



Numeracy for Life Committee

Corrected oral evidence

Thursday 4 June 2026

11.55 am

Watch the meeting

Members present: Lord Agnew of Oulton (The Chair); Baroness Alexander of Clevedon; Lord Blackwell; Baroness Bull; Baroness Garden of Frognal; Baroness Hamwee; Lord Hannett of Everton; Lord Massey of Hampstead; Baroness Spielman; Lord Stevenson of Balmacara.

Evidence Session No. 8

Heard in Public

Questions 95 - 104

Witnesses

I: Professor Brian Butterworth, Emeritus Professor of Cognitive Neuropsychology, University College London (UCL); Professor Camilla Gilmore, Professor of Mathematical Cognition, Loughborough University, Director, ESRC Centre for Early Mathematics Learning; Professor Jo Van Herwegen, Professor of Developmental Psychology and Education, UCL Institute of Education.

Examination of witnesses

Professor Brian Butterworth, Professor Camilla Gilmore and Professor Jo Van Herwegen.

Q95 **The Chair:** Good morning, everybody. Thank you so much for joining us today for this session of our numeracy inquiry. We look forward to hearing from you. I shall now hand over to the members of our committee. I would just ask that you keep your answers as pithy as possible because we are a bit tight on timing today.

Lord Massey of Hampstead: Welcome. The focus of today's session is on the early years and how babies and young children learn numeracy skills. Would you mind giving us a brief overview of the importance and impact of developing those skills in the very early years?

Professor Camilla Gilmore: Good morning. I am professor of mathematical cognition at Loughborough University and I lead the ESRC Centre for Early Mathematics Learning and co-lead the Maths Horizons project.

I am really glad that we are here talking about early maths in the context of numeracy for life because we know that the foundations of good maths outcomes are laid very early. Children's early maths knowledge and skills is the strongest predictor of their later outcomes and that is in terms of both academic outcomes and using maths in everyday life. We know that early maths relates to later employment, later quality of life and income. Getting those foundations there early is really important.

There is evidence from longitudinal research of a snowball effect. Young children who get those foundations early are better equipped to benefit from learning and to progress more quickly in their learning through school.

Lord Massey of Hampstead: What are those early years? What would you define as those critical years?

Professor Camilla Gilmore: When we are talking about early years in terms of the early years foundation stage, it is really important to remember that this is the period from birth to five. That includes reception year in school as well as all the different settings that children might be attending before school.

When we are thinking about maths, maths develops straightaway from birth. Young infants are sensitive to mathematical ideas around them in their own ways. There are really key periods of development through the ages of two, three, four and then into reception year in school.

There is no evidence for a critical window. We do not pass a point after which children cannot develop those foundations, but, as I said, there is a snowball effect where strong early learning is beneficial later on.

Lord Massey of Hampstead: I have a quick follow-up. I know we have

a lot of questions. Is that early learning around numbers? Is that early understanding just about numbers?

Professor Camilla Gilmore: No, maths is very broad and we need to be thinking about that breadth. Numbers are very important, but there are also spatial elements of maths and that broader conceptual understanding. That is really important to remember.

Lord Massey of Hampstead: That is even in the early years.

Professor Camilla Gilmore: Even in the early years, yes.

Professor Jo Van Herwegen: I am a professor of developmental psychology and education at UCL. My research is mainly focused on mathematical development for students with special educational needs and disabilities and dyscalculia.

Further to the point that Professor Gilmore has made, indeed, these abilities develop very early on, but, for students who have special educational needs and disabilities, early identification is so important during the early years because of the snowball effect. We also see that mathematical abilities continue to develop well into adulthood. There is not that critical window that we spoke about before.

One of the things to keep in mind is that research shows that students or children who have special educational needs and disabilities often have fewer opportunities early on to develop these numeracy skills because of their medical needs or their slower development in terms of motor skills or spatial abilities, which are the foundations that are required for mathematical abilities.

Professor Brian Butterworth: I am emeritus professor of cognitive neuropsychology at UCL. I wanted to draw attention to a condition that you are born with and that persists into adulthood and affects numeracy throughout the lifespan. I think Baroness Bull knows where I am coming from on this one. It is a condition called dyscalculia. It makes learning about numbers and arithmetic extremely difficult. If you are not very good at that, it is going to make the rest of mathematics hard for you.

Some people can overcome it and become very good at mathematics, but they are never good at arithmetic and calculation. You can be very good at geometry. We have tested people who are good on geometry but very dyscalculic. There is a famous case of a professor of cosmology who can do tensor calculus but is bad at adding and subtracting. She has made a little video that illustrates that.

I just want to say that this is different from just being bad at maths. Being bad at maths, as Professors Gilmore and Van Herwegen pointed out, can be overcome. It is not clear that dyscalculia can be cured, though you can get quite good at doing various tasks that involve numbers.

