Starting with Maths
A brief history of numbers

Alice Peasgood

Have you ever wondered where numbers come from and why we write them in the way that we do? It's so easy to take them for granted but in fact it has taken tens of thousands of years for numbers to develop and many different cultures have been involved. Hilary, the course team Chair, is here with me to talk about the history of numbers and how people have thought about numbers through the centuries and developed different ways of representing them in writing. When I first learnt about numbers as a child, the first thing that I did was learn how to count. I mean is that actually what has happened historically as well?

Hilary Holmes

Well counting is certainly a very important part as people do need to record sort of how many animals they have got and so on and you can imagine initially people would probably use their fingers or parts of the body to keep a note of how many different things they had and that has actually occurred all across the world from Greenland to New Guinea to Africa and so on. So yes, counting is a very important first step.

Alice Peasgood

But the thing about counting with parts of the body like your fingers, there is no record of that so what's the first record we have that somebody was actually counting?

Hilary Holmes

Well, the first piece of evidence is really a bone which was found in Central Africa at a place called Ishango, and it's known as the Ishango Bone for that reason and on there, there are marks made in lines that are actually grouped together in particular combinations and historians feel that that is evidence that people were interested in counting that many thousands of years ago.

Alice Peasgood

So what you are saying is that it's not the fact that there are scratches on this bone, it's the fact that they are in groups and it looks like there's a pattern that means someone must have been thinking about the numbers when they made the scratches. That was twenty thousand years ago – I mean, what happened next? Just making scratches on bone doesn't take you very far. What's the next step that we have on record?

Hilary Holmes

Well there is a limit to how many numbers you could record in that way and the next main development actually happened in the Middle East, about twelve thousand years ago, where people decided to use small, clay tokens to represent numbers. So for example a small cone would represent the number one. So if you have four goats you would represent that by the four small cones.

Alice Peasgood

So these were a bit like counters, so they're small enough to hold in your hand, and if you wanted to trade your goats you could take four of these little clay counters along and trade with those.

Hilary Holmes

And they also had other tokens of different sizes and shapes to represent other numbers. So for example, a large cone would actually represent 60, and if that large cone then had holes in it would represent the number 3600.

Alice Peasgood

How would that work if you had different numbers?

Hilary Holmes

Well then you would have to combine the small and large cones. So for example, if I gave you two large cones and three small cones the two large cones would represent two lots of sixty which is one hundred and twenty and then the three small cones would be another three. So altogether that would represent one hundred and twenty three.

Alice Peasgood

Oh right. So instead of having a lot of tallies really all you have to do is have a handful of these clay tokens and actually you can represent some pretty big numbers with them.

Hilary Holmes

That's right, and that's why it was important to have different cones to represent different amounts because obviously if you were trying to represent a number like one hundred and twenty three, the last thing you would want really is one hundred and twenty three small cones.

Alice Peasgood

But that's still not writing anything down is it? It's still just having collections of cones. I mean did they ever write anything down about this?

Hilary Holmes

Well they did but it actually took another five thousand years. What actually happened was when they were doing trading, they would put the cones into jars, to keep them safe as a record as I am sure you can imagine people could lift the cones out or put extra cones in so it wasn't a particularly secure system. So rather than just putting things into jars they then decided that it would be safer to enclose the tokens in clay and then people couldn't take them in or out. But there was a problem there because once they had covered them in clay they couldn't tell what was actually inside. So at that point they decided to make marks on the outside of the clay to show which cones were inside. And from that it was only a small step to decide to record those marks actually on to a clay tablet and that was the beginning of recording numbers and really the beginning of writing.

Alice Peasgood

The thing that puzzles me in all of this is that they are using sixty for their counting. They are going from one to sixty to three thousand six hundred, which is sixty times sixty, but we use tens as our basis so that does seem a bit odd.

Hilary Holmes

But if you think about how we measure time we still use a base sixty system in that we have got sixty seconds in a minute and sixty minutes in an hour. The other reason for using sixty is that you can actually divide a lot of numbers into sixty easily. So it would have made some calculations easier.

Alice Peasgood

Yes because it is quite handy when you are dividing an hour into minutes because you do half an hour, quarter of an hour, twenty minutes, whatever you want to. It divides quite well. That's covered different sorts of counting but what about if you wanted to talk about parts of something say fractions? What's happened there?

Hilary Holmes

Well there we need to move across to Egypt and see how the Egyptians were using number and they were very interested in building and measurement so they started to develop the use of fractions and we actually know this from an old papyrus called the Rind Papyrus, which is currently in the British Museum which shows some of these fractions and other numbers on it.

Alice Peasgood

But papyrus is a form of paper. Because I was wondering about how these records have actually survived as well?

Hilary Holmes

It is very fragile and there is the Rind Papyrus and also various other documents that historians have been able to decipher. This papyrus explains a lot of how the Egyptians were using number, in particular in the ways of calculating by doubling and halving numbers but also how they used fractions and the fractions that they tended to use were what we call unit fractions, which is just where you have one part of a whole like a quarter, half or one third. And they would use those fractions to build up other fractions.

Alice Peasgood

So if the Egyptians just used fractions which only had one at the top as unit fractions, how did they handle a number like three-quarters?

Hilary Holmes

Well there they would just add unit fractions together to make the fraction they wanted. So for example if you look at three-quarters, you can think of that as a half plus an extra quarter. So they would have expressed three quarters as a half plus a quarter.

