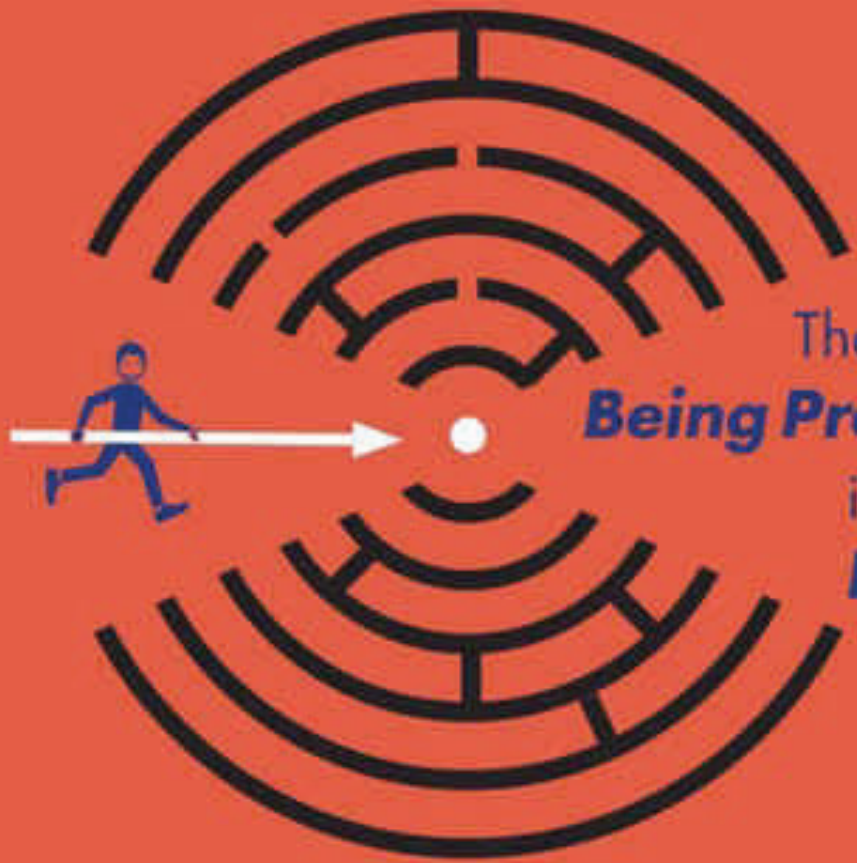
By the author of the **New York Times** bestseller

The Power of Habit

Smarter Faster Better



The Secrets of **Being Productive** in **Life** and **Business**

Charles Duhigg

ABSORBING DATA

Turning Information into Knowledge in Cincinnati's Public Schools

Students were settling into their seats as the PA system crackled to life inside South Avondale Elementary School.

"This is Principal Macon," a voice said. "I am declaring a Hot Pencil Drill. Please prepare yourselves, prepare your worksheets, and we will begin in five, four, three, two…"

Two minutes and thirty-three seconds later, eight-year-old Dante Williams slammed down his pencil, shot his hand into the air, and twitched impatiently as the teacher scribbled his finish time at the top of the multiplication quiz. Then Dante was out of his chair and flying through the door of his third-grade classroom, arms pumping as he speed-walked down the hallway, his worksheet creased in his fist.

Three years earlier, in 2007, when Dante entered kindergarten, South Avondale had been ranked as one of the worst schools in Cincinnati—which, given that the city had some of the lowest scores in the state, meant that the school was among the worst in Ohio. That year, South Avondale's students had fared so poorly on their assessment exams that officials declared the school an "academic emergency." Just weeks before Dante had stepped onto campus for the first time, a teenager had been murdered—one bullet to the head, one in the back—right next to South Avondale during a football tournament billed as a "Peace Bowl." That crime,

combined with the school's deep dysfunctions, poor academic scores, and a general sense that South Avondale had problems too big for anyone to solve, had caused city officials to ask if the board of education should close the campus altogether. The question, however, was where would they send Dante and his classmates? Nearby schools had scored only slightly better on assessment exams, and if those classrooms were forced to absorb additional kids, they would likely fall apart as well.

The community around South Avondale had been poor for decades. There were race riots in the 1960s, and when the city's factories started closing in the '70s, the area's unemployment had skyrocketed. South Avondale administrators saw students coming to school malnourished and with marks of abuse. In the 1980s, the drug trade around the school exploded and never really let up. At times, the violence got so bad that police would patrol the campus's perimeter while classes were in session. "It could be a pretty scary place," said Yzvetta Macon, who was principal from 2009 to 2013. "Students didn't go to South Avondale unless there was no other place to go."

One thing that wasn't a problem, however, was resources. The city of Cincinnati had poured millions of dollars into South Avondale. Local companies such as Procter & Gamble built computer labs and paid for tutoring and sports programs. In an effort to address the school's shortcomings, city officials spent nearly three times as many dollars on every South Avondale student as they did on students in more affluent communities, such as at the public Montessori campus across town. South Avondale had energetic teachers, devoted librarians and tutors, reading specialists, and guidance

counselors who were trained in early childhood education and prepared to help parents sign up for state and federal assistance programs.

The school also used sophisticated software to track students' performance. Administrators had embraced data collection and Cincinnati Public Schools had created an individual website for every South Avondale student—a dashboard of information that detailed kids' attendance, test scores, homework, and classroom participation—that was accessible to parents and educators so they could track who was improving and who was falling behind. The school's faculty received a steady stream of memos and spreadsheets showing how each pupil had fared over the past week, month, and year. South Avondale, in fact, was at the forefront of educational Big Data. "K–12 schools should have a clear strategy for developing a data-driven culture," read a U.S. Department of Education report that helped guide Cincinnati's efforts. By studying each student's statistics closely enough, educators believed they could deliver the specific kind of assistance each kid needed most.