Q96 **Baroness Garden of Frognal:** What are the fundamental skills needed

in mathematical and numerical development? What is the best way of helping babies and children to develop these fundamental skills?

Professor Camilla Gilmore: From cognitive science research, we have really good evidence about that. We know that there is a set of conceptual knowledge and skills that children need to develop. This includes a good understanding of the number system, how numbers work, an understanding of cardinality and how we can use counting to tell us about the number of objects in a set, for example.

Children then need to go on to understand about how we can group things and separate things. They need that kind of additive reasoning and so on. Alongside that, we know that skills such as spatial reasoning are really important. Spatial reasoning is not only important for geometry and the spatial aspects of maths. It is also really important for understanding of number and arithmetic.

There is a whole range of different ways that we can help children develop this. Evidence from intervention studies shows that different programmes take different approaches. There is not one pedagogy that seems to be the only way to do it. You can have effective programmes that are based around guided play, more explicit instruction or a combination of both.

When we look at those programmes, what they have in common is they have really good professional development for educators and practitioners. To help children develop good maths learning, we need to understand what is involved in maths learning. We need to understand the knowledge and skills that children need to develop so that practitioners are able to support them.

Alongside that, we can also help children in the home. Parents have a role to play here in supporting children's maths development. That does not have to be in any formal way at all. That can be through play, games, building blocks, playing jigsaws, helping with cooking and all sorts of things. There is a whole range of different ways that we can help children.

Baroness Garden of Frognal: Babies love repetition, do they not, and hearing familiar things?

Professor Camilla Gilmore: Absolutely, yes.

Professor Jo Van Herwegen: We have just completed a large review of what are the interventions that might work within the early years. There are not many of those kind of studies, but there are at least 17 across the world. They show that these interventions have good effect sizes. They are quite effective in raising outcomes for young people. They are from the age of three and onwards.

Most importantly, following on from what Professor Gilmore said, interventions that are broader and include wider mathematical skills—they are not too narrow and focus on multiple domains of mathematical

abilities—are more effective than those that have a single focus. However, we often see that what is being done in the early years has a very narrow focus on number skills and knowledge rather than having that broader depth.

We have developed Maths@Home and Maths Everywhere programmes for parents as well as for practitioners. We are doing pilot studies at the moment, but they are very positive. They raise parental self-efficacy, which is how confident parents are in terms of helping their child develop these skills, as well as raising children's mathematical abilities.

Professor Brian Butterworth: There is also an opportunity to use digital technologies to help even young children. We have been working on that. Most special needs teachers—in fact, most early years teachers, even in kindergarten—try to relate the symbols that our culture provides for numbers and arithmetic, the number words, the digit symbols, the addition, subtraction and multiplication symbols, with beads or other objects.

When you are adding three and five, let us say, you can help the child understand what that means by having five beads and three beads, combining them together and then letting the child count the result. That is one way of doing it if you have set union or subtraction, where you are taking away a subset.

All good special needs teachers and early years teachers do this, but you can now do it online. There are ways of helping kids that the actual teacher cannot do. For example, you could have a set of three beads that are yellow and a set of five beads that are blue. When you combine them, you can turn that set into a set of eight that is red, for example. This helps the child understand these particular numbers.

We have done very large-scale studies now using these techniques, not with preschoolers so far but with years 1 and 2, with very encouraging results. We have done it in Italy, Spain, Mexico and the United States. We have done it with about 15,000 kids altogether and 60,000 controls.

We have also used home trials, so that the kids can practise at home. They do not have to take time out of their numeracy lessons to learn this. The important thing here is that the child is constructing an answer, not selecting an answer. They do not have multiple choice. They have to make something. We know that this really helps kids of any age understand what they are doing.

When you ask kids to say whether something is this or that and they have to make a choice, if they make the wrong choice, we know from many studies in memory that the incorrect association between the wrong answer and the question gets stored in memory and this makes unlearning it a little bit more difficult. There are ways of doing this using modern technologies.

The other thing that I wanted to mention here is that, although modern digital technologies are really helpful, there is nothing that is going to replace a knowledgeable teacher or a reflective practitioner. A reflective practitioner can see where the child is not understanding the question or not understanding the components of the operations that the child has to carry out. It is really important to help teachers understand, particularly when they have to understand a child with special needs. I might want to address that further later on in the discussion.

Q97 Lord Blackwell: For this zero-to-five age group that you say is critical, parents are an important factor in that. You have already spoken about this bit, but is there more that you want to say about how we could help parents take on that role? Are initiatives such as the Best Start in Life hubs useful? Are there lessons from home education tools, et cetera?

Professor Camilla Gilmore: At the moment, the advice that goes to parents underemphasises the importance of maths. If you look at the Best Start in Life website, it does not provide any guidance for parents about supporting their children's maths skills. We need to build parents' confidence and awareness of this. We know from our research that parents are less confident in supporting their children's maths skills than they are with language and literacy.

