Rose ("The Rose Report", Rose, 2006), a former director of inspection at Ofsted, English state schools were heavily encouraged to adopt a synthetic phonics scheme. However, a systematic review carried out by Carol Torgerson and her colleagues at the Universities of York and Sheffield (Torgerson et al., 2006) found no statistically significant evidence for the use of synthetic phonics. Opponents of the phonics method of teaching point out that phonics works very well when there is a one-to-one relationship between letters and sounds in languages such as Italian, Greek and Spanish (Goswami, 2008), but that languages like English, where the letter "a" takes different sounds in common words such as "car", "talk", "cat" and "make" do not lend themselves as well to a phonological approach. The BASE assessment avoids these debates by recognising that children starting school are likely to have been taught some letters and letter sounds, but not necessarily using a specific phonics scheme. As such, it accepts the name or the sound as a correct answer to the recognition of a letter.

Word recognition provides an insight into a child's letter recognition, phonics, and their development of reading. Simple consonant-vowel-consonant (CVC) words such as "cat' or "dog' can be read by using a phonological approach, but given time, these words may be recognised without sounding them out. As Nation and Snowling (2004) point out, there is a distinction between decoding and word recognition, and reading fluency depends on automatic word recognition of familiar words.

Building a wide vocabulary is also extremely important in the development of reading skills. The vocabulary section of the BASE assessment concerns itself with the ability of the child to make sense of the world around them by naming the things they see. A number of studies (Lee, 2011; Hayiou-Thomas et al., 2012; Bleses et al., 2016), have established a link between vocabulary size and future achievement.

The responses to BASE questions in the areas described above can provide evidence of the progress any child has made. This evidence can be in the form of the final score (how many questions they answered correctly), but also in a qualitative way (how familiar was the child with letter or numbers, adding or reading simple words?). This evidence provides a richer picture of the child's skills and understanding of these basic concepts, which is of great benefit to teachers planning their lessons.

Method

BASE item-level data for the academic years beginning 2016 (32 047 individual pupils), 2017 (22 127 individual pupils) and 2018 (16 457 individual pupils), (total 70 631 individual pupils) was obtained for both SOY and EOY assessments. Although data was available from many different schools, this analysis was restricted to results obtained from state-maintained schools in England only. Initial sections of the assessment were chosen for analysis, covering the first stages of Literacy and Numeracy. These are shown in Table 2.

Table 2: Initial sections of the BASE assessment.

Area	Concept	How it is assessed
Literacy	Concepts about Print (CAP)	The child is asked to point to individual letters, words, where to start reading and some punctuation in a page of text shown on the screen.
Literacy	Letter Recognition	The child is shown letters of the alphabet, some as lower case and some as upper case. An acceptable response is either the sound or the name of the letter.
Literacy	Word Recognition	Here the child is shown very short (two or three-letter) words and asked to read them out loud.
Literacy	Vocabulary	The child is shown a series of pictures and asked to point to specific objects within each picture.
Numeracy	Shapes	The child is shown a picture containing many different shapes and is asked to point out specific ones (square, triangle etc.).
Numeracy	Number Recognition	The child is shown single-digit, then two-digit and higher numbers and asked to name them.
Numeracy	Counting	The child is asked to count items of varying numbers starting from four and increasing to numbers in the thirties.
Numeracy	Numeracy 1	The child is asked to do simple arithmetic such as addition or subtraction.

The data from all three years was combined and the items calibrated with an IRT (Rasch) model. For ease of interpretation, in the results section the item difficulties are presented as estimates (based on the model) of the percentage of the entire population of test-takers that would have answered them correctly if all the items had been presented to everyone. A higher percentage value therefore represents an easier item.[1]

Results

Concepts about Print

Figure 1 shows the item difficulties for the start and end of the year for all children combined when they were asked to point to specific items on a page of text.

