

“Groundbreaking...Not only is it fun to read, it just may change the way you think.”

—STEVEN D. LEVITT, coauthor of *Freakonomics*

**WHY THINKING-BY-NUMBERS
IS THE NEW WAY TO BE SMART**

SUPER CRUNCHERS

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IAN AYRES

CHAPTER



Are We Having Fun Yet?

Sandra Kay Daniel, a second-grade teacher at the Emma E. Booker Elementary School in Sarasota, Florida, sits in front of about a dozen second graders. She is a middle-aged matronly African-American woman with a commanding but encouraging voice.

Open your book up to lesson sixty on page 153. And at the count of three. One. . . . Two . . . Three. Everyone should be on page 153. If the yellow paper is going to bother you, drop it. Thank you. Everyone touch the title of your story. Fingers under the title. Get ready to read the title. . . . *The . . . Fast . . . Way*. We're waiting for one member. Thank you. Fingers under the title of the story. Get ready!

Class (in unison): "The Pet Goat."

Yes. "The Pet Goat." Fingers
Get ready to read the story

The class begins reading t
teacher taps her ruler against t
The students read one word pe

Class (to the beat): A girl go
Go on.

Class (to the beat): She liked
Go on.

Class (to the beat): She playe
Try it again. Get ready, from
READY!

Class (to the beat): She playe
Go on.

Class (to the beat): The goat
Go on.

Class (to the beat): One day
What's behind the word "sa

Class (in unison): Comma.

And what does that comma

Class: Slow down.

Let's read that sentence agai

Class (to the beat): One day
must go.

Go on.

Class (to the beat): He eats
Go on.

Class (to the beat): The girl
us I will see that he stop!

Nice and loud, crisp voices.

Class (to the beat): Her dad
Go on.

Yes. "The Pet Goat." Fingers under the first word of the story.
Get ready to read the story the fast way. GET READY!

The class begins reading the story in unison. As they read, the teacher taps her ruler against the board, beating out a steady rhythm. The students read one word per beat.

Class (to the beat): A girl got a pet goat.

Go on.

Class (to the beat): She liked to go running with her pet goat.

Go on.

Class (to the beat): She played with her . . .

Try it again. Get ready, from the beginning of that sentence. GET READY!

Class (to the beat): She played with her goat in her house.

Go on.

Class (to the beat): The goat ate cans and he ate canes.

Go on.

Class (to the beat): One day her dad said that goat must go.

What's behind the word "said"?

Class (in unison): Comma.

And what does that comma mean?

Class: Slow down.

Let's read that sentence again. Get ready!

Class (to the beat): One day her dad said (pause) that goat
must go.

Go on.

Class (to the beat): He eats too many things.

Go on.

Class (to the beat): The girl said that if you let the goat stay with
us I will see that he stops eating all those things.

Nice and loud, crisp voices. Let's go.

Class (to the beat): Her dad said that he will try it.

Go on.

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"The Pet Goat."

Class (to the beat): But one day a car robber came to the girl's house.

Go on.

Class (to the beat): He saw a big red car in the house and said I will steal that car.

Go on.

Class (to the beat): He ran to the car and started to open the door.

Go on.

Class (to the beat): The girl and the goat were playing in the backyard.

Go on.

Class (to the beat): They did not see the car robber. More to come.

More to come? This is a real cliff-hanger. Will the goat stop the car robber? Will the dad get fed up and kick the goat out?

Millions of us have actually seen Ms. Daniel's class. However, in the videotape, our attention was centered not on the teacher or the students but on a special guest who was visiting that day. The special guest, who was sitting quietly by Ms. Daniel's side, was President George W. Bush.

The videotape of the class was a central scene in Michael Moore's *Fahrenheit 9/11*. Just as Ms. Daniel was asking her students to "open your book to lesson sixty," Andrew Card, the president's chief of staff, came over and whispered into Bush's ear, "A second plane hit the second tower. America is under attack."

Moore's purpose was to criticize Bush for not paying more attention to what was happening outside the classroom. Yet what was happening inside Ms. Daniel's classroom concerns one of the fiercest battles raging about how best to teach schoolchildren. Bush brought the press to visit this class because Ms. Daniel was using a controversial, but highly effective, teaching method called "Direct Instruction" (DI).