"Any idea or new program, we signed up for," said Elizabeth Holtzapple, director of research and evaluation at Cincinnati Public Schools. "We had seen how data and analytics had turned around other districts, and we were on board."

The turnaround at South Avondale, however, was nowhere to be found. Six years after the online dashboards were introduced, more than 90 percent of South Avondale's teachers admitted they hardly ever looked at them—or used the data sent by the district, or read the memos they received each week. In 2008, 63 percent of South Avondale's third graders failed to meet the state's basic educational

benchmarks.

So that year, Cincinnati decided to try something different. The district's top officials targeted South Avondale and fifteen other low-performing campuses in what became known as the "Elementary Initiative," or EI. The effort was perhaps most notable for what it lacked: The schools were given no additional funds or supplementary teachers; there were no new tutoring sessions or after-school programs; the staff and student body at each campus remained basically the same.

Instead, the EI focused on changing how teachers made decisions in their classrooms. The reforms were built around the idea that data can be transformative, but only if people know how to use it. To change students' lives, educators had to understand how to transform all the spreadsheets and statistics and online dashboards into insights and plans. They had to be forced to interact with data until it influenced how they behaved.

By the time Dante entered the third grade, two years after the EI started, the program was already so successful it was hailed by the White House as a model of inner-city reform. South Avondale's test scores went up so much that the school earned an "excellent" rating from state officials. By the end of Dante's third-grade year, 80 percent of his classmates were reading at grade level; 84 percent passed the state math exam. The school had quadrupled the number of students meeting the state's guidelines. "South Avondale drastically improved student academic performance in the 2010–11 academic year and changed the culture of the school," a review by the school district read. The school's transformation was so startling that researchers from around the nation soon began traveling to Cincinnati to figure out what the Elementary

Initiative was doing right.

When those researchers visited South Avondale, teachers told them that the most important ingredient in the schools' turnaround was data—the same data, in fact, that the district had been collecting for years. Teachers said that a "data-driven culture" had actually transformed how they made classroom decisions.

When pressed, however, those teachers also said they rarely looked at the online dashboards or memos or spreadsheets the central office sent around. In fact, the EI was succeeding because teachers had been ordered to set aside those slick data tools and fancy software—and were told instead to start manipulating information by hand.

Each school, under orders from the central office, had established a "data room"—in some cases, an empty conference room, in others, a large closet that had previously contained cleaning supplies—where teachers had to transcribe test scores onto index cards. They were told to draw graphs on butcher paper that was taped to walls. They ran impromptu experiments—Do test scores improve if kids are placed in smaller reading groups? What happens when teachers trade off classes?—and then scribbled the results onto whiteboards. Rather than simply receiving information, teachers were forced to engage with it. The EI had worked because instead of passively absorbing data, teachers made it "disfluent"—harder to process at first, but stickier once it was really understood. By scribbling out statistics and testing preconceptions, teachers had figured out how to use all the information they were receiving. The Elementary Initiative, paradoxically, had made data more cumbersome to absorb—but more useful. And from those index cards and hand-drawn graphs, better

classrooms emerged.

"Something special happened inside those data rooms," said Macon, the principal. South Avondale improved not because teachers had more information but because they learned how to understand it. "With Google and the Internet and all the information we have now, you can find answers to almost anything in seconds," said Macon. "But South Avondale shows there's a difference between finding an answer and understanding what it means."

II.

In the past two decades the amount of information embedded in our daily lives has skyrocketed. There are smartphones that count our steps, websites that track our spending, digital maps to plot our commutes, software that watches our Web browsing, and apps to manage our schedules. We can precisely measure how many calories we eat each day, how much our cholesterol scores have improved each month, how many dollars we spent at restaurants, and how many minutes were allocated to the gym. This information can be incredibly powerful. If harnessed correctly, data can make our days more productive, our diets healthier, our schools more effective, and our lives less stressful.

Unfortunately, however, our ability to learn from information hasn't necessarily kept pace with its proliferation. Though we can track our spending and cholesterol, we still often eat and spend in ways we know we should avoid. Even simple uses of information—such as choosing a restaurant or a new credit card—haven't necessarily become more simple. To find a good Chinese restaurant, is it better to consult Google, ask your Facebook feed, call up a friend, or search your browser history to see where you ordered from last time? To figure out which credit card to sign up for, should you consult an online guide? Call your bank? Open those envelopes piling up on the dining room table?

In theory, the ongoing explosion in information should make the right answers more obvious. In practice, though, being surrounded by data often makes it harder to decide.

This inability to take advantage of data as it becomes more plentiful is called "information blindness." Just as snow blindness refers to people losing the capacity to distinguish trees from hills under a blanket of powder, so information blindness refers to our mind's tendency to stop absorbing data when there's too much to take in.

One study of information blindness was published in 2004 when a group of researchers at Columbia University tried to figure out why some people sign up for 401(k) retirement plans while others don't. They studied almost eight hundred thousand people, across hundreds of companies, who were offered opportunities to enroll in 401(k) plans. For many workers, signing up for the retirement plans should have been an easy choice: The 401(k)s offered large tax savings and many of the companies in the study promised to match employees' contributions—in effect giving them free money. And at firms where workers were offered information on two 401(k) options, 75 percent enrolled. Employees at those companies told researchers that signing up seemed obvious. They looked at the two brochures, picked the plan that seemed most sensible, and then watched their retirement accounts grow fatter over time.

At other companies, even as the number of plans to choose among increased, sign-ups remained high. When workers were offered twenty-five different kinds of plans, 72 percent of them enrolled.