1 A Marginal Maximum Likelihood (MML) algorithm was used to estimate the IRT model parameters in order to account correctly for the non-random nature of the missing data arising from the partially adaptive item selection algorithm in the BASE test. For further details see Eggen & Verhelst (2011).

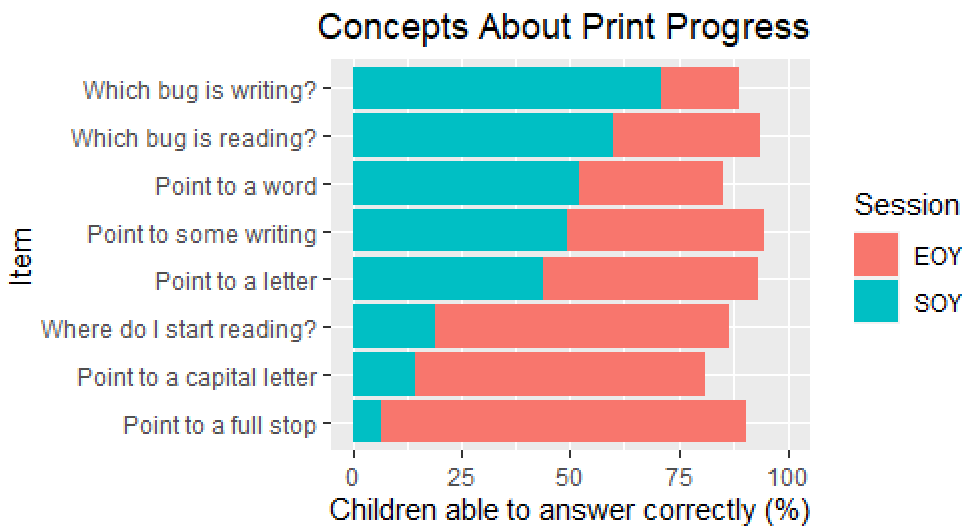

Figure 1: Concepts about Print items, difficulties and progress.

The easiest item required the child to point to someone who was writing. 71 per cent of pupils could do this at the start of the year, rising to nearly 89 per cent at the end of the year. The next easiest was pointing to someone who was reading. 59 per cent of pupils could do this at the start of the year and around 94 per cent by the end of the year. Fewer than 20 per cent of children entering school knew about full stops, capital letters or where to start reading, but by the end of the year 81 per cent or more were able to do this.

Letter Recognition

Figure 2 shows the difficulty values for the start and the end of the year for each letter of the alphabet. Note that some letters are capitals, and some are lower case. For expediency, the assessment does not ask children whether they recognise each letter as lower case and then again in upper case as it would be extremely time consuming. Moreover, the time for which young children can concentrate on a single task type is limited.

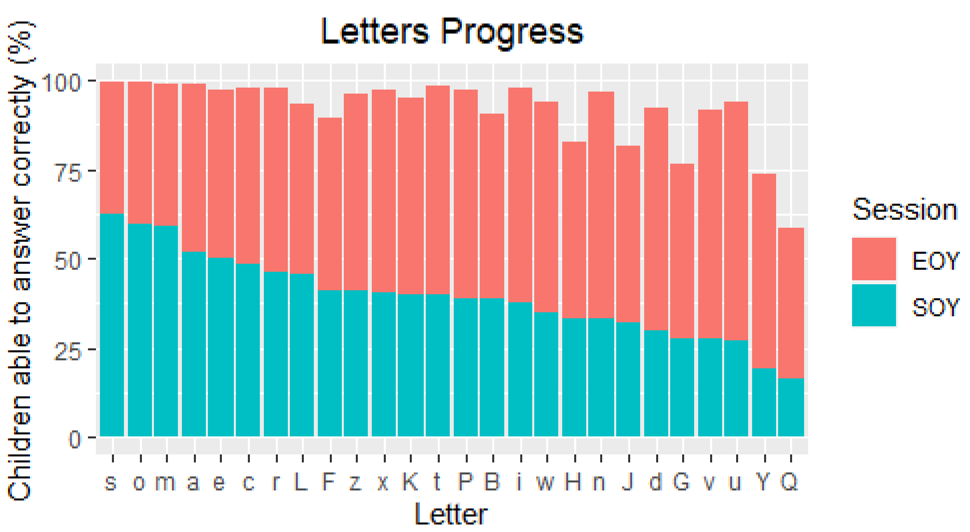

Figure 2: Letter Recognition items, difficulties and progress.

