Education and the New Laws of Robotics

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Introduction

This is the second of three interviews for our special issue of *Postdigital Science and Education* on 'Education in the Automated Age'. Here, we engage with different experts working *outside* of the educational studies domain who are nevertheless interested in the rise of artificial intelligence and other forms of automated decision making. This article presents a conversation with Professor Frank Pasquale. Frank is based in Brooklyn Law School in New York, and well known for his work on law and regulation issues thrown up by the increasing complexity of AI, robotics, algorithms, and platforms.

In this interview Frank talks with Neil Selwyn about his book *New Laws of Robotics* (Pasquale 2020) – already recognised as a seminal exploration of the emerging forms of automation associated with the rise of AI and other digital systems. Frank and Neil go through some of the main arguments that are developed in the New Laws of Robotics – particularly the book's extended discussions of AI and education professions, and Frank's reflections on the steady implementation of automated technology, algorithmic systems and AI into classrooms.

About the Conversation
This is a transcript of Frank and Neil's conversation, conducted online toward the end of December 2021, which they have both edited lightly for sense, clarity, and intended meaning.

The New Laws of Robotics

Neil Selwyn (NS): It is great to finally get a chance to talk with you! First off, I was really impressed with the breadth of *New Laws of Robotics* (Pasquale 2020). You develop some fascinating discussions around AI and automation in areas such as healthcare, medicine, journalism, defence, as well as education. I was wondering how responses to the book have compared across these different domains? Are there particular professions where you feel that the book's arguments have been picked up in a particularly attentive manner… and what reaction (if any) have you got so far from education audiences?

Frank Pasquale (FP): The medical side has gotten a good deal of attention, in part because AI in healthcare raises visceral concerns. It seems like AI is coming up very quickly on the side of physical health *and* on the side of mental health. On the side of physical health there's been real urgency around the idea that AI could help prevent errors—but also, there could be failures in the representativeness of its data, and that AI systems and machine learning could be just as biased as our healthcare systems already are against marginalized groups. On the mental health side, I have enjoyed discussions around the nature of conversation and meaningful human interaction, and whether or not a chatbot can provide that.

I think the final part where the medical side of these debates has really picked up steam relates to the professional model of medicine. In the book, I emphasize the idea that AI should be developed as 'intelligence augmentation' for professionals in many of the fields that you've just listed in your question. I think that the idea of professionalization is very advanced in medicine. Perhaps in some of the other fields there's less identity-formation via professionalization – there is perhaps less of a sense that there is a self-organized group of workers who can control entry to their field and develop standards for it. So that is where the debates around the book have been going so far. But certainly there is interest across many domains, including education.

(NS): But it strikes me that education is sometimes a bit slow to pick up on these issues. You suggest that health issues are particularly visceral, but education is an equally visceral matter for many people. Working with children is certainly an emotive area in terms of public and policy discourse, and is certainly an area where people value the qualities of conversation and human interaction. Teaching is certainly an area with a strong sense of professional identity. In all these ways, your description of why AI debates have been picked up in health and medicine should also apply to education. So why do you think education has been slower than medicine or law to pick up on tech issues and the changes that are occurring through AI and automation?

(FP): Well, I have to admit, I can't claim to be to have kept abreast of *all* of the literature in the education area, but I trust your characterization of the premise. I know certainly work from the likes of Paul Prinsloo, Ben Williamson, and Audrey Waters picks up on these issues. And I think from a neoliberal managerialist perspective, there *is* a lot of emphasis on automation as potentially increasing access to education while reducing costs. But, of course, I question whether that sort of 'free lunch' can actually be achieved.

For example, there is the basic issue of time – I don't think there is sufficient time for students and teachers to either try to find useful applications of automation or work out how to regulate them. If superintendents and principals were truly serious about digitization, they might give teachers more time to research it and prepare its implementation. This reminds me of how Google used to give their employees '20-percent-time' (the policy was ended in 2013). So, Google employees could assign 20 percent of their time to a project that they thought was of long-term importance. And I think that's part of the reason for the company's success with search.

So, if education had something like this '20-percent-time' where teachers and other professionals were able to read up in the area, experiment and think further out, then that would help ensure that tech (and much else) were wisely and patiently integrated into classrooms. I think it would lead to more focused, concentrated, and effective efforts to shape the future of technological adoption in education. I'm sure there *will* be a lot of new technologies adopted in education, but I think that there would be a lot more interesting technologies being adopted (and a lot more critique and analysis of existing adoptions) if people had more time.