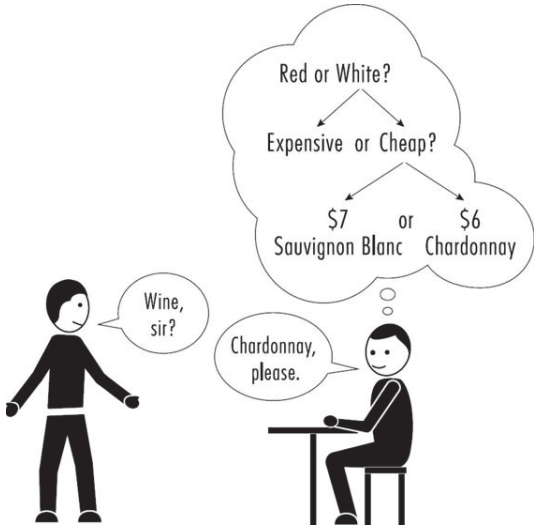
But when employees received information on more than thirty plans, something seemed to change. The amount of information people were receiving became so overwhelming that workers stopped making good choices—or, in some cases, any choice at all. At thirty-nine plans, only 65 percent of

people signed up for 401(k) accounts. At sixty plans, participation dropped to 53 percent. “Every ten funds added was associated with 1.5 percent to 2 percent drop in participation,” the researchers wrote in their 2004 study. Signing up for a 401(k) was still the right decision. But when information became too plentiful, people put the brochures in a drawer and never looked at them again.

“We’ve found this in dozens of settings,” said Martin Eppler, a professor at the University of St. Gallen in Switzerland who studies information overload. “The quality of people’s decisions generally gets better as they receive more relevant information. But then their brain reaches a breaking point when the data becomes too much. They start ignoring options or making bad choices or stop interacting with the information completely.”

Information blindness occurs because of the way our brain’s capacity for learning has evolved. Humans are exceptionally good at absorbing information—as long as we can break data into a series of smaller and smaller pieces. This process is known as “winnowing” or “scaffolding.” Mental scaffolds are like file cabinets filled with folders that help us store and access information when the need arises. If someone is handed a huge wine list at a restaurant, for instance, they’ll typically have no problem making a selection because their brain will automatically place what they know about wine into a scaffold of categories they can use to make binary decisions (Do I want a white or a red? White!), and then finer subcategories (Expensive or cheap? Cheap!) until they confront a final comparison (The six-dollar Chardonnay or the seven-dollar Sauvignon Blanc?) that draws upon what they have already learned about themselves (I like Chardonnay!). We

do this so quickly that, most of the time, we're hardly aware it's occurring.



"Our brains crave reducing things to two or three options," said Eric Johnson, a cognitive psychologist at Columbia University who studies decision making. "So when we're faced with a lot of information, we start automatically arranging it into mental folders and subfolders and sub-subfolders."

This ability to digest large amounts of information by breaking it into smaller pieces is how our brains turn information into knowledge. We learn which facts or lessons to apply in a given situation by learning which folders to consult. Experts are distinguished from novices, in part, by how many folders they carry in their heads. An oenophile will look at a wine list and immediately rely on a vast system of folders—such as vintage and region—that don't occur to novices. The oenophile has learned how to organize information (Choose the year first, then look at the pricing) in ways that make it less overwhelming. So while a novice is flipping through pages, the expert is already ignoring whole sections of the wine list.

So when we are presented with information on sixty different 401(k) plans and no obvious way to start analyzing

them, our brains pivot to a more binary decision: Do I try to make sense of all this information, or just stick everything in my drawer and ignore it?

One way to overcome information blindness is to force ourselves to grapple with the data in front of us, to manipulate information by transforming it into a sequence of questions to be answered or choices to be made. This is sometimes referred to as "creating disfluency" because it relies on doing a little bit of work: Instead of simply choosing the house wine, you have to ask yourself a series of questions (White or red? Expensive or cheap?). Instead of sticking all the 401(k) brochures into a drawer, you have to contrast the plans' various benefits and make a choice. It might seem like a small effort at the time, but those tiny bits of labor are critical to avoiding information blindness. The process of creating disfluency can be as minor as forcing ourselves to compare a few pages on a menu, or as big as building a spreadsheet to calculate 401(k) payouts. But regardless of the intensity of the effort, the underlying cognitive activity is the same: We are taking a mass of information and forcing it through a procedure that makes it easier to digest.

"The important step seems to be performing some kind of operation," said Adam Alter, a professor at NYU who has studied disfluency. "If you make people use a new word in a sentence, they'll remember it longer. If you make them write down a sentence with the word, they'll start using it in conversations." When Alter conducts experiments, he sometimes gives people instructions in a hard-to-read font because, as they struggle to make out the words, they read the text more carefully. "The initial difficulty in processing the text leads you to think more deeply about what you're reading,

so you spend more time and energy making sense of it," he said. When you ask yourself a few questions about wine, or compare the fees on various 401(k) plans, the data becomes less monolithic and more like a series of decisions. When information is made disfluent, we learn more.

In 1997, executives running the debt collection division of Chase Manhattan Bank began wondering why a particular group of employees in Tampa, Florida, were so much more successful than their peers at convincing people to pay their credit card bills. Chase, at the time, was one of the largest credit card issuers in the nation. As a result, it was also one of the largest debt collectors. It employed thousands of people, in offices all over the country, who sat in cubicles all day and called debtor after debtor, to harass them about overdue credit card bills.

Chase knew from internal surveys that debt collectors didn't especially like their jobs, and executives had grown accustomed to lackluster performance. The company had tried to make the work easier by giving collectors tools to help them convince debtors to pay. As each call occurred, for instance, the computer in front of the debt collector served up information that would assist in tailoring their pitch: It told them the debtor's age, how frequently he or she had paid off their balances, how many other credit cards they owned, what conversational tactics had proven successful in the past. Employees were sent to training sessions and given daily memos with charts and graphs showing the success of various collection tactics.

But almost none of the employees, Chase found, paid much

attention to the information they received. No matter how many classes Chase provided or memos they sent, collection rates never seemed to improve much. So executives were pleasantly surprised when one team in Tampa started collecting larger-than-usual amounts.

