
Human
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About to
Change
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Developments both in technology and in our understanding of the human brain and learning processes are laying the groundwork for exponential change. The way is being opened for bold new ideas regarding what we need to learn, how we will learn it, and what our ultimate potential can be if we throw off the yokes that we've been wearing.

Alice woke up early – she was too excited to sleep. Big changes were happening today: she was starting her transition from being a lab technician at a major research hospital to a new job designing the interiors of the autonomous vehicles plying the roads and airways. With artificial intelligence (AI) and advanced robots having taken over many of her manual lab-technician tasks, her career mentor encouraged her to make the big move. Such a change would never have been possible before, given the years of training both roles required, but these days, it was a cinch.

Her training for the hospital job fifteen years ago hadn't involved the ancient paper-and-lecture style that had long ago been abandoned for corporate training, but she still took classes. These global sessions allowed her to collaborate with coworkers around the globe, and they gave her access to the world's best instructors, regardless of their location. While she studied, her AI assistant

could detect which concepts were sinking in and where she was having trouble. For the difficult abstract notions – like the structures of proteins on cell surfaces, the virtual reality headset placed her inside whatever she wanted to study, where she could literally see what was going on rather than struggling to imagine it.

Ongoing training evolved during her tenure, but because so much artificial intelligence now handled the intellectual tedium – like publishing her work or scouring the web for research papers, she no longer had to be trained on processes, policies, and procedures; she was able to focus on those aspects of the job that really required her human brainpower. Her morning tonic kept her mind performing at its peak, and her gene therapy sessions had made her brain so much more receptive to new knowledge.

This transition was going to be different, however: training was no longer necessary. Before she switched roles, she needed to make sure that her old employer got the benefit of everything she had learned while working there, and her upload session was scheduled for that afternoon. Then, tomorrow, she'd go for the download session for her new job. One hour in a comfortable chair with a stylin' helmet, and she'd be as up to speed as a ten-year veteran. She couldn't wait.

This might sound like a futuristic scenario, but you'd be surprised at how fast we're approaching the point where it becomes reality. It's surprising because, while the world changes constantly, most of what we see is incremental change, with each generation layering fresh new ideas over the ones laid down by the previous generation.

Very occasionally, however, some innocuous-looking new technology ushers in massive changes in how we live and how we think.

We often point to Gutenberg's press as the archetype for such exponential change.

Education and corporate training undergo constant tweaking as educators try to find better ways to implant knowledge into minds young and old. And yet, for all the fuss, how we teach has changed little in the last couple of hundred years. While we're getting incrementally better at integrating subjects in schools, corporate training classes still tend to focus on very narrow topics – adequate for achieving specific goals, but less good at overall context.

How classes are conducted has changed only in allowing students more participation in the process. Individuals might have some input at the beginning of a course, but the reality is that few trainers are equipped to tailor their classes to the many learning preferences and aptitudes they're faced with. It's still largely lecture and exercises (along with the dreaded role-playing sessions).

Despite dramatic technology advancements, we haven't adapted our teaching approaches to take maximal advantage of that new technology. Yes, we have computers now, but documents are still documents, whether on paper or online, and videos are still videos, whether on film or on YouTube. These are incremental changes in the implementation of what remains a classic group teaching methodology.

This is all about to change, however. Developments both in technology and in our understanding of the human brain and learning processes are laying the groundwork for exponential change. The way is being opened for bold new ideas regarding what we need to learn, how we will learn it, and what our ultimate potential can be if we throw off the yokes that we've been wearing. This realization has come about as a result of research conducted by Singularity University and sponsored by Cisco, in which future thinkers grappled with these ideas to see where the changes are taking us.