The fight over whether to use DI, like the fight over evidence-based medicine, is at heart a struggle about whether to defer to the results of

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Super Crunching. Are we willing to follow a treatment that we don't like, but which has been shown in statistical testing to be effective?

Direct Instruction forces teachers to follow a script. The entire lesson—the instructions (“Put your finger under the first word.”), the questions (“What does that comma mean?”), and the prompts (“Go on.”)—is written out in the teacher's instruction manual. The idea is to force the teacher to present information in easily digestible, bite-size concepts, and to make sure that the information is actually digested.

Each student is called upon to give up to ten responses each minute. How can a single teacher pull this off? The trick is to keep a quick pace and to have the students answer in unison. The script asks the students to “get ready” to give their answers and then after a signal from the teacher, the class responds simultaneously. Every student is literally on call for just about every question.

Direct Instruction also requires fairly small groups of five to ten students of similar skill levels. Small group sizes make it harder for students to fake that they're answering and it lets the teacher from time to time ask individual students to respond, if the teacher is concerned that someone is falling behind.

The high-speed call and response of a DI class is both a challenging and draining experience. As a law professor, it sounds to me like the Socratic method run amok. Most grade schoolers can only handle a couple of hours a day of being constantly on call.

The DI approach is the brainchild of Siegfried “Zig” Engelmann, who started studying how best to teach reading at the University of Illinois in the 1960s. He has written over 1,000 short books in the “Pet Goat” genre. Engelmann, now in his seventies, is a disarming and refreshingly blunt academic who for decades has been waging war against the great minds of education.

Followers of the Swiss developmental psychologist Jean Piaget have championed child-centered approaches to education that tailor the curriculum to the desires and interests of individual students. Followers of the MIT linguist and polymath Noam Chomsky have

promoted a whole-language approach to language acquisition. Instead of breaking reading into finite bits of information in order to teach kids specific phonic skills, the whole-language approach embraces a holistic immersion in listening to and eventually reading entire sentences.

Engelmann flatly rejects both the child-centered and whole-language approaches. He isn't nearly as famous as Chomsky or Piaget, but he has a secret weapon—data. Super Crunching doesn't say on a line-by-line basis what should be included in Zig's scripts, but Super Crunching on the back end tells him what approaches actually help students learn. Engelmann rails against educational policies that are the product of top-down philosophizing instead of a bottom-up attention to what works. "Decision makers don't choose a plan because they know it works," he says. "They choose a plan because it's consistent with their vision of what they think kids should do." Most educators, he says, seem to have "a greater investment in romantic notions about children" than they do "in the gritty detail of actual practice or the fact that some things work well."

Engelmann is a thorough pragmatist. He started out in his twenties as an advertising exec who tried to figure out how often you had to repeat an ad to get the message to stick. He kept asking the "Does it work?" question when he turned his attention to education.

The evidence that DI works goes all the way back to 1967. Lyndon Johnson, as part of his War on Poverty, wanted to "follow through" on the vanishing gains seen from Head Start. Concerned that "poor children tend to do poorly in school," the Office of Education and the Office of Economic Opportunity sought to determine what types of education models could best break this cycle of failure. The result was Project Follow Through, an ambitious effort that studied 79,000 children in 180 low-income communities for twenty years at a price tag of more than \$600 million. It is a lot easier to Super Crunch when you have this kind of sustained support behind you. At the time, it was the largest education study ever done. Project Follow Through looked at the impact of seventeen different teaching methods, ranging

from models like DI, where less structured models where students selecting what and how they will sized acquisition of basic skills emphasized higher-order thinking still others emphasized positive esteem. Project Follow Through model performed the best, not emphasis, but also across the board.

Direct Instruction won hands down. Nadler summed it up this way: in DI classrooms had placed first in spelling, and first in language. This dominance wasn't just in basic skills more easily answer questions than example, DI students performed better to determine the meaning of a rounding context. DI students appropriate pieces to fill in gaps. DI even did better in practical child-centered approaches. The central purpose of child-centered by engaging children and making cation.

More recent studies by both and the American Institutes for "whole school" reforms and four model had the strongest empirical Federation of Teachers included increase student achievement." properly implemented, the "re outperforming control students the American Institutes for Research of more than twenty comprehensive

language acquisition. Instead of a top-down approach, the model emphasizes a bottom-up approach that eventually leads to reading entire sentences.