At the start of the year the most recognised letters were lower case “s”, lower case “o” and lower case “m”. Around 60 per cent of children were able to recognise them. The hardest letters for children to recognise were upper case “Y” and upper case “Q”. Fewer than 20 per cent of children could recognise those letters. By the end of the year most children could name almost all the letters of the alphabet. What is often overlooked is that the children are not only learning the shapes of the letters and their corresponding sounds and names, but as they will be taught using the phonics approach, they will be actively combining newly learnt letters to form simple words.

Word Recognition

Figure 3 shows the words that children are asked to read. Although the words themselves seem remarkably simple, learning to read involves a great deal of mental gymnastics. The reader must know the sounds associated with each letter and can then combine them to produce an overall sound – the complete word. Learning to read normally starts with CVC words (consonant-vowel-consonant), moving on to CVCC words or words such as “see” where the “e” sound is modified when two are together.

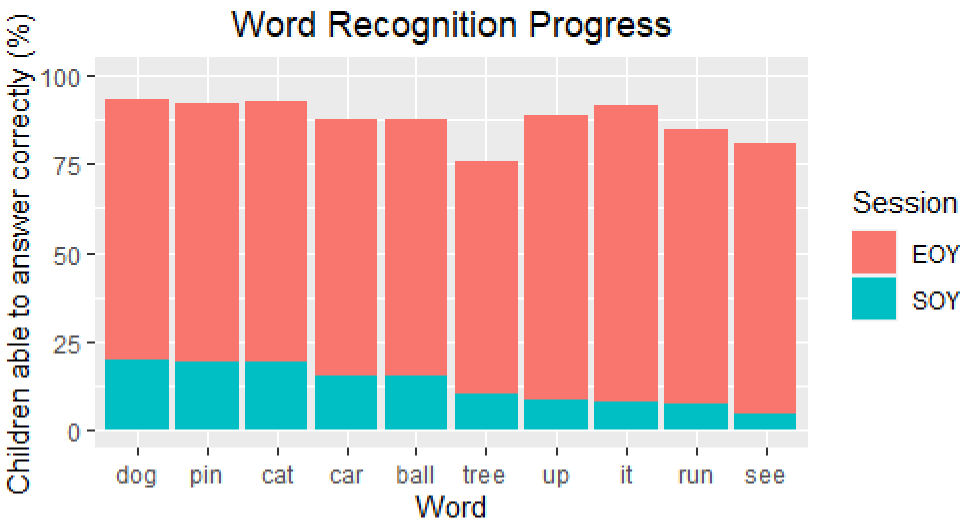

Figure 3: Word Recognition items, difficulties and progress.

Being able to read whole words was a skill that only around 20 per cent of children could do on entry to the school. The easiest item for those who could read simple words was “dog” and the hardest was “see”. However, after a year in school, between 75 per cent and 93 per cent of children could read these simple words. Of these, the most difficult at EOY was “tree”, containing as it does a combination of consonants “tr” and a double “e”.

Vocabulary

The ability to put names to objects is fundamental to learning about the world around you. Figure 4 shows the difficulty of the vocabulary items asked in the BASE assessment and the proportion of children that could recognise that item in a picture onscreen at both the start and the end of the year.

