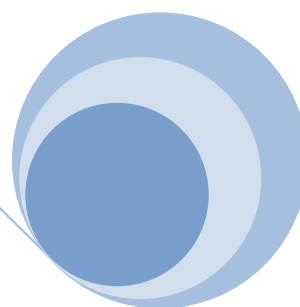
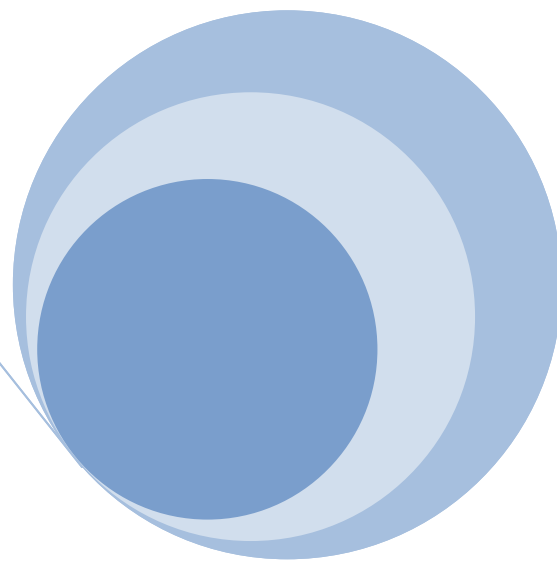


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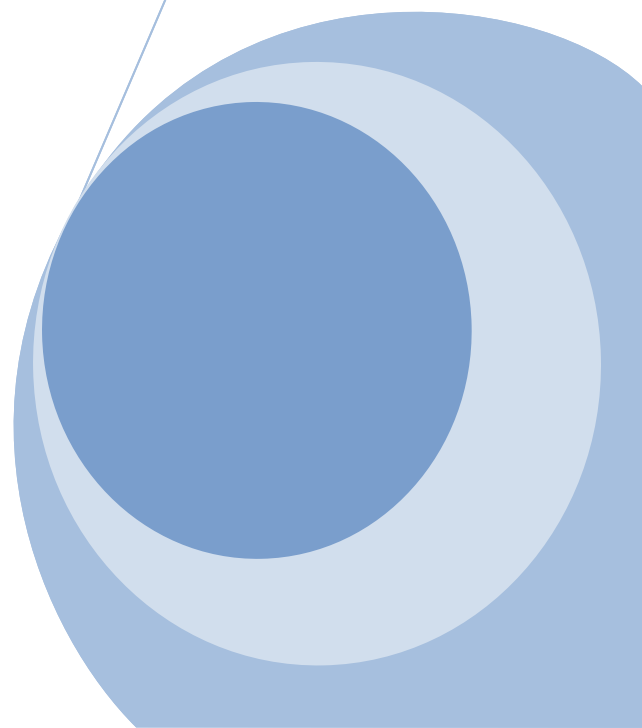


## 2020 Vision

A Mathematics lesson in 18 years time

This paper written in 2002 imagines the future of the teaching of mathematics. Written for a journal called MicroMath, it sketches out the impact of technology (and politics) on the design of the school of tomorrow

**Peter Lacey**  
**May 2002**



# **2020 VISION**

## **A GLIMPSE INTO THE FUTURE**

**A MATHEMATICS LESSON IN 18 YEARS TIME**

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**May 2002**

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## 2020 VISION – A GLIMPSE INTO THE FUTURE

### A MATHEMATICS LESSON IN 18 YEARS TIME

The class switched on their electronic whitepads<sup>1</sup>. The date 05.05.20 was flashing in the top left hand corner. The electronic whiteboard at the front was playing a video collage of groups of adults making various decisions based on their interpretations of data. Overlaid on this video was a matrix showing the day's learning programmes. Each was classified by subject and type. MaIP stood for "Mathematics: Interactive Presentation". MaTG stood for "Group Maths Tutorial and Guidance". MaSUS stood for "Mathematics: skill-up session", IWS stood for "Independent Work Session". Mary clicked her whitepad and the timetable appeared – she touched MaIP to see the range of topics on offer next week. Looking around the class she saw her usual friends who were on a similar learning pathway to her own. Today was an IP and the topic was "Using measures of centre and spread".

