

# SNS SPECIAL LETTER: SCIENTIFIC REVOLUTION AND EDUCATION, PART I

BY MARC PRENSKY

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**Publisher's Note:** It's easy to have an opinion about today's K-12 education systems. After all, like noses, everyone has one.

Unfortunately for our children, almost all of them are ill-informed, in the sense of offering the promise of better educational outcomes in the future. As with inferior healthcare, the US system seems imperfectly suited to perfection when it comes to establishing a theory and practice in curriculum, process, and teaching that would lift us and our children into even a high-mediocre global standing in STEM, much less creative problem solving.

Marc Prensky, a longtime SNS member and one of the founders of SNS Project Inkwell, is the kind of person who may someday be able to claim to have made a material change, for the better, in this system. I first met Marc many years ago in a top-security conference, but that is a different topic; what matters is that I learned on that day, and have since learned repeatedly, that he is brilliant, dedicated to truth, and will not give up.

In this week's issue, Part I of his latest piece on the future of education, our members will discover the long-hoped-for rebel-with-a-cause, someone who deeply understands basic education, knows its patriotic and financial value to the country, and is willing to keep working on improving it. What could matter more? – *mra*.

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**SPECIAL LETTER:****Scientific Revolution and Education, Part I****How revisiting Thomas Kuhn's *The Structure of Scientific Revolution* can point us to the education of tomorrow****by Marc Prensky**

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*"When the transition is complete, the profession will have changed its view of the field, its methods, and its goals."*

– Thomas Kuhn

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The terms "paradigm" and "paradigm shift" are on the keyboards, and lips, of a great many who write and speak about education these days. Has a paradigm shift in education really taken place? We can get some answers by going back to the book in which the terms originated.

In 1964, Thomas S. Kuhn, a scientific philosopher and historian at UC Berkeley who later went on to work at Harvard and Princeton, published a monograph in the *International Encyclopedia of Unified Science* titled "The Structure of Scientific Revolutions." Soon after, it was published as a book by the University of Chicago. Kuhn's original thinking and perspective, groundbreaking in its time, sparked intense debates and conversations in the scientific community. Today, more than half a century later, the book is still considered an important and fundamental contribution to our understanding of how science works and progresses.

In this two-part essay, I consider whether and how Kuhn's work – and his original model for how scientific revolutions take place – applies to what is happening in education today, circa 2018. In rereading the book (which I first read in college, over 50 years ago), my reaction was that it does strongly enlighten issues that, I believe, are currently very hard for many people – including educators, parents, politicians, and even kids – to understand. Among these are: Can we explain why our education no longer works as we want it to? Can we fix it, or do we need to replace it with something new? And how might such a replacement happen, given all the resistance we see?

## ***Prologue: Education Today***

The world is rapidly changing. And many of us, if not most, would agree that education throughout the world is struggling to keep up.

What educators, employers, parents, and kids are finding, almost everywhere, is that the kind of “academic” education that worked so well for decades – and opened so many doors for so many people – is no longer doing the job it once did. Despite continued testimonies to its value by their elders, more and more kids find the education they are given in school irrelevant to their future (and present) lives, don’t like it, and tune out or drop out.

Parents search frantically, often in vain, for “better” education and schools for their kids. Countries and politicians make systemwide reforms.

Yet while everyone is busy trying to improve education, few, if any, school systems or districts – or countries – know precisely how to do it, or even what directions to take to make it better. They hear from pundits around the world that our industrial-era needs are changing, but they’re given a surprisingly narrow list of new options, often developed with long deliberations and billed to the public as big “education reforms.”

These lists consist almost entirely of tinkering at the margins of the current systems by adding “modern-sounding” features such as “innovation,” “creativity,” “21st-century skills,” “STEM” and “STEAM” classes, and “social / emotional skills” to their current offerings. The reformers try to “raise standards” and spend a ton of money on new technologies – primarily to teach to all the old core curriculum of math, language, science, and social studies, which has hardly changed. But while perhaps giving the appearance of progress, this “tinkering” approach does not really address the deeper underlying cause of our educational malaise – and is therefore unlikely to work.

### **Our View of Kids**

What is that underlying cause? No matter what system changes the reformers make, or what features they add, one thing almost always remains the same: *their view of who our young people are and what they can do*. Reformers – like most adults who have gone through school in their youth – see today’s students as *they* were at that stage of life – i.e., as powerless beings who need to be “educated” by adults according to an adult-designed plan, before they can function in the adult world.

Almost all the practitioners of our current education – the education that, in one form or another, currently dominates the entire world – share these common, unstated, underlying assumptions: that our kids enter school unable to accomplish anything; that we, the adults, must and can figure out what instruction to give all of

them; and that our teachers should be retrained to deliver whatever newly reformed program the adults decide is best. Again, like most adults, they concur in the belief that the goal of education is to make young people into “better” individuals – better, that is, at a limited range of (mostly intellectual) subjects and skills – and that the way to do this is to have our kids spend years in classrooms learning content, taking tests, and earning rankings and degrees.

### **The Emerging Alternative**

“Every country on earth, at the moment, is reforming public education,” says Sir Ken Robinson, a well-known education speaker and author. Yet while all this time-consuming and often quite expensive “reform” is going on top-down, another, very different perspective on education is emerging, bottom-up, in small pockets all over the globe. It varies from place to place in its particulars but is remarkably similar in its overall approach.

This “new” kind of education is based on a very different view of kids on the part of its practitioners: that today’s young people are far more empowered – partly by technology, but also by the times in which they are growing up. They see kids as being able to do many useful things immediately, without having to sit through a decade of classes before they can contribute to the adult world.

These practitioners believe that the education today’s kids need is not just “learning” in preparation for an uncertain future, but rather the continuous challenge of world-improving projects and real-world accomplishment so that kids know how to get things done. These practitioners see as irrelevant much of the content that current educators often call “basic” and “necessary.” They’re busy designing new processes, different challenges, new combinations of skills – i.e., new ways of becoming “educated” – to prepare these newly empowered kids for whatever comes their way in the 21st century and beyond. They are helping kids to search for their own unique combinations of interests, strengths, and passions, and to understand how to apply those to the real world. They’re replacing prescribed curricula for all with custom-designed educations. They link education far more closely to the communities in which kids live, and to bettering the world the students live in.

Unlike the current education, with or without reforms, wherever this new type of education is offered – as it now is by a smattering of schools, teachers, and programs all over the world – it is a process that today’s kids enjoy and thrive on. It is an education kids *want* to get – because it’s designed with kids’ dreams, and not just adults’ desires for the kids, in mind.

The essence of this new education is a new way of viewing our kids: as increasingly empowered people who can, and should, better their own world today. Its buds are emerging all over the globe. But will a worldwide transition to this new and better kind of education actually happen? And how?

