

Transcript of

Learning and Teaching in the Machine Age

delivered by

Junaid Mubeen (Head of Product, Whizz Education)

at the

2016 International Education Policy Alumni Conference, Harvard Graduate School of Education

Thank you, it's great to be back. I arrived at HGSE in 2011 as a recovering mathematician. I studied maths for eight years at Oxford. And I always struggled with a disconnect. Maths brought me so much joy and success and yet the maths I knew and loved was a world apart from the maths experienced in classrooms all across the world. So I came to HGSE searching for ways to reform maths education. There's something Fernando said to us that year that's always stuck with me as a game-plan: he said that as educators we're in the business of saving minds.

Well, the world's a big place: there are billions of minds to be saved. So I've always been challenged by the question of scale: how do you take what works and deliver that to communities all across the world?

I was at HGSE when digital learning tools were starting to take hold, with the promise of personalisation and meeting each child where they are. And I have to tell you I was sold, and I've been immersed in the EdTech ever since.

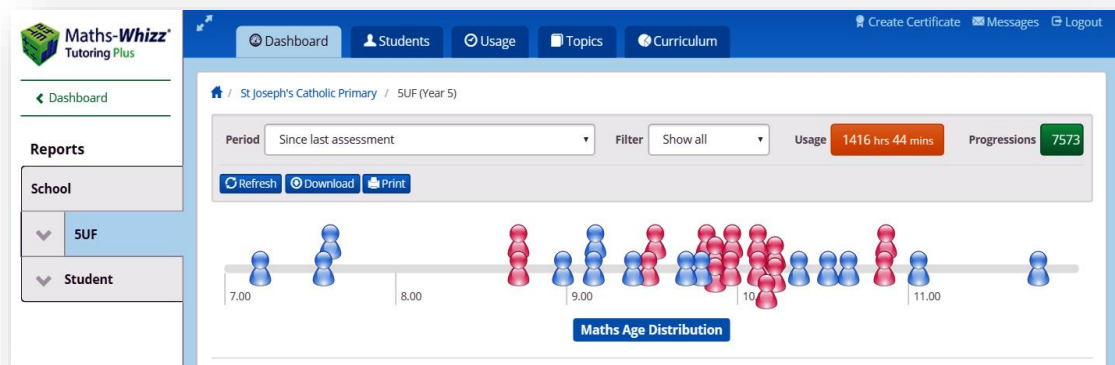
So I'll talk today about technology. But what I really want to explore is our relationship with technology as educators, and our responsibility to use technology in ways that serve our educational goals.

I'm Head of Product at Whizz Education. We're an international education company that partners with parents and schools, ministries of education and donor organisations to raise standards in maths throughout the world. We've delivered personalised maths tutoring to over half a million students. We've reached communities in Kenya and Mexico, here in the US and back home in the UK. Our service is based on a virtual maths tutor, which we call Maths-Whizz.

So Maths-Whizz was created around 12 years ago. It's a fully automated program that is designed to simulate the behaviour of a human tutor. When a child first signs up they receive an initial diagnostic assessment that maps their strengths and weaknesses across the curriculum. And from this the tutor calculates the child's overall level, which we call Maths Age. It's our international standard for

maths achievement and has a natural interpretation, much like Reading Age. So a child with a Maths Age of 9 is progressing at the level we would usually expect of a 9-year-old.

