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CHAPTER ONE

Pinning Our Hopes on Our Machines

One day in 1999 some children playing in the streets of Kalkaji, New Delhi, found a computer fixed in a wall that separated their poor neighborhood from a rich office district. It might have been a strange sight for these young residents of such disadvantaged circumstances, but within hours they had mastered some basic workings of the device and had begun surfing the web.[1] The man who put the machine in the crevice, education engineer Sugata Mitra, later told the world in a series of web articles and TED talks, "within six months the children of the neighborhood had learned all the mouse operations, could open and close programs, and were going online to download games, music and videos." When Mitra discovered that the kids had taught themselves how to work the magic box, he saw it as proof of his favorite educational theory: If you let children follow their own curiosity, they will learn by tinkering about, discovering something new, and teaching each other.

Mitra called this process "Minimally Invasive Education," and after he showed his "Hole in the Wall" experiment before television cameras in 2007 and again in 2010 and 2013, more than seven million people eventually downloaded and watched the excited Indian professor bubble with enthusiasm. Mitra told stories of Tamil-speaking and poverty-stricken children learning English *and* the biochemistry of DNA replication in a matter of months. While they played with a computer he had placed under a tree, a twenty-two-year-old woman looked over their shoulders and occasionally vocalized little signs of encouragement: “Well, wow, how did you do that?” (in the fashion of a doting “grandmother,” as Mitra put it). Without conventional teachers, these poor children with so few worldly advantages had outperformed rich kids in a traditional school.

When the effervescent researcher spoke about his experiment on a TED talk, his live audience gasped, laughed, and applauded, and around the world, internet viewers contemplated the wonders of letting children follow their own curiosity and the alleged fascination of computers. One of those viewers in faraway northern Mexico taught in a conventional school located next to a foul-smelling garbage dump in Matamoros, Tamaulipas, just south of Brownsville, Texas.

Sergio Juárez Correa, a thirty-one-year-old teacher who had grown up in similar circumstances, stumbled onto Mitra’s videos one day, and they changed his life. How they did so, however, has been seriously misunderstood, even by the *Wired* magazine editors and writer who made Correa and his students somewhat famous. Indeed, as we will see, many people have misunderstood what took place with both Mitra and Correa and the role that computers did and did not play in teaching and learning. In the process these commentators have created a serious misunderstanding about the nature of our emerging Super Courses.

In a story that has become part of the lore of the computer industry’s promise to the world, Correa decided to do his own version of Mitra’s experiment. It would be quite a challenge. But for one twelve-year-old girl it would reveal the “extraordinary abilities” of a budding genius. Paloma Noyola Bueno, a thin young girl with long black hair, lived in a world where a foul smell “drifts through the cement-walled classroom,” a world where her father scavenged for little pieces of scraps he might sell to eke out the barest of existences, and where cement and wood “homes had intermittent electricity, few computers, limited Internet, and sometimes not enough to eat.” On their daily trek to school, Paloma and her classmates would walk along beside a sewage-filled ditch and sometimes find dead bodies on the streets, victims of a drug war shootout the night before.[2] They didn’t have a generous and inventive benefactor like Mitra to set up a magic box for them.

In the fall of 2011, on the first day of class, Correa put his students in a circle, sat down with them, and told them they had as much potential as anyone. He invited them into a world where they could "build robots and airplanes" and "write symphonies." The young educator then asked that powerful question, "So, what do you want to learn?" That was a radical change. No more would he follow some fixed curriculum handed down from on high. Those traditional lessons often wore the tattered clothes of their nineteenth- and twentieth-century origins, and Correa would have no more of it. From now on he would simply follow the whims and inquisitiveness of the kids in his class. Or so it seemed.

The results were astounding. In June 2012, when his students took the national standardized exams that Mexico uses to find out how schools and children are doing, Paloma made the highest math score in the country, even better than rich kids in major cities who attended posh private schools. Some of her classmates did almost as well. Ten placed in the 99.99th percentile in math, and three did so in Spanish. In the weeks to come, television and newspaper reporters showered Paloma with attention.

