

EDUCATION: FUTURE FRONTIERS

OCCASIONAL PAPER SERIES

Educating for a Digital Future: Notes on Curriculum

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EDUCATION: FUTURE FRONTIERS is an initiative of the NSW Department of Education exploring the implications of developments in AI and automation for education. As part of the Education: Future Frontiers Occasional Paper series, the Department has commissioned essays by distinguished authors to stimulate debate and discussion about AI, education and 21st century skill needs. The views expressed in these essays are solely those of the authors.

In *Educating for a Digital Future: The Challenge*, I described how artificial intelligence, automation, robotics, natural language processing, neural networks and related disciplines have been evolving in recent years and the implications for work, jobs, the distribution of income, and, indeed, what it means to be human. In this brief article, I explore the implications for what young people might need to know and be able to do to cope with the world I described and perhaps flourish in it, and, in particular, offer some ideas about the kind of experiences young people might need as they grow up in this new world.

In that article, I described the ways in which these technologies are creating a world in which many parts of the jobs that have long been available to young people are disappearing, made unnecessary by machines that can do those parts of those jobs faster, more accurately and less expensively than humans—or simply eliminating the need for those jobs altogether. And I showed how and why these technologies are leading to a world in which a much smaller group of very highly educated and very well trained people in a small number of fields are in high demand and in a position to do very well in this new environment.

In between those who simply do not have the education and skills needed to do the work that will be available in the short to medium term and those whose particular configuration of high education and high skills put them in a position to command very high compensation even before they graduate from university is a group who can compete for work that will enable them to earn a good living for themselves and their families, but are most likely to be living in a world of contingent labor, selling their

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services as independent contractors, in an environment in which advancing technology is reducing the need for the specific skills they are offering and putting a very high premium on their ability to learn new skills very quickly.

Those in the greatest danger now and in the near and intermediate term are those who leave high school with what in the United States would be considered a 7th or 8th grade level of literacy in their native language and mathematics. They are particularly well prepared for jobs involving the kind of routine work and modest literacy levels that intelligent machines are increasingly well suited for. I am speaking here of retail clerks, people who drive vehicles for a living, most construction workers, miners, most manufacturing workers as well as office workers whose work, even though skilled, still involves routines that can easily be captured by an algorithm, such as insurance policy pricing, real estate appraising and middle management jobs that mainly involve data gathering and analysis.

Two points are very important here. The first is that I have just described a very large fraction of the jobs that people do. The second is that in the United States and many other industrialised countries, half or more of the young people leaving high school every year have no more than

the level of skills needed to do the jobs just described, the very jobs slated for a mass extinction. By mass extinction, I do not mean that these jobs will go away altogether. Many will not be automated, either because important aspects of them will involve skills the machines do not have or because it is less expensive to have a person do them than to employ a machine to do the work. But, because there will be many more people who have low skills than there are jobs available to such people, they will pay very little. What this means is that, in some industrialised countries, the education levels to which we are currently educating and training half or more of our high school graduates will condemn them to a lifetime of poverty. I believe the first obligation of education policy makers in the advanced economies in the near term—meaning right now—is to greatly ratchet up the standards for compulsory education to avoid this outcome. This involves, as I will explain in a moment, not just bringing up the lower half to meet the standards now being met currently by those in the middle of the distribution, but changing the kind of education and training we offer all young people in ways I will describe below.

Education for a Digital Future: The Challenge then went on to show how the continued evolution of digital technologies could plausibly create futures for our children and grandchildren that can plausibly be described as utopian and dystopian. And I pointed out that whether they in fact play out as utopian or dystopian will depend to a great extent on how young people are educated and trained—what kind of values they hold dear, what they think it means to be human and how important it is to them to preserve what is most important about being human, how much they value democracy and what they think it will take to preserve and defend it, whether—as citizens—they understand these new technologies and what it will take to make them forces for good and not evil. To what extent they have the knowledge and skill to

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fashion a new kind of human society with an economic system that fairly distributes what people need and want when a great deal of what they now pay for is made in abundance by machines and a political system that will enable everyone to lead free and fulfilling lives when the technologies now emerging could just as easily lead to a handful of people reaping most of the rewards of these technologies for themselves and leaving the rest of humanity to lead crabbed and limited lives as “surplus labor.”

These are immense challenges. Meeting them will require not just a few brilliant minds but an electorate that recognises a demagogue when it sees one, can fully understand the complexities I have just briefly skimmed over and can participate fully in the transformations human society will have to go through to be successful. It is entirely possible that the most important function of education in the years ahead will be to prepare our future citizens for citizenship in a world only barely imaginable today. I will, in the next few pages, have something to say about this aspect of the education challenge, too.