No one knows for sure. But it turns out that, thanks to Thomas Kuhn, we do have some guidance – and a possible roadmap.

### **Part I: *The Structure of Scientific Revolution* and Kuhn's Concept of Paradigm Shift**

In his book *The Structure of Scientific Revolution*, Thomas Kuhn considers the process by which, from time to time, mainstream scientific thinking radically changes direction. He proposes a model and framework for how such major shifts in scientific thinking and practice have occurred – e.g., the shifts from the Ptolemaic to the Copernican view of the world, or from the Newtonian to the Einsteinian – each extremely different than what came before. Kuhn proposes that rather than science just being a continuous, linear progression of discovery and thought, it moves from one period of “normal” behavior to another – i.e., from one “paradigm” to a new paradigm. Further, he describes how these transitions typically occur, and their accompanying crises and disruptions.

In a later postscript to his original publication, Kuhn mentions briefly that his model of scientific change has been applied by others to fields outside of science, including philosophy, sociology, economics, and political science – but he does not in this book mention education specifically as a field to which his theories might apply. Yet many have since applied to education if not Kuhn's exact theories, his use of the terms “paradigm” and “paradigm change.” Still, although educators today use these coined terms with great frequency, I am not convinced that Kuhn's original ideas, perspectives, and model have yet been accurately applied to education. And his model has a lot to teach us, I believe, about what is currently going on around the world in the education field.

So I will add my own perspective here. My intent is to first describe what I see as the key elements of Kuhn's original thesis and model, using as much as possible his own words, and then – in Part II of this article, coming next week – suggest the implications for education, today and tomorrow.

#### **Kuhn's Concept of Paradigms**

As some have pointed out, Kuhn uses the term “paradigm” in multiple ways throughout the book. Of these, for me – and unlike, I believe, for many others who have since adopted this term – what is most useful is when he defines a paradigm not just as a set of practices that are currently widely accepted, but rather as *the set of common assumptions* on which those practices are founded.

In Kuhn's words, a paradigm is “a collective way practitioners look at the world.” Importantly, for him, it is “not about facts, or behaviors, but about *perspective*. It governs ... not a subject matter but rather a group of practitioners.” So a paradigm,

for Kuhn, is not what people do, *but rather how they perceive the world which causes them to act in that way*. This point, I think, is often missed.

According to Kuhn, the currently prevailing paradigm – i.e., most practitioners' shared view of the world around them – in turn defines the kind of work practitioners are permitted and expected to do. He refers to such work – that is, the work that happens within the confines of a prevailing shared paradigm – as “normal science.” “Normal,” for him, does not mean “ordinary,” but rather “falling within the norms of the then-prevailing paradigm.” This prevailing paradigm defines, he writes, “the kinds of behaviors and practices declared to be acceptable” by the practitioner group, and so “normal” means what most practitioners think it is right and proper to do. This includes, importantly, many types of innovation.

There are, however, practices and activities deemed by the group to be outside the current paradigm, or collective view of the world. According to Kuhn, these are typically rejected by the community of practitioners as “unworthy of pursuit” – and the practitioners are shunned. When the prevailing paradigm and commonly accepted view of scientists was that one element could never be changed into another, for example, any work that tried to do so – such as alchemy – was considered “outside of science.” But later, when the prevailing paradigm had changed to a world in which atoms and elements could be fused and split, the pursuit of changing one element into another was re-legitimized (albeit with new approaches).

### How Paradigms Change – The Kuhnian Model

Kuhn uses the phrase “paradigm shift” to describe a major change in practitioners' perspective on the world. His model for how paradigms change and evolve is simple in its overall structure; many refer to it as “periodic.”

Kuhn proposes that there are long periods in history during which the group of practitioners in a given field does its work within the confines of a common understanding (paradigm) of how the world operates (i.e., periods of “normal” science). Within each particular paradigm, the science advances “normally,” via an accumulation of new experiments and practices, all answering questions the paradigm deems worthy of consideration. This leads to refinements, but it also typically leads to, and includes, many advances in the field and in scientists' understanding of the world (within the paradigm).

### Anomalies

However, from time to time, posits Kuhn, results, events, and problems arise that the prevailing “normal” science – no matter how much scientists try to twist and turn it – cannot adequately account for or address. These events and problems – things not producing the results expected by the paradigm's theories – Kuhn calls “anomalies.”

“All is well,” says the author of Kuhn’s introduction, “until the methods legitimated by the paradigm cannot cope with a cluster of [such] anomalies....”

When the prevailing paradigm was that all other planets revolve around the Earth, for example, as the measurement accuracy of the Ptolemaic astronomers gradually increased, their theories could not accurately account for the actual movements observed, no matter how many sub-orbits they added to the theoretical orbits of planets. Yet evidence of anomaly had to build up for a new perspective, contrary to the established order, to take hold.

But if severe and persistent enough, posits Kuhn, such anomalies eventually lead to what he calls a “crisis” in the science involved. As the writer of the book’s introduction states, “Crisis results. Anomalies become intractable. No amount of tinkering will fit them into established [practice].”

### **The Kuhnian Crisis**

Such crises, says Kuhn, “simultaneously loosen the stereotypes and provides the incremental data necessary for a fundamental paradigm shift.” He further observes that “typically, during the crisis period, individuals arise with new and different perspectives on the world – i.e. different paradigms.” In fact, Kuhn argues, “crises are a necessary precondition for the emergence of novel theories.”

During each so-called “Kuhnian crisis,” the body of scientists, once more or less united in its view of the world it’s dealing with, starts to fracture: these are the periods of Kuhn’s “scientific revolutions.” “At [those points],” Kuhn writes, practitioners are “divided into competing camps or parties, one seeking to defend the old institutional constellation, the others seeking to institute some new one.”

Kuhn is at great pains, however, to explain that the new, competing worldviews that emerge from a scientific crisis are not necessarily “right” in any absolute sense. What they are better at, though, is dealing with particular kinds of problems which have suddenly become very important. “Paradigms gain their status,” Kuhn writes, “because they are more successful than their competitors in solving a few problems that the group of practitioners has come to recognize as acute.”

During the crisis periods, practitioners try hard to convince one another that their view of the world – whether the old view or a new one – is a “better” view to hold. Because “better” cannot, Kuhn believes, be proved in any absolute sense, this is typically difficult. And so “the parties to a revolutionary conflict must finally resort to the techniques of mass persuasion.”

In Kuhn’s model of paradigm change, one of these revolutionary perspectives eventually gathers more practitioner / adherents than others and gradually becomes more popular among the body of practitioners. When a new view of the

world has won the allegiance of enough of them, there follows a long transition period in which practitioners shift over to the new paradigm. During this period, many, if not most, supporters of the old paradigm feel to some degree threatened, and some never make the transition. Writes Kuhn: “[T]he new theory implies a change in the rules governing the prior practice of normal science. Inevitably, therefore, it reflects upon much scientific work they have already successfully completed. Its assimilation requires the reconstruction of prior theory and the re-evaluation of prior fact, an intrinsically revolutionary process.”