A popular TV show sent a variety of gifts, and even a year later, *Wired*, the industry-favored magazine that celebrates technological advances, called her "the next Steve Jobs" and put a somber-looking picture of the young girl on its cover. Since Jobs made no major contributions to mathematics, it wasn't at all clear why the magazine didn't label her the next Albert Einstein, or, better yet, the next, Emmy Noether. But the comparison with the Apple founder fit the narrative that *Wired* seemed to push: it's the high-speed processors that made the difference.

But was it?

It's easy to read these stories and agree with that assessment. Sugata Mitra even fell into that trap and once proclaimed, "If you put a computer in front of children and remove all other adult restrictions, they will self-organize around it, like bees around a flower."[3] He should have known better, and we suspect he did. After all, the South Asian scholar was not the first person to pin his hopes on our machines. But the general move in that direction has not always gone well. The *Wired* article by Joshua Davis that made Paloma something of an international celebrity got much of the story right, but it littered its tale with too much unrelated noise about computers and technological progress, rather than focusing on the news about changes in the way we understand and foster learning.

Devil in the Wired City

Contrast for a moment the stories you just read with this one. In the 1980s Jeffrey Hawkins dreamed of putting a computer in everybody's pocket. Make it small enough, and the costs will go down, he once told us, bringing near universal access to the world.[4] Surely that vision could support Mitra's. By the early 2000s, such miniature computers existed, and Hawkins's Treo company was one of the first to build such devices. They were called smartphones. Apple, Samsung, and other companies have sold them by the billions.

Yet their presence didn't always boost learning. Educators began to worry that the little demons distracted more than they helped. Researchers found that even a cell phone sitting on a table could diminish the quality of conversations—and learning. If someone picked it up and used it, the damage grew. A recent study in the classroom found that not only did use of cell phones damage learning for the user; it also hurt long-term retention for others in the same room.[5] Studies of both students and workers, as James Lang noted in the *Chronicle of Higher Education*, have found that when people are interrupted by a ringing cell phone, it takes them, on average, almost thirty minutes to refocus and fully engage in what they had been doing.[6]

But the potential damage of pocket computers goes much deeper. Two brain scientists from California have developed a powerful way to understand how the devices can harm our learning. Human beings are highly curious animals, Adam Gazzaley, a neurologist, and Larry Rosen, a psychologist, explain.[7] That thirst for knowledge is part of our ancient DNA, and we can't avoid it. You might think then that smartphones and the internet would feed that hunger to the delight of everyone. But not so fast. The speed of the new devices has introduced an element that creates unprecedented problems.

To understand those difficulties and dangers, the brain scientists used studies of animal feeding behavior in the wild. Humans search for information the way beasts forage for food, they argued. When squirrels find a tree full of nuts, for example, they will stay with that patch of food until the supply runs low. But when will they give up on a walnut grove and move on to a new source of nourishment? That depends on how many nuts are left and how far it is to the next tree. If it is close by, the furry rodents will abandon ship when a limb still has some fruit left because an even bigger supply of nuts is a mere leap away. If the new source is, however, across a meadow on the other side of a river, they will exhaust every opportunity before leaving the first tree.

Same for humans looking for knowledge. If it is easy to get to a new source of information, we will go there even before we deplete our current supply. Someone with a smartphone can jump quickly from one information load to another, but it is the thrill of *moving on* that soon rocks our boat, especially if the new is often glitzy, surprising, loud, or even violent. As a result, we get addicted to the bang of finding something new, always jumping from one webpage to another rather than harvesting everything from a current location.

That tendency to forage like animals has been passed down to us over millions of years as ancient forms of life evolved into new ones, and it is now written into the core of our being. But it was our smartphones, social media, and the internet that deeply reinforced the practice of jumping around. Or so these researchers argue.

That habit of switching rapidly became embedded in our brains through a process that the twentieth-century psychologist Burrhus Frederic Skinner called "intermittent reinforcement."[8] Not every new email or Facebook post yields something interesting and rewarding, but it is actually the uneven pattern of rewards that keeps us coming back and embeds the habit of flitting about deep in our brains. If we don't know what the next click will bring but it sometimes gives us a real charge (intermittent reinforcement), we'll keep probing, especially if we can't predict when the payoff will happen. A fear of missing out (FOMO) on something really good drives us into a frenzy of fast-paced clicking, and that addiction stays with us longer than it would if we could predict when the rewards would come.