If we do not provide parents with this advice, we are setting the expectation that maths is something that happens in school and it is not for real life or everyday life. There are so many ways that parents can help children. It does not have to be doing any form of formal maths teaching; it can be through games and activities. That is a message that we need to share with parents.

The other thing that is really important when we are thinking about parents and the family environment is attitudes. We know that parents' attitudes to maths have an effect on the amount of maths they do with children, which can therefore impact children's own learning and development. We want to help parents to realise that, even if they had a negative experience in school maths, they can help their children. They can set this positive view of maths. They can support children's maths. They can do this through the activities that they are probably already doing, if they have more awareness of how to draw out the mathematical content of it. We need to do more, and we need to get that message out to parents.

Professor Jo Van Herwegen: Similarly, our research has shown that parental self-efficacy—how confident they feel in delivering activities at home—is really critical. The parents who feel they have more knowledge and understanding about mathematical development are able to implement these activities that we know build the foundations for later maths skills.

As I mentioned before, our Maths@Home programme is full of short, targeted games that parents can do in the home using materials in the home. They do not have to prepare anything.

Similarly, parents often think that, if they are going to do mathematical abilities with their children, they need a worksheet like at school and they need to sit down with their child and give them a pen. We show in our games that you can do this with very simple exercises, such as ordering teddies in a line and talking about who is first, who is last, who is second and who is third. That is a very simple game. When you are at the table, you can do simple mathematical counting. Number talk is very important. That is how parents talk to their children using numbers.

As Professor Gilmore said, we see a lot of national campaigns about reading. I remember, when I had my children, I was given books to read to my child. We do not talk about how as parents we can support our children's mathematical abilities from those very early days onwards.

Lord Blackwell: Are there opportunities for more digital support for parents?

Professor Brian Butterworth: Yes. We did a study in which we looked at the amount of numerical activities in the home and what happened when the child started school. This was quite a large study that we did in Italy. We found that there was a positive effect if the parents, for example, took their kids to the shops and talked about how much money they had to spend, how many objects they had to buy or the number of steps they had to walk up. This is not really formal arithmetic. Just having experience of the number system in the world seems to make a difference on first-year arithmetic in schools. I agree with the other speakers that this is really important.

The other thing I would want to say is that if the child has a special disability in maths, if they have dyscalculia, it is really important that the parent understands what the problem is. If the parent does not understand it, the parent will assume that the child is stupid and the child will assume they are just stupid. It is important for parents to understand this particular difficulty, which affects about 5% or 6% of the population.

The way that parents might understand it is if the teacher understands it. If the teacher does not understand it, the parents and the teacher will not understand why Johnny is not learning arithmetic. It is very important that dyscalculia and other special needs are taught in initial teacher training or in continuing professional development later on for practising teachers, so that they understand why Johnny is failing in arithmetic, even though all his classmates have moved on.

One of the things that I would recommend as a policy recommendation is that the Department for Education officially recognises this condition, as indeed do Education Scotland and the Irish Department of Education and Youth. The United States recognises it. Italy recognises it in law 170. If it is recognised, people have to take it seriously. If they have to take it seriously, teachers, particularly if they get taught about it, are likely to be able to help parents whose child is really struggling with learning the basics of arithmetic.

Professor Jo Van Herwegen: Very quickly, I just wanted to clarify that Maths@Home, which I was talking about, is an app for parents with ideas of games to play. They are physical games. I can tell you a little bit more about educational technology later, if you would like. We have done some reviews of which apps work for children and which ones do not.

The Chair: We will come back to that.

- Q98 **Lord Hannett of Everton:** This is a parent question again. I have heard lots of examples of parents who are quite intimidated by supporting the children with different types of education. We have heard about supporting children itself can be a motivator, even though on the other side it can be intimidating as well. It could be a motivator for adults to seek support with their own numeracy skills. Is this something that you have come across? Is there any evidence for this?

Professor Camilla Gilmore: It is important to realise the cyclical nature of this. Young people go through education. They might have a negative experience; they might not have acquired the maths skills that they need. In a very small number of years, they may be parents. We have this influence going around.

We know that the point when many adults seek help with their own numeracy skills is when they have children and they want to support their children. We need to recognise that it is a cycle and we need to make sure we are supporting with those maths skills and that knowledge.

If we look at the relationship between attitudes, attainment and confidence, there is a bidirectional relationship between attitudes and attainment. That means your attitudes will influence your attainment in maths, perhaps because you avoid doing maths, but your attainment also influences your attitudes. Interestingly, if we look at young children, we see that that relationship is stronger. In fact, the relationship between attainment and attitudes is stronger in young children.