Therefore, Kuhn states, “at times of revolution, when the normal-scientific tradition changes, the scientist’s perception of his environment must be re-educated – in some familiar situations he must learn to see a new gestalt.” “It is a good sign,” says Kuhn elsewhere, “if the new paradigm permits the prediction of phenomena that had been entirely unsuspected while the old one prevailed.” Because it requires re-education of practitioners, scientific revolution, and paradigm change, it “is seldom completed by a single man and never overnight.”

But once enough practitioners have shifted to the new paradigm, a new period of “normal” science begins – and endures until the next anomaly occurs. In the end, “an older paradigm,” writes Kuhn, “is replaced in whole or in part by an incompatible new one.” “When the transition is complete,” Kuhn tells us, “the profession will have changed its view of the field, its methods, and its goals.”

Kuhn also emphasizes that the old paradigm and the new one are almost always incompatible – “incommensurate” is the term he uses; a practitioner cannot subscribe to the old and the new simultaneously. Therefore, when scientific revolutions occur, typically practitioners *must change paradigms to remain in the field*. (There are, of course, always some who remain unconvinced and never change their views – Kuhn gives the examples of scientists not accepting the ideas of Darwin or Planck.)

### The Heart of the Change

It cannot be over-emphasized that at the very heart of Kuhn’s process of paradigm shift is a change in the way practitioners *see the world*. In fact, I believe Kuhn’s key insight is that *these paradigm shifts represent a move to a very different way of practitioners viewing and thinking about the world in front of them and about their practice within it*. That is why paradigm shifts are revolutionary. Kuhn says this again and again, in a variety of ways:

“[N]eural reprogramming..., however inscrutable at this time, must underlie conversion.”

“The conversion experience, that I have likened to a Gestalt switch, remains, therefore, at the heart of the revolutionary process.”

“[T]he ... revolution is a displacement of the conceptual network through which [practitioners] view the world.”

“What a [scientist] sees depends both upon what he looks at and also upon what his previous visual-conceptual experience has taught him to see.”

“During revolutions scientists see new and different things when looking with familiar instruments in places they have looked before.”

“[T]he scientist who embraces a new paradigm is like the man wearing inverting lenses [...who has...] undergone a revolutionary transformation of vision.”

“[F]amiliar objects are seen in a different light... [There is] a switch in visual gestalt.”

“[After a revolution] the scientist works in a different world.”

Kuhn also strongly emphasizes how difficult it is for the people on either side of the paradigm change to communicate and persuade one another:

“Practicing in different worlds, the two groups of scientists see different things when they look from the same point in the same direction.”

“Neither side will grant all the non-empirical assumptions that the other needs in order to make its case... they are bound partly to talk through each other.”

“Communication across the revolutionary divide is inevitably partial.... Schools guided by different paradigms are always slightly at cross-purposes.”

“The competition between paradigms is not the sort of battle that can be resolved by proofs ... neither proof nor error is at issue.”

“[Something] that cannot even be demonstrated to one group of scientists may occasionally seem intuitively obvious to another.”

“A decision between alternate ways of practicing science is called for, and in the circumstances that decision must be based less on past achievement than on future promise.”

“Before they can hope to communicate fully, one group or the other must experience the conversion that we have been calling a paradigm shift.”

“The transition between competing paradigms cannot be made a step at a

time, forced by logic and neutral experience.”

“The man who embraces a new paradigm at an early stage must often do so in defiance of the evidence provided by problem-solving.”

“[T]he superiority of one theory to another is something that cannot be *proved* in the debate. Instead, I have insisted, each party must try, by persuasion, to convert the other.”

“The proponents of competing paradigms practice their trades in different worlds.” “[The] debate is about premises.”

“How, then, are scientists brought to make this transposition? Part of the answer is that they are very often not.”

Finally, because they see their world differently after the revolution is complete, practitioners *do* different things:

“After a scientific revolution, many old measurements and manipulations become irrelevant and are replaced by others instead.”

## **Part II: Applying Kuhn’s Ideas of Paradigm Shift to Education**

With Kuhn’s words and model of scientific change in mind, let us now consider how it might inform us about education today and tomorrow in the world.

In the final chapter of his book, Kuhn himself suggests that his “periodic” model of paradigm shifts in science exists in other fields as well, mentioning, for example, how art moves through periods – times at which new styles are considered appropriate and older styles not.

But he never addresses education specifically. So how can he enlighten us here?

### **“Normal Education”**

The first helpful idea I found was Kuhn’s concept of “normal science” – the kind of practice that goes on between paradigm shifts. Might there be there such a thing as “normal education”?

I believe there is, and that the world has been going through a long period – for the past several centuries, at least – of such “normal education,” based on a particular, and specific, worldview. During that period, practically the entire world has come together in a common, prevailing understanding of certain things. Among the most important are: 1) what the students sitting before them in class can and should be doing at particular ages; 2) what an “education” means for those students; and 3) as

a result, what is appropriate and “right” for educational practitioners to be doing to and for them.

### “Helpless,” Unempowered Kids

One way I describe this currently prevailing view of the world is the “helpless kids,” or the “our young people need to be instructed for many years before they can contribute” paradigm of education. It’s been with us for so long that many have come to think that instruction is all that education is, or ever could be.

But it is only, as Kuhn describes, a “period.” We know this because before this current view of the world took hold, there was, for millennia, another prevailing paradigm: that kids can start work early and pick up what they need by imitating their parents (or, if apprenticed, by imitating their master). And even though our current worldview has prevailed for some time, we can expect, as more and more anomalies occur, to have a different paradigm, and a different education, in the future.

### Results

The results of our currently prevailing paradigm and view of the world and our kids are the educational practices now considered “acceptable,” including grouping kids in classrooms by age and subject, having a single teacher in each classroom delivering – in his or her own way – a curriculum that has been decided and provided centrally, and administering periodic examinations and tests to students, “ranking” the students in order of their scores and progress.

Yet it is crucial that we continually remind ourselves that this now near-universal view of what an education consists of – and the systems and behaviors that are considered appropriate for educators – is based on a particular way of looking at and seeing the world, and especially the young people we are trying to educate. The lens through which educators (and as a result, parents) have viewed our kids for several centuries, if not millennia – has been that *young people are essentially helpless and powerless and need to be instructed, for many years, in both content and skills, by professional teachers, before they can become productive, useful contributors, workers, citizens, and people.*

It is to do this “necessary” instruction that we have established a common set of behaviors, creating schools – similar throughout the world – in which teachers in classrooms deliver material and assignments to groups of kids and evaluate and rank them on their progress in “learning” the material – mostly through testing.