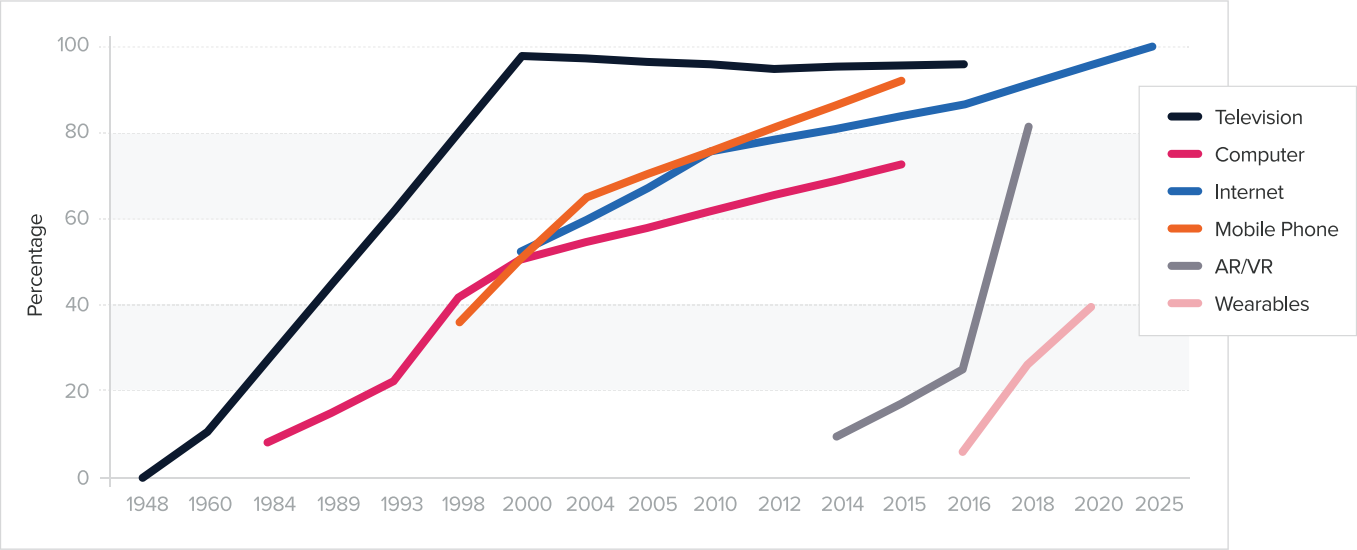
So we present nine bold predictions about how we will learn in the future. Some are already in play; others might feel shockingly foreign. They reflect two evolutionary paths:

Human, including what we know about how our species operates internally, and technological. We'll present predictions for both paths. Eventually, these paths merge into a currently incomprehensible state known as a "singularity," where man and machine come together in the ultimate symbiosis. This vision may sound as futuristic as the scenario we started with, but it's all backed up by solid research activity that's underway at this very moment.

As with all major technological revolutions, these predictions raise follow-on ethical and social questions – we won't be addressing those here.

We'll be focusing on the developments themselves in order to reorient how we think about training. This will enable all of the other necessary conversations about how we manage these new capabilities.

Adoption



The Technology Path

1. Enhanced reality tools will transform the learning environment.

Training tools today are limited to what can be created or illustrated directly in the "real" world. That typically limits the tools to two dimensions – paper, images, and video. In some specific cases – like chemistry, for example – 3D models can help to a limited degree.

Augmented reality (AR) and virtual reality (VR) can obliterate the limits that traditional tools have faced. AR refers to technologies that can supplement what we see, read, or hear with additional contextual or explanatory information – like a digital annotation. VR eliminates the "real" part entirely, immersing the student in a completely virtual world. While these technologies have been honed in the world of gaming and the Google Glass experiment, they have the potential to completely revolutionize training.

Concepts that cannot be directly seen – because they're too small (like proteins on a cell wall) or too abstract or too distant, for example – can be simulated using VR and presented in a way that makes them feel real. Meanwhile, AR can help integrate knowledge by overlaying context or facts from an intersecting discipline. For instance, when viewing a particular molecule, one might see historical information, or perhaps applications or variations on that molecule, all within view at the same time.

These technologies put the learning materials under the control of the student – a dramatic change from the traditional role of student as a passive absorber of knowledge. Well-constructed AR and VR tools will let students explore their topics in a way that best suits them.

But these tools may also eliminate the need for some training. Rather than studying in advance of a new procedure, AR and VR tools can guide an employee through the procedure. If the procedure is to be used often, the employee will learn through repetition. If not, then no time was wasted studying for something that will be done only once.

Cost has been a barrier, but continued development has brought costs down, and that's expected to continue. As that happens, Singularity University's Jody Medich predicts that, "This technology will be ubiquitous – it won't affect little bits of our lives; it's going to affect every aspect of our lives."