(NS): You're absolutely right - education is an area where people are certainly 'time poor'. But just to roll the conversation back a little, we probably need to contextualise what we are talking about. A lot of people talk blithely about 'AI' without specifying exactly what sorts of technology they are concerned with. So, what are the general forms of AI, automated decision making, and other kind of 'Bots' that you cover in the book?

(FP): I think there are a few different forms. First, I would think about the robot as a physical entity in the world with sensors, actuators, and the ability to move around, sense things, and react and process information. That's relatively uncommon in our everyday experience, but it's becoming more common. Such robots dominate some factories and warehouses.

Physical robots aside, I would categorize the real cutting edge of AI that is being deployed now into at least four categories. The first is 'reputational' AI - AI that evaluates how well a person has performed, and then projects into the future how well they're likely to perform in a variety of areas. The second is 'search' – AI that helps individuals make sense of the world and understand the world. Third, I'm particularly interested in the 'educative' (or mal-educative) function of AI-driven mass media. Indeed, I call out in the book that the media and finance are perhaps the key industries where automation has gone the furthest in terms of impacting on our mental processes.

Finally, I would highlight the automation of government decision-making. For example, in Australia it seems that RoboDebt was a pretty poor implementation of automated decision-making, but there are other potentially more positive implementations of automated reviews. I mean, a lot of people who get caught up in the bureaucracy of welfare benefits certainly wish that there was a way that their cases could be automatically approved. So, that is an area of real promise. All of these are topics that I think are on the horizon in many different domains.

(NS): The failure of Robo-Debt was definitely something which captured the Australian imagination and pushed the public and politicians into talking more seriously about automated

technology. There is something about these technologies that mean they are often not taken seriously by policymakers or the public until there is a high-profile controversy.

So, just before we move on to the educational aspect of the conversation, can we just go through your general pitch for your book around the notion of 'Four New Laws' of Robotics? What are the core concerns that you are raising around automation and AI… and where do you hope these new 'four laws' might take future discussions of AI?

(FP): My 'Four New Laws' are an effort to bring a political economy perspective to the ethical laws that Isaac Asimov proposed. Asimov proposed 'three laws of robotics' in 1942 which are hugely influential among a lot of technology leaders. But they mainly focus on controlling machines, rather than regulating the persons making machines. Since we are so far from truly autonomous AI and robotics, that person-centred focus is what's most important in the real present (as opposed to Asimov's sci-fi future).

So, beyond his 3 laws, I wanted to add four more. I start with the idea that, in most situations, *AI and robotics should complement – rather than substitute – for professionals*. Here, I try to develop a theory of what a profession is – i.e., labour where we expect individuals to exercise judgment, to take on a fiduciary role, and to develop self-governance mechanisms to ensure quality work by professionals. Of course, these boundaries are contestable, but I think that this type of work is an area that we need to guard from the substitution of AI technologies for human judgment.

The second 'new law' is to *avoid counterfeiting humanity*. I am concerned with keeping coders and designers from trying to fool people into thinking that AI and robots are humans… or that they should be treated like humans. This law, I think, is really important, and it flies in the face of an entire 'affective computing' agenda in human computer interaction and AI research that says, 'we should make the robot as much like a human as possible when interacting with it'. I go in the exact opposite direction. I say that we should *always* be aware that we're dealing with a machine that has all manner of influences and powers that are often hidden to us, that are extremely opaque and hard to understand. Dealing with such machines is an occasion for extra caution, not for comfort and complacency.

The third law is that *robotic systems and AI should not intensify zero-sum arms races*. Often in AI you will see an arms race develop, where one entity gets a form of technology and then another entity tries to outdo it. This is most obvious in areas such as military and policing – the logic that if China gets killer robots then America needs killer robots… and then if *they* get killer robot deflectors then *we've* got to get the same thing, etc. It's pretty worrisome to me in these high-tech fields, because they promise forms of violence and control that are potentially far more granular and ambient—and far less attributable--than traditional weapons But this law goes beyond weaponry, to cover almost any area where zero-sum competition is intensified by AI and robotics.