This is not the only kind of education we could give our kids, but today, it is what most of the world believes education, and therefore the educational practitioners it hires, is supposed to do. Educators are supposed to instruct our kids systematically, in advance, on what their elders consider important to know and important to be

able to do. The instruction can certainly be delivered in a variety of ways. But any education that does not do this – the so-called “unschooling” movement, for example – falls outside our current “normal” paradigm, and most practitioners dismiss it as not a valid educational practice.

We should remind ourselves, though, that a Kuhnian paradigm is neither right nor wrong, good nor bad, in any absolute sense, and that this applies to our current paradigm of education – i.e., how we see our kids and what we do as a result.

### **“But the Current Way Works!”**

It’s true that the world’s current education model has worked well, for a long time, in many places. In many cases, people who went through it became intellectual leaders and capable citizens and industrial workers (although we have little proof that this is because of, or in spite of, the system). Moreover, the paradigm’s key assumption, that kids are helpless and need to be instructed, fits with the world as many, or even most, have perceived it.

And education under the current paradigm has not, despite what some claim, remained the same over this time. There have been numerous instances of evolution and progress within this view of the world over the past several hundred years – what Kuhn would call the “normal” evolution of the field.

We have seen the introduction of hundreds of new techniques, tools, and technologies over the last several hundred years, including improving the core curricula of math, science, and social studies; adding additional subjects such as arts and social-emotional skills; reducing class size; adopting higher standards and “competencies”; and adding new technology – all of which have made the current paradigm-based education better and more successful.

All of these many “educational innovations” are acceptable under the prevailing education paradigm (i.e., our current view of kids), and most are accepted by practitioners. Certainly, those practitioners who create and implement these innovations see themselves, and education, as making progress. What has *not* changed, however, in quite some time, is the still-prevailing view of the world and of our kids: that young people are helpless and need to be instructed before they can contribute.

***Next week: Part II: The real anomaly that is causing education to change, and the emerging battle it has produced.***

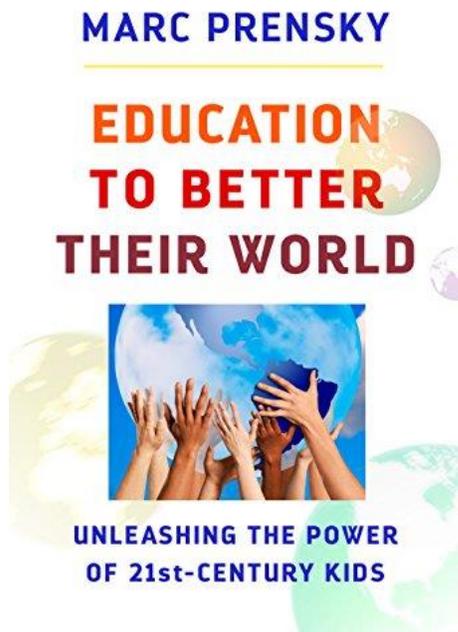
SNS SPECIAL LETTER:  
SCIENTIFIC REVOLUTION AND EDUCATION, PART II  
WHY TODAY'S EDUCATION WON'T WORK IN THE FUTURE

BY MARC PRENSKY

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**Publisher's Note:** Members who have read Part I of Marc Prensky's new work on education will understand the stark differences between his approach and the many "aspirational" tomes on what to do to "fix" education: Marc starts with the kids, how their minds and brains work, and what roles they see themselves in as they grow and learn. In Part II, he expands on this new approach to "the problem" and provides an optimistic and convincing path for creating real change, and measurable advancement, in our K-12 systems.

Having spent years reading about and discussing this situation with others, I can testify that this is a major breakthrough in seeing this landscape from a different, and more productive, perspective.

If money alone were the answer, we would have solved the problems decades ago; for better or for worse, the real solutions lie in our understanding, or lack of it. Since a radical rethinking of our basic education system is the highest leverage point society has for improvement, I hope our members will finish reading Marc's work with a new sense of hopefulness and purpose in the sphere that matters most. – *mra.*

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### SPECIAL LETTER:

## Scientific Revolution and Education, Part II: Why Today's Education Won't Work in the Future

**The “anomaly” that underlies our need for civilization-level educational change, and the emerging battle it has produced**

**by Marc Prensky**

Today all is not well in the world's educational system. As author and education speaker Sir Ken Robinson reminds us, people everywhere are trying to “fix” it. Yet problems have begun to occur within our education that cannot easily be fixed – no how much we try to “innovate” around them. I believe we have begun to see, and recognize, what Thomas Kuhn would call “anomalies” in this system.

The most important anomaly is that the same kinds of educational activities, programs, and procedures that have been successful for a long time no longer produce the same results – even when we try to “update” them. The value of the formal education we give our kids – so long held in high esteem and important for anyone who could get it – has more and more come into question, despite the well-known statistics showing that more education has, in the past, led to higher incomes (our proxy for “success”). A great many are wondering why this is happening. So what can Kuhn tell us?

As described in last week's issue, according to Kuhn, paradigms are essentially practitioners' views and assumptions about the world, and the practices those lead to. The reason behind our current problems in education, I submit, is that *our paradigm's key assumption is no longer valid: our fundamental view of our kids which underlies and validates our longtime “normal” education perspectives and practices – that our young people are helpless – is no longer the case.*

Today, more and more kids have become, and all are increasingly becoming, empowered by the tools and culture of the 21st century. They have radical new capabilities, and aspirations, that people didn't have at their age in the past. Today's young people are empowered by both the evolving technologies and the evolving attitudes and culture of our changing world; and that empowerment, although not yet everywhere, is both accelerating and, at varying rates, spreading to all kids. A large and quickly growing number of our kids are not the same people that today's adults were at that age – they are no longer the people that “normal” education was designed for.

Here we should note an important difference from the precise model Kuhn proposes. In Kuhn's model of scientific revolution and paradigm change, the world stays the same, but practitioners' perspectives on that world change. In education today, the world has actually changed, and kids have become empowered; yet practitioners still need to change their “lenses” – formed in an earlier age – to see it.

A better analogy might be that practitioners' lenses need to be cleaned. And if they were, what today's teachers would see sitting in front of them when they looked out at their classes is not just individual young people, as in the past. More and more, they would see – with clean lenses – young people with radically *extended brains, all networked together*.