All those activities we do on our second screens are going to change in a radical way. Instead of looking into a screen, we will be looking through the screen. When we do that, magical things will happen.

While these tools will have a dramatic impact on the individual, might they also allow us to engage with other students more easily?

2. People will learn collaboratively, no matter where they are.

The traditional structure of classrooms in the West has discouraged social learning by establishing the teacher as the sole source of knowledge. Collaborative projects have increased in recent decades, but even there, the focus is on the process of executing a project, not so much on pure learning.

Various experiments, such as those conducted by Sugita Mitra, Professor of Educational Technology at Newcastle University, show that children learn from each other – even in the absence of a teacher.

He theorizes that, "… education is a self-organizing system, where learning is an emergent phenomenon." In other words, it's not always required that a teacher be present to organize the learning for the children.

Technology can increase the scope of this social learning to a global scale. Today's social collaboration platforms – internet video services, social media, and video conferencing – can help, but they're merely tools; they don't promote learning unless specifically engaged for that purpose.

This is an area in which fully immersive VR can transform learning by bringing physically distant people together into virtual proximity. Study and experimentation are completely transformed when students share a virtual space. In his book, "Virtual Reality Applications and Explorations," Alex Wexelblat proposes that, "The ability to exchange or share points of view literally in multiple-participant virtual worlds may intensify [the] social learning experience. Co-creating virtual worlds for learning allows teachers and students to use computers in a cooperative group situation, where learners tend to be more productive." So learning, alone or with others, becomes more effective. But what kinds of things will we need to learn in the future?

3. Artificial Intelligence will banish intellectual tedium.

Automation has focused on mechanical operations both in the pursuit of lower cost and because machines can execute repetitive, potentially dangerous functions more quickly, more reliably, and more safely than humans can.

There are plenty of jobs, however, that involve intellectual, rather than mechanical, tedium that have not yet been addressed by automation. When lawyers research cases, perform discovery, or search for patent prior art, that's a manual task. Physicians understanding how random symptoms lead to a diagnosis use a manual process of online searching and rummaging through books. The bulk of the time spent in these examples is in the gathering of information; only at the end is the high-value decision-making performed.

Artificial intelligence (AI) is already changing this. Specialized legal tools are emerging, for instance, to handle routine tasks. Meanwhile, the IBM Watson Group has developed a question-and-answer tool that helps doctors determine a patient's prognosis based upon the collection of symptoms. These tools eliminate processes that would otherwise necessitate training.

But this same AI can transform training itself, as described by University of Massachusetts, Amherst's Dr. Beverly Park Woolf: "AI could be instrumental in delivering high-quality learning opportunities for people all over the world. It can help connect learners to mentors, train people for effective 21st-century soft and hard skills, support learning with analytics, and provide universal access to students even from the poorest or most remote classrooms." It becomes a great democratizer, making learning possible anywhere, anytime.

A step beyond AI is the notion of an artificial general intelligence (AGI), which takes AI beyond the menial and endows it with full human intellectual capacity and creativity. Able to replace humans at any economic task, it will further upend the very meaning of corporate learning and development in ways that are not likely to be evident today.

So, how we learn and what we will learn will become more focused. Can we also leverage technology to boost the abilities of our brains?

4. We will maximize our mental potential with wearables and neural implants.

Wearables can take many forms. They may improve our waking performance by helping us to sleep better, or they may synchronize a frantic brain. At the very least, they can give us information about how we're doing so that we know when to eat, take a 10-minute walk outside, or nap.

Wearables are most common outside of the body, but, ultimately, we might benefit from devices implanted inside our brains. DARPA has seen results with their RAM program, stimulating the brain directly in order to repair memory damage in returning soldiers.

Embodiments of the implant notion range from simple probes to a "neural lace" concept originally conceived by science fiction writer Iain M. Banks. The latter effectively integrates AI with the brain, with the two working together. "I think one of the solutions [to staying competitive with AI] that seems maybe the best is to add an AI layer," says Elon Musk, Founder, Tesla and SpaceX. The lace implements that layer.

While, as yet, there are no efforts to develop such technology on a commercial basis, it's likely to catch on as we crack the code on how our brains work and what opportunities exist both to counteract injury and to open up untapped mental capacity.