Mary is thirteen. She scored highly on her numeracy visa assessment when she was ten. By the age of 11, 95% of pupils had achieved their basic skills passport (with visas in numeracy, literacy and ICT). A passport with the three visas gave permission to "travel" through a learning territory. The learner has access to high quality advice and guidance. Mary has a mentor who draws on the expertise of a team of educational psychologists, guidance advisers, her learning centre subject tutors, and, where necessary, health and social welfare advisers. Her 'case' is discussed weekly at a planning conference. Mary and her parents regularly join in through their home video-link.

The school curriculum has moved on since the prescription era at the start of the century. Increased prescription had choked off the supply of teachers. The use of "teaching assistants" to substitute for teachers failed and levels of attainment not only reached a plateau but they began to fall.

A new government, elected in 2008, had won the election on the radical ticket of "Don't raise taxes but do things differently". The Common Sense Party won on a landslide. The Minister for Learning excised the quangos and used the money to establish an independent National Forum for Curriculum and Pedagogy. Subject associations played a key role in the NFCP and stimulated new research and development networks. In 2010 the General Teaching Council combined with NFCP to form the National Learning Partnership. Advances in pedagogy, informed by understandings of how the brain works, coupled with the four day pupil contact week, which released teachers to work on developing learner success, led to significant improvement. Sample tests set against the old National Curriculum Standards showed pupils were making significant learning gains.

Teacher shortages in mathematics by 2007 were reaching crisis but "work-placed learning" was now an element in all HE maths courses and the Minister for Learning had won her case in making these placements in schools compulsory. By 2012, the trend altered – many UGPs (under graduate placements) enjoyed their experience and signed up for the one-year initial Qualified Tutor school-based course which included a compulsory research element, which should be developed throughout

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<sup>1</sup> Electronic whitepads are a development in hand-held technology. They have the functionality of a mobile video-phone and computer with wireless intranet and internet connectivity. The pad can be written or drawn on freehand, by keyboard or voice recognition. Though it is known as a whitepad, different colour combinations of text, graphics and background can be used. This was found to help some dyslexic learners. Its multi-sensory input and output modes made communication accessible to learners with visual and hearing impairments.

their career. Others were attracted to teaching because it was a career in which they could fulfil their commitment, use their initiative and make a contribution to the continued evolution and improvement of the curriculum. They became school-based maths tutors.

Assessment, informed by research and conducted by tutors, became more about a navigational tool to assure progress of learners. International comparisons showed increasing levels of confidence and competence with mathematics in England.

Being an IP Mary knew there would be a lot of people in her class. She looked around again. The UGPs had entered the room as well as the LSAs (Learning Support Assistants). She noticed her cousin Peter who had gained his passport when he was 7. She looked at the other adults and waved to Sophie's mother who she knew was on an adult learners' programme. All the learners had dutifully swiped their cards into the reader on the way in. Not only would this record their choice but Mary knew that this determined the funding to the learning centre, and would, in due course store assessments of her work. Mary's friend Rachel had decided to go to a session about the distribution of prime numbers. Mary was interested but decided to store this on her PC – maybe she would access a PI on this at another time.

The whiteboard cleared and the title appeared. A team of ASTs faded in on the video. They would be ready to give one-to-one responses to questions asked on the whitepads. The camera zoomed into Nigel. Nigel welcomed the 17 learning centres he was about to work with. The camera behind him panned across the different groups. Wow! 17 classes, average size 40 means nearly 700 learners. The LSAs quietly take their places while the UGPs sit in their seats around the edge of the room.

Mary tapped her whitepad to remind herself of what she needs to know to access this session: "calculate the mean, median and mode of a set of discrete data". This is easy! She taps again to remind herself of where this could go: "similar measures with continuous data; entry to stochastic processes". She remembered that 'stochastic processes' had grabbed her interest, though she was unsure what it was about. It sounded good! Her parents were impressed and her mentor had told her that this was something to do with using probability models.