They would see that today, students of all ages are capable of doing, and are doing, things that people their age have never been able to do before: inventing things, designing things, fixing things, discovering things, and more. For example:

- Primary-school kids in India wanted to add traditional crafts to their curriculum. They taught themselves the crafts and then sold them to get additional funds for their school.
- College students in Denmark created an app, implemented by the local government, to alert people online when their garbage bins were full or needed maintenance.
- High-school students in California grew tired of waiting, after numerous failed attempts by school administrators, to control a large cockroach infestation at their school. They started a Facebook page and public group to pressure school administration for more action.
- High-school students in Singapore who wanted to reduce unnecessary waste in their community advocated against the use of Styrofoam cups and plates through campaigns, talks, skits, and flash mobs, and got them banned at their school.

- Kindergarteners in France taught the senior citizens at a local home how to operate iPads in exchange for being tutored by the elders in reading and writing.
- High-schoolers in Texas designed and prototyped a complex robotics system to clean and maintain the world's largest radio-telescope.
- A first-grader in Canada, after learning that parts of Africa lacked clean water, started a foundation to dig wells.
- A fourth-grade class in Missouri responding to a "Request for proposal" for a new waterpark, formed teams to design a waterpark to their own needs, lobbied the City Council, and ultimately got their ideas incorporated into the plans of the architectural firm that was awarded the contract.
- A US fifth-grader, frustrated about being given books she couldn't relate to at school, set a goal to collect 1,000 "Black girl books" by the following February. She collected over 4,000, and created the now widespread "#1000blackgirlbooks" campaign.
- High-schoolers in New York created an app to help people who suffer from depression by giving them tips on improving their mood.
- High-schoolers in San Francisco transformed their school into a multimedia museum dedicated to the memory and lessons of the Holocaust.
- An 11-year-old reacted to the water crisis in Flint, Michigan, by building a sensor and app system that reliably detects lead in water far more quickly and cheaply than existing systems.
- A 15-year-old designed a 3-cent test for pancreatic cancer that finds it earlier and is 100% accurate.
- A 17-year-old researched, developed, and tested a global neural network cloud service that is able to detect 99% of life-threatening breast cancer tumors.
- Eleven-year-olds in Texas identified the "trap houses" in their neighborhood where drugs were being sold and worked with police to get them shut down.
- High-schoolers doing investigative journalism at a school newspaper in Kansas questioned their newly hired principal's credentials, forcing her to resign.

- Students in South Africa replaced their wetlands flower garden with small vegetable gardens, protecting the wetlands and feeding students.
- A high-schooler in the US created an app that allows students bullied at lunch to reserve a seat at a safe, welcoming lunchroom table.
- Students in Pakistan concerned about the issue of child abuse created a campaign of sharing children's stories to promote public discussion of the topic throughout their community.
- 15-year-olds in India taught gardening activities to the elderly, helping give seniors' lives meaning and dignity.
- A 14-year-old created an app that uses AI and facial recognition technology to help Alzheimer's patients recognize their loved ones.
- Eleven-year-olds in Taiwan helped immigrant children better integrate into their new country and culture by teaching them about Taiwanese rituals and creating a newsletter with important cultural information.
- Students in India who found that there were many problems regarding menstrual hygiene among rural women, yet discussing them was a big taboo, consulted gynecologists, collected material for sanitary pads, and developed workshops to teach women about good practices.
- Kindergarteners who interviewed neighborhood store owners learned that the owners wanted kids to be more polite; their next step would be a project to change the behavior of other kids.

These examples are all taken from a database with more than 100 real-world student projects from all over the world, available online at [btwdatabase.org](http://btwdatabase.org).

*This is new, and **very** different. Calling it an "anomaly" is probably understating the magnitude of the change.*

In more and more places in the world, the "normal" education of the past hundreds of years is not preparing our newly empowered students for their future as it used to do – even with all of the "improvements" currently being added. We see evidence of this in the rise of school dropout rates, in the growing dissatisfaction with school on the parts of both kids and parents, in kids who have been admitted to college not finishing, in employers not happy with the applicants they get, and in the many school graduates still living with their parents and struggling to find employment. And, of course, we see it in the many attempts to "reform" education around the world. So, using Kuhn as our guide and map, what can we expect to happen?

## Our Kuhnian Educational Crisis

The anomalies the world is now experiencing in education have led us, I believe, to precisely one of the crisis periods Kuhn describes. This is the stage in Kuhn's model, remember, where consensus breaks down on how to proceed, where novel and competing alternative approaches appear and vie with one another for general acceptance, and where new, alternative theories begin to gain practitioners' allegiance.

At this stage, says Kuhn, "the [practitioners are] divided into competing camps or parties, one seeking to defend the old institutional constellation, the others seeking to institute some new one." We can certainly observe this in the educational world today.

On one side, we have the defenders of the old paradigm – educators pushing for raising standards, hiring "better" teachers, and creating charter schools that do the "old" education in new ways (or that go back to more traditional ways). We see pressure from parents who demand that their kids get the same education they got (only better), and who tell educators, "Don't experiment with my kid." We see growth in tradition-oriented education movements such as Steiner schools and the creation of new, traditional – and costly – private schools such as Avenues.

On the other side, we see new initiatives around the world. Some are small and grassroots; others, such as AltSchool, XQ, and initiatives at Facebook, Google, and Apple in Silicon Valley, are funded with millions of dollars from philanthropists and companies. Billions of investment dollars are going into educational startups. Conferences like the annual ASU/GSV draw thousands of attendees. We see new programs that empower kids, like Design for Change, expanding rapidly to 66 countries. We see new forms of educational initiatives and institutions, from the Media Arts Center at Palo Alto High in California to the Concept Schools in Brazil to individual provinces in China.

This Kuhnian crisis caused by our newly empowered kids is being felt around the world by practitioners, parents, politicians, and especially by students. "School is not preparing me – it's irrelevant to my future life," think (and say) more and more students. "What I'm required to teach my kids is not what they need for the future," think (and say) more and more teachers. "We need to reform the system (or curriculum)," think (and say) more and more politicians. And parents are wondering and asking, "What should I really be doing to prepare my kid?"

Our current crisis stage feels uncomfortable to almost everyone – as it always does, according to Kuhn. He argues, however, that such crises are both good and "a necessary precondition for the emergence of novel theories."

## From Kuhnian Crisis to Paradigm Shift

What else can we learn from Kuhn?

Crisis, remember, in Kuhn's model, is the stage that precedes a major paradigm shift – i.e., a major transition in how practitioners view their world. Crisis is important precisely because it loosens previously strongly held perspectives and biases, as it “simultaneously loosens the stereotypes and provides the incremental data necessary for a fundamental paradigm shift.”

This loosening is what we are seeing today. I believe that what's beginning to change – in the world and in the minds of more and more educators – is the stereotype of kids who are “incapable and unempowered.” This stereotype is being loosened, principally, by the observations of adults – i.e., parents and educators – of what their children and students can now do and are doing.