So far we have explored how technology will change or enhance the learning experience. But the future isn't just about better machines; it's also about adapting to – and even improving - individual humans.

Our brains are good at many things, but machines are good at other things. Bringing them together gives us the best of both, with a complementary approach letting humans and machines learn together.

The Human Path

5. Learning will be radically personalized.

Today's educational model is an outgrowth of an industrial past, where the role of school was to turn out well-prepared manufacturing workers, while glossing over the differences in learning preferences and aptitudes between students. In recent years, however, automation and outsourcing have eliminated most repetitive jobs that can readily be performed by machines. That leaves either low-wage service jobs or high-value, high-creativity jobs that leverage uniquely human capabilities.

Creativity is a hugely personal trait. In order to retune education to foster creativity, learning will need to become a much more personal process – and technology can make the difference as it adapts lessons to the needs and skills of individual students. A key concept here is the notion of "recursive learning," which describes a process of cycling through materials multiple times, adjusting each time both to reinforce what's been absorbed and to address remaining gaps in understanding. Exactly how this cycle proceeds will be different for each individual.

Software is already being used for teaching languages and other subjects. The feedback that drives that cycle today has to rely on older methodologies like quizzes in order for the software to gauge what to repeat and how to present the material in subsequent cycles. But early developments are leveraging technologies like eye tracking to identify automatically where a student is struggling and how best to support the learning. This will support a quick, hyper-efficient recursive loop.

Further into the future, AI technologies can assist the teaching tools by providing context and background on the student. What is their living situation? What are their parents' and siblings' skills? Are there sociological or medical challenges acting as barriers or distractions to learning? These and numerous other issues can be incorporated into the teaching tools in a way that puts the individual student squarely in the center of the learning activity.

Given better individual learning outcomes, does this mean that we'll all have 5.0 GPAs and be fighting for entrance into a few top-rated universities?

6. Grades and brand-name schools won't matter for employment.

This is already happening. Hiring focus has moved away from broad generalizations about a candidate's potential based on a single number, and instead it is moving to certificates or other indications of proficiency in specific topics. Whereas one's transcript used to end upon graduation, it will instead become a living, growing part of each employee's résumé as new skills are gained and as performance is demonstrated in the employee review process.

In the UK, EY Corp. has already made this move. Starting in 2008, they removed academic qualifications as a primary requirement and went instead to a system of open-ended questions that help identify, for each individual, their "learning agility" – their ability to continuously learn new things, acquire new capabilities, adapt to change, and "see around the corners." They could then identify the available roles that best fit the individual. EY reports that an 18-month study confirmed the effectiveness

of this new approach, calling it "a robust and reliable indicator of a candidate's potential to succeed in their role."

Google has a similar view of academic performance. While good grades aren't a problem, Laszlo Bock, SVP of People Operations, sees them as "worthless as a [criterion] for hiring." As to elite schools, Google finds their graduates to be lacking in "intellectual humility." By contrast, those who have achieved success without any degree are highly valued.

Properly executed, this can benefit both employer and employee. The employer gets a better sense of the skills and suitability of a candidate; employees can succeed based on their skills, without being penalized for degree decisions made many years prior.

It's one thing to maximize one's innate potential. But it would be even better if we could boost what we were born with.

7. Supplements will improve our mental performance.

We live with a long-established realization that, for all our learning efforts and successes, we use only a portion of our brain's capacity. But there is growing evidence that we can unlock dormant mental capabilities: the right chemicals can make us super-human.

This was the theme of the movie Limitless: a new pill, taken regularly, would keep you performing at an astounding level. Knowledge appeared, seemingly, out of nowhere, while in reality it had been locked away as some irretrievable buried memory – only to be brought back into the foreground with this pill.

In real life, individuals try to find the right mix of supplements and vitamins to keep their brains in top shape. Worryingly, some high-performance high-school kids go beyond this, supplementing with Adderal due to competitive pressures. Meanwhile, it has been documented that some tech professionals use micro-doses of hallucinogens to improve performance – activity that is both illegal and questionable, given that issues of safety, efficacy, and dosage have never been scientifically resolved.

Supplements that improve our brain function are referred to as "nootropics." Says Jesper Noehr, founder of BitBucket, "I would say that most tech companies [in Silicon Valley] will have at least one person on [nootropics]." But given the questionable legal status of many of the target substances, targeted research is limited. Concerted focus and investment can bring forward supplements that are both safe and effective, making them available to the mainstream population. At that time, we'll be able to learn more effectively and efficiently, fitting more into our heads and keeping it there longer.