Finally, the fourth new law of robotics is one of attribution – that *robotic systems and AI must always indicate the identity of their creators, controllers and owners*. Now, this is both a simple and a complex task. This is simple if you just analogize it to a car needing a license plate. We don't allow people to just drive around in unmarked cars and do whatever they like. Instead, we think it's a relatively important privilege to drive, and we want to trace every car back to an owner. So it's an attractive and relatively simple rule.

Yet, if we take it seriously, this simple requirement for attribution unravels the entire dream of autonomous general intelligence. People that want to create AI technologies that are entirely autonomous and just sort of do their own thing in the world, don't want that to happen. But I want any AI that is out there - any drone that is flying, any sort of sidewalk robot, autonomous car, or any online Bot - to be tied back to a person, who has responsibility for monitoring it and freezing or terminating it if it goes awry. Actually, there already is legislation in California to require the disclosure of whether something is a Bot online. I would hope that goes further to require the disclosure of who owns the Bot as well.

So, to just summarize these laws, they really come down to complementarity, non-counterfeiting of humanity, anti-arms race, and attribution. I think those four laws together provide really important foundations for technology regulation. They certainly don't answer very specific questions about what this regulation might look like, but they provide broad principles that then I apply throughout the rest of the book to look at particular dilemmas.

The Four Horsemen of Deregulation

(NS): I think these new laws are particularly valuable – certainly for an education audience – in that they raise a host of issues around AI and automation that are not usually acknowledged. So, to drill down to the specific domain of education, I'm really interested to hear how you anticipate those logics and concerns playing out in educational terms.

First off, you cover what could be described as some rather 'avant-garde' technologies in the chapter on education. A lot of these technologies would not yet be considered to be mainstream technologies, but they are beginning to be used enough to now merit being talked about by educators. So, what specific avant-garde AI and automated technologies did you come across in schools and universities that surprised you when you were writing the education chapter? What kind of automations are we talking about here?

(FP): I lead off with the example of a Chinese classroom system called 'Class Care'. Class Care involves a camera in the front of the classroom that looks at each student's face and takes a picture either every minute or every second, depending on the company. It then can use these pictures of faces to rate the students' level of engagement, assign them to one of five affective states. It can then rank those affective states and give points for those that are the most 'engaged', and then report back to the teacher and to parents about how 'engaged' their children are. At this point, it can also aggregate point levels for classes, and rank the classes in the school.

This example is quite remarkable - there's so much to say about it. One thing is that it is showing the dark side of 'soft skills'. The OECD and other economic advisory bodies sometimes push visions for ensuring there will be human jobs in the future by emphasizing the importance of soft skills. But if it's a computer that drilling the 'soft skills' into you, or making you feel like you are being surveilled to constantly be on guard to be 'engaged' (or looking 'engaged')—well, this is a kind of training that translates the logic of the assembly line to the realm of emotions and culture. Of course, I'm sure the persons behind it (and it's only been trialled so far) would say that substantive learning and better test results are the true aim. But if so, it may be better to

stick to these ultimate outcome measures, rather than trying to make every moment a possible outcome to maximize.

A second example is a Bot that Georgia State University in the US deployed that pretended that it was a TA [teaching assistant] (see Kelly 2022). So the students would ask questions online. In one sense, most of these questions are pretty standard. As a professor, I would certainly love to have a Bot to answer standard questions. I can't you tell how many times I've explained to students what 'arbitrary' and 'capricious' mean in an administrative law context.

But on the other hand, I think that this case is troubling. Firstly, the students didn't know that this was a Bot - so it was an experiment on them. Secondly, each time I explain something to students as a professor, I feel like I get a little bit better at explaining it. I can explain it at a certain level for a certain student, or come back to an example that they might be particularly interested in, etc. It is very hard to imagine the Bot being personalized in that way.

(NS): But a lot of people who are selling these systems (and perhaps those purchasing them) would ask what the problem is with these examples. Teachers have always looked at students' expressions, some teachers have always given rote answers to questions. So, it might be argued that while using these technologies perhaps run the risk of missing a few things around the edges, what is the fundamental problem here? … Schools are not perfect, and these technologies are also not perfect …

(FP): I think that in certain contexts you could argue that any of these technologies would be better than nothing, right? If the student has a question at 3am that needs to be answered immediately, then it's certainly better that they use the Bot than call the poor TA at 3am and wake them up. But I think with the example of the 'Class Care' system there really are some very big differences. One problem here, I think, is that a teacher is not constantly looking at every student. In a typical classroom there's always a bit of micro time 'off stage' to use Goffman's (1956) formulation of the need for humans to have time 'off stage'. Also, the teacher does not have a perfect digital memory of facial images of each student second by second.