We previously saw a number of examples of this. Here are more:

- Primary students in India, experiencing bad odors in their classrooms and tracing the cause to urine on their feet and clothing, found a way to make inexpensive urinals from old water bottles and installed them in their bathrooms, eliminating the odor.
- A 12-year-old Illinois student collected over 152,000 signatures supporting the banning of plastic bags and travelled to the state capital to ask the governor to veto the bill written by the oil lobbyists, which the governor did.
- Thousands of kids (including primary-school kids) in many locations have contributed to real neuroscience by using the Eyewire software game to help map the human brain's connectome.
- High-school students are using drones and existing data to monitor marine debris in Alaska.
- High-school students from around the world are working with NASA on a worldwide earthquake prediction system.
- Students in India, when historic *ghats* were damaged by floods, designed solutions, worked with government, and physically helped in cleanup, restoration, and preservation.
- Students in Colombia, concerned about the disappearance of their community's indigenous language and culture, helped preserve it by inviting elders to share their wisdom, starting a curriculum that included the

language of their forefathers and celebrating the main festivals and foods of the culture.

- Female students in Benin created programs to keep more girls in school and prevent their families from marrying them off, getting authorities to sign a petition banning forced marriages.
- An 11-year-old student in Texas, concerned about “hot car” deaths, invented and built a device that senses when a car is overly hot and a kid is inside, and blows cool air onto the kid’s car seat while notifying parents and police.
- 15-year-old students in India invented a women’s sandal that stores energy from walking and can deliver an electric shock to a rape perpetrator while sending an alert for assistance to police and family.
- Students in Idaho, alarmed at suicides among their fellow schoolkids, created programs to help prevent them.
- High-school students in California have started and now regularly publish prize-winning high-end glossy magazines on arts, culture, news, and sports for their community.
- Teens in Georgia created an app to rate police encounters and compare local police forces.
- High-school students in India, concerned about corporal punishment in schools, designed alternatives and got teachers to change their behavior.
- High-school students in Colombia, seeing their rural areas devastated by mining, built a “toy-sized” airplane to reseed those areas.
- High-school students in Hawaii traveled to a bombed-out Hawaiian island to begin a restoration and healing process.
- A Washington, DC, 14-year-old started a program that has collected, sanitized, and redistributed over one-half million used restaurant crayons.
- Twenty-one young people in Colorado, aged 8 to 20, sued the US government for its inaction on climate change.
- High-school kids in California continued the government’s important water monitoring program when the state ran out of money, using the state-purchased equipment.

- Middle-school students in India who wanted to increase fellow students' engagement in science created a "science park" from scrap materials.
- Thirteen-year-olds in Colombia created 100 pieces of useful furniture out of old tires and distributed them to the community.
- 8th-graders in Ohio discovered a way to convert Styrofoam waste into activated carbon that can be used to filter water.
- 8th-graders in California wrote and published a widely praised observation-based nature guide.

### What's *Really* Going On: The True Paradigm Shift

Today, many apply the term "paradigm shift" to almost any change in educational practices, such as putting students' chairs in a circle for discussions or letting the kids roll their chairs into temporary groups for projects. But for Kuhn, a true paradigm shift occurs at a much deeper and more fundamental level.

While a growing number of educators believe we are not teaching our kids the right skills for the future – which is almost certainly true – they also believe this is "fixable" by incrementally adding various things to our existing curriculum, such as "project- (or problem-) based learning," "21st-century skills," STEM and STEAM classes, "social / emotional skills," and others. This is precisely what many places are already starting to do.

But it is not enough. It does not address, even slightly, the anomaly that has led to the Kuhnian educational crisis we see today. So it is extremely important that people who care about the future of education not get distracted by the kinds of reforms now going on – because, as Kuhn's example teaches, they aren't paradigm changes at all. They're just the "normal" innovations of "normal" education.

These kinds of incremental changes are not part of, or even leading to, a true paradigm shift, because there is almost no change in most practitioners' view of the kids in front of them. No matter how well-meaning and desirous of reform, those practitioners continue to see kids as helpless and in need of instruction. While noting that today there are some new things to instruct kids about, *their efforts do not address the true Kuhnian crisis, which lies, rather, in the dissonance between what kids can now do and what education asks them to do – i.e., between the kid's ability to add value to the world and the kinds of activities that practitioners are expected, by top-down authorities, to do with their kids.*

No matter what new subject matter or technology schools may add to their programs, *teachers are still, in most places, expected to instruct their kids rather than empower their kids.*

## Practicing in Different Worlds

Yet I believe that, out of the current crisis, the *truly needed* adaptation of our education – and a true paradigm shift – has already begun. Almost every group of teachers I talk to, throughout the world, both feels and suffers from the dissonance between what kids can now do and what education asks them to do. More and more teachers know, at some level, they should be doing different things for their kids, yet they feel they're prevented from treating their kids differently in class – this despite the fact that many tell me they already treat kids differently in after-school programs. I have heard hundreds of teachers express the fear that they would lose their jobs were they to do what they believe is right for their kids in their classrooms. As Kuhn tells us: “The proponents of competing paradigms practice their trades in different worlds.”

Practitioners of the old paradigm still try to educate kids in a world that continues to see the kids as unempowered (which, of course, until quite recently, was the case). Today, though, a growing number of people are seeing the same kids differently, and are practicing their trade in a world of empowered kids. They see the kids in front of them – through their new, cleaner lenses – as already increasingly empowered, and in need of becoming more so through their efforts.

*This is the paradigm shift. This is the new way educational practitioners are beginning to see the world.*

To shift one's perspective requires a leap and a conscious choice on the part of practitioners. As Kuhn writes: “A decision between alternate ways of practicing ... is called for, and in the circumstances that decision must be based less on past achievement than on future promise.”

In this case, it's the promise of kids knowing how, because of their education, to improve their world.

## What's Emerging?

Over the last decade, in pockets around the world, I have observed something changing: some practitioners are beginning to see our young people differently. They are gradually putting on a new set of lenses through which to see our kids. Design for Change talks about “infecting kids with the ‘I CAN’ virus.” The global organization Ashoka speaks of kids being “changemakers.” Writers like Andrew Keen, author of *How to Fix the Future*, talk about “agency.”

This changing view of our kids is as significant and as far-reaching in its implications as the Copernican or Einsteinian scientific revolutions that Kuhn analyzed. It is a change in perspective as significant as going from thinking the Earth is flat to

understanding that it's round; from thinking the sun revolves around the Earth to understanding that the Earth revolves around the sun.

This new perspective – that kids are empowered to immediately make changes in the world – is not emerging “top-down,” i.e., from the educational establishment, at all, which is focused on the curricular reforms. Rather, it's emerging bottom-up, in the minds and organizations of more and more practitioners. Because it has not yet happened in any country as a whole, it isn't noticeable yet to many. Perhaps some assume that it's included in the curriculum revisions now appearing in various countries. But that's not the case.