Child-centered and whole-school approaches, like Chomsky or Piaget, don't say on a par with Zig's scripts, but Super Crunching actually helps educational policies that are instead of a bottom-up approach. Don't choose a plan because they think it's consistent with what they should do." Most educators, however, are in romantic notions about the fact of actual practice or the fact

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Concerned that "poor children," the Office of Education and the Department of Health, Education and Welfare set out to determine what types of programs were in a cycle of failure. The result was a massive effort that studied 79,000 schools for twenty years at a price tag of \$1 billion. Super Crunching was behind you. At the time, it was the most expensive. Project Follow Through was the most expensive teaching methods, ranging

from models like DI, where lesson plans are carefully scripted, to unstructured models where students themselves direct their learning by selecting what and how they will study. Some models, like DI, emphasized acquisition of basic skills like vocabulary and arithmetic, others emphasized higher-order thinking and problem-solving skills, and still others emphasized positive attitudes toward learning and self-esteem. Project Follow Through's designers wanted to know which model performed the best, not only in developing skills in its area of emphasis, but also across the board.

Direct Instruction won hands down. Education writer Richard Nadler summed it up this way: "When the testing was over, students in DI classrooms had placed first in reading, first in math, first in spelling, and first in language. No other model came close." And DI's dominance wasn't just in basic skill acquisition. DI students could also more easily answer questions that required higher-order thinking. For example, DI students performed better on tests evaluating their ability to determine the meaning of an unfamiliar word from the surrounding context. DI students were also able to identify the most appropriate pieces to fill in gaps left in mathematical and visual patterns. DI even did better in promoting students' self-esteem than several child-centered approaches. This is particularly striking because a central purpose of child-centered teaching is to promote self-esteem by engaging children and making them the authors of their own education.

More recent studies by both the American Federation of Teachers and the American Institutes for Research reviewed data on two dozen "whole school" reforms and found once again that the Direct Instruction model had the strongest empirical support. In 1998, the American Federation of Teachers included DI among six "promising programs to increase student achievement." The study concluded that when DI is properly implemented, the "results are stunning," with DI students outperforming control students along every academic measure. In 2006, the American Institutes for Research rated DI as one of the top two out of more than twenty comprehensive school reform programs. DI again

outperformed traditional education programs in both reading and math.

"Traditionalists die over this," Engelmann said. "But in terms of data we whump the daylights out of them."

But wait—it gets even better. Direct Instruction is particularly effective at helping kids who are reading below grade level. Economically disadvantaged students and minorities thrive under DI instruction. And maybe most importantly, DI is scalable. Its success isn't contingent on the personality of some über-teacher. DI classes are entirely scripted. You don't need to be a genius to be an effective DI teacher. DI can be implemented in dozens upon dozens of classrooms with just ordinary teachers. You just need to be able to follow the script.

If you have a school where third graders year after year are reading at a first-grade level, they are seriously at risk of being left behind. DI gives them a realistic shot of getting back to grade. If the school adopts DI from day one of kindergarten, the kids are much less likely to fall behind in the first place.

Imagine that. Engelmann has a validated and imminently replicable program that can help at-risk students. You'd think schools would be beating a path to his door.

What Am I, a Potted Plant?

Direct Instruction has faced severe opposition from educators on the ground. They criticize the script as turning teachers into robots, and for striving to make education "teacher proof."

Can you blame them for resisting? Would *you* want to have to follow a script most of your working day, repeating ad nauseam stale words of encouragement and correction? Most teachers are taught that they should be creative. It is a stock movie genre to show teachers getting through to kids with unusual and idiosyncratic techniques (think

To Sir with Love, Stand and Deliver, and The Godfather Part II or *Opus*). No one's going to mal Instruction.

Engelmann admits that teachers initially think this is horrible," counter to everything they've e months, they realize that they a tried to teach before and never

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Instruction.

Engelmann admits that teacher resistance is a problem. "Teachers
initially think this is horrible," he said. "They think it is confining. It's
counter to everything they've ever been taught. But within a couple of
months, they realize that they are able to teach kids things that they've
tried to teach before and never been able to teach."