Nigel is now full screen. Mary remembers him from a topic about compound interest. He made his students work hard on a challenging problem about what rate of interest does she need to invest at in order to double her money in ten years. She had needed to discuss this at a tutorial. She had spent time working it out and looking at similar problems after joining a group IWS (independent work session). Her mentor was impressed with her results and had suggested a session on exponential functions.

Here we go. Nigel starts with a problem and we have to form groups to solve it. The LSAs are quick to make sure that groups are formed. The problem is flashed onto our whitepads.

## The Basketball Challenge

Your group is the board of directors of a highly successful mixed basketball team. One of your best scorers has moved to another team. You have £100 000 to spend to replace the player.

In your group you have the chair person, the scout, the press secretary and the accountant.

- The Chair person makes sure you agree on a decision;
- The scout has some information on players you are interested in;
- The press secretary is going to tell everyone who they have selected and why;
- The accountant will make sure that the club's money has been used properly.

In your group, sort out who is who.

You have 20 minutes to make your decision. You will then have 3 minutes to explain your decision to everyone else. The press secretary does this.

### HINTS:

- Calculate the mean, median and mode for each player.
- Discuss what you find out. Which is the best measure of average for this problem?
- In making your decision, are you looking for consistency or occasional flair? Is there a best combination of the two?
- Consider the spread of scores made by each player.
- Don't forget the cost

Good luck! - I look forwards to hearing your report.

This is the scout's information. The scout has watched the last 8, 9, 10 games of 4 particular players. The scout has made a spreadsheet.

Player	Pat Bowland	Jo Kamau	Sam Smith	Yan Lee
Game 1	4	7	2	3
2	4	0	2	0
3	4	0	2	0
4	5	10	2	4
5	0	0	8	2
6	2	2	8	2
7	0	3	0	1
8	3	0	0	1
9	-	0	1	5
10	-	6	2	-
Cost	£100 000	£100 000	£100 000	£75 000

After 20 minutes, group reports from groups across all the learning centres are shown on the whiteboard. Sophie's mum had joined Mary's group and their work had been observed by a UPG. They had had a discussion about whether the range was really helpful and the group had learnt about the inter-quartile range and the mean

deviation. Mary jotted down some notes on her whitepad and sent them to her own computer, she then sent through the group's conclusions to Nigel.

Nigel worked for MathsCo – a group of professional tutors who were all qualified mathematicians. At the start of the century there had been an experiment with advanced skills teachers (ASTs). The Universal Broadband Learning Link was also developing from NGfL at this time. ASTs and Broadband combined with teacher shortage was a solution sitting on top of a problem. By 2010 they had combined. In addition, mobile telephone, television and computer technology had become one, freely available and paid for by advertising sponsors. At the turn of the first decade attempts to provide a national learning service collapsed. Groups of schools, now redesignated as learning centres, wanted more local production centres who could relate closely to local contexts and cultures. Private local providers were more attractive to schools than the national network. MathsCo (North East) had started from some members of a local branch of a subject association.

Nigel was the face on the screen. Behind him was a team of teacher mathematicians, working like a call centre responding to comments and questions coming in from the whitepads, selecting interesting responses and sending them to the main transmission screen. Other responses were sent back to the whitepads. The team visited learning centres in person, meeting learners, mentors and UGPs and maths tutors. MathsCo was closely associated with the NLP (maths) and had a direct relationship with MPRN (Maths Pedagogy Research Net). Susan, part of the team at MathsCo NE received Mary's report and put it on the main transmission screen.

Nigel brought the classes together and asked particular groups in the learning centres to talk to their conclusions, which had been pasted on the whiteboard. Each whitepad submission remained in the corner whilst a video-link transmission showed the group explaining their reasoning. Mary disagreed with one line of reasoning, of why the median was the best measure of average, and pressed the red switch on her console. In two minutes Mary and her group were on the whiteboard video, arguing their case – and so the discussion progressed. After 20 minutes Nigel came back. He explained some principles of probability and how this affected decisions we make. He introduced an interesting story about how the height of a flood defence wall of the NCC building in York in the last century was calculated to be breached, on average, once a century and how it was breached on average every two years. His team discussed possible reasons, using terms such as 'expected frequency' and 'expected probability'. Graphs produced from spreadsheets were used to explain the reasoning.