Alice Peasgood

Oh I see. So all they do is keep adding together small fractions until they get the large one that they need.

Hilary Holmes

That's right. And they would have used documents to help them do that.

Alice Peasgood

Where did our modern numbers, one to nine, come from?

Hilary Holmes

About two and half thousand years ago in India they started to use the numbers one to nine but it actually took another thousand years before they used them in the place value system that we have today.

Alice Peasgood

What's the place value system?

Hilary Holmes

That's just where the position of the digit represents its value. So for example if you look at the number twenty-three that means two lots of tens and three units. One of the first places that this place value system was actually recorded was in 458AD in an Indian book on cosmology which was called The Parts of the Universe, and there they wrote down the number fourteen million, two hundred and thirty six thousand, seven hundred and thirteen.

Alice Peasgood

So that's really the oldest record of a number that's written in a modern way?

Hilary Holmes

That's right.

Alice Peasgood

That sounds very advanced with what we have been talking about so far. I mean how did they use this number system?

Hilary Holmes

It enabled them to write down all sorts of different numbers, some very big numbers and that helped them in all sorts of calculations to do with measurement, the earth and so on.

Alice Peasgood

Once we have the digits nought to nine, and the place value system, somewhere along the line somebody must have put a zero in because if you haven't got any hundreds you have got to put a zero in that column. So did that happen around about that time as well?

Hilary Holmes

That's an essential part of the place value system because if for example in a number you don't have any hundreds then you do have to put the zero there to ensure that the other numbers are in the correct columns.

Alice Peasgood

But the thing is you are talking about this being developed in India but we call the numbers nought to nine Arabic numerals. So what has happened there?

Hilary Holmes

As people realised how useful they were for calculations and so on, the numbers did spread across to the West and they reached Iraq and Baghdad in about 800AD. There, there was a mathematician called Al-Khwarizmi who started to use these new numbers and actually wrote a book explaining how to add and subtract with the

numbers. He went on further to develop all sorts of other mathematics like what we now know as algebra and that area became another centre of mathematical development in addition to the Indian centre.

Alice Peasgood

So what we are really saying is there are two major cultures which contributed hugely to the development of mathematical ideas because we are going way beyond numbers for counting here. I mean algebra is actually an Arabic word. So it has been carried through into our modern language. And the Islamic world actually has made a huge contribution to mathematical thought over the centuries.

Hilary Holmes

It was so important that Al-Khwarizmi's book was then translated into Latin and that's how the use of the number system spread across to Europe.

Alice Peasgood

Now you have mentioned Latin I want to ask about Roman numerals because we see them on carvings and on walls all over the place. How did the Romans cope with MCXV when they did any counting?

Hilary Holmes

Well if you imagine trying to do any sort of calculations with Roman numerals it's very difficult. So they only used those numerals on documents and buildings and so on. When they actually had to do any calculating they would use a counting table. Nevertheless, the Roman numeral system did exist for thousands of years and it was what people felt familiar with. So when the new, Arabic system or Indian system arrived, there was some resistance to using it. One of the most important developments there was actually by an Italian mathematician called Fibonacci and he also wrote a book that described how to use the Arabic number system which helped people to get to grips with this new form of calculating.

Alice Peasgood

And someone told me that was actually one of the most popular books in its time. I mean it could be seen as a mathematical best seller in its own terms…

Hilary Holmes

…Because it was so useful, because it enabled people who were trading to do the calculations quickly and efficiently.

Alice Peasgood

What intrigues me is that Roman numerals have still survived from monuments and if you look very carefully at the end of a television programme or a film they are still used for the copyright date at the end.

Hilary Holmes

Which just shows the dominance that they had and their resistance to change.

Alice Peasgood

So what we are saying here is that really the history of the development of number and mathematical ideas started out with counting and people wanting to do practical things and then as writing developed they found new ways of representing numbers

and then started solving problems with them. So all of these cultures that were trading with each other over thousands of years have swapped ideas, found different ways of solving problems and that's how the maths has developed. But is the story continuing? I mean what about more modern ideas like negative numbers?

Hilary Holmes

Well negative numbers first arose in trade and so on but when people first started to use them they found that it was a very difficult concept and actually referred to them as fictitious numbers because they were so difficult to understand and it wasn't until the eighteen hundreds that negative numbers were really placed on a firm footing. So they really are quite a recent development.

Alice Peasgood

So that's only two hundred years ago which is hardly any time at all compared with some of the dates we have been talking about. Is that the end of the story? Have we stopped doing more new numbers now or is there anything else?

Hilary Holmes

The story is carrying on all the time. I mean if you look back to the history, numbers have developed as people have needed to solve new problems and some of the developments that we have got now are things like the binary system because at the moment our society is dominated by computers and they use the binary system which just involves two digits – zero and one. So in a way we have come from a base sixty system to a base ten system and now we are heading towards a base two system. The other development is looking at numbers which are infinitely large or infinitesimally small and mathematicians this century have been researching into this kind of number which is known as the hyper-real numbers.

Alice Peasgood

So, we are going to continue to develop new numbers, as there are new problems to solve; that the story never really quite comes to an end.

Hilary Holmes

Well that's the excitement of mathematics. As you have said when you have a new problem, you have got to find new ways of dealing with it. Who knows where it will lead in the future?