What I see emerging, from the bottom up, is a *much more profound change* than anything any country has done so far. It can be observed, for the moment, only in individual educators, schools, and organizations – and only if you look for it, as I have. But it is happening, to some degree, *everywhere*. If you do look closely, you will see that the world's education is – in a very profound sense – going through precisely the type of paradigm shift that Kuhn describes: a true change in perspective.

Remember, for Kuhn a paradigm is a *lens for seeing the world*. It provides a particular belief structure within which to advance and innovate. It determines what the body of practitioners think is important to do, build around, and pass on to those entering the profession.

Lots of people – from Mark Zuckerberg to kindergarteners – have now demonstrated that the old paradigm and perspective of “helpless kids” is, in both our present and future worlds, no longer true. As we've seen in many examples, more and more kids know this and are continuously accomplishing things that demonstrate their empowerment.

For the moment, the world's mainstream education remains, in Kuhn's terms, deeply in the old paradigm. Even with its many reform initiatives, the world is still in a period of the “old, normal” education, “progressing” only by innovating incrementally within the confines of the prevailing worldview of kids as unempowered.

While more and more teachers are beginning to see their students in a new way, of course there are also many, particularly those with a lot of time invested in doing things the old way, who feel threatened by their kids' new capabilities. Some will never change their perspective of kids as helpless. In Kuhn's words, the change “reflects upon much ... of the work they have already successfully completed.”

But for those educators who are more open, but haven't yet changed their view of kids, Kuhn's words have this to offer us: “At times of revolution, when the normal ... tradition changes, the [practitioner's] perception of his environment must be re-educated – in some familiar situations he must learn to see a new gestalt.”

That is what I believe is happening. I believe Kuhn's perspective and thinking help us see the current situation for what it is: a sea change in our perception of our kids, a new view of the students who sit in front of us. Seeing our young people – our students – as “extended brains all networked together” is very different than viewing them as helpless individuals who have to be instructed in everything.

Today, just as Kuhn predicts in times such as these, “the society is divided into competing camps or parties, one seeking to defend the old institutional constellation, the others seeking to institute some new one.” Yet he also reminds us that eventually “an older paradigm is replaced in whole or in part by an incompatible new one.”

In the epigraph at the top of Part I of this article, I quoted Kuhn's statement: “When the transition [to the new paradigm] is complete, the profession will have changed its view of the field, its methods, and its goals.” Based on my recent re-reading of his book *The Structure of Scientific Revolution*, what I expect to happen is that we'll see – sooner, perhaps, than later – the majority of the world's educators taking a new view of empowered kids, using a new methodology of real-world projects to empower them further, and having a new goal for their students: making their world, through their projects, a better place.

## Summary and Conclusion

To summarize, here is what I think we can learn from re-reading *The Structure of Scientific Revolution*:

1. The kind of education we currently offer in the world is not necessarily right or permanent, despite its current ubiquity and universality. It is very much dependent on our currently held view of kids as helpless, and is just a consensus as to what worked in the past.
2. A new paradigm, or view of the world, on the part of practitioners is generally precipitated by an “anomaly” – i.e., something no longer coming out as expected. The anomaly today is that the education we universally offer no longer works as before, because our kids have become empowered.
3. A “true” Kuhnian paradigm change happens not when practitioners “normally” innovate or progress within their current worldview, as is happening, but only when they take a new and different view of the world around them. Despite today's many reform attempts, the dominant paradigm remains that our kids are unempowered and have to be instructed in everything. Therefore, a true paradigm change has not yet taken place.
4. An anomaly that is sufficiently important triggers a crisis in a field, leading to new, often competing, theories. We see this currently, just as Kuhn's model

predicts, in education. The proponents of the existing educational paradigm of helpless kids are fighting hard to protect their views and to prevent kids from exercising their new power (e.g., through “banning” their devices in the classroom). Yet new perspectives are already occurring among educational practitioners. The different camps, as Kuhn predicts, are now trying to persuade each other that their perspective leads to more useful results.

5. In Kuhn’s perspective, one new view eventually emerges as dominant, and most practitioners switch to it. I believe that more and more education practitioners are starting to realize that the emerging paradigm, that our empowered kids require a new kind of education – based on unleashing their power to better their world – is far more useful, and that most will eventually switch to that paradigm.
6. The final stage of the “revolution” Kuhn describes is when practitioners make this switch, and the field – in this case, the world’s education – progresses to a new period of “normal” within a more appropriate paradigm: the paradigm of empowered kids.

The last two stages, of course, have yet to happen. Let us hope, for our kid’s’ sake, that they happen sooner rather than later.

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## APPENDIX

### Interview of Marc Prensky by Maria Clara De Aquino Vieira

Published in *VEJA* Magazine, Brazil, March 2018

**The inventor of the expression “digital natives” says that the children of the internet age form a generation that thinks along new lines, and does not give so much importance to the privacy threatened by Facebook**

Seventeen years ago, Marc Prensky, an education expert, created the terms “digital natives” and “digital immigrants” to differentiate those who were born in the internet age from those who had to adapt to it. Since then, the natives have multiplied and grown to the extent that, according to him, there are currently no digital immigrant students in classrooms in the United States.

Author of several books and a sought-after speaker, Prensky, 72, who studied at Harvard and Yale universities, agrees that there has been an excess in recent use of

Facebook's personal information for election purposes, but wonders that privacy in these times may no longer be as relevant. He spares no criticism of current teaching methods, which he considers to be out of step with student and market needs. "We need our young people to write fewer articles and essays, and to accomplish more in the real world," he said in an interview with *VEJA* during a visit to Brazil.

**VEJA: The recent discovery of the use of personal information captured via Facebook for election purposes and disclosure of fake news has reignited the privacy debate on the network. Is there a way to preserve at least some of this privacy?**

**Marc Prensky:** The point is to know what is worth worrying about. It's like moving to a big city – we know there are dangers, but we really want to live there, so we accept the risks and take precautions. Access to personal information is not harmful unless the information is used maliciously. That's the only issue. The rest is silly secrecy, like the insistence on keeping salaries confidential. I see the current generation moving toward a much more open society in terms of information.

**What can be learned from this scandal involving Facebook?**

The case is not as scandalous as the press makes it seem. We are, in fact, at the very beginning of a vast experiment in defining what is private life in the virtual world. Many questions will arise, as happens whenever pioneers explore new places. The difference is that now we are more than 2 billion individuals exploring together. This means that problems come up faster and we can find solutions sooner. In the long run, the lesson of this "scandal" is the same one we learn from democracy: "Always be vigilant."