Direct Instruction caused a minor schism when it was introduced
into Arundel Elementary in 1996. Arundel Elementary is perched
upon a hill in Baltimore's struggling Cherry Hill neighborhood. It
is surrounded by housing projects and apartment complexes. Ninety-
five percent of its students are poor enough to qualify for federally sub-
sidized lunches. When Arundel adopted DI, several teachers were
so frustrated with the script that they transferred to other schools.
The teachers who stayed, though, have come to embrace the system.
Matthew Carpenter teaches DI seven hours a day. "I like the struc-
ture," he said. "I think it's good for this group of kids."

Most readers of this book probably couldn't abide the idea of hav-
ing to follow a script hour after hour. Still, there is a joy in seeing your
students learn. And a public school teacher confided in me that some
of her colleagues liked it for a very mundane reason: "Zero prep," she
said. That's right, instead of having to plan your own class lesson day
after day, DI instructors can walk into class, open the book, and read,
"Good morning, class . . ."

Engelmann's website is clear, if somewhat diplomatic, in emphasizing
that teacher discretion is reduced by the Direct Instruction method.
"The popular valuing of teacher creativity and autonomy as high prior-
ities must give way to a willingness to follow certain carefully pre-
scribed instructional practices," reads the DI website. Engelmann puts
the matter more bluntly: "We don't give a damn what the teacher
thinks, what the teacher feels," he said. "On the teachers' own time they
can hate it. We don't care, as long as they do it."

The Empire Strikes Back

Engelmann also faces resistance from the academic establishment. The education community is largely unified in their opposition to Direct Instruction. Ignoring the data, they argue that DI doesn't teach high-order thinking, thwarts creativity, and is not consistent with developmental practices.

Opponents argue that DI's strict methodology does not promote learning so much as prompting students to robotically repeat stock answers to scripted questions. They contend that while students learn to memorize responses to questions they expect, students are not prepared to apply this base knowledge to new situations. DI's critics also express concern that its structured approach, with tedious drills and repetition, stifles both student and teacher creativity. They argue that the method treats students as automatons leaving little room for individual thinking. These criticisms, however, ignore the possibility—supported by evidence from standardized tests—that DI equips students who have acquired a stronger set of basic skills with a greater capacity to build and develop creativity. Teachers interviewed after implementation of DI in Broward County, Florida, said the “approach actually allowed more creativity, because a framework was in place within which to innovate,” and added that classroom innovation and experimentation were a lot easier once DI had helped students acquire the necessary skills.

Lastly, critics try to discredit DI by arguing that DI causes antisocial behavior. At public meetings, whenever the possibility of switching to DI is mentioned, someone is sure to bring up a Michigan study claiming that students who are taught with DI are more likely to be arrested in their adolescent years. Here's evidence, they say, that DI is dangerous. The problem is that this randomized study was based on the experience of just sixty-eight students. And the students in the DI and the control groups were not similar.

In the end, the Michigan education establishment is wedded to the evidence says. Education the *All* teaching model Robert Slavin research, many schools would say their philosophy.” For many it ophy trumps results.

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In the end, the Michigan study is just window dressing. The education establishment is wedded to its pet theories regardless of what the evidence says. Education theorist and developer of the *Success for All* teaching model Robert Slavin puts it this way: "Research or no research, many schools would say that's just not a program that fits with their philosophy." For many in the education establishment, philosophy trumps results.

The Bush administration, however, begs to differ. The 2001 "No Child Left Behind" law (NCLB) mandates that only "scientifically based" educational programs are eligible for federal funding. The NCLB statute uses the term "scientifically based research" more than one hundred times. To qualify as "scientifically based," research must "draw on observation or experiment" and "involve rigorous data analyses that are adequate to test the stated hypotheses." This is the kind of stuff that would make any Super Cruncher salivate. Finally a fair fight, where the education model that teaches the best will prevail.

Bush's education advisors have been taking the mandate quite seriously. The Department of Education has taken the lead, spending more than \$5 billion in funding randomized testing and funding evidence-based literature reviews to assess the state of knowledge of "what works." As *Fahrenheit 9/11* shows, Bush is personally flogging the effectiveness of Direct Instruction.

