Maker
EDUCATION
REVOLUTION

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Maker Education Revolution

Learning in a high-tech society

Peter Dalmaris, PhD

To Leo and Ari.
You are pioneers in a new world and you have already achieved so much.

I admire you and I love you.

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Please let me know! Using any browser, go to txplo.re/typo and provide me with the details. I'll get it fixed right away, and you could win a signed copy of the book!

Table of contents

*The role of the teacher is to create the conditions
for invention rather than provide ready-made knowledge.*

—Seymour Papert

An Introduction

When I was a kid, my understanding of what technology was revolved around my parent's video cassette recorder and television. TV stations back then would transmit a test card image. This image contained a pattern of boxes, circles and lines that a TV technician would use to fine tune the TV receiver to the channel. I remember that I could never fine-tune the receiver so that the lines were actually straight because the screen of our TV was curved. All TVs back then had curved screens because of the way that cathode ray tubes worked. There was no such thing as a flat panel display. Somehow intuitively, I knew that other people would be as frustrated about this as I was. I was sure that engineers were working on this problem. I wanted to be one of them.

Something similar was happening with the video recorder. It was an impressive machine at the time. It had an LCD screen for showing the time elapsed of a movie. It had the ability to program it with the start and end times and day of a program I wanted to record. But I vividly remember my dissatisfaction with its many short-comings. The recording medium was a thin plastic tape inside a plastic case, with a lid that would open to expose it. The assembly was fragile, large, and expensive. The quality of the recording would degrade with use over time. The programming interface was terrible so that only someone with ample time to play with it, like a child, would ever be able to understand it and use it. I was sure that someone, somewhere was working on this problem, and I wanted to do that too.

Everywhere I looked, there was technology, albeit simple by today's standards, which made life easier, but that was clearly in need of radical improvement. Being a Star Trek fan did not make things easier. The transporter, the communicator, the talking computers, the replicator, the scanners and all the amazing things on board the Enterprise resonated with me and gave me a vision of how things can be.

A few years later, my parents bought me an Apple //e, one of the early home computers. I still have that computer. Along with it came a couple of programming books. The programming language was built-in to the computer. It was Applesoft Basic. I started programming it right away, and I felt a bit like Scotty, the Engineering Chief on the Enterprise. Now, that was technology. Now we are getting somewhere. Steve Wozniak became my new superhero, replacing Spiderman.

A few years later, I bought an electronics kit to make an LED blink with a 555 timer IC. All the documentation was basically the assembly instructions of which components go where. There was nothing about timers, LEDs, etc. I had no access to the Internet, no electronics book, and I did not know anyone who had some knowledge on these things to ask. Despite that, this is what technology was to me. Whether in a kit with all its components mixed, or perfectly assembled into a beautiful computer, I knew some engineers out there had done what needed to be done to get us closer to my Star Trek ideal.

From the video recorder to the Apple //e and then to the 555 integrated circuit, I quickly developed an intense interest in engineering and programming. But I had no access to documentation and had no-one around me to ask for help. Not only that but at school, none of my teachers was able to help me. They were all excellent in their particular subject matter, mathematics, history, geography, science, but none of them had ever touched a computer.

The fact that my school was ill-equipped to help me learn how to program my computer, or to give me some basic pointers around electronics, is simply an example of how schools do not really prepare students for the future. They prepare them for the past. I have memories of thinking how firmly I believed that computers were the present and the future, and how bored I felt at school because none of my strong interests in technology was

met. School was dreadful. I felt that I was sacrificing my best hours, every day, for a purpose that I did not understand. Perhaps school was about accumulating grades; perhaps it was about, other than for gathering marks. My boredom had affected my ability to learn, and my lack of interest made it impossible to get a grade better than average. My parents were averagely thrilled about that.

I knew I wasn't stupid. I was able to learn a lot on my own. I was lucky to have parents that had no reservations about buying books and magazines. I had an encyclopaedia, a subscription to a foreign computer magazine (I remember the difficulty of buying foreign currency to pay for it), and programming books. My software collection grew and included the Logo programming language. I found a book that taught me how to do low-level programming on the Apple //e, manipulating bytes and working with 6502's op-codes. I found perhaps one of the first science kits for a home computer, that could measure temperature and lung air capacity (I used that to train my ability to hold my breath for what seemed to my like a very long time). Home was heaven. Home was where learning was actually happening, disguised as play, at least after my school homework was done.

Today, while schools have not changed fundamentally, the sheer opportunities for learning are truly stunning. Not only there is an abundance of resources, from Arduino's to robots, to connected everything, but there is a wealth of knowledge in video, text, illustrations on your computer, your iPad, even on paper, but people with knowledge are within instant reach.

The experience of sending my own children to school reminded me much of my own school years. The fixed curricula, the separation of subjects, the focus on delivery rather than the individual, the lack of sufficient time for play and exploration. The list can go on. This recent negative experience with school was also amplified by my children's dyslexia, which made it even harder for them to develop a happy relationship with learning. Learning, under these circumstances, was externally enforced. It was painful. It was seemingly pointless. And it was distracting them from the things that were most important to them.