I was actually just commenting on this to some friends, about the phenomenology of Zoom versus having dinner with friends. There's a wonderful essay by Michael Sacasas (2020) called 'A Theory of Zoom Fatigue', and also a psychological study of why Zoom fatigue happens (Nesher Shoshan and Wehrt 2022). Part of the explanation here is that when I am out having dinner with my friends I spend probably 80 percent of the time looking at the food, looking at the menu, looking at the cars coming down the street, looking at whatever it might be, and then occasionally making eye contact. With Zoom - and it is the same with this Class Care system - there's often a sense of, 'Well, I can always be in trouble if I'm not looking engaged enough'. So there's a pressure to always be—or at least look—engaged.

So, I think that's a major difference, right? Because looking constantly engaged involves all manner of systemic distortions, alongside a heightened sense of alienation. You know, if I had to rewrite the book I probably would have focused on alienation more. I think alienation a very useful, multifaceted concept which has really been pushed to the side somewhat in discussions of technology, but which I think would be very useful to revive nowadays.

(NS): Well, that's certainly an idea for the next book! Actually, from my own experience the other alienating aspect of Zoom is that you're always looking at a video stream of yourself – something you would rarely do if not interacting through a screen. Anyway, I think we are in agreement that there are clear harms to all these technologies, and I guess the obvious subsequent response would be: Right, we should regulate these things! These are technologies that need to be regulated. So, it is instructive to speak to you as someone with a formal legal background, and I note that you are at pains to argue in the book that it is incredibly difficult to regulate autonomous technology. Can you elaborate on this? For example, you talk about 'the four horsemen of deregulation'. Why can't we just regulate our way out of these problems?

(FP): I'm glad you picked up on that! The 'horsemen of irresponsibility' comes from a piece I wrote for the Maryland Law Review a few years ago (Pasquale 2019). Whenever regulators try to intervene in these information-intensive spheres they face a lot of complications and difficulties. First is the 'trade secrecy' difficulty that I got into in my last book, *The Black Box Society: The Secret Algorithms That Control Money and Information* (Pasquale 2016). It's often very hard to figure out what's happening because a lot of tech companies are just going to tell you that the algorithms driving their key business processes are trade secrets. 'If we told you the ways we are ranking students that would give up the most valuable part of the company' etc.

Secondly, there are exculpatory clauses in contracts. So, tech companies ask you to sign Terms of Service, promising that you'll never sue. Even worse is the promise that you'll indemnify them if anything goes wrong at all – so you'll indemnify the company rather than them being responsible to you.

Third, then, there are problems of free expression opportunism. These are less of a problem in most of the world other than the US, but are certainly a problem in the US. For example, if you try to regulate what algorithms can communicate, then you'll run into the problem of certain courts saying, 'well, that's a vital resource for First Amendment-protected activity'. I don't know about the algorithm itself having First Amendment rights, but certainly the corporations and owners of the algorithm have First Amendment rights, sometimes quite expansive. In fact, they are so expansive that when I discuss them outside the US, the response is sometimes incredulity or laughter. There's an immediate understanding of how harmful such a sweeping deregulatory tool can be.

And fourthly, is the general trend toward deregulation and preemption of local authorities by national legislation and international treaties, or in other contexts by international authorities (such as the World Trade Organization). So, all of these factors make it very difficult to regulate well, and this leads me to think that there needs to be a lot more investment in the regulatory sphere. This could perhaps be paid for by a tax on certain revenue streams attributable to the technology we're discussing – even a minimal percentage tax would go a long way toward funding regulators who can understand what's going on, and propose and apply common sense regulation in response.

(NS): The idea of an algorithm having First Amendment rights is terrifying - I don't even want to start thinking about that scenario! But it does raise the point that we need to be thinking about alternate ways of addressing the harms of automation in education. So, in your chapter on education, you do raise a number of suggestions which I thought were great provocations to

think further. I'm not sure how practical they would be, but it would be very useful to consider them in a little more detail.