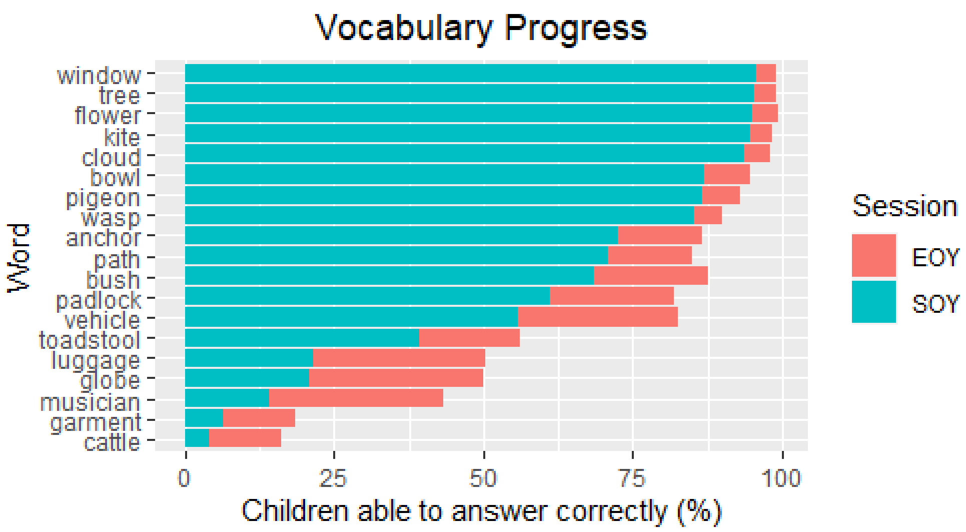

Figure 4: Vocabulary items, difficulties and progress.

English vocabulary contains many synonyms, some of which cause issues with vocabulary tests. For one child it is a “pan”, for another child it is a “pot”. However, at the start of the year most children (around 95 per cent) could point to a window, a tree, a flower, a kite, and a cloud. Very few children (less than 10 per cent) understood the words “garment” and “cattle”. Even at the end of the year “garment” and “cattle” were extremely challenging words, but a significant proportion of the children in the group were able to answer them correctly (18 per cent and 16 per cent respectively).

Shapes

Figure 5 shows the names of the shapes that the children were asked to point to.

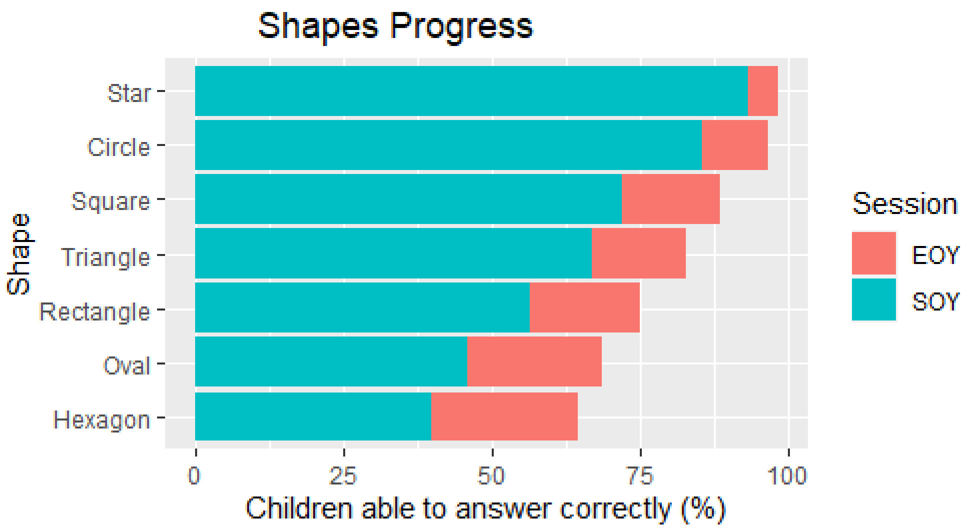

Figure 5: Shape recognition items, difficulties and progress.