Attitudes are really important and supporting parents to give that positive attitude to maths is really important, but getting the foundational knowledge and skills is equally important. That might be the driver that can improve attitudes rather than focusing on the attitudes themselves.

Professor Jo Van Herwegen: Following on from that, it is not just the attitudes of the parents but the attitudes of siblings, teachers and grandparents. It is wider society. It is how we talk about maths. We often agree quite eagerly or are quick to say, "I am not good at maths", or, "I find it difficult", much more so than when we talk about literacy, for example.

The good news about that is that there is evidence that interventions can help to target the more negative attitudes or insecurities that people have around mathematical abilities.

Professor Camilla Gilmore: If I can just follow up, when we look at young children, they do not have negative attitudes to maths. At the start

of school, young children are very positive about maths. It is not that we have to focus on improving their attitudes; we need to maintain their attitudes. It is only through primary school and into secondary school that we see those negative attitudes developing.

In terms of gender, at the start of school, girls and boys are equally positive about maths. They are equally confident; they are equally enjoying it. It is only later that those gender differences emerge. We do not have to fix a problem with attitudes at the start of school. We need to keep those positive attitudes going. The strongest way of doing that is to make sure children develop the knowledge and skills that they need, feel equipped to solve problems and see maths in the world around them as well as in the classroom. That will have this positive influence on attitudes.

Professor Brian Butterworth: Of course, dyscalculics or other people who are really bad at maths have terribly negative attitudes, as has been pointed out, about maths. They are avoidant. That means that not only are they bad now but, because they are avoidant, they are going to continue to be bad in the future. There has to be a way of breaking into that cycle of bad attitude and bad performance. That can only be done if teachers really understand what the problem is for these kids. They are really at the bottom of the scale.

Can I say something about money? Is this the right place to talk about money? Some years ago, the accountancy firm KPMG looked at the cost of the lowest 6% of attainers in mathematics. They are not all going to be dyscalculics, but a lot of them will have been.

They calculated the level of lost taxes because people who are bad with numbers are not going to have such good employment prospects. They are also, by the way, not going to have such good educational prospects. They are going to get up to 20% fewer good GCSEs, if they are really bad at maths. They are also going to have trouble with the law. In fact, the first dyscalculic that we encountered was in prison for repeated shoplifting. The reason he repeatedly shoplifted was because he was too embarrassed to go to the till because he did not know how much money to give and how much change to get. This is before you could do it with a card.

Taking all those things into account, KPMG calculated that it cost England, not the whole of the UK, £2.4 billion a year in lost taxes and all the additional costs that poor maths gives rise to. That would be about £3.8 billion today. That is a lot of money, and that is just for England.

The other point about money that I would make is that the OECD did a calculation a few years ago saying that, if you could raise the standard of the lowest 11% of children in Britain, which would include quite a lot of dyscalculics, up to the PISA minimum level, level 2, you would have an annual increase in GDP of 0.44%. This is a big number when you calculate it. I cannot remember now how they calculated that percentage of GDP then and I do not know what it would be now.

If the Government are really committed to growth, intervening with this relatively small but very important sub-population, the dyscalculics, could make significant inroads into their costs of treating these individuals and the amount of taxes that they will be able to harvest. Just concentrating on the lowest 5% could be economically very desirable.

The Chair: Could you send us links to those two reports from KPMG and OECD?

Professor Brian Butterworth: Absolutely, yes.

Q99 **Baroness Bull:** I should declare my interest, as Professor Butterworth already did: I am patron of the Dyscalculia Network. We are looking, of course, at numeracy across the life course and trying to unlock the benefits to the whole of society. As you have indicated, that clearly includes people with dyscalculia, but we all recognise that, over 10 months, this special inquiry committee is not going to be able to address all the issues of what we know is a very under-recognised condition.

As we have world-leading experts in the room today, I could not miss the opportunity to draw on your knowledge. You mentioned a prevalence rate of 6%, but, Professor Van Herwegen, in your written submission, you put it higher. I think you put it at 14%. This shows under-diagnosis and a lack of awareness. It is important to put that into context. It is roughly the same as dyslexia. It is far higher than autism, which is 1%, and ADHD, which is up to 5%. That makes it more astonishing that it is under-recognised.

In thinking about supporting dyscalculic children to develop the numeracy skills that they need for life, as you have said, what would you each say are the biggest barriers? We have already heard some. I am not going to start with Professor Butterworth. What are the biggest barriers? What should this committee recommend to address those barriers?

One of our written submissions, which was from Judy Hornigold, suggested that a review similar to the Rose report could be useful because it did so much for dyslexia in 2006. I did not want to steer you on to that, but I do not want to come back because we are tight of time. We can start with Professor Van Herwegen.