First, you argue that there needs to be more informed procurement of new technologies by educational institutions and by educators. This raises the broader point that education administrators need to be a lot savvier about how they interact with tech firms and the vendors selling education technologies. Educators need to negotiate for control of their data and have input into how systems and software might be revised. I'm interested to hear your thoughts on how informed and agentic procurement might work in practice. To me, this is a substantially different way of engaging with technology in education than most schools and universities are currently used to.

(FP): It is… and I think that the most detailed plan for accountable AI procurement was probably laid out in a report by the AI Now Institute (2021) that was a shadow report written after a New York City government taskforce failed to fulfill its mandate. The NYC taskforce was supposed to develop a really strong set of recommendations for conditions before the City bought any algorithmic processes or AI-driven processes. But the taskforce punted, so civil society had to fill in the gap—and hopefully their recommendations will eventually govern AI procurement.

As I recall, part of their strategy for ensuring more accountable AI was to first condition the governmental purchase on some basic norms of transparency. This makes sense because government is purchasing AI systems to perform quintessentially governmental functions. The government is supposed to respect basic freedom of information laws (FOILs). So, if the AI is effectively becoming part of government, then it makes sense for FOILS to apply to it, too.

Another aspect of ensuring more accountable AI is to separate out: (i) the data used, (ii) the algorithms used to process this data, and (iii) its results. Even if the algorithms used to process the data in these AI applications are supposedly trade secret protected, I think that there's very little sense that the data (processed by the algorithm) or the results of the algorithmic analysis *should* be trade secret protected. Algorithms should not be immune to scrutiny, either. I'm actually working on an article now called 'Five Principles of Reputational Justice', where I argue that in any situation where a human being is evaluated by an algorithmic system, trade secrecy should not apply.

Danielle Citron's (2008) concept of technological due process could entail not having one's reputation harmed by automated decision-making without some procedural rights to know the basis of the evaluation. And due process is quite a robust concept, right? It involves a neutral tribunal, knowing the charges laid against one, scrutinizing the evidence, etc. So, if we start to think about these AI systems as essentially operating as judges or in a quasi-state role, then we see more clearly the need for these types of transparency in procurements, and other similar regulations to ensure transparency and accountability in them.

(NS): Allied to this, you also raise the point of empowering classroom teachers to become what you describe as 'full partners' in the use of technology in the classroom. So, you are arguing here for positioning the teaching profession to take a more active stance in terms of the technologies that they work with. But again, that leads me to think that such a shift implies a different level of professionalization than we have at moment around teachers and technology?

(FP): That's a really good question in terms of where and how we create the institutional foundation for empowering teachers to co-govern the future of EdTech. There was a controversy in the US few years ago about a National Academy of Sciences' recommendation that childcare personnel should have at least a college degree. And this led to a fascinating battle in the US, because you had real splits where there were some individuals (both on the left and the right), who said 'anybody can do this'. You know, anybody can take care of a two-year-old - just as long as they have a good heart, and they're friendly, then let them take care of the two-year-old. College costs so much and requiring a college degree is really harming those who can't afford it.

But then there was also a broad – and, dare I say, technocratic - centre that replied: 'Wait a second, this is a very sensitive time in the child's development … this is incredibly high stakes. Let's make sure early childhood educators are trained well.' I fall very much in that latter camp: educators need more and more training, and that certainly applies to professionalisation around technology.

Indeed, I hope that eventually we see these educational technologies as being akin to prescription drugs. So, just as we probably would *not* want to go on our own to the pharmacy and say: 'My heart's beating a little fast. Maybe I'll take that pill that I looked up on Google that said it treated tachycardia?'. Pharmacology is complicated. Potential drug-drug interactions are complicated. Of course, even this norm is being undermined by a sweeping pharma-libertarianism that would give anyone the right to try any drug they'd like. I suspect, though, that if this pharma-libertarianism were actually implemented, it would be rolled back pretty quickly, because it's almost a certainty that many, many people would be hurt.

All these ideas about drugs are second nature to us now. But they weren't second nature in the early twentieth century. It took enormous political battles. It took Upton Sinclair's (1906) revelatory book, *The Jungle*, the Food and Drug Act of 1906, the Food, Drug and Cosmetic Act 1938, and then the Kefauver-Harris amendments to it in the middle of the twentieth century, to really set up our modern drug regime. These changes were being battled every step of the way.