Finally, the obvious. The fates of all of us are intertwined with others all over the world. The temptation in times when incomes are falling and futures are in doubt is to blame others outside our immediate circle, our family,

our culture, our religious group and to shut them out. But isolation is no longer an option. As in so many other respects, we live in two worlds here, too. Those of us who are highly educated and doing well are very likely to think of ourselves as bound inextricably to others all over the planet in a web of connections that enrich us in many ways. Those who are facing the abyss, who feel they have no control over their lives, who suspect that their misfortunes are the result of the openness of their society to people who look and talk very different from them want to find a way to run the clock back to a time in which they and people they feel close to were respected and prosperous. It is essential that educators find a way to enable all young people to see people from very different backgrounds, in their own backyard and on the other side of the world, as people very like them with similar aspirations and needs. In a very tightly laced world, empathy is the coin of the realm.

We will begin by focusing on the near to intermediate term. Let's start by getting one thing clear. It will not do to ask, as so many do, what employers need. The world we are in is moving toward a labor market that will be defined by an increasing number of people who will be regarded as surplus labor. That is a world in which employers will want and need a relatively small number of people who will be paid handsomely to invent and manage technologies and companies that lead the digital revolution I have described, a larger group of people who will serve them and provide a wide range of professional and middle skill services and a larger group of people, considered surplus labor, who will be given a "universal basic income," but no work. That is a world in which educators would be, in effect, asked to decide which children are going to be assigned to each of these three groups, because, it will be said, it would make very little sense to invest heavily in the education and training of people who would not be regarded as contributing members of society.

The stand I take is simple. We should never agree to pick the winners and losers in a dystopian world. The obligation of educators should be to prepare everyone to be a strong contributor in the years ahead. If we are successful, they will create a world that does not include a growing number of people who will be regarded as surplus labor, a world in which, as there is less and less work that has to be done, there is more work that is fulfilling than people able to do it. So my frame of reference in thinking about the task ahead is to think about what an education ought to look like if the purpose of that education is to prepare everyone for participation in an economy

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in which the routine, low skill work is mainly done by machines and the more complex work, more fulfilling work, is done by human beings. But the nature of that work is constantly changing, many will be doing more than one job at any given time and they may be very different kinds of jobs, and learning is a constant, built into the daily routine. And finally, for such people, their contribution is defined by the distinctly human, the things that increasingly capable intelligent agents still cannot do: the sudden insight, the warm greeting, the act of kindness, the intuitive grasp of the other person's outlook, the truly creative flourish, the courageous leap, the human bond, the sheer determination, the pride in a job really well done, the creation and development of a team that goes from success to success.

Learning new things very quickly, deeply and well is no mean trick. It is no problem to acquire new knowledge, but it goes in one ear and out the other very quickly unless there are structures of knowledge already in our brain to hang it on, conceptual structures that are essentially explanations of how the world works in that domain, even better when those conceptual structures in our brain are connected to other, related, conceptual structures. When all that is in place, the new knowledge fits with something we already know and we can see why it makes sense. When the new knowledge is integrated with the old, the conceptual structure—the explanation of how the world works—becomes richer, more complex and more powerful and explains even more of how the world works. When we hold up one conceptual structure and then use it to look at a part of our experience for which it was not intended, this new perspective often yields fresh insights that we call creativity. But these conceptual frameworks and the knowledge we gain from them atrophy if they are not used. Every time we use our knowledge to do something important to us, we strengthen the connections, deepen them and build

more powerful explanations of how the world works. The knowledge we gain from reading about things is sterile and evanescent if it is not used, especially if it is not used for something that is important to us. Human beings evolved these extraordinary brains in order to survive. So we throw away what we do not use, to make room for the information, knowledge and understanding that we do use.

Every piece of this litany is important as we think about what it is going to take for our students to be successful in the years ahead.

Basic literacy will be absolutely necessary but nowhere near enough. Our students will have to understand the big ideas in the core subjects in the curriculum. They will need to have a deep understanding of the underlying concepts that structure knowledge in those core subjects. They will have to be using those concepts every day to solve complex problems in domains that they find interesting and even compelling. Their curriculum will need to be structured in ways that not only reveal the big ideas in their core courses and demonstrate the power of the underlying conceptual structure to explain a wide range of phenomena in that subject, but they will have to have opportunities to see what happens when the conceptual structure that underlies one subject is held up to another subject.

