Manu Kapur, Professor of Learning Sciences and Higher Education at ETH Zurich, developed the concept of “Productive Failure”. In the second part of our interview he talks about tacit and explicit knowledge, and points out that technology will eventually be the primary means of conveying the latter, but not the former. He explains why standardised tests don’t prepare learners for real life and presents a positive example of an education policy intervention.

Sabine Gysi: The disruption of the traditional classroom is upon us. Artificial intelligence is becoming increasingly important in teaching and learning. Assuming that we want to promote Productive Failure learning designs: A human teacher may not be able to resist the impulse to scaffold and guide. Since human teachers have such limitations, are they less capable of teaching than robots are? Will AI prove to be the perfect teacher?

Manu Kapur: There are two levels in answering this question. Your observation is right; teachers have this teaching impulse. If they see somebody doesn’t know something, their immediate impulse is to help them. Can teachers control this impulse? I’ve worked with teachers for a decade and we’ve gone through training to withhold that impulse; I explain to them why this makes the learner engage in greater cognitive effort, which in turn helps them learn better. With training and an understanding of how learning happens, teachers are able to withhold the impulse.

Will AI be a better teacher? Let’s talk about explicit versus tacit knowledge. If you ask an expert, ‘How did you solve this problem?’ or you ask an artist, ‘How did you draw this?’ it’s often very hard for them to explain. They may be able to explain some aspects of their performance – the explicit knowledge – but there are aspects that they simply will not be able to articulate; they might say, ‘I don’t know, I just did it!’ This is tacit knowledge, and it is something you can only learn in the actual activity, working with an expert in a group with complex problems; it’s not something which can be specified. It happens over a longer time-scale.

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Explicit knowledge is programmable. Technology can deal with it; I think anything that’s explicit will eventually be codified. If a teacher’s main role is to transmit explicit knowledge he will be irrelevant in no time; but deep learning happens when explicit knowledge is coordinated with tacit knowledge, and that’s where AI has still a long, long way to go.
AI is not in a place where it will replace teachers to the extent that teachers are able to design learning that coordinates explicit and tacit knowledge in strong ways.

SG: You once said, ‘Challenge, but do not frustrate.’ But where does challenge end and frustration begin? In other words: Is there a way to personalise Productive Failure in order to address the individual needs of students at different levels within a class?

MK: That is where technology and AI can help because in a classroom with 25-30 kids or even more, it’s hard to calibrate that level for everybody; that’s a practical constraint. One of the provisos of machine learning and deep learning is that we might be able to do that calibration better using AI and machine learning techniques and provide more personalisation to the learner.

But, even then, the process of calibration would have to be iterative - I will have to engage you in something and, based on how you perform, I will either ratchet it up or bring it down – this is something that can’t be pre-determined. I have to design activities to determine where you are and then design the next level adaptively-based on where you are.

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We know that you, as a learner, have to be in the zone where you’re learning something. It’s the zone – the so-called ‘Goldilocks Zone’ – where it’s sufficiently challenging that you remain engaged but not so challenging that you give up. You feel there is something you can do about the problem but you can’t solve it completely. That’s the zone where deep learning happens. And the trick is to design learning in that zone.

Productive Failure (PF) does exactly that; we don’t want to make it so hard that students don’t understand it at all; and we don’t want to make it easy so they can accomplish it – success is not the criteria. We want to keep it at a level where, if they try something, they will not be able to solve it. And that’s okay because the goal of the activity is not learning per se; it is the preparation for learning, and failure to solve the problem in spite of having tried several ways to solve it provides the necessary preparation for learning. This is how PF works.

SG: Does Productive Failure also work for children and young people of low socioeconomic status and/or for underachievers?

MK: In Singapore, we’ve worked with students who have even failed the national exams. And we have shown that PF worked well with these kids.

The idea is simple: formal schooling and instruction puts a lot more focus on formal knowledge, and formal knowledge from an expert’s standpoint. But PF focuses a lot of attention on student thinking – formal and intuitive. In that way, for students who are traditionally low in scores, low achievers, we are building that initial background knowledge to help them learn these concepts better.

In one finding, we have taken students who are very far apart on national exams and have shown...
we can close this achievement gap. The greater resistance against the concept of PF is not from the lower-achieving student group; it's actually from the higher achieving group who are more resistant to using PF. They might say 'I know how to play this game, that's why I'm in this good school, why do I need to learn from Productive Failure now!'

SG: Singapore is among the top PISA performers, and its students are able to use their knowledge and skills to solve novel problems. However, Singapore’s innovation rate is lower than Switzerland’s, for example. Why is that?

MK: I'm not the biggest fan of standardised tests, even PISA. You don't become innovative or creative by solving problems over a short period of time, in a strange location, sitting in front of a computer, without any resources, or without talking to anybody – that kind of a situation is not often replicated in real life. If you're in this very contrived activity of standardised assessment, there is no reason to expect that this will transfer into real life, especially when it comes to innovation and creativity.

“You don’t become innovative or creative by solving problems over a short period of time, in a strange location, sitting in front of a computer, without any resources, or without talking to anybody – that kind of a situation is not often replicated in real life.”

So, if students are doing well in a PISA task which tests novel problems, does that mean they are more creative and innovative? That’s a false premise because, from a cognition standpoint, it doesn’t transfer very well.

Over the last 10-15 years, the Singapore government has funded research programmes that design interventions in schools to engage students in more creative learning experiences that we’ve designed, including PF. The current generation of kids are going to experience interventions and learning experiences that are more aligned with theories and mechanisms of learning that develop both deep knowledge as well as flexibility, adaptiveness, and creativity. The idea is that, over time, perhaps in ten years or more, you’ll have a generation of students which will be different from today’s.

SG: Twenty-first-century skills are becoming increasingly important, in education and at work. If we want to redesign learning, methods like Productive Failure have to become socially acceptable. But many policymakers are still working in systems that don’t support Productive Failure. How can they be reached?

MK: Firstly, things are changing. Policymakers are not as averse to these ideas as they were ten years ago when I started. I see some progression; more and more people are open to these ideas.
“The current generation of kids are going to experience interventions and learning experiences that are more aligned with theories and mechanisms of learning that develop both deep knowledge as well as flexibility, adaptiveness, and creativity.”

Secondly, we need to bring scientific evidence and show that PF produces learning outcomes for the 21st century. Like in Singapore: We started very small and slowly and grew the body of evidence, and it came to the point where the policymakers said, ‘Yes, okay, you’ve done this work in a range of schools, in a range of contexts, and it seems to be working; let’s scale it.’ Today, PF is being scaled up in the Singapore pre-university statistics curriculum.

This does require a lot of research work and a lot of communication, and a shared vision coupled with stakeholder buy-in. But it can be done.

In the first part of this interview, Manu Kapur explains his concept of Productive Failure and why teaching should be guided by the latest research on human cognition and learning.

Manu Kapur is a full Professor at the Department of Humanities, Social and Political Sciences of ETH Zurich, Switzerland, and holds the Chair of Learning Sciences and Higher Education.

Prior to joining ETH Zurich, he was a Professor of Psychological Studies at the Education University of Hong Kong (EduHK). Manu Kapur also worked as the Head of the Curriculum, Teaching and Learning Academic Group (CTL AG) as well as the Head of Learning Sciences Lab (LSL) at the National Institute of Education (NIE) of Singapore.

Read more about Manu Kapur

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