At the start of the year the most recognised shapes were the star and the circle. Over 85 per cent of children could point to these. The most difficult was the hexagon, although around 40 per cent of children knew this shape. At the end of the year hexagon and oval were still the hardest shapes to name, but over 64 per cent of children could do this.

Number Recognition

The children were asked to name numbers as they appeared on the screen. As with most parts of the assessment, if they started to get the answers wrong the program would move on to another section of the test covering a different topic. The numbers selected include some tricky items, but due to the adaptive algorithm built into the assessment, fewer children would see these.

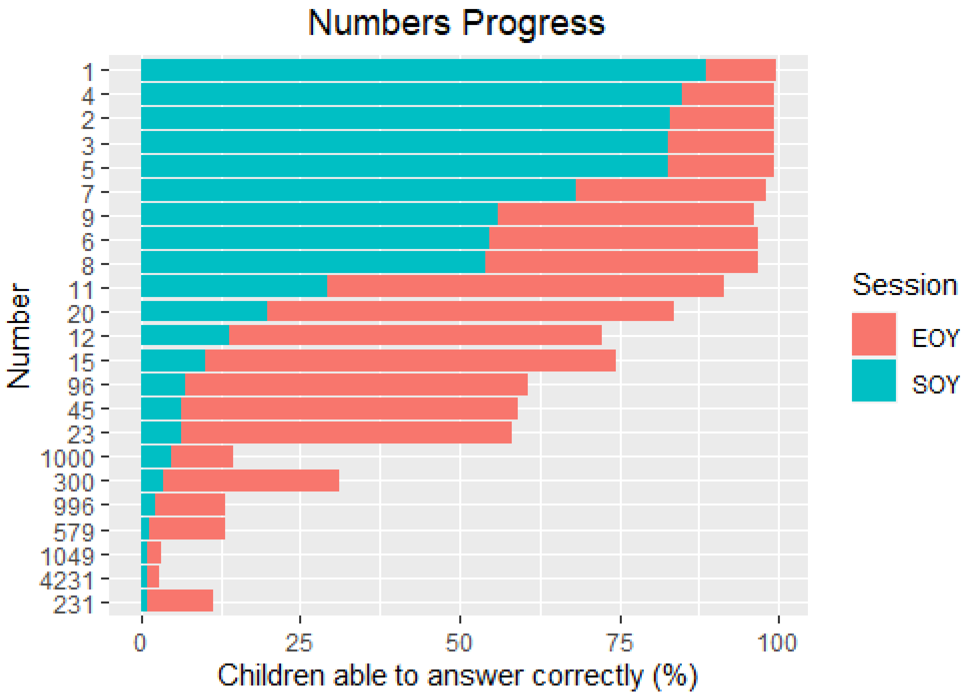

Figure 6: Number recognition items, difficulties and progress.

Interestingly, the difficulty of recognising individual digits was found not to correspond with their numerical order. At the start of the year around 80 per cent of children knew the numbers 1 to 5, but only 55 per cent of children could recognise the number 6. Slightly more children were able to recognise the numbers 7 and 9. Fewer than 10 per cent of children recognised numbers greater than 15. The end of the year showed a vast improvement and more than 58 per cent of children could name one- and two-digit numbers. As would be expected at this age, three- and four-digit numbers still proved to be challenging for these children. Some results stood out, particularly the large rise in the number of children that could name the numbers 300 and 231. This could be evidence of more children understanding the concept of place value combined with the lower value digits with which they might be more familiar.

Counting

Children were asked to count the spots on the back of a ladybird, and later, count the number of ladybirds on a page. This method is preferred over counting on a number line as children can be observed pointing to each spot as they count, and it is easier to see those who count the same spot twice, miss a number or do not know where to stop.