What I have just described is fundamentally different from a curriculum that is designed to fill a student's head with regurgitable knowledge and to provide "coverage" of the subject. In an age in which the Internet provides access to an unimaginable bounty of information, the aim cannot be to fill the student's head with information, but to provide a sound framework on which to hang it, as well as the tools needed to sort out facts and sound analysis from clever lies and propaganda.

Schooling for a long time has drawn a line between “hands on” learning, which has been put in the domain of vocational education, and book learning, which has been the special privilege of the college bound. In my view, this has to end. It is no good to say you have to take this course in order to be able to take the next one. To educate is to explain and to put the tools of learning in the student’s hands and head. As I said a moment ago, real learning rarely takes place unless it is used—not ten years from now but today—to solve interesting, real problems. So curriculum designers face a double challenge, to make the courses in the core curriculum much deeper, pointed much more at deep conceptual understanding and, at the same time, much more applied, much more integrated with doing things, real things with the knowledge gained, and then, in class, talking about what was learned from the doing.

And you will say, but all that takes time. Where is the time going to come from? And I will say, you have not heard anything yet. I think that primary (what we in the United States call elementary) education needs to be much more exploratory and hands on and secondary education needs to be much more like the best modern university education in medicine and engineering. Doctors would take courses in pathology and other medical disciplines for years on end before they could put on lab coats, become residents and go on rounds and help out in the hospital. Much the same was true of engineers. Not any more. Now, teams of doctors in training are brought into the hospital early on, given a carefully chosen presenting case and told to go to work to make a diagnosis. The team members divide up the tasks they need to accomplish to get there, mostly doing research in a variety of domains. They have access to beautifully developed little minicourses in the basics that they can access when they think they need them, and these minicourses point to others that are available. The trainees present their findings and ideas to each other and the others will critique their presentation. Gradually, working together in this way, the team learns how to figure out what might

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be wrong with the patient and, at the same time, begins to master the material that would otherwise have been presented in a conventional course. But most important, they learn how to learn what they do not know, and you can believe that their professors make sure that they learn how to distinguish research findings they can rely on from research findings that are not so reliable. They are not trained in the expectation that they will know everything they will have to know to be a good doctor. They are trained in the expectation that they have just begun a life of continuing learning, and they have been given the tools to do just that.

On this formulation, the content of the conventional course and the responsibilities of the instructor in that course are transformed. Much of the content is on the web. The key portions of it, however, are deliberately and carefully designed and developed to form the backbone of the curriculum. Teachers are Socratic instructors, asking pointed questions more often than giving the answers.

As I envision this system, it will be crucially important for students to understand and embrace the core values of the Enlightenment, upon which all the progress humanity has made since has been based, especially reasoning from evidence. This applies to physics and history, mathematics and the electronics lab. It is not so because you saw it on the internet or it is here in your textbook. How do you know this is true? Where is the evidence? How can we judge the merits of two policy proposals? Two views of the same historical event? Two proposed treatments for the symptoms this patient is showing? Two interpretations of this novel? Classes can be conducted this way and formal debates can be used for the same purpose. Ask students to take first one side of the debate and then the other, so they are forced to see issues from different points of view. They should be asked to do this kind of research on all kinds of topics and to write papers—at the secondary school level papers of 5 to 20 pages—and should get a lot of feedback on what they write. Those comments should focus not just on whether students discovered the relevant facts but on the quality of the analysis, the way the paper synthesises the facts to address the problem the paper posed, the way alternative interpretations of the facts are presented and the degree to which the conclusion is persuasively argued.

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The point of the teaching is not to provide basic facts and to provide an opportunity to practice basic algorithms and procedures—all of that is done on line—but to build deep understanding, strong thinking skills and the ability to learn and communicate all kinds of things quickly and well. People who have the kind of education I just described will have an edge on intelligent machinery for years to come.

This kind of teaching takes exceptionally good teachers.

But all I have described thus far is coursework. In the world I see ahead, coursework is only part of the curriculum and not always the most important part. I listed above a set of qualities that one can regard as distinctly human, ranging from courage to empathy, from leadership to the capacity to set high goals for oneself and then do whatever is necessary to achieve them. In the world that is coming, people who have these attributes and qualities of character will complement the most capable intelligent machines and will not be sidelined by them. The best schools have always held these qualities in high esteem, but they did not develop them in class. They developed them on the playing field and in their extracurricular activities.