I decided to write this book because I was convinced that there is a better way to learn and to teach. Just like engineers succeeded in creating flat screen TVs, and improved computers and networks to the extent that we no longer need video cassette players and recorders, I was convinced that there were educators who had solved the problems that I mentioned earlier. Educators who realised that learning does not need to be painful, that children with different learning needs can be cared for. I was convinced that there are educators who can help in creating an educational system that instils its students with the qualities that we want to see in a happy and successful individual rather than the specific bits of knowledge that they need.

My conviction was not arbitrary. I had spent the last 15 years as an educator myself. First as a University lecturer, and now as an online instructor. I witnessed both the limitations of traditional education as well as the potential of Maker-style education when combined with modern educational technology. My conviction is that after the pain of the past, we are now entering a golden age of education. An age in which education is better aligned with its real purpose of helping to shape happy and creative individuals. An education that helps the learner to learn how to think critically, solve problems independently but in collaboration.

An education that helps people to think like a scientist and implement like an engineer.

Technology plays a huge role in this education. I have visited high schools where I could see the effect that technology has on the quality of learning that student can achieve. Imagine four or five teenage students gathered around a wheeled robot. They are making the final preparations ahead of a yearly robot competition. They are each working on a particular subsystem, but they all understand how the robot works as a system. There's always one student that goes deeper than everyone else. He or she does the troubleshooting, can move wires around before anyone knows what's happening, does the last code modifications for an instant performance improvement. And guess what she wants to do? Become an engineer.

I wrote this book because I had to. I needed to organise my thoughts around what a modern educational system should look like. I wrote it so that I can systematise the elements that can help my children, with their spe-

cial learning requirements, not just cope but to thrive in a world full of opportunities of any kind, but especially learning opportunities. I wrote it for my young self, struggling to keep my love for learning and curiosity alive.

I wrote it for teachers who are dedicated to creating awesome learning experiences for their students. For parents who care not just about their children's academic achievements, but also for their overall development as happy and creative individuals with their own unique set of passions and curiosities. I wrote it for the learners themselves, who are perhaps discouraged by their experiences in school and wonder if there is another way.

I sincerely hope that this book will help you change your view of what modern education should look like. Because with every successful learning, there is change.

Peter Dalmaris, May 2017

A brief history of modern education

"Education is the most powerful weapon which you can use to change the world" — Nelson Mandela

In the early 1800s, mechanised textile production spread from Great Britain to the rest of Europe and beyond. Factory cities such as Manchester and Dewsbury emerged and grew rapidly during the 19th century, with new factories attracting more and more people from the countryside.

Factories were organised in rows and columns, optimised for efficiency. At each station, a worker would repeat that same movements again and again, for the duration of his shift. At the end of the shift, a fresh worker would take his place and repeat the same movements, again and again. Just like the factory was organised for efficiency, each station was also optimised for efficiency. The repetitive movements of the worker, over time, had removed anything not strictly necessary for the task in hand. The tools that he used were built for the single purpose of the task in hand. There was almost no talking at all, since talking can increase inefficiency. What had to be accomplished can be done so with minimal interaction with other workers. Each worker was trained to do one thing; one thing only and to do it efficiently.

Thanks to the way that factories were organised, each worker only had to be proficient at a very small repertoire of functions. Assemble a box, connect a couple of wires, attach a label. The workers did not need any special training, and in most cases they didn't even need to read. In fact, these factories required workers with minimal knowledge of reading and maybe of simple arithmetic; however, most of them had no schooling of any kind, and could barely read at all.

This prompted the factory owners to create in-house training, where new workers would learn the basics of factory operation. Sometimes, this even included some reading and arithmetic.

Schools, of course, existed outside of factories. Children in the late 18th and the 19th century did receive formal education in schools that was very similar in terms of organisation to those that we are familiar with today. Although attendance was not high in the early years, it did increase to eventually guarantee that the majority of the population of a country, at least in developed countries, could graduate with adequate ability to read and write.

If you walked into a typical classroom in England of the 18th and 19th century, you would see desks and chairs organised in rows and columns. At the front of the class was a blackboard from where the teacher would address the class. The students were required to always look towards the front of the class, at the teacher. Talking was forbidden, unless the teacher had asked a question. The tools of teaching and learning were very simple, but just like their factory counterparts, they were efficient: a blackboard, chalk, books, pencils and paper.

The teacher was tasked with the responsibility of conveying knowledge to the students by means of a formal presentation. The students would be required to follow the instructions issued by the teacher, which included reading and writing tasks. The teacher would also quantify the knowledge accumulated by students by issuing formal or informal tests, and then rank the students based on the results of those tests.

Indeed, the purpose of these schools, unlike their counterparts in places like Ancient Greece and Ancient Rome, was to increase the literacy of 'common people' to a level adequate for life as a factory worker. This was the mantra of conventional, classroom-style schooling back in its early days, and, as I argue in this book, it still is.