That group was overseen by a manager named Charlotte Fludd, an evangelical minister in training with a passion for long skirts and Hooters chicken wings, who had started out as a debt collector herself and had worked her way through the ranks until she was overseeing a group responsible for some of the hardest accounts, debtors who were 120 to 150 days overdue. Cardholders that far in arrears almost never paid off their balances. However, Fludd's group was collecting $1 million more per month than any other collection team, even as they were going after some of the most reticent debtors. What's more, Fludd's group reported some of Chase's highest employee satisfaction scores. Even the debtors they collected from, in follow-up surveys, said they had appreciated how they had been treated.

Chase's executives hoped Fludd might share her tactics with other managers, and so they asked her to speak at the company's regional meeting at the Innisbrook Resort near Tampa. The title of her talk was "Optimizing the Mosaix/Voicelink Autodialer System." The room was packed.

"Can you tell us how you schedule your autodialer?" one manager asked.

"Carefully," Fludd said. From 9:15 A.M. to 11:50 A.M., she explained, the collectors called people's home numbers because they were more likely to reach a wife taking care of the kids. Women were more likely to send in a check, Fludd said.

“Then, from noon to one thirty, we call debtors’ work numbers,” Fludd explained, “and we get a lot more men, but you can start the conversation by saying, ‘Oh, I’m so glad I caught you on your way to lunch,’ like he’s real important and his schedule is busy, because that way, he’ll want to live up to your expectations and he’ll promise to pay.

“Then at dinnertime, we call people we think are unmarried because they’re more likely to be lonely and will want to talk, and then right after dinner, we call people whose balances have ballooned up and down, because if they’ve already had a glass of wine and they’re relaxed, we can remind them how good it feels to start paying the card off.”

Fludd had dozens of tips like these. She had advice on when to use a comforting tone (if you hear soap operas in the background), when collectors should reveal personal details (if the debtor mentions kids), and when to deploy a stern approach (to anyone invoking religion).

The other managers didn’t know what to make of these suggestions. All of them sounded perfectly logical—but they didn’t think their employees would be able to use any of them. The average debt collector had just a high school diploma. For many collectors, this was their first full-time job. Managers mostly spent their time reminding employees to avoid sounding so wooden on the phone. Their debt collectors weren’t going to be able to pay attention to what television shows were playing in the background or listen for religious references. No one was adept enough at analyzing debtors’ records to figure out how to reach a housewife versus her husband. They just talked to whoever picked up the phone. Chase might send the collectors memos each morning, the company might give them computer screens of information

and provide them with classes—but managers knew almost no one actually read those memos or looked at the screens or used what they learned in class. Simply having a phone conversation with a stranger about a sensitive issue like an overdue bill was overwhelming enough on its own. The average collector couldn't process additional information while conducting a call.

But when Fludd was asked why her employees were so effective at processing more information than the average collector, she didn't have any great answers. She couldn't explain why her workers seemed to absorb so much more. So after the conference, Chase hired the consulting firm Mitchell Madison Group to examine her methods.

"How did you figure out that it's better to call women in the morning?" a consultant named Traci Entel asked her when Fludd was back in the office.

"Do you want me to show you my calendar?" said Fludd. The consultants weren't certain why she needed a calendar to explain her methods, but sure, they said, let's see the calendar. They expected Fludd to pull out a datebook or journal. Instead, she dropped a binder onto the table. Then she wheeled over a cart containing several more binders just like it.

"Okay," Fludd said, leafing through pages filled with numbers and scribbled notes. She found the sheet she was looking for. "One day, I came up with this idea that it would be easier to collect from younger people, because I figured they're more eager to keep a good credit score," she said.

Fludd explained that coming up with such theories was common on her team. Employees would gather during lunch breaks or after work to kick around ideas. Typically, these ideas didn't make much sense—at least, at first. In fact, the

ideas were often somewhat nonsensical, such as the suggestion that an irresponsible young person who is already behind on her debts, for some reason, would suddenly care deeply about improving her credit score. But that was okay. The point wasn't to suggest a good idea. It was to generate an idea, any idea at all, and then test it.

Fludd looked at her calendar. "So the next day, we started calling people between the ages of twenty-one and thirty-seven." At the end of the shift, employees reported no noticeable change in how much they had convinced people to pay. So the following morning, Fludd changed one variable: She told her employees to call people between the ages of twenty-six and thirty-one. The collection rate improved slightly. The next day, they called a subset of that group, cardholders between twenty-six and thirty-one with balances between $3,000 and $6,000. Collection rates declined. The next day: Cardholders with balances between $5,000 and $8,000. That led to the highest collection rates of the week. In the evenings, before everyone left, managers gathered to review the day's results and speculate on why certain efforts had succeeded or failed. They printed out logs and circled which calls had gone particularly well. That was Fludd's "calendar": the printouts from each day with annotations and employees' comments as well as notes suggesting why certain tactics had worked so well.

With further testing, Fludd determined that her original theory regarding young people was a dud. That, in itself, wasn't surprising. Most of the theories were duds initially. Employees had all kinds of hunches that didn't bear up under testing. But as each experiment unfolded, workers became increasingly sensitive to patterns they hadn't noticed before.

They listened more closely. They tracked how debtors would respond to various questions. And eventually, a valuable insight would emerge—like, say, it's better to call people's homes between 9:15 and 11:50 in the morning because the wife will pick up and women are more likely to pay a family's debts. Sometimes, the debt collectors would develop instincts they couldn't exactly put into words but learned to heed nonetheless.

Then someone would propose a new theory or experiment and the process would start all over again. "When you track every call and keep notes and talk about what just happened with the person in the next cubicle, you start paying attention differently," Fludd told me. "You learn to pick up on things."

To the consultants, this was an example of someone using the scientific method to isolate and test variables. "Charlotte's peers would generally change multiple things at once," wrote Niko Cantor, one of the consultants, in a review of his findings. "Charlotte would only change one thing at a time. Therefore she understood the causality better."