The next challenge was to design a similar question. Mary and her group ended up with the question "who is the best mathematician in the group?" They decided to reveal their percentage scores in their last 20 assessments. The UGP suggested that they should group their data. The discussion moved towards what value should be chosen to represent the group. Mary scribbled the thinking onto her pad and sent it to all the computers of members of her group. The UGP noted their progress and, talked to them about a SUS (skill up sessions) on standard deviations and normal distributions. He made some notes on his whitepad and sent them through to the maths tutor and personal mentors.

Nigel came back on the screen and some of the interesting questions were flashed onto the screen. Mary's question was there along with a number of others. Nigel talked about the questions and explained the ideas of grouped discrete data and continuous data. The questions on the board were exported to the learners'

computers and they were reminded to work on these problems before their next maths tutorial.

Nigel faded from the whiteboard and the video collage that was playing at the start of the lesson faded back in. Some notices and messages flashed in front.

Mary brought her individual timetable onto her whitepad and made a few additional notes. She wondered if there was a difference between the way grouped-discrete and continuous data were shown on a graph. She noticed her next session was a French tutorial. She called up the previous IP, which had been a video-conference discussion with students at a learning centre at Nantes. Mary's International Understanding project – a compulsory element across all learning pathways for 12 and 13 year-olds – was about contemporary music across the world. Mary's choice! Mary had established a number of telefriends around the world and they regularly got together on "Common Link". She, and Benedict from Nantes, had discovered a common interest in mathematics and they were following a similar pathway in that subject at the moment. She would get in touch with him tonight when doing her homework.

With half an hour to go before the next session, Mary went to the café. Her maths tutor was talking with the UGP who had worked in her group earlier. Mary joined them. She wanted to ask her question about grouped and continuous data but her maths tutor, who was well over sixty years old, was telling the young UGP about his earlier teaching career. Mary listened in amazement, and not a little horror. Apparently, in those days, the learner had to fit into the curriculum. Of course many did not. Not only did learners lose interest in what they were expected to learn, but many lost interest in learning itself. Worse still, students were frequently tested with similar tests even when they were not ready to demonstrate mastery<sup>2</sup>. Mary and the UGP recoiled in shock.

"The same test regardless of learning style", remarked the UGP.

"So most students failed?" asked Mary.

"Quite so", said the tutor, "but they were given grades such as E, F and G to show how little they had achieved. Actually you could get a C grade in an examination called GCSE by achieving less than a fifth of the marks!"

The UGP guffawed. The maths tutor looked shameful and lowered his voice. "It was awful. Because schools wouldn't or couldn't change the way they worked, they used the test results in each subject to sort students by what they called 'ability'".

An educational psychologist, who had joined the group raised her eyebrows and shook her head.

The tutor continued quietly. "These students were put into separate classes – we called them 'sets'. I used to teach what was known as the 'bottom set'. Little was done to repair their learning gaps, actually, little was done to identify their learning gaps – and some didn't even have any learning gaps.

Schools didn't have mentor teams in those days. LSAs used to work with the whole group using what were called 'catch-up' materials. The dwindling numbers of maths

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<sup>2</sup> With learners progressing on different pathways at different rates, meaningful and reliable assessment tools were needed to plan, navigate and chart progress along these pathways. The National Tests and GCSE were not fit for this purpose. 'Bite-sized' mastery assessments were made available for learners and teachers to use at the point of learner readiness. Broader synoptic assessments, still based on mastery, focused on connections across and applications of subjects and themes. Learners banked successes in these assessments to gain certificates and awards. It was a natural consequence of the broad and flexible curriculum model alluded to in a 2002 Green Paper related to 14 – 19 education. The National Learning Partnership, in collaboration with similar partnerships across the world, conducted occasional worldwide sample assessments in order to gauge national rates of progress and make comparisons that informed further research.