Professor Jo Van Herwegen: As Professor Butterworth said, it is about thinking about what teachers and parents know about dyscalculia. Our research—it is unpublished yet because it is ongoing—is looking at the difficulties that primary and secondary students with dyscalculia experience. What we see is that there are difficulties not just with particular areas of mathematics but with a number of other areas. There are also maybe different subgroups. Different students might have difficulties with different tasks. That might also explain the discrepancies in the percentages of people who we pick up with the diagnostic criteria of dyscalculia.

Teachers and maybe parents need to have a better understanding of the foundations of good mathematical abilities and the roots of difficulties

with mathematical abilities. As we know, spatial abilities are important. There are what we call overall cognitive abilities that need to be in place. We need to rule out that these are causing any of the mathematical learning difficulties that we might see in students with dyscalculia and then we can recognise the dyscalculia aspect of development.

If teachers and parents had a better understanding of that cumulative or cascading effect of early mathematical difficulties on later difficulties, dyscalculia and mathematical abilities in general, that might be a first starting point. It would not only benefit children with dyscalculia; it would benefit all children. Many children with special educational needs and disabilities have difficulties with maths. Providing that broader knowledge to early years providers and parents will allow all children to have better experiences.

Baroness Bull: Raise all boats, as it were.

Professor Jo Van Herwegen: Raise all of them, yes.

Professor Camilla Gilmore: I will just add that we know that there are a variety of different skills that are involved in learning maths. We have talked about this already, and Jo has mentioned some of those broader skills as well. This is recognised in the most recent diagnostic criteria for dyscalculia that came out last year, which recognise that a subgroup of individuals with dyscalculia will have this fundamental number deficit that Brian was talking about, but there is a set of broader skills that can also lead to very low performance in maths. Whether you call that dyscalculia, it becomes a matter of definition rather than anything else.

It is really encouraging that what is good for individuals with dyscalculia is also good for all individuals to learn. We need to think about diagnosis and making sure that those children who need extra help are getting it, but we should be focusing on making sure that all the children in the class are developing that fundamental knowledge and the skills that they need.

What is really necessary is for early years practitioners and teachers to have a very good understanding of what is involved in learning maths. If they understand those trajectories, what that fundamental knowledge is and what all those broader skills are, they can ensure that all the children in the class are developing those things.

Wherever we put this definition and therefore the prevalence rates, we know that a lot of young people are coming through education with very low levels of maths achievements and they are not dyscalculic. Those sorts of methods are going to help everyone to improve.

Baroness Bull: Brian, is there anything you want to add? We have heard some policy ideas.

Professor Brian Butterworth: I want to endorse this. We have done large-scale studies with interventions for dyscalculics in many countries now. One of the things that we found is that the games and activities that

we design for dyscalculics benefit other early learners as well. We now have a lot of data on this. I would just reiterate the point that Camilla made. If we design for the few, we can benefit the many.

Q100 Baroness Alexander of Clevedon: I want to continue the focus on the education side of things in the early years. I just wondered whether you had any additional comments to make about the current early years framework for assessment and guidance and the delivery of mathematical education.

Professor Camilla Gilmore: We need to recognise that there is a lot of really high-quality provision in the early years sector. There are a lot of children doing really well. There are very skilled and qualified practitioners who are able to support them.

It is true to say that the framework for maths in the early years foundation stage is perhaps not really well aligned with the latest research on maths learning. In particular, we should look at the early learning goals. At the end of the foundation stage, children are teacher-assessed against a set of early learning goals, two of which relate to maths. If we look at these—they were last changed back in 2021—they are not well aligned with the research evidence.

They are too narrowly focused. They do not recognise the breadth of the different skills and knowledge that is involved. They underemphasise conceptual aspects of maths. They underemphasise spatial aspects of maths. They focus too much on automatic recall. That is a really important part of children's maths learning journey, but focusing on that too early, before children have the conceptual knowledge around it, is perhaps not helpful. We have to remember that some children are still four at the end of reception year.

There are two consequences of the problem with the early learning goals. First, early years practitioners and teachers are not being encouraged to focus on the most important aspects of children's learning. Secondly, for teachers in year 1, whether or not children pass those early learning goals is not giving them the information that they need to know whether children have those fundamental foundations or whether they need additional support. That is a really important thing that we should look at.

Professor Jo Van Herwegen: I have very little to add to that because that is exactly what our research suggests as well.

The only thing to add is that might be the reason why, when we looked at the early adopters of the new early learning goals in 2020-21, we saw that many of the practitioners were still relying on the previous early learning goals, which were broader, because they felt more confident delivering those. Of course, that has cascading effects on how useful that information is for key stage 1 teachers.

Professor Brian Butterworth: One of the things that seems to me important is being able to identify very early kids who are going to have

trouble. I want to introduce something that has not been mentioned before, which is the brain. We know that there are differences.