But something else was going on, as well. It wasn't just that Fludd was isolating variables. Rather, by coming up with hypotheses and testing them, Fludd's team was heightening their sensitivity to the information flowing past. In a sense, they were adding an element of disfluency to their work, performing operations on the "data" generated during each conversation until lessons were easier to absorb. The spreadsheets and memos that they received each morning, the data that appeared on their screens, the noises they heard in the background of phone calls—that became material for coming up with new theories and running various experiments. Each phone call contained tons of information that most collectors

never registered. But Fludd's employees noticed it, because they were looking for clues to prove or disprove theories. They were interacting with the data embodied in each conversation, turning it into something they could use.

This is how learning occurs. Information gets absorbed almost without our noticing because we're so engrossed with it. Fludd took the torrent of data arriving each day and gave her team a method for placing it into folders that made it easier to understand. She helped her employees do something with all those memos they received and the conversations they were having—and, as a result, it was easier for them to learn.

III.

Nancy Johnson became a teacher in Cincinnati because she didn't know what else to do with her life. It had taken her seven years to make it through college, and after graduating, she'd become a flight attendant, married a pilot, and then decided to settle down. In 1996, she started substituting in Cincinnati's public schools, hoping it would lead to a full-time job. She went from classroom to classroom, guiding classes on everything from English to biology, until she finally got a permanent offer as a fourth-grade teacher. On her first day, the principal saw her and said, "So you're Ms. Johnson." He later admitted he had gotten a number of applications with the same last name and wasn't fully certain which one he had hired.

A few years later, in response to the federal government's No Child Left Behind law, Cincinnati began tracking students' performances in reading and math via standardized exams. Johnson was soon drowning in reports. Each week, she received memos on students' attendance and their progress in vocabulary, math proficiency, reading, writing, literature comprehension, and something called "cognitive manipulation," as well as reviews of her classroom's proficiency, her teaching aptitude, and the school's overall scores. There was so much information that the city had hired a team of data visualization experts to design the weekly memos the district delivered via the Internet dashboards. The graphics team was talented. The charts Johnson received were easy to read, and the Internet sites contained clear summaries and color-coded trend lines.

But in those first few years, Johnson hardly looked at any of

it. She was supposed to use all that information in designing her curricula, but it made her head hurt. “There were lots of memos and statistics, and I knew I was supposed to be incorporating them into my classroom, but it all just kind of washed over me,” she said. “It felt like there was this gap between all those numbers and what I needed to know to become a better teacher.”

Her fourth-grade kids were mostly poor, and many were from single-parent families. She was a good teacher, but her class still fared badly on assessment exams. In 2007, the year before Cincinnati’s Elementary Initiative began, her students scored an average of 38 percent proficiency on the state’s reading test.

Then, in 2008, the Elementary Initiative was launched. As part of that reform, Johnson’s principal mandated that all teachers had to spend at least two afternoons a month in the school’s new data room. Around a conference table, teachers were forced to participate in exercises that made data collection and statistical tabulation even more time consuming. At the start of the semester, Johnson and her colleagues were told that as part of the EI, they had to create an index card for every student in their class. Then, every other Wednesday, Johnson would go into the data room and transcribe the past two week’s test scores onto each student’s card, and then group all the cards into color-coded piles—red, yellow, or green—based on whether students were underperforming, meeting expectations, or exceeding their peers. As the semester progressed, she also began grouping cards based on who was improving or falling behind over time.

It was intensely boring. And, frankly, it seemed redundant because all this information was already available on the

students' online dashboards. Moreover, many of the people in that room had been teaching for decades. They didn't feel like they needed piles of cards to tell them what was going on in their own classrooms. But an order was an order, and so they went into the data room every other week. "The rule was that everyone had to actually handle the cards, physically move them around," Johnson said. "Everyone hated it, at least at first."

Then one day a third-grade teacher had an idea. Since he had to spend so much time transcribing test scores, he decided to also note on each student's index cards which specific questions they had gotten wrong on that week's assessment exam. He convinced another third-grade teacher to do the same. Next, they combined their cards and made piles by grouping students who had made similar mistakes. When they were done, the piles showed a pattern: A large number of students in one class had done well on pronoun use but had stumbled at fractions; a large number of students in the other classroom had scored the opposite way. The teachers traded curricula. Both classes' scores went up.

The following week, someone else suggested dividing cards from multiple classes into piles based on where students lived. Teachers started giving everyone from the same neighborhoods similar reading assignments. Test scores ticked up. Students were doing their homework together on the bus rides home.

Johnson began putting her students into work groups based on the piles of cards she was making in the data room. Handling the index cards, she found, gave her a more granular sense of each student's strengths and weaknesses. She found herself going into the data room a couple of times a week and

putting students' cards into smaller and smaller piles, experimenting with arranging them in different ways. She had felt, before, like she knew her class pretty well. But this was a far deeper level of understanding. "When there are twenty-five students and just one teacher, it's easy to stop seeing them as individuals," she said. "I had always thought of them as a class. The data room made me focus on particular kids. It forced me to look at them one by one and ask myself, what does this kid need?"

Midway through the year, some of Johnson's colleagues noticed that a small group of students in each class were struggling on math questions. It wasn't a big enough trend that any one teacher would have noticed on their own, but inside the data room, the pattern became clear. That's how the school-wide Hot Pencil Drills started. Soon, students such as eight-year-old Dante were spending each morning filling out multiplication tables as fast as they could, and then speed-walking to the main office to have the fastest test takers' names read over the PA system. Within twelve weeks, the school's math scores were up by 9 percent.

Eight months after the Elementary Initiative was launched, Johnson's class sat for their yearly assessment exam. By that point, she was visiting the data room all the time. She and her colleagues had created dozens of piles of index cards. They had tested various lesson plans and were tracking results on long strips of paper torn from rolls and taped to the walls. Columns of numbers and scribbled notes filled the data room.