I have seen a high school in Asia that sent its choir to perform at Kings College at Cambridge University in Cambridge, England at Christmas, another serving very poor students in a downtrodden community that sent its robotics team halfway around the world to compete in an international robotics competition and another whose graduates top the scales in international machining competitions. And, of course, countless high schools that send their athletes to regional and national competitions. I've seen high schools in which the school heads have carefully divided the student body into a hierarchy of governing bodies in order to provide not just multiple opportunities for students to participate in student government, but a structure just like that of junior varsity and senior varsity sports to climb up a ladder of responsibility as they gain more leadership skills. In every case, the students involved are working in teams to achieve almost unattainable goals that require determination, hard work, planning, expertise and teamwork.

And then there are the opportunities that might be available outside the school, in the community. These might range from community service to opportunities to engage in regulated apprenticeships in firms offering the opportunity to acquire high level skills of the kind needed to begin well-paying careers right after high school. In some schools, communities and even nations, these kinds of opportunities are mandatory but in many others they are available simply as options.

In many schools, these activities are available to all, but although it is hoped that all students will participate in something, there is no requirement that they do so. In many schools, the hope is that students will find something to participate in but no expectation that the student will get anything in particular out of the experience, much less attain a particular level of expertise.

In the world I have in mind, the school would regard the attributes and qualities of character and skills that can be acquired through all of these opportunities as no less important than those that are acquired in class. The school would decide, as a matter of school policy, what skills and attributes they really wanted all students to acquire while in the school and would deliberately create a wide range of opportunities to acquire them, in and out of school, during class and after class. And the faculty would hold itself accountable for making sure not only that those opportunities were available, but that each of them were set to high standards and there was a system for tracking each student as he or she went through school to counsel them on the options, sign them up and track their progress. Such a school would see the classwork and all of these other activities as equally important components of the curriculum, equally worthy of faculty attention and of the faculty's development and assessment time.

In this conception of the school, what is most important is not the school as such or the formal curriculum, but rather the whole skein of learning opportunities that students have as they go through primary and secondary education. The ordered progression of hour-long classes one after another in high school is gone and in its place a well-orchestrated set of learning opportunities, constructed from short courses, seminars, projects, clubs, sports and apprenticeships. It becomes the job of the faculty to design and orchestrate those experiences and to make sure that every student is on a path which, while exposing that student to different experiences, is nonetheless designed to make sure that every single student acquires the full range of cognitive abilities, non-cognitive attributes, especially character and values, that that student will need to cope and prosper in the kind of world I have described. In that scheme of things, what happens outside of class is no longer thought of as

enrichment smorgasbord, but rather as just as essential a part of the curriculum as what goes on in class and just as worthy of careful planning and supervision for each student.

And now I come to the second part of the analysis contained in the *Education for a Digital Future: The Challenge*, the part that posed the very real possibility that our digital future could be a future in which a small group of people end up dominating a much larger population who have little to do and few resources to do it with, or just as possible, a world in which the machines take over and, as one wag put it, humans become pets for their machine overlords.

Every advanced industrial nation is now very focused on instruction in the STEM subjects and with good reason. But I am of the view that our fate as a species may depend as much or more on the teaching of history, politics and comparative studies. As I pointed out in the earlier article, the advances automation has already made are responsible in no small measure for a neat division in the United States between a portion of our population who are among the best educated, most cosmopolitan and wealthiest in the world and others, more than half, who are literally experiencing a standard of living statistically indistinguishable from that of people living in the world's developing nations. That is fertile ground for demagogues.

Against that background, it is noteworthy that another recent study found that the majority of young people in the United States do not think it is very important that the United States continue to be a democracy. There is clearly a connection between these two facts. If democracy has not delivered for a majority of the people, they may not be all that devoted to democracy as a form of government. That may be all the more true because they have no experience of what it is like to live in a country without the kind of freedom that democracy affords.

Thus the very conditions that breed demagogues and autocratic government are the conditions that undermine the commitment to democracy that would enable us to avoid an autocratic future.

A curriculum that includes courses that conceive of history as the story of our country and of the world described as a series of events attached to dates and of civics as instruction in the mechanics of our form of government will not address this problem. But history taught as the struggle for democracy and representative government, a story that makes it clear how fragile democracy is and what is needed to keep it alive is another matter. That history has to be taught warts and all. The story of democracy is a story replete with horrible deeds done by democratic regimes through the ages, but that is true of all regimes, given enough power and enough time. What is crucial here is that students understand that their ability to affect the outcome depends on having a voice and on the protections that true freedom affords for making that voice heard, for making a difference. Unless that happens, a handful of technologists and economically powerful people are more likely than not to reserve most of the benefits of advancing digital technology for themselves and confer most of the costs of that advancement on the rest of us. That process is already underway.