I will make two points. First, we know that newly born infants and infants up until one year notice changes in the number of things that they are looking at or hearing. We also know which bits of the brain seem to be involved. That is the interparietal sulci, which are these areas. These areas develop. Sometimes, in some kids, you do not find these activations. We do not know whether these are going to be reliable indicators of the kids who are going to grow up having real trouble with arithmetic. We know that there have been some studies of very early readers. There have been some Finnish studies on the brains of very early readers that suggests it is possible to pick out the kids who are going to be dyslexic, in effect.

Dyslexia is a much more complicated issue than dyscalculia, in my view, because it involves connecting up visual patterns with the sound and meaning of language. That is a really complicated process. Of course, for 200,000 years, people did not read so the brain was not immediately set up for this. For numbers, the brain was set up to extract numerical information from the environment. In almost all species where it has been properly tested—I am happy to talk about this for hours, by the way—animals have some number sense. My own particular area is in the number sense in fish, which I am happy to talk about, but we have looked at other areas as well.

The point is that the relevant brain areas, both in human brains and in the brains of some other species, have been identified as being the hubs for numerical processing. It might be possible, with the appropriate research, to detect kids who are going to have really serious problems very early on because these bits of the brain are not responding in the right way or in the typical way to the numerical stimuli that they see, hear or try to put together.

I will make one other point. There has been some recent research showing that the brains of dyscalculics are different even when they are not doing number tasks. These brains are wired up in a methodology called resting-state functional connectivity; we need not go into the methodology unless you particularly want me to. The brain just seems to be wired up differently. This is very recent research. I have not been able to properly evaluate it. That might be another way in which we might be able to identify kids who are going to have serious early learning problems.

You could also track their improvement. Do their brains become active in a more normal way? Are they connected up in a more normal way? These are areas of research that would be fascinating but at the moment do not seem to be properly funded. I just thought I would mention that.

Q101 Baroness Hamwee: First of all, can I apologise that I keep glancing at the screen? I have to speak in the next debate and this one is going alarmingly fast.

I am very glad that you mentioned grandparents. You do not need to expand on it. You could do that subsequently, if you would like to. They have such an important role as caregivers. I do not want to overlook that.

I wanted to ask about early years teachers and training. Do they have the training and support that is needed to give the most effective teaching to young children? I do not mind who starts.

Professor Camilla Gilmore: When we look at that question, we need to remember the diversity in the early years sector. The opportunities that are available for reception teachers are very different from those that are available for practitioners in early years settings. The early years sector is very diverse. There are maintained nursery settings, but there are also a very large private, voluntary and independent sector and, of course, childminders as well. That diversity should be valued, but we need to make sure that everyone in that sector can access high-quality maths-specific PD.

That is a really important point. It is not just about general PD around how to support children's learning. As I was talking earlier, it is about having a really good understanding of what is involved in learning maths. We know that there are really significant barriers for practitioners in different types of settings in terms of accessing PD. Teachers in reception have an entitlement to paid professional development through inset days, but practitioners teaching children just a few months younger in PVI settings have no entitlement.

In terms of access and take-up, there are really significant barriers in place. There are barriers of funding, but one of the most significant barriers is around the ratios. In early year settings, there are set ratios. You have to have a certain number of qualified staff for a certain number of children. It is very difficult for an early years setting to allow staff paid time to engage in professional development because that is going to affect their ratios.

Particularly with funding levels being very narrow and tight for those PVI settings, in terms of the funding that they get to deliver free funded childcare, it is very difficult. We see barriers in funding, in access and in terms of being able to release staff from their settings.

When we look at the take-up of PD, it is not surprising that it is highest for teachers in reception classes, then practitioners in PVI settings and then lowest for childminders, who have the least possibility of getting access because they are often alone with the children.

Baroness Hamwee: The clue is in the term, "minders".

Professor Jo Van Herwegen: Yes, I have nothing to add to that.

Professor Brian Butterworth: As a relatively new grandparent, I think grandparents can be helpful, but I agree with Camilla that the opportunities for professional development among teachers are very

mixed. It would be really helpful for them to be informed of the latest and best research in how to help kids in the very early years.

Professor Camilla Gilmore: Yes, can I just pick up on that point? As a centre, we deliver PD to the settings that we are working with and more broadly. The level of knowledge that practitioners have really surprises us. The things that we are telling them feel quite basic. The knowledge from research decades ago has not yet got through into professional development. It is really about good access and high-quality math-specific PD. That is what is needed.

Q102 **Baroness Bull:** Just very quickly, before I go to my question, nobody mentioned the removal of the requirement for early years staff to have a level 2 qualification in maths, whereas they do have to have that qualification in English. Do you have concerns about that?

Professor Camilla Gilmore: That might mean that we will have practitioners who have very low confidence in their own maths skills and then we will see that cycle, with that influencing children's development.