The test results came back six weeks later. Johnson's students scored an average of 72 percent, almost double her class's result the previous year. The school's overall scores had more than doubled. In 2009, Johnson became a teacher

coach, traveling to other schools in Cincinnati to help instructors learn to use their own data rooms. In 2010, she was selected by her peers as Cincinnati's Educator of the Year.

IV.

Delia Morris was a high school freshman when Cincinnati launched the Elementary Initiative, and so she was too old to benefit from the reforms occurring at places such as South Avondale. And by the time city officials began expanding the program, it seemed too late for her in other respects. Delia's father was fired that year from his job as a security guard at a local grocery store. Then he got into a fight with their landlord. Not long after, Delia came home to find an orange sticker and a padlock on the apartment's front door and everything she and her seven siblings owned stuffed into black garbage bags in the hall. The family was able to stay with people from their church for a while, and then crowded into the apartments of family friends, but from that point on, they moved every few months.

Delia was a good kid and a hard worker. Her teachers had noticed she was unusually smart—gifted enough, they felt, to make it out of Cincinnati's bad neighborhoods and into college. But that didn't mean escape was guaranteed. Every year there were a handful of students who seemed destined for something better until poverty pulled them back down. Delia's teachers were hopeful but not naïve. They knew that even for gifted students, a better life was sometimes out of reach. Delia knew that, as well. She worried that even a whiff of homelessness would change how her teachers perceived her, so she didn't tell anyone what was going on at home. "Going to school was the best part of each day," she told me. "I didn't want to ruin that."

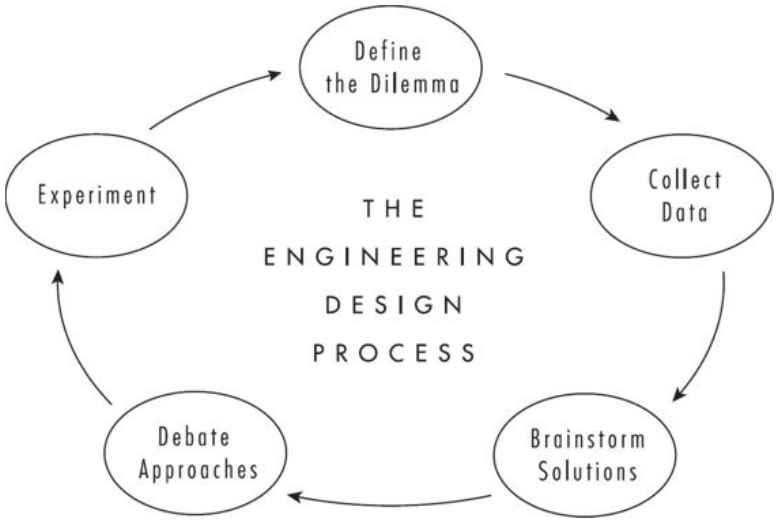
When Delia started her sophomore year at Western Hills High in 2009, the city began expanding its education reforms to high schools. However, some early results among older students proved disappointing. Teachers complained that innovations such as the data rooms were a start but not a solution. Older students were already too hardened, their teachers said; their timelines for intervention were too short. To change kids' lives, they argued, schools needed to help students get better at making the kinds of decisions that offered few opportunities for experimentation. They needed to help teenagers decide between going to college or getting a job; whether to terminate a pregnancy or get married; how to pick among family members when everyone needs your help.

So the school district shifted its focus for high school students. Alongside the Elementary Initiative, the district began creating engineering classes within Western Hills High and other schools in partnership with local universities and the National Science Foundation. The goal was "a multidisciplinary approach to education that encourages students to leverage the technology they use in their daily lives to solve real world problems," a summary of the program read. Ninety percent of students at Western Hills lived below the poverty line. Their classrooms had peeling linoleum floors and cracked chalkboards. "Leveraging technology" was not what most students worried about. Delia signed up for an engineering course taught by Deon Edwards, whose introductory remarks reflected the reality that surrounded all of them.

"We're going to learn how to think like scientists," he told his class. "We're going to leave your parents and friends behind and learn to make choices with clear eyes, without the baggage everyone wants to put on you. And if any of you

didn't have anything to eat this morning, I keep energy bars in my desk and you should help yourself. There's nothing wrong with saying you're hungry."

The real focus of Mr. Edwards's class was a system for decision making known as "the engineering design process," which forced students to define their dilemmas, collect data, brainstorm solutions, debate alternative approaches, and conduct iterative experiments. "The engineering design process is a series of steps that engineers follow when they are trying to solve a problem and design a solution for something; it is a methodical approach to problem solving," one teacher's manual explained. The engineering design process was built around the idea that many problems that seem overwhelming at first can be broken into smaller pieces, and then solutions tested, again and again, until an insight emerges. The process asked students to define precisely the dilemma they wanted to solve, then to conduct research and come up with multiple solutions, and then conduct tests, measure results, and repeat the procedure until an answer was found. It told them to make problems more manageable until they fit into scaffolds and mental folders that were easier to carry around.



The class's first big assignment was to design an electric car. For weeks, students in Mr. Edwards's class arranged themselves into teams and followed flowcharts detailing each engineering design process step. The classroom had few materials to work with. But that was okay, because the real point of the exercise was to learn how to squeeze information from your environment, no matter where it comes from. Soon students were visiting car dealerships, going to mechanics' shops, and raiding aluminum cans from recycling bins to make battery-testing kits from instructions they had found online. "My first job is to teach them to slow down a little bit," Deon Edwards told me. "These are kids who solve problems all day long. They deal with missing parents and violent boyfriends and classmates on drugs. Everything they experience says they have to choose quickly. I just want to show them that if you have a system for making choices, you can afford to slow down and think."

Midway through the semester, after the class had completed their car designs and moved on to building marble sorters, Delia's twenty-one-year-old sister had a baby. The child's father was out of the picture and Delia's sister, exhausted, begged her to babysit in the afternoons. It felt like a request that was impossible for Delia to refuse. The right decision, Delia's dad told her, was obvious. This was family.