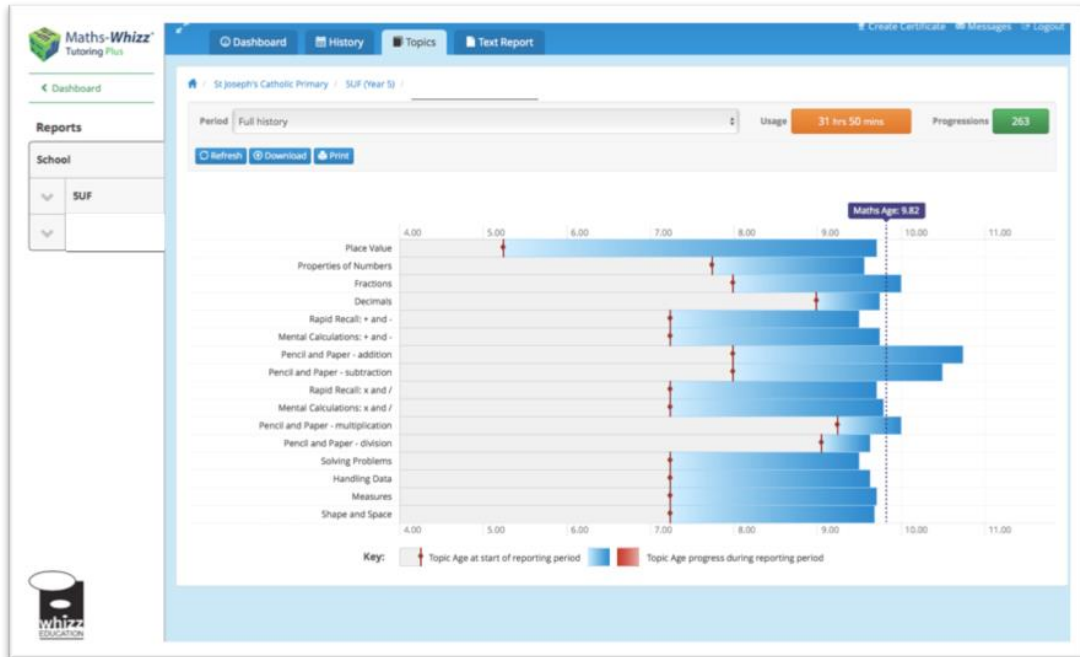
So let's look at the Maths Age distribution for a whole class of students.



This is real data, we have permission from a school to share their reports, and it's all up-to-date. Each of these icons is an individual student and their Maths Age is plotted on this scale. And this visual highlights the fundamental problem in maths education today: the sheer diversity of learning needs. We can see a four-year gap between the highest achieving students and the lowest achieving students. That trend is consistent in classrooms all across the world. So the challenge for the teacher is clear: how do they deliver an educational experience that caters to each child's individual needs? That's where the Maths-Whizz tutor comes in.

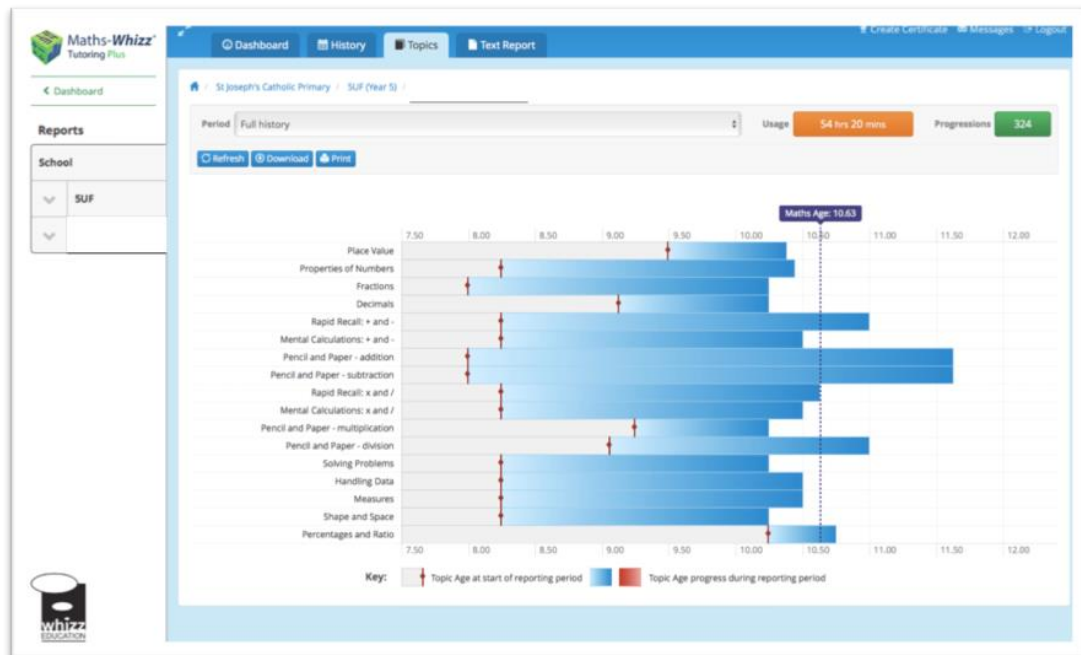
It uses artificial intelligence to deliver lessons by adapting to each child's pace of learning. Now, it's important to say that the tutor wasn't created by AI experts. In fact it was built on a set of educational principles around how students learn maths, and how a tutor should interact with a child. We gathered those principles from a team of curriculum experts and pedagogues. They said that every lesson should have an instructional component and an interactive component, that students should be continuously assessed, that they should only move forward in a topic when they have mastered each lesson and receive targeted support when they're stuck, and that they should cover several topics in parallel. And the Maths-Whizz tutor models those behaviours.