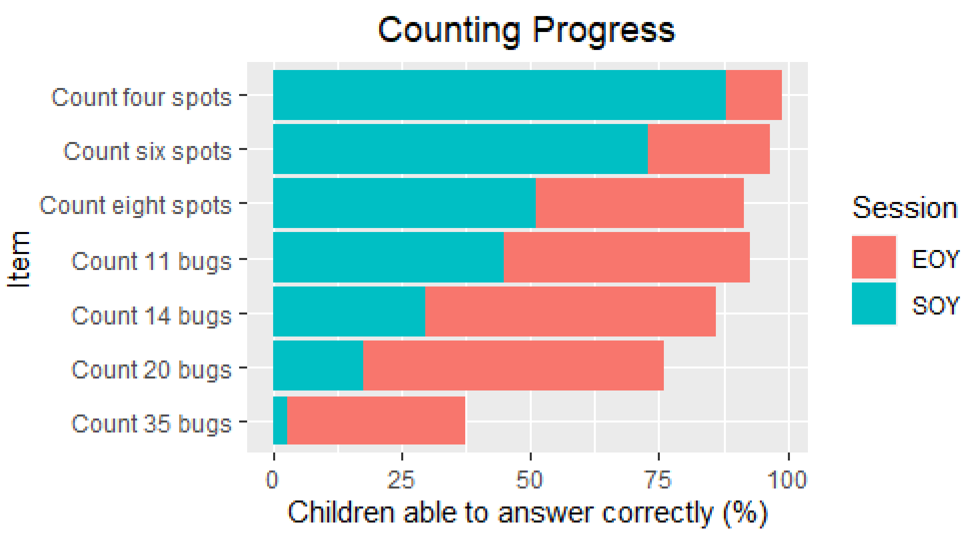

Figure 7: Counting items, difficulties and progress.

At the start of the year many children (88 per cent) were able to count four items and slightly fewer (73 per cent) could count six items. By the end of the year just over 75 per cent could count 20 bugs and 37 per cent could count 35 bugs, a large rise from just under 3 per cent at the start of the year.

Numeracy

This section of the assessment allows the teacher to observe how children performed when they attempted addition and subtraction problems.

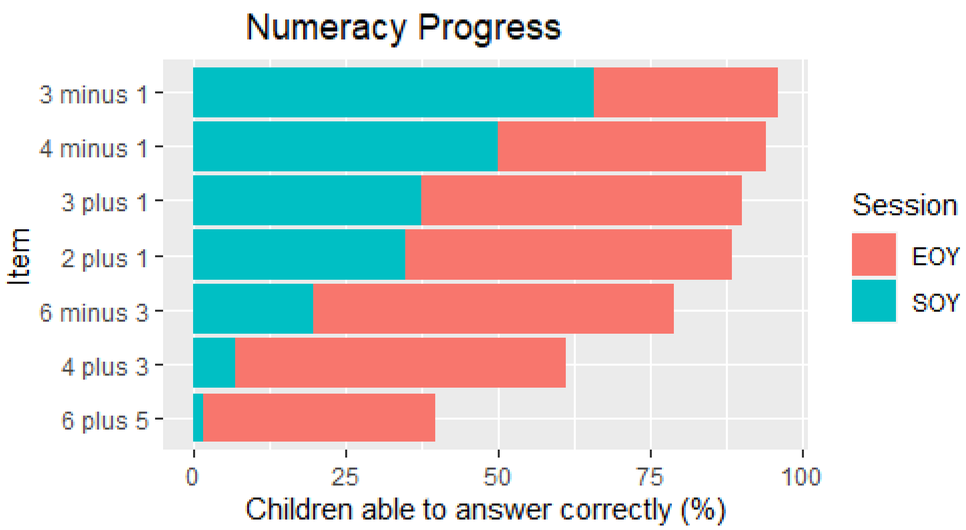

Figure 8: Basic mathematics items, difficulties and progress.

Initially, just over 50 per cent of the group were able to subtract 1 from a small number. Far fewer (around 36 per cent) could add 1, and even fewer (<10 per cent) could add a number other than 1. At the end of the year there was remarkable progress. Almost everyone could add or subtract 1, and over 60 per cent could add or subtract 3. Around 39 per cent could add 5 to a number, up from less than 2 per cent at the start of the year.