So one day in Mr. Edwards's class, Delia pulled the engineering flowchart from her binder and, with her group, put her dilemma through the design process's steps. If she babysat, what would happen? One of the first tasks in engineering design is finding data, so Delia began making a list of experiences that seemed germane. Another sister, Delia told the group, had taken an after-school job a few years earlier

and the family had quickly come to rely on that paycheck, making it impossible for her to quit and putting her hopes of community college on hold. If Delia started babysitting, something similar would happen, she suspected. That was data point one.

Then Delia began writing out what her schedule might look like if she was responsible for an infant every afternoon. School from 8:30 to 3:30. Babysitting from 3:30 to 7:30. Homework from 7:30 to 10:00. She would be tired after watching her nephew and would probably end up watching television instead of doing her math or studying for a test. She would become resentful and make bad choices on the weekends. Data point two.

As her group walked through the flowchart, they broke her dilemma into smaller pieces and brainstormed solutions and role-played conversations while the rest of the class discussed how to separate colored marbles from clear ones. Eventually, an answer emerged: Babysitting seemed like a minor sacrifice, but the evidence suggested it wasn't minor at all. Delia prepared a memo for her father listing the steps she had gone through. She wouldn't be able to do it, she told her dad.

Psychologists say learning how to make decisions this way is important, particularly for young people, because it makes it easier for them to learn from their experiences and to see choices from different perspectives. This is a form of disfluency that allows us to evaluate our own lives more objectively, to offset the emotions and biases that might otherwise blind us to the lessons embedded in our pasts. When the animators behind Frozen were trying to figure out their film, the Disney system pushed them to look to their own lives as creative fodder. But it's not just creative material we

can mine from our experiences—we can find data in our pasts, as well. We all have a natural tendency to ignore the information contained in our previous decisions, to forget that we've already conducted thousands of experiments each time we made a choice. We're often too close to our own experiences to see how to break that data into smaller bits.

But systems such as the engineering design process—which forces us to search for information and brainstorm potential solutions, to look for different kinds of insights and test various ideas—help us achieve disfluency by putting the past in a new frame of reference. It subverts our brain's craving for binary choices—Should I help my sister or let my family down?—by learning to reframe decisions in new ways.

One important study of the power of such decision-making frames was published in 1984, after a researcher from Northwestern University asked a group of participants to list reasons why they should buy a VCR based on their own experiences. Volunteers generated dozens of justifications for such a purchase. Some said they felt a VCR would provide entertainment. Others saw it as an investment in their education or a way for their families to spend time together. Then those same volunteers were asked to generate reasons not to buy a VCR. They struggled to come up with arguments against the expenditure. The vast majority said they were likely to buy one sometime soon.

Next, the researcher asked a new group of volunteers to come up with a list of reasons against purchasing a VCR. No problem, they replied. Some said watching television distracted them from their families. Others said that movies were mindless, and they didn't need the temptation. When those same people were then asked to list reasons for buying a VCR,

they had trouble coming up with convincing reasons to make the purchase and said they were unlikely to ever buy one.

What interested the researcher was how much each group struggled to adopt an opposing viewpoint once they had an initial frame for making a decision. The two groups were demographically similar. They should have been equally interested in buying a VCR. At the very least, they should have generated equal numbers of reasons to buy or spurn the machines. But once a participant grabbed on to a decision-making frame—This is an investment in my education versus This is a distraction from my family—they found it hard to envision the choice in a different way. A VCR was either a tool for learning or a time-wasting distraction, based on how the question was framed. Similar results have been found in dozens of other experiments in which people were presented with decisions ranging from the vital, such as end-of-life choices, to the costly, such as buying a car. Once a frame is established, that context is hard to dislodge.

Frames can be uprooted, however, if we force ourselves to seek fresh vantage points. When Delia put her babysitting dilemma through Mr. Edwards's flowcharts, it introduced just enough disfluency to disrupt the frame she had initially assumed she should use. When she went home and walked her father through her logic, it shifted his frame, as well. She couldn't care for her nephew, she told him, because Mr. Edwards's Robotics Club required her to stay at school until six o'clock on Tuesdays and Thursdays, and that club was her path to college. What's more, the other days of the week she needed to get her homework done in the library before coming home because otherwise it wouldn't get finished amid the family's chaos and noise. She reframed the decision as a

choice between helping her family now, or succeeding at school and helping in other, more important ways down the road. Her father agreed. They would find another babysitter. Delia needed to stay in school.

"Our brain wants to find a simple frame and stick with it, the same way it wants to make a binary decision," Eric Johnson, the Columbia psychologist, told me. "That's why teenagers get stuck thinking about breaking up with a boyfriend as, 'Do I love him or not?' rather than 'Do I want to be in a relationship, or do I want to be able to leave for college?' Or why, when you're buying a car, you start thinking, 'Do I want the power windows or the GPS?' rather than 'Am I sure I can afford this car?'

"But when we teach people a process for reframing choices, when we give them a series of steps that causes a decision to seem a little bit different than before," said Johnson, "it helps them take more control of what's going on inside their heads."

One of the best ways to help people cast experiences in a new light is to provide a formal decision-making system—such as a flowchart, a prescribed series of questions, or the engineering design process—that denies our brains the easy options we crave. "Systems teach us how to force ourselves to make questions look unfamiliar," said Johnson. "It's a way to see alternatives."

As Delia moved into her senior year at Western Hills High, her home life became increasingly chaotic. Her sister was there, raising the baby. Another sister had dropped out of school. The family would find a place to live and then something would happen—another lost job or a neighbor who complained about too many people in a one-bedroom apartment—and they

would have to move again. In her senior year, Delia's family finally found a long-term rental, but it didn't have heat and, sometimes, when there wasn't money to pay the bill, the electricity went off.