You can see the results in the way people often use their smartphones and computers. One study of Stanford University students, for example, found that they switch screens "roughly five times a minute."[9] More alarming still, researchers took those measurements while students were supposedly studying. Other investigators have found similar results. We've become a world of hopscotching media users. Such habits make us impatient and anxious, always looking for that next intriguing find on the internet, afraid we will miss out on something big. Millions of students interrupt their own work and seldom stick with one task long enough to enjoy or appreciate it. They become easily bored because they have become addicted to constant change—and it is an addiction. As numerous studies have found, the quality of learning goes down.[10] The iPad and smartphone junkies understand less and remember little.

In this fast-paced world, we try to do more by attacking two tasks at the same time, but our ancient brain structures can't really read email and learn chemistry simultaneously. Multitasking is a giant illusion. It isn't just hard, as a student contended recently; it's impossible. At best, our brains don't really do two things at once; they switch rapidly back and forth between two or more mental actions, harming the quality of each one. (Compare writing all the letters in the alphabet followed by the numbers from 1 to 26. Then do it by "multitasking." Write A1, B2, and so forth. You'll find the second way much slower and more prone to mistakes.) With heavy episodes of FOMO, people become more anxious. It is not at all surprising that depression and anxiety levels among students at all levels have skyrocketed in recent years.[11]

Some of the increase may arise because more high school and college students believe they have little control over their lives, a trend that began long before Steve Jobs even dreamed of iPhones.[12] But you put the two historical developments together (changing technology and the rising sense among students that they've lost the locus of control), and that double whammy mixes like a psychological Molotov cocktail, ready to explode in the lives of millions. Indeed, a study in Taiwan found that the declining sense of control makes people more susceptible to smartphone addiction and "techno stress." The result is more anxiety and increased compulsive use of phones in a frantic attempt to keep from feeling hopeless, guilty, and depressed.[13] Meanwhile, "our brains," Gazzaley and Rosen conclude, "struggle to manage a constantly surging river of information in a world of unending interruptions and enticements to switch our focus."[14]

How Do People Learn?

How then do we explain Gazzaley and Rosen's research and reconcile it with the successes of Paloma and her classmates and with the children who found Sugata Mitra's computer in a wall? The answer to that question can tell us a lot about the nature of the Super Courses we are going to explore, and perhaps keep us from following false gods.

Despite Sugata Mitra's vision of honey pots that lured children into learning, it wasn't the computers that turned the trick. The magic boxes sometimes became a bountiful grocery store where curious people could find the nourishment they craved, but it was the food (or the information and questions) that enticed them, not the delivery system. Indeed, in Paloma's case, she didn't even have a computer.

She and her classmates feasted instead on the opportunity to explore, to ask questions, to control their own education, to hear the inquiries and problems the teacher invented, and to play with the ideas they entailed. Sergio Juárez Correa dangled delicious morsels in front of their noses, ears, and eyes and invited the children to enjoy, making sure the best food came in the right portions and at the proper time (and without coercion, but more on that later). If Gazzaley and Rosen are correct, Paloma may have been better off without a personal computer or smartphone.

Correa would pose questions and then sit back and let students struggle with a problem and invent ways to solve it. The chance to speculate became part of the inducement, as we will see in other contexts. While his ideal educator, Sugata Mitra, had urged schools to give students access to computers, Correa didn't have that luxury. No one had one of the magic machines at home except the teacher. If the children asked about something he didn't know, he'd search for an answer on the internet that evening and report back the next day. The process proved slower but had some advantages as his students anxiously awaited the outcome of his daily diggings.

If you listen carefully to Mitra, Correa, and other purveyors of minimally invasive education, you learn that they act like someone paddling a canoe downstream, not like a rudderless boat or hapless bystander adrift in a sea of ignorance.[15] Only occasionally would Correa stick his oar in the water to keep the boat headed in the right direction and away from dangerous shoals, but paddle he did. He guided the discussion and didn't rely on some invisible hand of education, often raising intriguing questions that his young pupils would probably never invent on their own.

One day, for example, he challenged the children to add all the numbers from 1 to 100 as fast as possible. Paloma quickly recognized that if she added the top and bottom number (1 plus 100, 2 plus 99, and so forth) she would have 50 sets of 101, or 5,050, and then she helped her classmates understand the same idea. It was the first day her teacher began to consider the power of pupils fostering learning in other students. In the days to come he teased the class with fascinating mind games. We'll see in a variety of Super Courses how different instructors did their own paddling.