On the ground, however, the requirement that states adopt scientifically based methods has not worked a sea change on the education environment. State education boards currently tend to require textbooks and materials to be a mishmash of elements that individually are supposed to be scientifically based. A "balanced literacy" approach, which mixes elements of phonetic awareness as well as holistic experiences in reading and writing, is now in the ascendancy. California requires that primary reading materials contain a mixture of broad features.

Ironically, NCLB's requirement of "scientifically based" methods has become the catalyst for *excluding* Direct Instruction from many states' approved lists because it does not contain some holistic elements. There

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are no good studies indicating that “balanced learning” materials perform as well as Direct Instruction, but that doesn’t keep states from disqualifying DI as even an option for local school adoption. At the moment, Direct Instruction, the oldest and most validated program, has captured only a little more than 1 percent of the grade-school market. Will this share rise as the empirical commands of NCLB are more fully realized? In the immortal words of “The Pet Goat,” “more to come.”

The Status Squeeze

The story of Engelmann’s struggle with the educational establishment raises once again the core themes of this book. We see the struggle of intuition, personal experience, and philosophical inclination waging war against the brute force of numbers. Engelmann for decades has staked out the leading edge of the Super Cruncher’s camp. “Intuition is perhaps your worst enemy,” Engelmann said, “if you want to be smart in the instructional arena. You have to look at the kid’s performance.”

In part, the struggle in education is a struggle over power. The education establishment and the teacher on the line want to keep their authority to decide what happens in the classroom. Engelmann and the mandate of “scientifically based” research are a direct threat to that power. Teachers in the classroom realize that their freedom and discretion to innovate is threatened. Under Direct Instruction, it is Zig who runs the show, who sets up the algorithm, who tests which script works best.

It’s not just the teacher’s power and discretion that is at stake. Status and power often go hand in hand. The rise of Super Crunching threatens the status and respectability of many traditional jobs.

Take the lowly loan officer. Once, being a loan officer for a bank was a moderately high status position. Loan officers were well paid and had real power to decide who did and did not qualify for loans. They were disproportionately white and male.

Today, loan decisions are in the results of a statistical algorithm. Loan officers’ discretion was used this discretion to help them (consciously) discriminate against a customer in the eye and establish dict whether or not the customer is creditworthy.

Bank loan officers, stripped of more than glorified secretaries, are now just a click away from sending a customer to the wall. It’s little wonder that the struggle between the intuition and the algorithm is being waged, but in consumer lending.

Following some other guy’s lead, the most interesting job, but not the most effective business model. We are seeing a decline in discretion from line employees. Super Crunching higher-ups are being treated as “potted plant” functionaries. Marx was wrong about a lot of things, but he looks downright prescient when he says that the introduction of capitalism would increase the productivity of labor.

These algorithm-driven sourcing movements are changing the way we do business. Once they don’t need to be as skilled as they used to be—lead customers through a sales process—and it’s even cheaper if you’re running a large-scale operation. Third-World call center. Sorry, but your intuition and experience may not be enough. If you’re running a large-scale operation, you’re going to do what you can to keep your staff to stick with a tried and true method.

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Today, loan decisions are instead made at a central office based on the results of a statistical algorithm. Banks started learning that giving loan officers discretion was bad business. It's not just that officers used this discretion to help their friends, or to unconsciously (or consciously) discriminate against minorities. It turns out that looking a customer in the eye and establishing a relationship doesn't help predict whether or not the customer will really repay the loan.

Bank loan officers, stripped of their discretion, have become nothing more than glorified secretaries. They literally just type in applicant data and click send. It's little wonder that their status and salaries have plummeted (and officers are much less likely to be white men). In education, the struggle between the intuitivists and the Super Crunchers is ongoing, but in consumer lending the battle ended long ago.

Following some other guy's script or algorithm may not make for the most interesting job, but time and time again it leads to a more effective business model. We are living in an age where dispersed discretion is on the wane. This is not the end of discretion; it's the shift of discretion from line employees to the much more centralized staff of Super Crunching higher-ups. Line employees increasingly feel like “potted plant” functionaries who are literally told to follow a script. Marx was wrong about a lot of things, but through a Super Crunching lens, he looks downright prescient when he said that the development of capitalism would increasingly alienate workers from their work-product.