Indeed, little has changed in the methods of schooling in our advanced 21st-century technological societies. Not only there is a striking resemblance between schooling in the 18th/19th and the 20th and even 21st centuries, but the emphasis is still in maximising efficiency and productivity (measured as the volume of product that exits the production line in a given unit of time) is the common denominator between traditional schooling and factories.

Modern factories may not be powered by coal and steam, but they typically still require workers with a basic and common level of education. Modern factories require workers, that can work harmoniously together thanks to a common set of assumptions and beliefs, optimised to deliver specific outcomes. Without doubt, comparing the level of education of the average person today to a person from the 18th century is like comparing a Tesla Model X to a Ford Model T. Yet the uniformity, rigidness and high output rate requirements of that era, to name just a few similarities, still exist in modern schooling.

Unfortunately, the citizen of a modern, technologically advanced and hyper-competitive society of the 21st century needs to be prepared to navigate a world that is far more complicated than that of our 18th-century counterpart. Globalisation, hyper-competition and frictionless commerce, rapidly advancing technologies, social change, global and localised conflicts, climate change and mass migration are only some of the high-stake issues that a modern citizen must be able to comprehend and act upon.

Even the factories, traditionally associated with low-skill work, are being transformed. Robotics, artificial intelligence and automation have evolved to a level of effectiveness enough to be rapidly replacing human labour with machine labour. This inevitable process is causing massive unemployment to people in many industries around the world. Millions of people are left out of work, with no real prospects of ever catching up in the work market. This is the generation that is loosing out in this process of modernisation, and largely depend on social policies and social safety nets for ensuring the basics for their survival, if they are available.

Will the next generation of people that are growing up now be more fortunate? Will these next generations be able to adapt to a world where machines, more and more, are taking over jobs that traditionally used to be done by humans? Not just factory jobs, but jobs across the whole spectrum?

This kind of disturbance in the connective tissue of societies is not new. People went through similar experiences during the shift from the early agrarian and feudal societies to the those of the industrial revolution. Mechanisation and automation changed the ways that large populations made a living, and it did take them generations to adapt.

But this time, it is very different. The speed, breadth, and depth of changes are far bigger and more impactful than what we have every seen in the past. The speed by which technology has moved in to redefine whole industries, combined with its global reach, means that there is not escape. People have to adapt because they can't hide from the change.

I believe that there are unique opportunities for people in a world where automation is everywhere. But to strive in such a world, we have to exploit and believe in what is unique in humans. Imagination; creativity; drive; curiosity; empathy; self-awareness; feeling. These are some of the traits present in every human, and the raw ingredients of products like art, science, language, society, and culture.

Going forward, more than ever before, our ability to thrive in a world where machines play a more significant role than ever before, depends on our education. How we learn, teach, and magnify our uniquely human traits.

So, we have to think about school, since this is the institution with the critical task of educating the young, and preparing them for the future.

Are our schools an outdated version of the same schools that contributed immensely during the Industrial Revolution? The same schools that produced the millions of workers that powered factories and paved the way to our modern way of life?

In this book, I argue that the answer to this question is 'yes', and that a solution in modern education's dead end lies in the core of human ingenuity and creativity.

The system is broken, like an old machine. A 200-year-old machine, to be more precise. It was designed for a world that does not exist anymore. In the US, the industries that contributed the most in the Industrial Revolution—manufacturing, construction, mining and the like—comprise of less than 20% of the total output. Even in those industries, much of the demand is for people with highly developed skills in leadership, management, engineering and finance. In Australia, and other developed countries, the statistics are similar.

A modern society increasingly needs people who have a diverse range of skills. It needs people who are innovative and creative in order to generate new wealth for themselves and those around them. They need to be adaptable in order to be able to respond to rapidly and ever-changing conditions, locally and internationally. They need to be able to think independently, and to be able to set fulfilling courses for their lives.

These are people that approach a problem with the playfulness of a child and the thinking process of a scientist: people that can engineer their own solutions to problems that perhaps have never been seen before. People that thrive in complex, competitive, ever-changing and open societies.

What kind of educational system can help people become scientists, engineers, philosophers, humanists and politicians, all at the same time?

It must be a system that advocates that the individual is at the centre of the learning process. A system that believes that the scientific method and technological competency is a key component for personal and social growth and prosperity. A system that fosters collaboration and innovation, that focuses on the learner instead of the teacher, in adaptability instead of obedience, in creativity to support and enhance abstract thinking. A system that emphasises a growth mind set rather than the fixed mind set was a main characteristic of the 19th, 20th and 21st-century human.

I wrote this book because I wanted to explore this theme and show that the answer to our educational system crisis is already being enjoyed and transforming the lives of countless people around the world.

Interesting readings

- Where machines could replace humans—and where they can't (yet), txplo.re/mck
- Economy of the United States, txplo.re/eus

Sample content from the full book