**Your article on digital natives was written in 2001, and the children there cited today are teenagers. What has changed since then?**

We are seeing the emergence of a new culture. Being a digital native does not mean automatically knowing everything about technology; it means that, because they have always lived with technology, our children see the world differently. A good example of this cultural change is the privacy issue. The people of my generation find the preservation of a private life to be a non-negotiable and extremely important asset. They are afraid to expose their lives online and often tell younger people to be careful what they post. There are some dangers, it's true, and no one should have access to all your information without appropriate filters. But the value of privacy itself is no longer the same.

**Is it no longer relevant?**

Not as it was in the past. Young people born in this new culture are not afraid to be seen. Someone who grew up in the pre-digital era, highly valuing privacy and having had to adapt to the new times, is an immigrant into the new, digital world. Someone

who was born and raised in the world of digital technology, however, is a native. Now, of course, it's a metaphor. You cannot classify natives and immigrants by the year they were born. The question is whether or not we have been through digital adaptation. It's almost as if the two groups lived on different planets.

### **Besides familiarity with the networks, what else is typical of digital natives?**

They have great ease of sharing, and so often work better in teams. They also have a broader worldview because they communicate easily with people everywhere. I have noticed that young people, especially those who understand technology well, are practically the same everywhere. I often say that digital natives form the first worldwide "horizontal" generation.

### **How does this show up?**

When I talk to children and adolescents, whether in Brazil, Japan, or New York, everyone shares similar ideas. They want to have more power, they want to connect and act in a group very early. There was a time when adults could control children and require them to repeat tricks taught, as if they were pets. I can no longer completely control my son's actions, as was common in the past. If something in Syria catches his attention, for example, he can easily contact someone there to talk about what is happening. It is a powerful generation that wants to, and can, take actions that we never took at their age.

### **Are there risks in this revolution?**

Yes, but the risks are bigger for the immigrants. If young people were in charge of nations, I believe many ministers of education and educators would be unemployed, because what is being taught today is not what today's students want or need. There is no escaping the revolutionary changes taking place in the lives of the new generations. But the kids will work it out – and they will do so sooner and better if we adults mostly stay out of their way, provide guidance from time to time, and stop worrying so much about what young people are doing.

### **Are not digital natives losing valuable lessons when they stop listening to their elders?**

Not necessarily. When life was lived in a less accelerated way, what older people knew was valuable for a long time. Now, much of their knowledge and advice gets outdated quickly, and much no longer applies to their kids' world. College is an example. Many older people believe that having a college degree is essential to gaining a good and successful career, and often cite statistics that "confirm" this. But those numbers are from the past, and nothing guarantees that they will be valid in the future. Many companies already give much more weight to the experience than to the diploma. They're looking for people who solve problems, get involved with work, make things happen – and that's not taught in college.

**What adjustments do you think are necessary in education?**

Education, in my view, is the process that transforms children into young people and young people into good, effective, world-improving adults. The school system we have – even with the marginal reforms we are making in many places – is no longer able to achieve this goal. An example such as Pisa, which ranks the students of the world on their knowledge of mathematics, language, and science, reflects an outmoded teaching model.

**Are you in favor of eliminating the traditional disciplines of the curriculum?**

I think they should be very minor. The amount of stuff that everyone needs to store in their heads in advance, in our times, is very small. The problem is that escaping from the known model is a risk, and neither teachers nor parents are very open to new experiments in the field of education.

**Is Google making memory expendable?**

I do not think memory will become dispensable, but we have to decide what is worth keeping in our heads and what we delegate to machines. Children and adolescents memorize a lot of information for no reason. Of course, it is important they have some skills and knowledge, but in fact very little really matters to everyone. The important thing is to understand what is important in the big picture, to have an overview, to be able to understand concisely the essential history of a place – Brazil, or the US, for example – in only a few sentences (or tweets). For more detail than that, anyone who cares is going to search the internet.

**Does this not promote mental laziness?**

Socrates thought writing would create lazy minds. Fortunately, he was wrong. It was precisely by applying the new technology of writing that Plato was able to preserve the thoughts of his master for posterity. Every generation thinks *they* were so industrious and their kids are so lazy! I, for one, am glad I no longer have to put in the effort to memorize something someone else wants me to, but I do remember lots of things – from names to facts to quotes to poems – that are important to me. As educators, *we can and should* help kids understand what is valuable for them to think about and keep in *their* heads. This will be different for each individual.

**Several surveys point to increasingly anxious and depressed young people. Do digital natives have any disadvantages compared to other generations?**

They only have advantages compared to the past. They are anxious because we live in an anxious world.

**Another criticism of today is that young people only know how to connect virtually. Is it true?**

It may be, but there is nothing that guarantees that talking face-to-face is the best form of communication in every situation. Still, there will always be a need to learn to relate and to form bonds, both personally and on social networks.

**Nobody comes knocking on the door or screaming in a virtual fight. Is not there a loss in terms of emotion?**

Whoever thinks this disregards all the power of literature, which expresses deep emotions without the involvement of any kind of physical contact. When the phone was invented, people discovered how much emotion can be transmitted using only the voice. Now, in the case of the phone, there are applications that allow you to see the other person's face. Yet often we do not want to see that, which we can turn off virtually, but it is much harder to turn it off in person.

Emotion will never disappear, but there are many ways to demonstrate it. Text messages are now accompanied by emoji, icons, pictures, videos, sounds. Soon, we will be able to transmit our emotions by projecting them on our avatar faces. And remember, many people, when they talk face-to-face, go out of their way to disguise their emotions. Face-to-face communications are often overestimated, in a knee-jerk reaction.

**It is difficult to distinguish between truth and lies on the internet. Will not the digital natives have even more trouble?**

I do not believe this is true – they will have the same difficulties as the rest of us. The people who learned to drive when the car was invented had the same problems as a young man who first picks up the wheel these days. But we have to be careful what we teach our young people. In the conversations that I have around the world, I have been told many times by students that they are taught that “one should not believe anything on the internet.” It is absurd to be teaching this.

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**About Marc Prensky**

Marc Prensky is an internationally acclaimed speaker, award-winning author, and “practical visionary” in the field of education. Coiner of the term “Digital Native,” Marc currently promotes “civilization-level change” in global education, championing an emerging paradigm that more directly benefits both students and the world.



Marc has spoken in over 40 countries, authored seven books, and published over 100 essays; his writing has been translated into 11 languages. He is currently the founder and executive director of the Global Future Education Foundation and Institute. Marc's latest book, *Education to Better Their World: Unleashing the Power of 21st Century Kids* (Columbia TC Press, 2016) won the Forward Indies Book of the Year 2016's Gold Prize for Education.

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I would like to thank Marc for taking the time to provide this detailed roadmap into the hearts and minds of our future learners, and how we might one day reach them more effectively than we are doing today. And, last but never least, our gratitude to Editor-in-Chief Sally Anderson, for putting all of these thoughts into perfect shape.

Your comments are always welcome.

Sincerely,

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