Sugata Mitra didn't leave his Tamil children to wander aimlessly in a sea of porn, urban legends, and mindless ignorance. Rather he loaded his machine with "all kinds of stuff from the Internet about DNA replication."[16] It wasn't just everything but a limited body of information where he wanted the children to focus. He also raised problems, posed questions, and invented games. He placed among some Telugu-speaking Indian children a voice-recognition computer that could understand only neutral British accents. After challenging the kids to get themselves understood by the device, he went away, leaving them to their own curiosity and ingenuity. In two months, their speech changed, and they all began talking like a Newcastle English professor.[17]

Even Mitra admitted that, at times, "intervention is required to plant a new seed for discovery, such as 'Did you know that computers could play music? Here, let me play a song for you.' "[18] We call what the Indian professor did "scaffolding," that is, building structures that facilitate students' exploration and even guide them in certain directions. Now, we have to imagine how something similar could be done with history, chemistry, psychology, mechanical engineering, philosophy, and a host of other subjects. We'll return to the art of scaffolding later in the book.

It Isn't the Shoes

When he was three years old, Adam took a fancy to his mother's iMac and soon taught himself how to surf the web. He found a site called Starfall, which used phonetics to help children learn to read. Within a few weeks, the young boy had moved quickly through the learn-to-read lessons with their enchanting songs and colorful graphics, and by the time he was three and a half, he began reading books and even helped write a poem about the origins of mac and cheese ("Did it grow on trees"). At his preschool, he sometimes helped the teacher by reading aloud to his classmates, and when he entered kindergarten, he continued in that role. His precocious progress seemed quite natural to him and his friends, and when he reached seven, he expressed concern about his younger brother. "I'm worried," he told his father one day; "he's four years old and can't read a word." By the time Adam reached the eighth grade and beyond he applied those reading skills to advanced texts in math, science, and history and to novels and short stories.

Nate had learned to read by the time he was six, without much input from Starfall, and soon consumed books with a mad passion. By the time he was ten, he read far above his grade level, plunging through an array of novels, short stories, and nonfiction. In the fourth grade he fell in love with the saxophone and every night after school found lessons on YouTube where he could learn how to play the instrument. He advanced rapidly with that computer-assisted tutoring and soon mastered a whole string of songs, claiming first chair in his school band and flooding his house with the sounds of Charlie Parker. In the fifth grade, he started writing a graphic novel, filling it with a wondrous tale and illustrations he'd learned to draw with painstaking precision, again with the help of lessons he found on the web.

Junhui came to the United States from rural China when he was eighteen months old and quickly became engrossed in YouTube videos of tractors and earthmovers. The iPad he found on his new parents' couch became his favorite toy, filling long sessions with him sitting in someone's lap watching big machines transform a construction site. While that fascination soon faded, the English he began learning in the process stuck with him and grew. So did his enchantment with building stuff. By his sixth birthday he could wield a hammer, drill, and screwdriver like a master carpenter, and he had his own set of advanced tools and workbench where he crafted an array of toys from pieces of lumber. The young boy lived in an old neighborhood undergoing a facelift. New buildings sprang out of freshly dug holes while ancient houses sprouted replacements for rotting timbers, broken windows, and missing bricks. Some of the row houses on his block grew third stories and displayed a rich palette of paint colors. The parade of changes sparked his imagination and wonder. He became a keen observer of small details and could discuss the intricacies of joints and joists with the best of them.

His parents restricted his "iPad time" but found other ways to tickle his fancy. For his annual birthday party they brought something special to each event. One year a snake handler exhibited an array of reptiles. The next, a "science is magic" show displayed the wonders of nature to the delight of neighborhood playmates.

Learning often flows from a rich milieu in which a smartphone, iPad, or computer *could* play a role, but it isn't the electronic device that makes or breaks the education that happens any more than Michael Jordan's shoes explained his extraordinary jumping ability. Something far more subtle and complex has built the new Super Courses that we will examine. For the past two decades, we've explored highly engaging educational experiences and repeatedly found a collection of practices and conditions we have dubbed a *natural critical learning environment*, and it is that educational ecosystem that we must explore and understand if we are to comprehend and replicate the successes of the phenomenal new breed of Super Courses.

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