WHAT IS CRUCIAL HERE IS THAT STUDENTS UNDERSTAND THAT THEIR ABILITY TO AFFECT THE OUTCOME DEPENDS ON HAVING A VOICE AND ON THE PROTECTIONS THAT TRUE FREEDOM AFFORDS FOR MAKING THAT VOICE HEARD, FOR MAKING A DIFFERENCE.

The kind of history I have in mind is history that enables the students to understand how power has been acquired over the years and how it has been used; why, through most of history, government has been run by autocrats to benefit the few, not the many; how the march of science and evidence-based inquiry that has provided the incredible improvements in the human condition that have marked the last few hundred years of history have gone hand in hand with democracy and freely-elected government and what could happen if that light were extinguished.

The history we need is history that gives students the tools they need to form their own views on the issues, based on the evidence and on close reasoning. A history of that sort that emphasises the tortuous history of freedom and liberty, that enables students to understand the fundamentals of how the modern global economy developed and how it works and a history that enables students to imagine what the world would be like without any powerful democracies and without the international institutional order created by the world's democracies at the end of World War II—that is the kind of history I have in mind. Without a history of that sort, it is all too easy to see the more dystopian kind of vision of the digital future taking shape in a few short years. It will take the kind of Socratic teaching environment that I mentioned earlier, an environment for learning in which the instructor is constantly demanding to know what you think and why you think it, what your evidence is, where you got it and why you analysed it that way. The student who has learned her history that way is the student least likely to be buffaloed by a demagogic bully and most likely to bring to the fashioning of a new world the best of the lessons drawn from the old one.

But history is not all we need in the core curriculum, apart from the usual suspects of language, mathematics, science and technology.

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If I could, I would require every secondary school student to study some part of the world very different from his or her own in a serious way—its people, history, economy, values, religions, literature and music. Growing fear among those who have been greatly damaged first by globalisation and now by automation has led to a growing desire to retreat into isolation and to blame others elsewhere in the world for everything that has gone wrong. But reversing the effects of advancing technology will require more not less integration with the rest of the world, because those who do not put up trade and immigration barriers between nations will end up much richer than those who do, and because isolation leads to fear and fear to war. Growing economic suffering will inevitably cause growing conflict among nations, especially since autocrats often rise to power and stay in power by emphasising and exaggerating the threats posed by others outside their own country.

Far more important than teaching other languages, which can only be done with years of instruction, is teaching students to see other, very different, people as much more like themselves than they thought likely and by helping them to understand how others see them, as mediated by their own history, economic situation and values. Whether the aim is avoiding catastrophic war or enabling trade that benefits all parties, it is essential that the citizens of the advanced industrial countries help their future citizens and

workers understand the world from the point of view of people outside their own country. The best way to do that, in my view, is not to study many places superficially, but to study a few places in depth.

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Imagine, for a moment, that the world managed to avoid the dystopic future I described and landed, instead, on the broad sunlit plains of a more utopian alternative. Instead of most people living just above the poverty line, people worked just a few hours a week for wages because they had figured out how to get intelligent machines and systems to provide real abundance for virtually everyone. Suppose that humans had developed an economic and political system in which a few winners had not walked away with the whole shebang, but the fruits of the new intelligent machinery were widely shared.

What would we do with our time? Or suppose, as I suggested in my earlier paper, that humans get to the moment of truth, and have to decide whether to merge with the machines—a future forecast by many futurists—or keep them at bay, reserving for ourselves that which is truly human, that part of us we value the most, boxing

the machines into roles that enable and serve us instead of inviting them into roles in which we end up serving them.

Whether we enter the age of widely shared abundance, or we get to the point where we have to draw a line in the sand about what we reserve for humans as the machines become ever more intelligent, we would have to decide what is uniquely human and make the most of it. That, in my mind, is where art and music and literature and philosophy come in.

Literature is about the experience of being human. Great literature captures the dilemmas, anxieties, ecstasies and agonies of the human experience and offers centuries of wisdom about life on this planet for our species. The greatest, most universal music and art similarly plumb the depths of our emotional life. The best literature, art and music, at least so far, enable us to lead far more fulfilled lives than we could without them. If our children are able to make it through to an age of abundance in which they are free to spend their time as they wish, one would hope that we would have opened a door for them to the world's best music, art and literature.

I have been describing an ideal. It would be an ideal for children from the most favoured of families. But today, the majority of children who attend schools in the United States live in poverty. To do for them what I have just described is an immense challenge. But to do otherwise is to condemn their children to deepening poverty as the minimum standards for getting and keeping a good job continue to ratchet up. Enabling them to reach the standard of provision I have been describing would require a comprehensive redesign of the public school system for all the children served by it, not just the poor. But nothing less will do. ➔