To see how these principles come together, let's look at the learning profiles of two students from this class. So here's Nancy, this is her learning profile.



These are the different topics in the curriculum, and the red markers show Nancy's level in each topic after her initial assessment. We can see that Nancy was weakest in Place Value, where her Maths Age was around 5. Now why might that be? Perhaps she missed school the week they covered Place Value, or maybe she just doesn't grasp number lines. Well, Nancy's been on Maths-Whizz for two years, receiving dedicated 1:1 support from the tutor, and these blue bars show her progress in each topic. We can see that Nancy now has a much more rounded learning profile because the tutor has focused on her weaker areas.

Now let's look at another student in the same class, so the same teacher, getting the same support and instruction. Here's Liam.



Now, we hear all the time that no two students are the same. Well, here's the evidence: we can see that Liam's needs are vastly different to Nancy's. It turns out Liam was just fine in Place Value but he struggled with Fractions. But again, after two years of interacting with the Tutor Liam also enjoys a more rounded learning profile.

Two students in the same learning environment with two very different learning profiles. Both supported by the Maths-Whizz tutor that constantly adapts to their individual needs.

I could go on and describe the exciting roadmap ahead for virtual tutors. But there's something unsettling about all this and so let's address elephant in the room: what does all this mean for teachers? What is the teacher's role in the classroom?

Man vs Machine

That question fits into a broader context. Let's call it the battle of man versus machine. And it's a battle that's been raging for well over fifty years.

Games are one yardstick for measuring the development of artificial intelligence – to answer the question of whether a machine can *think*. By 1994 the world Checkers champion was not a human but a computer named Chinook. Even then it was widely believed that computers would never outdo humans in more complex games like Chess that require ingenuity and creativity. Of course, IBM's Deep Blue dismantled that theory by defeating the reigning world chess champion Garry Kasparov in 1997. AI has marched on ever since – IBM's Watson trounced the greatest Jeopardy player of all time. And only last month, of course,

Google's DeepMind beat the world Go champion using more nuanced forms of AI; a feat that has sent shockwaves through the scientific world.

Machines are growing exponentially more powerful, and they are displacing human intellect in much the same way the machines of the industrial revolution displaced human muscle.

In Education, the battleground of man vs machine has been fought with automated, intelligent tutors. Here the question isn't whether a machine can think – it runs much deeper: the question is whether a machine *teach*.

The behavioural psychologist BF Skinner, an early pioneer of intelligent tutoring, was convinced that students should be taught through programmed instruction. And he viewed the teacher's role as simply transferring knowledge to their students.

So for Skinner, there were obvious economic benefits in building automated teaching machines: In his own words he wanted to “save time and labour” for teachers, and allow them to “teach more students than ever before”. Efficiency was his goal.

Well if efficiency is the goal then the teaching machines of the digital age pose an existential threat to teachers. Jose Ferreira, CEO of the adaptive learning platform Knewton, describes his product as a “mind-reading robo tutor”. With machines like these, who needs teachers, right?

But we all know better. This entire narrative is anchored by a narrow view of pedagogy. It's one that reduces teachers to content delivery vehicles and reduces students to passive consumers of static knowledge. It mechanises learning and teaching.

This attitude is very common in EdTech. In their zeal to scale new technologies, innovators too often succumb to a weak vision of what education can be. EdTech goes back at least 100 years and throughout that time technologies have been pushed into the classroom with little to show for all the hype.