Professor Jo Van Herwegen: The reason why that has happened is because, if we were to ask for higher levels, we would have serious issues in terms of getting the number of staff required. We should think about whether we could skill up early years practitioners later on, when they have started to build that confidence, rather than having it as a requirement from the beginning.

Baroness Bull: That is great, thank you. That was not my question; my question is about phonics for maths. We heard this proposed before. We had a very interesting written submission—you will not have seen it—from Winning With Numbers, which talked about number fluency as being a sort of equivalent to phonics and that number fluency could lead to good numeracy and good maths skills. Of course, we do not have that. The submission was just imagining or wishing for that. Do you have a view on whether a phonics for maths would add value and, if so, what would it look like?

Professor Camilla Gilmore: There are two things to take into account here. First, if we look at phonics for reading, this is based on helping children build a single mechanism for linking letters and sounds. When we look at maths, as I mentioned before, maths is really broad. There is no single mechanism that is going to be the key to learning maths. We need to think about the set of concepts and skills that children need to develop and the supporting skills. We know what those skills are. We know what that knowledge is. We are in the right place to deliver it.

What we can learn from the phonics experience is the way that that revolution happened. It started off with high-quality cognitive science research to understand the mechanisms of learning. We are at that point. We have that information for maths as well. There was then development and research that took that cognitive science research and worked out the most effective ways that teachers could support children to learn. You

had the developmental research that took the cognitive science findings and worked out what that looks like in practice in a classroom, and then you had the professional development that allowed teachers to deliver that.

We can learn from phonics in terms of that sequence of what we need to know and how we need to move from basic research into classroom impact, but the idea that there is a single mechanism that will lead to maths learning is not in line with any of the research evidence.

Baroness Bull: That was extremely clear. If anybody wants to add, please do.

Professor Jo Van Herwegen: Just drawing on the evidence that comes from students with special educational needs and disabilities, the reason that this is important is because, when we look at typically developing children, everything develops very quickly at the same time. It is difficult to see what comes first and what the cascading effect is.

Looking at how children with Down syndrome might learn, for example, can give us further insight. If you look at children with Down syndrome, for example, they can reach quite high levels of numeracy fluency—that is counting and recognising symbols—and yet they still have significant difficulties in terms of their overall mathematical abilities. That gives us a good example of why, even if we were to train children to be very good at a phonics for maths, it would be too narrow to provide the wider skills that we need for broader mathematical abilities.

Professor Brian Butterworth: Phonics is an important basis for particular alphabetic orthographies. It is not so important for different orthographies, such as Japanese and Chinese. In fact, you can be dyslexic in English, which depends a lot on phonics, but not dyslexic in Japanese. That was a study that we did some years ago.

Is there some conceptual equivalent of phonics for maths? The answer is probably yes. That would be the way in which the symbols that we learn, like the symbols that we use in reading, the number words and the digits and so on, are related to their meaning, to the sets that they denote. It may be possible to help kids with that. We have developed some games precisely with this in mind. We have never thought of calling them phonics for maths, but it is quite an interesting parallel.

Professor Jo Van Herwegen: Can I come back to that? Looking at the research on targeted interventions and what interventions may work, as I mentioned before, the evidence suggests that, if you target in a very narrow area, such as just fluency in numbers and recognising that, that alone is not sufficient or will not give you the wider benefits that we see in interventions that are broader and focus on broader mathematical abilities.

Q103 **Lord Massey of Hampstead:** I wonder whether I could just quickly come back on that last question. In terms of our subject here, which is

really financial literacy and numeracy as opposed to broader mathematical knowledge and understanding, how important is that breadth if your objective is to make sure that the population is financially literate?

Professor Camilla Gilmore: It is very important. The same fundamental broad set of knowledge and skills is relevant, whether we are looking at later academic achievement or using maths in everyday life.

Professor Jo Van Herwegen: Can I give an example? Take the example of people who might struggle with maths and have to go to the shop and pay for something. Without having a broader understanding of how numbers relate to each other, they will not have any idea whether £33 is a lot to pay for one loaf of bread or whether it should be £3. Having that broader understanding of how numbers relate to each other, what is a lot, what is little and having that mathematical language will give them the ability to function well in daily lives when it comes to financial matters.

Lord Massey of Hampstead: Does that breadth include algebra and geometry? Would you include those in that?

Professor Jo Van Herwegen: That is for later on in life. It is not so much for the early years.

Baroness Bull: Very quickly, when you say "breadth", just so we are clear, you are not talking about branches of maths; you are talking about spatial reasoning, number comparison and subitising. Is that right?

Professor Jo Van Herwegen: Yes.

Q104 **The Chair:** As the last question, I will use the opportunity to pick up on your earlier point about technology. What technology are we not using at the moment that might help on this? Does it conflict with the bigger worry about excess screen time and the impact, probably negative, on brain development? Let us start with technology.