Discussion

It is clear from the results shown above that many children arrive in school with a great deal of academic knowledge and many skills. They can count, recognise shapes and simple letters, and have a growing vocabulary. The results also show the astonishing progress that four-year-olds make once they are in school. For example, at SOY fewer than 20 per cent of children could read simple CVC (consonant-vowel-consonant) words, but 85 per cent of children could read those words at EOY. Similarly, fewer than 20 per cent of children could calculate 6 minus 3 at SOY, but at EOY the number that could do so had risen to around 80 per cent.

As our results show, around 88 per cent of children starting school can count four things, but just under 3 per cent can count 35 things. At the end of the year this changes radically: over 75 per cent can count 20 items and nearly 40 per cent can count 35 items. Again, it is important to clarify that what is being assessed is not the ability just to count to an arbitrary number, but to engage with items in several patterns and layouts – a much harder problem.

Some issues do arise though. In schools, letters and letter sounds are often taught initially using synthetic phonics schemes which begin with the letters "s", "a", "t", "p", "i" and "n" (Jolly Phonics, Letterland, FFT Success for All Phonics). The rationale for this is that these are common letter sounds and many simple words can be created by combinations of those letters. As may be seen from the analysis of BASE data, although the letters "s" and "a" are reasonably well known among school starters, the letters "t", "i" and "n" are not. (BASE asks children to recognise the upper case letter "P".) Ironically, it may be those letters that children are most likely to recognise that are problematical. Phonics teaching applies very specific sounds to each letter that are unlikely to have been taught by parents. It may be that the most common letters cause more difficulties in phonics learning than those that are yet to be learnt, because children may have been taught the letter with a different "sound" than that taught in synthetic phonics lessons.

We also see a link between digit recognition and counting. More than half of the children entering the Reception class could recognise the digits 1 to 9, but Figure 6 shows that the order of difficulty does not follow the natural order of the numbers. For instance, fewer children could recognise the number 6 than could recognise the numbers 7 or 9. Following on from this, counting (the application of number) shows that most children could count four and six spots on the back of a ladybird, but counting eight or more was much more difficult.

The area where most pupils starting school struggled was in arithmetic. Although around half the pupils could take 1 away from a small number, far fewer could carry out additions of any type, or subtraction of numbers larger than 1. This type of insight is extremely useful in informing pedagogy. Why is it that children who have understood the concept of subtraction find it more difficult to subtract numbers larger than 1? Some studies (Carey, 2001; Rips et al., 2008) have suggested that this ability is limited by short-term memory and attention. If they are counting back in single digits from the given number, then is there too much cognitive overload to keep track of the number of times they must count back, and the result?

Conclusions

Children often learn many basic skills before they enter school, and the sources and extent of this learning can be very varied. Some will be taught by their parents or other relatives and carers. Some will attend playgroups or nursery schools. Even those without these advantages may be able to learn a great deal from the excellent learning resources readily available from a range of digital providers.

This diversity of experience prior to entering formal schooling is why it is important to establish a baseline for children entering the Reception class. Equally valuable is repeating the assessment at the end of the first year in school. It can provide a measure of relative progress for each child, and of the whole group.

The BASE assessment provides an opportunity to assess a class of children objectively and comprehensively in a range of basic skills. The results are often surprising, as initial perceptions of what children can or cannot do are frequently challenged. It is easy to overlook this, and treat every child the same, rather than aiming to differentiate groups according to their individual learning needs. Similarly, it is vital to realise how important early learning opportunities are to growing minds.

As the data shows, young children can make remarkable progress when placed in an environment that encourages active and engaged learning. Indeed, the effects can be extremely far reaching. A longitudinal study by Peter Tymms and his colleagues (Tymms et al., 2018) found that "Membership of an effective Reception class/school was associated with a boost in attainment that was still apparent at age 16."

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