So supplements can improve our use of the brain we started with; is there any way to make fundamental improvements to that brain?

8. Gene editing will give us better brains.

Until recently, genetic engineering has been a blunt tool, manipulating relatively large strands of DNA. Insertion of desirable genes may bring along undesirable traits that happen to reside elsewhere on that strand.

This has changed with the advent of more precise gene-editing procedures, notably one called CRISPR. By editing a single gene, without dragging unwanted genes into the mix, beneficial traits can be precisely dialed in. Ironically, this can help us remain competitive with the AI that would otherwise replace us at the top of the intelligence hierarchy.

Today, this tool primarily assists researchers in finding new cures for cancer and other diseases. The FDA recently approved the University of Pennsylvania's use of the approach against three different cancers, for instance. That said, we're still roughly twenty years away from regular and widespread use of the technique. At that point, "Any scientist with molecular biology skills and knowledge of how to work with [embryos] is going to be able to do this," says Jennifer Doudna, co-discoverer of the CRISPR procedure.

As we learn more about the connections between our mental capacity and our genetics, we will be able to selectively edit critical genes in order to reverse inherent deficiencies or even to improve our naturally endowed brains. Nick Bostrom, an Oxford philosopher and student of computational neuroscience, believes that such an approach could provide anywhere from 4 to 25 additional IQ points – an amount that might rise ten-fold over generations.

Having explored the path of technology and the path of our own biology, the main event happens when technology and humans merge into a singularity.

The Singularity

9. We won't have to learn: we'll upload and download knowledge.

Uploading the brain into a machine allows all of humanity to benefit from the knowledge of those that have done exceptional things. Imagine if Einstein had been able to upload his knowledge for us to download; relativity would be intuitive to us rather than some impenetrable topic that only the smartest can truly appreciate.

This isn't simply a function of wiring; it requires understanding variations in brain activity and the patterns of signals that constitute our memories, emotions, personalities – even our consciousness. It's the sum total of all of these and any other related characteristics that define us. We're not just uploading what we know; we're uploading who we are.

This has obvious immense implications for learning. In fact, it renders traditional classes or effort-based learning obsolete, replacing them with a simple download.

Of course, if we limit our knowledge to a download of what has already been known, then, at some point, uploads would no longer be necessary – all knowledge deemed necessary would have been captured. But humans learn through more than just training; we learn through experience. This is where efficient

knowledge transfer can be tremendously effective: one person's new discovery can be shared with everyone else – with no need for a formal training session.

Human-machine interface (HMI) projects are already teaching people who suffer paralysis to control a computer simply through thought; a joint project between Brown University and Blackrock Microsystems targets this application. The equipment required to do this is currently bulky; if a digital connection to our brains becomes mainstream, it will need to be dramatically refined.

But the culmination of those efforts will completely change the nature of learning. With a download of existing knowledge, we'll be free to use our intellectual capacity to build on that base with new knowledge for eventual or even immediate download to anyone else that could benefit. The classroom would close forever.

While this might sound highly speculative, neuroscientist Dr. Randall Koene reassures us that, "All of the evidence seems to say in theory it's possible – it's extremely difficult, but it's possible." If it still sounds fanciful, Facebook and others are actively researching it, so it's likely to materialize sooner than we think. Ultimately, humans and machines merge, allowing AI to supplement the human brain, effectively becoming an extension of it.

Change Is Imminent

While much of this vision of future learning will unfold over decades, the enabling technologies – and the understanding that powers those technologies – are nearing a breakout point. We're entering a hockey-stick transition, after which today's slow and cumbersome processes will blossom into efficient research and development to transform learning more in the next 50 years than has happened in the last several millennia. Given Kurzweil's Law of Accelerating Returns, where the speed of evolution increases exponentially, vast societal transformation is likely to occur sooner than anyone expects.

This has specific implications for corporate learning and development. It will no longer be necessary to develop traditional coursework for the variety of skills necessary for a given discipline or technology. Learning will no longer be applied on a uniform basis to non-uniform minds. Eventually, we'll share knowledge through technology.