PART I

Voices from the Field

CHAPTER 1

Changing the Subject

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High Tech High

What should students learn in the 21st century? At first glance, this question divides into two: What should students know, and what should they be able to do? Knowledge and skills. For more than a century, policy makers and educators have drawn a sharp distinction between the two – between college preparatory and technical education. John Dewey argued against this division early in the 20th century. It is now way past time to integrate hands and minds, as the skills and knowledge required for "college" and "career" have become virtually identical.

But there is more at issue than knowledge and skills. For the innovation economy, dispositions come into play: learning to learn, readiness to collaborate, seeing from multiple perspectives, initiative, persistence, and curiosity. While the content of any learning experience is important, the *particular* content is irrelevant. What matters is how students apply it, react to it, or shape it. The purpose of learning in this century is not simply to recite inert knowledge, but rather to transform it. It is time to change the subject.

This is no small matter. For more than a century, the whole point of schooling has been to restrict the curriculum, specify the content, keep it inert, and limit the entry points to it – often by means of a watered-down, already obsolete text, mediated by a manager tasked with transmitting the content to 30 or more individuals of diverse backgrounds, experiences, and resources. This is particularly true of the "big four" core subjects that the Carnegie Commission decided, nearly a century ago, are the subjects that matter. English, math, science (biology, chemistry, and physics), and social studies count, and the fine and practical arts are irrelevant.

Why not study anthropology, zoology, or environmental science? Why not integrate art with calculus, or chemistry with history? Why not pick up skills and understandings in all of these areas by uncovering and addressing real problems and sharing findings with authentic audiences? Why not study a nearby estuary, invent a useful product that uses electricity, or devise

solutions to community problems, all the while engaging in systematic observation, collaborative design, and public exhibitions of learning?

If we are to change the subject in this way, then we must change the trappings within which we educate our youth. It is a fool's errand to expect teachers to model 21st-century skills in a 19th-century work environment. Instead, situate them where they can collaborate with other teachers – and with their students – to pose problems, engage expert assistance, and design products and performances of lasting value. Embrace a cohort model, where teams of teachers and students work together. Build professional collaboration and development time into the daily schedule, so that teachers can meet variously in teaching teams, academic departments, and study groups to reflect on and refine their day-to-day practice.

The aim is to unleash teachers – and their students – to design learning experiences that are applied, integrated, situated, expeditionary, and alternatively assessed.

It has long been axiomatic to separate students according to perceived academic ability, to separate academic from technical teaching and learning, and to isolate adolescents from the adult world they are about to enter.

Instead, our aim should be to integrate students by eliminating tracking, integrate the subjects via problem-focused experiences, and integrate school with the world beyond through fieldwork, service learning, and internships.

What might student do in such schools, in the absence of prescribed subject matter? They might work together to build robots, roller coasters, gardens, and human-powered submarines. They might write and publish a guide to the fauna and history of a local estuary, or an economics text illustrated with original woodcuts, or a children's astronomy book. They might produce original films, plays, and spoken-word events on adolescent issues, Japanese internment, cross-border experiences, and a host of other topics. They might mount a crime scene exhibition linking art history and DNA analysis, or develop a museum exhibit of World War I as seen from various perspectives. They might celebrate returning warriors, as did the skop or bard in Beowulf, by interviewing local veterans and writing poems honoring their experiences. The possibilities are endless.

In executing such projects, students develop deep understandings by making something new of their subject matter. Of necessity, they learn how to collaborate, how to plan, how to give and accept critique, how to revise, how to self-assess. They read complex texts and write a wide range of pieces, from personal reflections to news articles, project proposals, memos, research reports, stories, and essays. They interview community members, learning to listen and appreciate diverse perspectives. As they present their

work to important audiences, they begin to understand what it means to be a member of the human community. And the irony is that as students pursue their passions and interests, we rediscover the living curriculum.

"Changing the subject" in this way means deriving the curriculum from the lived experience of the student, which becomes a text to be "read" and interpreted, just as any print or video text might be. In this view, rather than a fixed text, the curriculum is more like a flow of events, accessible through tools that help students identify and extract rich academic content from the world: guidelines and templates for project-based development, along with activities and routines for observation and analysis, reflection, dialogue, critique, and negotiation.

When we learn – really learn – we transform the self, the content, and the very context for learning. This is what it means to change the subject. We can do this. If we value our future, we must.

CHAPTER 2

Creativity and the Invention Convention

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Connecticut Invention Convention

I am living my boyhood dream – and no, it's not the one involving Raquel Welch.

When I was 16, like many young people, I wanted to have an impact and to change the world. I became an engineer in order to design and build things that would change the world. But then I became a teacher so that I could educate hundreds of students who would then themselves change the world. Now I am working with the Connecticut Invention Convention where I am supporting hundreds of teachers who are educating thousands of students who will change the world.

I love every day of it.

The Connecticut Invention Convention (CIC) is the largest and oldest continuously operating student invention program in the United States. Last year more than 16,000 students in grades K through 8 from 246 schools across the state experienced this program, which brings creativity and problem solving into the classroom in the form of an invention education curriculum and competition.

When I first started out teaching, it was something of a personal mandate for me. I wanted to be able to take my years of engineering experience and inspire young people toward those same wonders. If there ever was a STEM-focused problem-solving teacher, it was I. In fact, I would not tell my kids I was a teacher because in my heart of hearts I was still an engineer. So I would tell the students that I was hired to be a problem solver. "In the beginning of the year, the School Board gives me a curriculum and a school room of empty heads, and I have until the end of the year to get that knowledge into your heads. The teaching and homework is about me trying to solve the problem of how to get all the cool information into your heads. All those quizzes and tests we take? You think those are for you? No, they're for me – to help me see if I am doing a good job and if I am solving the problem."