tutors – they were called maths teachers then – were usually deployed to work with the top sets. In 2002 even the government coined the phrase ‘gifted and talented’ to legitimise this practice. You see, they thought that only 10% of the population should benefit from what we now regard as an entitlement for all. But, back to the bottom sets. Remember, they were there because they had low scores on tests – not because they had damaged brains. They were usually given work to do in areas of their learning gap so they became increasingly frustrated and often gave up. In some cases they were given more tests to prove that their learning gaps had not been repaired. Because they were in separate groups they rarely had access to the same curriculum as those in the higher sets – and they called it “comprehensive education.”

The group sat in shocked silence. “But that’s awful,” said Mary. “How could it be allowed to happen?”

“Well,” said the tutor, “I’m afraid this may sound political – but it isn’t meant to be – it’s an observation. Schools were based on a factory model developed in the nineteenth century. A group entered the factory at one end and came out manufactured at the other end. As the age for compulsory schooling was raised, so this model applied to older and older learners. Learners were ‘batched’ by age and then by ability. They nationalised schooling in 1870, the curriculum in 1988 and the testing by 1994. They made a start on nationalising pedagogy around 2000. They even invented measures to show the system was working. In areas where they thought it might be under performing they introduced even more prescription and testing.

“Who are they’?” asked Mary. “Hush!” said the tutor.  
“What made it stop?” asked the UGP.

“I can remember the actual moment”, said the tutor. “It was the launch of Phase 10 of the Key Stage 3 Strategy in 2007. The National Mathematics Text Book was launched with huge media coverage. It included detailed teacher notes on how each lesson should start and end, materials on the national learning web, worksheets for students, topic tests – the lot! On the same day it was announced that there were insufficient maths teachers left to teach the new text. And that was it!

That was when the reconstruction of education began. I can remember the excitement. I was in the Association of Teachers of Mathematics at the time and we were asked to work with other teacher associations to produce the ‘Axioms of Education’ based on principles of equality of opportunity and universal entitlement. You can find them all on the net – they were big ideas, which we are still working on. Some axioms are etched on my mind: for example:

- We are born with a propensity to learn;
- We are born with a propensity to be aware of our learning;
- We live to learn and we learn to live;
- The potential of the human brain is limitless;
- Communication builds learning communities.

Starting with a blank sheet of paper (OK a blank whitepad!) we were able to construct our thinking from the axioms. For example, a curriculum, not just built around end points, but based on the notion of learning pathways. It was obvious really – structures and pedagogies should exist to enable learning journeys. Batch processing by age and/or ability just didn’t fit this thinking. Schools, as we knew



them had to be replaced by something, so we called them learning centres, which used teams of professionals, including psychologists, and new technologies to ensure each and every learner embarked on and travelled along stimulating learning pathways. Of course, we needed subject expertise and this is where the UGP and I fit into the picture – but we also have the benefit of MathsCo. Actually, we now work together half a day each week to develop our pedagogy. The other half day is spent with the professional mentor team making sure that people like you, Mary, are advised on your choices and continue to make progress.”

Mary nodded, remembering how useful her last home-video link with her mentor had been. Just then, Mary’s whitepad buzzed. It was time to make her way to the next session. The maths tutor noticed and turned to the rest of the group who had been joining in to listen.

“You know”, he said, “since we focused all our efforts onto ensuring everyone progresses along their own learning journey, we have passed all those destinations which used to define the old National Curriculum.”

Mary smiled. She thought she would telelink her Grandfather tonight and ask what he thought when he was at school. Was it the same for Benedict’s grandparents? How could everyone of the same age learn the same thing at the same time in the same way? She remembered her mentor saying that if you choose what you learn you will learn what you choose. Did learners, or teachers for that matter, have any choice in those days? As she got up to go she tapped her whitepad. The notes and messages were in French. “Comme c’est intelligent”, pensa-t-elle.

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Sunday evening  
May 12<sup>th</sup> 2002

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