Motion pictures were supposed to make books obsolete. Radio and then television were going to revitalise instruction. And interactive boards were going to transform the classroom. A litany of failed promises.

The failure is partly down to the technology but in the end, technology only exists to amplify human effort. And as a community of educators, we have not been prepared to challenge the narrow pedagogy of direct instruction on which these technologies are designed and implemented.

Seymour Papert shared his vision for a deeper pedagogy in his book, *Mindstorms*. He envisioned using computers to empower students as creators of knowledge and to give them the freedom to explore and discover rich ideas. But

Mindstorms was written in 1980. Papert's future has yet to pass; his hopes and visions for a new pedagogy are just as relevant today.

Only now the stakes are higher. I fear that existing pedagogies that mechanise learning will combine with exponentially powerful technologies to make teachers dispensable. Arthur C Clarke was quite right when he said that "any teacher that can be replaced by technology will be replaced".

So we need to rethink EdTech. Let's put technology to one side for a moment and focus on that deeper pedagogy. Let's ask the question first posed by Aaron Sams and Jon Bergmann: what is the best use of a teacher's face-to-face time with their students?

I think this is such a powerful question because it humanises the role of the teacher and recognises that a teacher's relationship with her students lies at the heart of the educational experience. The prevailing didactic model of direct instruction is deeply impersonal because it shackles the teacher from attending to her students' needs, which we've seen are so, so diverse. This is where I think technology can play a positive role, in humanising that teacher-student interaction.

I'm just about old enough to remember the uproar when Deep Blue beat Kasparov back in 1997. We were told that it was a landmark moment for AI and that the race against the machines was over. But then something fascinating happened. The chess community came together to organise freestyle tournaments, where hybrid teams competed as a mix of computers and human chess players. And the best teams were not the ones with powerful supercomputers, or the ones with human grandmasters. In fact the first winning team comprised a pair of amateurs and three basic computers. According to Kasparov himself, what set these teams apart was that they understood Chess as a *process* and achieved the best combined potential between the computational power of machines and human insight.

There's a powerful message here of what happens when we stop racing against machines and start racing with them.

Imagine now that the Virtual Tutor is not simply a machine that discretely interacts 1:1 with each child. Instead it is a teaching assistant that the teacher can delegate tasks to.

A teaching assistant for every child, pooling insights back to the teacher, supporting their lesson planning, enriching their classroom dynamics and enabling deeper learning. Consider that in a class of 30 students there are over a billion ways to organise students into groups. And now teachers can access this ocean of possibilities with technology at their service.

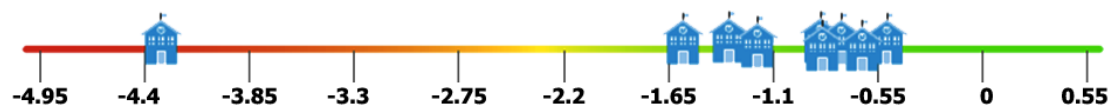
So what we're talking about is a hybrid pedagogy that wraps technology around deeper instructional goals. It even has a name – you may know it as Blended Learning. The Clayton Christenson institute has developed a framework to help

codify the practices of blended learning: it includes various implementation models, from Flipped Classrooms to Station Rotation. We should not take Blended Learning lightly. It is hard, hard work; Every Sunday I teach 5 young girls, we work on a range of maths problems. I've been experimenting with a range of models. I've yet to nail it with 5 students. It's hard work.

That's the challenge ahead for Whizz Education. It's important to understand that Maths-Whizz is not a virtual tutoring *product*. It's a *service*: we work closely with every one of our teachers to ensure our technology integrates in their learning environment. I believe we can realise Papert's vision of a richer pedagogy if we reorient technology in servitude of our educational goals: empowering teachers and meeting each child where they are.

So let's turn now to the question I posed at the beginning: how do we scale these practices on a global level? How do we address the needs of each learning community, within their own individual context?

For each of the eight regions Maths-Whizz is in we can calculate how far off students are, on average, from our international standard. Let's take a look.



Comparison of the average Maths Delta within your region 🔍

There's something quite striking, isn't there? We can see a consistent pattern: most regions hover around the same mark except for this one that's lagging behind.