So I feel we're maybe at the cusp of a similar situation with technology. I think there are many modern Upton Sinclair's warning us about technology. Ruha Benjamin's (2019) *Race After Technology: Abolitionist Tools for the New Jim Code* and Cathy O'Neil's (2016) *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy* are certainly like Sinclair's (1906) *The Jungle* – all saying, 'Hey look, there are some real dangers here'. I think that that a real goal would be to alert the public to those problems, and then to hope that they have enough trust in their teachers' professional expertise to engage in real due diligence of these technologies, rather than just saying, 'Oh, yeah, I will just buy whatever I want off the off the shelf, and it'll be the best'.

Towards A Regulation of Ed-Tech

(NS): And these thoughts also lead on to another recommendation you make about establishing 'Education Technology Agencies' in a similar manner to a Drug Regulation Agency as part of a resilient governance structure. We might have education technology agencies that evaluate and license the different technologies that are coming into education systems. But looking back to

the commercial imperatives that we were talking about earlier, I can imagine that any such proposals would provoke a huge amount of pushback from industry. So, how realistic is the idea of establishing education technology agencies? How might we go about setting that sort of governance structure up?

(FP): I think that in Europe these sorts of structures are going to be developed, if not for *ex ante* licensing, then at least for *ex post* auditing and regulation. I think that the EU AI act will provide a level of structure and guidance for the member states to invest, if not in an entirely distinct Education Technology Agency, then at least in ensuring that there are adequate personnel and existing education regulators to ensure compliance with the Act's requirements. The Act's requirements are not burdensome, but they are serious, and they do require certain levels of certification of any AI technology by external bodies in order to avoid potential consumer or human rights harms.

I do agree that at the federal level in the US, this is not going to happen. The power of industry (and gridlock) is far too strong. Yet there certainly are some states like New York and California that are poised to empower their own education and privacy protection agencies to regulate EdTech. The California Privacy Agency is a great example of an agency that is stepping out. And certainly China is an interesting case in terms of its ban on many forms of EdTech, in part in order to stop arms race dynamics in education (where richer families can afford better tutoring, and thus convert economic capital into educational capital, which Bourdieu and 'signaling' theorists have critiqued). If China can go so far as to ban a massive sector of the education economy, then it certainly should be interested in regulations along the lines that I've described.

Of course, I have to admit, regulation can be a double-edged sword. It can be used to both promote human freedom, but also to bring in restrictions we wouldn't want to see. With that in mind, I think that there are lots of different models out there. For example, in terms of another form of pushback, probably the entity that would have some level of ability to push back might be teacher unions. If the teacher unions understood that technology is potentially replacing them (more accurately replacing them in a shoddy way), then that's where the argument also has to be made.

That said, I don't think that any worker can say, 'Don't replace me with a machine' just because they feel they deserve a living doing the same job they have always done. The argument has to be that the machine you're trying to replace me with is much worse than I am… and here's why it's worse… and by the way, here is why it's very unlikely it will ever get better unless front-line workers like me are assessing its strengths and weaknesses. I think you can make that case for many professions, and probably for many occupations which are not yet professions.

(NS): Absolutely - I think the principle of professions standing up and making a case for what they bring to the table is really important… So it is really important to make the case of what the 'added value' is of having a human teacher in the room, and teacher unions should be a key part of that.

You also focus on the need to acknowledge and invest in education as a way of better preparing people and communities in general for the AI age. You talk of education having a key

role. So, what might this involve in practical terms if we took up this recommendation? How would we set about establishing forms of education that make people and communities fit for the AI age?

(FP): It's a tough question. My quick answer would be to refer to a book by Joseph Aoun, *Robot-Proof: Higher Education in the Age of Artificial Intelligence* (2017), which is about higher education and how he, as President of North-Eastern University, restructured the collegiate experience there. Aoun emphasizes the critical need for humanities and social sciences education in an age of AI. *New Laws of Robotics* (Pasquale 2020) elaborates on the type of institutions and culture and political economy necessary to ensure that this type of critical thought continues to be valued.

I also think Jeannette Wing's (2011) emphasis on computational thinking is very helpful. I would put some computational thinking very early into the elementary school curriculum, just to get young people thinking about how you solve problems the way a computer would. And secondarily, what are the types of problems computers cannot solve. This doesn't involve coding and complicated ways of understanding programming languages, but it does require being able to decompose a problem into different sub-problems that might eventually be able to be answered in a series of Yes/No/And statements.