Her teachers, by then, had figured out what was going on, and had seen how hard Delia was working. She was getting straight As. They committed themselves to helping her however they could. When Delia needed to do laundry, her English teacher, Ms. Thole, would invite her over for the afternoon. When Delia seemed exhausted, Mr. Edwards would let her stay late in his classroom and nap, her head on the desk, as he graded exams. They saw her potential. They hoped, with a little help, she could make it to college.

Mr. Edwards, in particular, was a constant in Delia's life. He introduced her to the school's guidance counselor and helped her apply for scholarships. He edited her college applications and made sure they were sent in on time. When Delia had a problem with her friends, when she was fighting with a boyfriend or sparring with her dad, when it seemed like she had too much homework and too little time—whenever it seemed like life was overwhelming—she pulled out Mr. Edwards's flowchart and put her troubles through the engineering design process. It was calming. It helped her think of solutions.

In the spring of Delia's senior year, letters began arriving from scholarship committees. She won the $10,000 Nordstrom Scholarship, then a Rotary prize, then the University of Cincinnati's minority scholar's grant. The envelopes kept coming. Seventeen scholarships in all. She was the class valedictorian and was voted most likely to succeed. The night before graduation, she slept at Ms. Thole's house so

she could take a hot shower and curl her hair before the ceremony. In the fall, she enrolled at the University of Cincinnati.

"College is a lot harder than I expected," Delia told me. She's a sophomore now, majoring in information technology. She's often the only girl in her classes and the only black student. The university has tried to help students like Delia, first-generation college attendees, by creating a program named "Gen-1" that provides mentors, tutors, mandatory study sessions, and guidance counseling. Gen-1 participants all live in the same dorm freshman year and sign a seven-page contract in which they promise to abide by a curfew, respect evening quiet hours, and participate in study halls. The idea is to help them get some distance from where they grew up, to see themselves in a new context.

"There's still drama at home," Delia said. But when things feel overwhelming, Delia thinks about Mr. Edwards's class. Any problem can be worked through, step-by-step. "If I take something that's bothering me and make it into smaller pieces, it feels like something I can think about without getting upset," she said.

"I've been through a lot. But I feel like, as long as I've got a system for getting outside my head, I can learn from it. Anything that's happened to me can be a lesson, if I think about it right."

The people who are most successful at learning—those who are able to digest the data surrounding them, who absorb insights embedded in their experiences and take advantage of information flowing past—are the ones who know how to use

disfluency to their advantage. They transform what life throws at them, rather than just taking it as it comes. They know the best lessons are those that force us to do something and to manipulate information. They take data and transform it into experiments whenever they can. Whether we use the engineering design process or test an idea at work or simply talk through a concept with a friend, by making information more disfluent, we paradoxically make it easier to understand.

In one study published in 2014, researchers from Princeton and UCLA examined the relationship between learning and disfluency by looking at the difference between students who took notes by hand while watching a lecture and those who used laptops. Recording a speaker's comments via longhand is both harder and less efficient than typing on a keyboard. Fingers cramp. Writing is slower than typing, and so you can't record as many words. Students who use laptops, in contrast, spend less time actively working during a lecture, and yet they still collect about twice as many notes as their handwriting peers. Put differently, writing is more disfluent than typing, because it requires more labor and captures fewer verbatim phrases.

When the researchers looked at the test scores of those two groups, however, they found that the hand writers scored twice as well as the typists in remembering what a lecturer said. The scientists, at first, were skeptical. Maybe the hand writers were spending more time studying after class? They conducted a second experiment, but this time they put the laptop users and the hand writers in the same lecture and then took away their notes as soon as it was over, so students couldn't study on their own. A week later, they brought everyone back. Once again, those who took notes by hand

scored better on a test of the lecture's content. No matter what constraints were placed on the groups, the students who forced themselves to use a more cumbersome note-taking method—who forced disfluency into how they processed information—learned more.

In our own lives, the same lesson applies: When we encounter new information and want to learn from it, we should force ourselves to do something with the data. It's not enough for your bathroom scale to send daily updates to an app on your phone. If you want to lose weight, force yourself to plot those measurements on graph paper and you'll be more likely to choose a salad over a hamburger at lunch. If you read a book filled with new ideas, force yourself to put it down and explain the concepts to someone sitting next to you and you'll be more likely to apply them in your life. When you find a new piece of information, force yourself to engage with it, to use it in an experiment or describe it to a friend—and then you will start building the mental folders that are at the core of learning.

Every choice we make in life is an experiment. Every day offers fresh opportunities to find better decision-making frames. We live in a time when data is more plentiful, cheaper to analyze, and easier to translate into action than ever before. Smartphones, websites, digital databases, and apps put information at our fingertips. But it only becomes useful if we know how to make sense of it.

In 2013, Dante Williams graduated from the fifth grade at South Avondale Elementary. On his last day of school, he went to a party at the same playground where the teenager had

been murdered at the Peace Bowl six years before. There were balloons and a bouncy castle, a cotton candy machine and a DJ. South Avondale was still located inside one of Cincinnati's poorest areas. There were still drugs and boarded-up homes near the campus. But 86 percent of the school's students exceeded the state's education standards that year. The previous year, 91 percent of students had tested above the state's standards. There was a list of kids from outside the district waiting to transfer in.

No school changes because of just one program, of course, just as no student succeeds because of one class or one teacher. Both Dante and Delia, as well as South Avondale and Western Hills High, changed because multiple forces came together at once. There were dedicated teachers and a renewed sense of purpose among administrators. There were focused principals and parents supporting the reforms. But dedication and purpose only succeed when we know how to direct them. The data rooms that turned information into real knowledge, the teachers who learned how to see their students as individuals with different needs and strengths: That's how Cincinnati's public schools shifted.

At the graduation ceremony, as Dante walked across the makeshift stage, his family cheered. Like all diplomas handed out that day, his contained a blank space. There was one last thing, the principal told him. No one was allowed to finish elementary school without doing a final bit of work. Dante had to transform this diploma and make it his own. She handed Dante a pen. He filled in the space with his name.