Professor Jo Van Herwegen: Two or three years ago, we did a wide review of what apps have been evaluated in research and what the mathematical apps look at. We also looked at the top 50 downloaded apps for early years, particularly looking at the early years.

What we see within that is that most apps that are very popular have not been evaluated. We do not know whether they work. When we look at the apps that have been evaluated, many of the apps that target children are very narrow in their scope. They look at recognising numbers and linking the digits to amounts that are on the screen, for example. They look at the very basics. It is numeracy fluency, but it does not cover the breadth of abilities, such as subitising, spatial understanding, how numbers go on a number line. Those are the kinds of understanding that young children need. Ordinality is another area that is not covered.

We also see that a lot of the apps that work best are apps that give feedback. That is not only apps that say, “Well done. Keep going”, but those that tell children why they go wrong. Of course, it is also important that the apps are at the right level for the child. Do they start easy and then make it harder or do they just stay at the same level, meaning that children do not learn anything?

If you think about it, when we then talk to a lot of parents, parents are worried that their children spend too much time on apps. Our research shows that there are two things that are very important to raise outcomes through apps, which are levelling and feedback. Parents and educational practitioners are the best at providing those features when it comes to mathematical learning.

The Chair: The technology market is underdeveloped and under-researched.

Professor Jo Van Herwegen: It is under-researched, but it is also not based upon the research that we have. Again, lots of developers put apps out there that are not based upon the best evidence that we have around how children learn. We do not look at the harm that might be done through that. Parents pay a lot of money for some of these apps, which they think are going to make a difference, but they are unlikely to help their child. They might not be harmful, but they are not going to be really helpful.

Professor Camilla Gilmore: When we are looking at the early years sector and thinking about the use of technology in early years settings, we know from decades of research what makes high-quality early years support. It is about really high-quality interactions between adults and children. It is about having adults who are knowledgeable about children and their development and are able to use questioning and extending activities to help move children along in their development. Any use of educational technology in that kind of setting has to fit within that high-quality pedagogy and not be seen as an alternative that can replace those interactions. Those interactions are absolutely crucial.

Professor Brian Butterworth: Yes, can I draw attention to a written submission from Professor Laurillard about how teachers can share best practice? It is a technology called the Learning Designer, which I understand has just been taken up by the French ministry of education. It is a way in which teachers can, in a very systematic way, share best practice. It is something that this Government should look at.

I completely agree with Jo that most of the apps available—there are thousands—are awful. They are not properly evaluated. They are badly designed. They have no pedagogical theory. They are not based on the science. It is possible to create good apps. We have created some good apps. They could be particularly aimed at things that teachers find difficult, such as number understanding. I sent the committee an example of a game that we developed.

The other thing that teachers tell us is very difficult is fractions. How do kids understand fractions? We have a game based on the best science, the best pedagogy, as far as we know, for helping early learners, meaning third or fourth-year learners, learn about fractions. It seems to be working. We have tested it on about 10,000 or 12,000 kids, but we do not have all the analysis in yet. Let me keep you posted about that.

The other thing that teachers tell us that kids find very difficult is place value. This may be why place value took—I do not know—10,000 years to be developed by humans, but we have it now. How do you teach it? We have an idea about this, but it turns out to be very difficult to teach place value using apps. This is where maybe Professor Laurillard's learning designer can help because it can share best practice and allow people to do things that we scientists do not know about but that teachers do.

There are two ways in which technology can be really helpful: one is properly designed apps and the second is the connectivity that it enables.

The Chair: You can have the last word, Professor Van Herwegen.

Professor Jo Van Herwegen: Can I just come back on one point? It is relevant here and to a previous point that was made. It is the point of development. I should also have declared I am the director for the Centre of Educational Neuroscience. When it becomes about place value and other things, in early development children do best not with technology but by learning through interactions with parents or grandparents and wider society.

The other thing that we have to keep in mind from a developmental point of view is that the brain develops over time. The evidence that Professor Butterworth was talking about in terms of the parietal lobe being very important for mathematical development is not necessarily something that we see early on in development. It is not necessarily what we see in children who might have learning difficulties.

That is because the brain is plastic. The brain develops, changes over time. It is really important to keep that in mind because it might question about how much we can use the brain to identify difficulties early on in life. Our brains are all slightly different. When we are neurotypical, they are more similar than they are different. There are other ways in which the brain might learn mathematical abilities. We might see activity in the brain in different places. I just wanted to clarify that.

The Chair: Thank you all very much. It has been a very interesting session. If any of you have postscripts that you feel you want to add, do send them in. I am particularly keen to see those two reports, Professor Butterworth, from KPMG and the OECD. We are going to have to make a case for the Government to spend more money somehow. Of course, there is no more money. The only real way to create the money is to grow the economy. If we can make a strong case for that, it starts to give us some impetus. Thank you very much indeed.