Well I can tell you that we're currently in the middle of an international aid project called iMlango, where we're delivering Maths-Whizz to up to 100,000 students in rural Kenya, many of them marginalised girls. And our students in Kenya are the outlier; they are over four years behind the international standard. Now why is this? Now why is that? Could it be that Kenyan students are just not genetically disposed to maths. Or is there something else going on? I can tell you that we're also in three private schools outside of iMlango. And what I'm going to show you next is how all the schools in Kenya compare with each other. See if you can spot the three private schools.



Comparison of the average Maths Delta within your region

Doesn't take an M&E expert, does it? And what you're seeing here, folks, is the poverty gap. The social, economic and environmental challenges facing iMlango students, that translate into 4 years of lost learning, are not systemic to the whole of Kenya. Context matters.

Remember this data is updated with every interaction a child has on Maths-Whizz. We think of it as an on-demand monitoring and evaluation tool, breathing real-time insights to our implementation team. We can track learning gains day-to-day. We can see the bright spots. We can identify schools where adoption is low and deploy resources on the ground.

Context is key. My favourite story in all of mathematics is that of Hardy and Ramanujan. Ramanujan was born and raised in rural India. He was a genius in the true sense of the word but he toiled in an education system that only rewarded conformity. One day Ramanujan stumbled upon a primitive, outdated maths textbook and from that he derived deep mathematical theorems, many of them unknown at the time. Ramanujan sent his manuscripts over to England. And Hardy, a maths fellow at Trinity College, Cambridge, immediately recognised Ramanujan's genius and arranged for him to visit Cambridge. There the two men enjoyed a fruitful collaboration in the years leading up to the first world war. Everyone thinks of mathematicians as all being alike. It's not a flattering stereotype. But it's also untrue. We saw that with Nancy and Liam. And in fact, Hardy and Ramanujan could not be more opposed in their approach to problem solving. Hardy was trained with all the formality that comes with a Cambridge maths degree. He was an atheist evangelist and for him logical reasoning and rigorous proof was king. Ramanujan, on the other hand, was from the Hindu Brahmin tradition and relied on a holistic approach grounded in intuition and regular leaps of faith. What Hardy and Ramanujan had in common is that their environment and upbringing shaped their way of thinking and being.

This example is profoundly important because it reminds us that education is cultural. And as we delight in progress data that scales to multiple regions, we have to remember that it is wrapped in cultural sensibilities that technology alone cannot do justice. And that's why when think about localisation, we have to go beyond translated content. We have to engage native experts on the ground, serving each community within their context and finding deeper meaning behind the data.

Conclusion

My work forces me to go beyond technology. It can be humbling. Recently I was at a school in Seattle and I met a young boy, let's call him Joshua. And Joshua had been rewarded for achieving the highest progress on Maths-Whizz. We had a delightful chat and I told him that Oxford awaits him if he keeps going. I asked Joshua what his favourite topics were and since he was wearing a Star Wars t-shirt we had some good nerd talk as well. And after Joshua left the principal asked me what I made of the young man. I said he's a quietly unassuming student, and all his progress data pointed to consistency and discipline in his work ethic. And that was all true, the principal told me, but there was something

I'd missed – something the data would never reveal: Joshua is homeless. Well I could barely react - I cannot fathom that in 2016 a young, hardworking American boy with a love of Star Wars has no home to call his own. It turns out that Joshua lives in a hostel, sharing a bedroom with his mother and siblings. He has no computer and so his mum takes him to the library every week to get his Maths-Whizz usage up. And when he goes to school he has dedicated time on Maths-Whizz because the school has imbibed it in their daily schedule. If it takes a village to raise a child then I'm convinced that it takes a whole learning community – parents, teachers, librarians, Whizz's support team – to save a young mind.

There's a generation of Joshua's waiting to be discovered with the help of technology, ready to be inspired to take on the world's pressing problems. But I promise you this: we won't find them and we certainly won't lift them up if we strip them of their humanity - their identity - and reduce them to data points.

Those of us working in EdTech must understand education as a deeply human process and devote our innovation efforts to supporting students, teachers and learning communities with richer, more empathetic pedagogies that are situated within their context.

Let us never forget, we're in the business of saving minds, and that's the only metric that truly matters.