I think that's a fascinating approach. I've supervised a few Law papers where I ask a student who is interested in automation to try to boil down a key part of a statute or regulation into a series of Yes/No questions. And even though it almost always fails, it is a wonderful pedagogical exercise to see where the points of failure are, where the points of necessary human judgment remain.

Those are some ideas, but I don't want to under-emphasize the fact that a huge part of what is needed is giving the folks in STEM a substrate to have conversations with everybody else. I've been in too many rooms, where someone will say, 'How dare *you* propose technology regulation? Do *you* know how to code at a sophisticated level?'. And I would just say, right back, 'Well, many of my proposals are based on Charles Taylor's critique of behaviorism and allied philosophy of social science. So tell me what you know about philosophy of social science?'. In other words: there are many ways to 'disqualify' someone from participating in a purposive conversation. The point should be to find ways of mutually educating each other across disciplinary lines.

Faced with technical complexity, some in the law and the policy realm are prone to just shrivel up and say, 'Oh, I can't say anything about this'. But I love to challenge my law students to embrace the complexity—be it statistical methods in legal cases, AI and machine learning in law and medicine, or quantitative valuation for policy evaluation tools like cost benefit analysis or comparative effectiveness research. I lead it off with Joan Robinson's (1978) wonderful thought (I paraphrase): you learn economics, not necessarily to be an economist, but to avoid being fooled by economists.

I think there is a place for many individuals in society to play that role - to at least get to the point where they will not be cowed into submission or fooled into assuming the technology is automatically valuable or right simply because it incorporates AI or ML methods. I realise that is a double-edged response - I simultaneously want to see more computer literacy, computer science literacy, and coding literacy, and also more informed scepticism about such fields. But I

think that dual movement is necessary for wise policy, give the need for bridge-building between STEM and non-STEM approaches.

(NS): So, a new broad form of interdisciplinary education - liberal arts and STEM for everybody. I think that is a promising way to go forward. So, finally, I'm interested where you think this is all going? You work in a university - where do you think universities are going to be going in twenty years' time? Where are you going to be working in twenty years' time?

(FP): I don't know… the way things are going now maybe I'll be selling apples in the aftermath of the second US Civil War? Less facetiously, what's fascinating to me about Covid-19 was that the sudden shift of everybody into online education was an incredible stress test for the idea that we are moving toward a generalised online form of education.

I was struck particularly by the sense of dismay and stress that accompanied this sudden change to online education. And I shouldn't really say 'sudden'. By the second semester of the 2020/2021 school year we had some of time to figure out what to do, but a lot of people's experience of online education was still pretty substandard.

That made me feel that there is something about bringing people together in a university setting, into the classroom, into extracurricular activities, and when possible, into dorms in a campus. That is really valuable. I think that the challenge for universities going into the next twenty years is figuring out how do you simultaneously maintain that tradition, but also bring in the best of technology to make sure that we're really maximizing opportunities for our students?

I think that is the challenge. And it's not just a challenge for universities. The challenge that goes all the way down to the earliest educational experiences is how to figure out that balance. So, in the education context, I can see far more justification for people saying, 'You've got to be aware of the cutting edge of AI in education'. I think that you do have to expose your students to this technology in order to do a good job as a teacher, professor, or instructor at any level. I do think also that we'll see a few more opportunities for hybrid classes, flipped classrooms, and those sorts of things moving forward more. But I have to admit my imagination is not as bold as I would like it to be… I should probably read some science fiction of education and get back to you on this!

(NS): No! Reading science fiction is where everyone goes wrong with anticipating the future of education technology! But I do like your emphasis on keeping the spontaneity of face-to-face encounters and valuing the ways in which face-to-face contact sparks some sense of what it is to be human. I think one of the arguments that develops across your book is the idea that getting the best out of AI in education relates to developing uses of technology that don't simply aim to counterfeit or replicate the teacher, but instead attempt to achieve completely different things. I would love to see more AI technology in education that completely surprises me - doing something that I could never even imagine doing as an educator, rather than just trying to replicate the work that I am already doing. That is an automated future that might be worth looking forward to! Thanks ever so much for taking the time to do this Frank. I look forward to reading the next book.

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