These algorithm-driven scripts have even played a role in the outsourcing movement. Once discretion is stripped from line employees, they don't need to be as skilled. A pretested script is a cheaper way to lead customers through a service problem or to upsell related products—and it's even cheaper if the script is read by someone sitting in a Third-World call center. Some individual salespeople using their intuition and experience may in fact be legitimately outstanding, but if you're running a large-scale operation selling relatively homogenous products, you're going to do a heck of a lot better if you can just get your staff to stick with a tried-and-true script.

The shift of discretion and status from traditional experts to database oracles is also happening in medicine. Physicians report that patients now often treat them merely as alternative sources of information. Patients demand, "Show me the study." They want to see the study that says chemo is better than radiation for stage-three lung cancer. Savvy patients are treating their doctors less like 1970s television icon Marcus Welby, and more like a human substitute for a web portal. The physician is merely the conduit of information.

The rise of evidence-based medicine is changing our very conception of what doctors are. "It is a signal that in medicine," Canadian internist Kevin Patterson laments, "ours is a less heroic age."

"So the warriors are being replaced by the accountants," Patterson said. "Accountants know the whole world thinks their lives are gray—demeaned by all that addition. Doctors aren't used to thinking of themselves that way. But in the real world, where numbers matter, accountants know how powerful they are."

Physician status is in decline. People are looking past the M.D.s, who merely disseminate information, and toward the Ph.D.s, who create the database to discover information. While a graduate student in sciences has to actually create information in his or her thesis to get a Ph.D., med students only have to memorize other people's information (including how to do certain procedures). In a world where information is sovereign, there may come a time when we ask, "Are you a real doctor, or just a physician?"

Or maybe not. Respect doesn't necessarily come with power. Society is used to revering sage intuitivists. It can bow down to the theoretical genius of an Einstein or a Salk, but it is harder to revere the number-crunching "accountants" who tell us the probability that our cancer will respond to chemotherapy is 37.8 percent. In the movie *Along Came Polly*, Ben Stiller plays your typical actuarial gearhead. He's the kind of guy who's afraid to eat bar peanuts because "on average only one out of every six people wash their hands when they go to the bathroom." His character leads a small, circumscribed life that is devoid of passion. He may wield power, but he doesn't claim our

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Would You Buy a Used Ca

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are looking past the M.D.s, toward the Ph.D.s, who cre- While a graduate student in n in his or her thesis to get a prize other people's informa- (ures). In a world where infor- me when we ask, "Are you a

ecessarily come with power. sts. It can bow down to the , but it is harder to revere the l us the probability that our 37.8 percent. In the movie t typical actuarial gearhead. ar peanuts because "on aver- their hands when they go to ll, circumscribed life that is r, but he doesn't claim our

respect. Power and discretion are definitely shifting from the periph- ery to the Super Crunching center. But that doesn't mean Super Crunchers are going to find they have an easier time dating.

Would You Buy a Used Car from a Super Cruncher?

Even in areas where number crunching improves the quality of advice, it can sometimes perversely undermine the public's confidence. The heroic conception of expertise was that of an expert giving settled an- swers. People are more likely to think of statistics as infinitely mal- leable and subject to manipulation. (Think of the "Lies, damn lies and statistics!" warning.)

This is a more precise, but less certain world. The classical concep- tion of probability is a world of absolutes. To the classicist, the proba- bility of my currently having prostate cancer is either 0 or 100 percent. But we are all frequentists now. Experts used to say "yes" or "no." Now we have to contend with estimates and probabilities.

Super Crunching thus affects us not just as employees but also as consumers and clients as well. We are the patients who demand to see the study. We are the students who are forced to learn *The...Fast... Way*.™ We are the customers who are upsold by a statistically validated (outsourced) script.

Many of the Super Crunching stories are examples of unmitigated consumer progress. Offermatica helps improve your surfing experi- ence by figuring out what websites work the best. Thanks to Super Crunching we now know that targeted job search assistance is a lot more effective than financial incentives in getting unemployed work- ers back on the job. Physicians may dislike the reduction in their sta- tus and power, but at the end of the day medicine should be about saving lives. And for many serious medical risks, it is the database analysis of scientists that points toward progress.

Super Crunching approaches are winning the day and driving out intuition and experience-based expertise because Super Crunching