Being creative in a traditional school situation is actually very difficult. Creativity and education are, in some ways, almost contradictory. A standard education system is based on a fixed curriculum and delivering that curriculum. It is approved and set. Teachers are creative and innovative themselves, but limited by what they can do. I've known many very creative and wonderful teachers, but schools are governed by a lot of constructs that are anything but creative – standard curricula, schedules, assessment testing, and so on. Teachers and schools really do want to be creative, but how can they do that while still delivering a set standard education curriculum? Given the pressures and directives a school operates under – and I understand why those are necessary – I would not want to be a Superintendent of Education; it is a tough job.

This is why working with the CIC as a program is so fulfilling. I'm helping all these great teachers and principals do what they really would love to be doing – being really creative – but within the constraints of also fulfilling their curriculum-based systems.

The CIC is a K–8 invention education curriculum that aligns to the Connecticut Common Core standards and Next Generation Science Standards. It helps teach creativity and problem solving to kids by allowing them to seek out and identify a problem that they feel passionate about – and lets them craft a solution to solve that problem. The program starts in the Fall with Professional Development sessions where teachers can learn cutting-edge ways to teach creativity by using the invention process in their classrooms. There are basic sessions for first-time CIC teachers and advanced sessions for returning ones. In the early part of the year, teachers start an introductory program to help the students seek out and identify problems in the world around them, document a possible solution, and then undertake an Invention Process to refine that concept into a working prototype. Students present their projects – with accompanying display boards and Invention Logs – at their local school Invention Convention. Selected students then progress to higher competitions, up to the State Finals event held at the University of Connecticut's Gampel Pavilion – home of the UCONN Huskies basketball team.

For many students, everything about the CIC is a life-changing experience. It is one of the few opportunities in school where the kids can take what they have learned in math, English, science, art, and other courses and apply it to a real-world problem that they themselves relate to on some personal level. It is not the teacher's problem, but rather an issue in their own world that they are addressing and solving. I have spoken with hundreds of student inventors, and there always is a great story about why they

invented what they did. And it is usually quite empathic. "My grandma has so much trouble reaching high places." "My best friend is blind." "My dad travels a lot and misses my ballet performances." Some of them are quite personal. "I always hit my head on the bathroom door." "My ball gets lost in the storm drain when we play street ball." "I hate having to get up from bed to shut off the light when I've just about read myself to sleep." This is their world, and where else in school can they use their knowledge to make their own world better?

The students learn that inventing solutions to problems is what the real world is all about. Take, for example, electricians – they solve energy problems with wires and electrical outlets. Doctors use medicines and surgery. Plumbers use pipes and solder. But whatever the technology or the materials used, the basic process of problem discovery, goal determination, and evaluation of the result is the same. That is the experience students have at the Invention Convention. The curriculum is problem solving articulated. The Invention Log that the student creates is essentially a step-by-step cookbook for how to solve problems, any problems. And like in real life, the students have to be able to explain what the problem is and how their solution works. "People need to have faith in what you did . . . that's the real world," we tell them.

Students use all types of creativity at the Invention Convention. The program allows the student to apply what they have learned in school to issues in their own world. They are going to think the facts – measure, do calculations, get something to balance. They apply their learning about the center of gravity, moment of inertia, and electricity circuits. When they make their display board, they are using the concepts of aesthetic design, contrasting colors, and drawing skills. When they write, they are using the techniques of grammar, composition, and storytelling that they have learned.

When I was in elementary school, I was an annoying child. I was always raising my hand and asking, "Why do I have to know this?" I hated the usual response: "Because the school says so." It turned me off. But if I could see a relevance to my life, some value to me about what the teacher was presenting, then I would be interested in it. The Invention Convention takes this one step further. The students think to themselves, "If the facts I learned last year can be applied to a problem in my life this year then maybe stuff I'm learning this year will help me in the future, too!" The CIC actually changes the way students view school.

Perhaps most amazing to me is that in the CIC experience, the students seem to forget their limitations. I cannot tell you how many times I've had a teacher or parent come up to me and tell me that we've brought a child out

of their own narrow world. Numerous times, after a student has explained their invention to me, I have been told that the student has Asperger's Syndrome and they have never been so animated or engaged before. All I can do is say, "Well, if they did it once, they can do it again!" The Invention Convention is all about the students finding and discovering themselves. It is their world, and they get to do what is important to them. Students get a chance to find other ways to express themselves, and this stays with them the rest of their lives.

Let's be honest: almost none of these students are going to win a Nobel Prize or achieve some other type of global acclaim. Most will stay in Connecticut and lead relatively ordinary yet meaningful lives. The students who end up in the Invention Convention State Finals are the ones who have done something in a way that adults think is appropriate. The display board is pretty and filled with info; the Invention Log is complete; the prototype actually works as advertised. So it is still an adult's view of the world, even if that adult is open and creative. In any given year, you can find inventions that will range from a simple netted bag to prevent socks from being lost in the wash to RFID sensors on hearing aids to prevent them from being accidentally washed at all. But the reality is that the students who really benefit are not the classic ones that always do well in school, but rather the real outliers. They might not do especially well in math or English, and on quizzes and tests. But in the world of their own problems that they can solve themselves, they see a whole new future. "I really like my invention. I thought what I did was good, I can do this." Especially for the inner city, low-income kids, it changes their outlook. Of these kids that do make it to the State Finals, they usually had no idea that UConn looked like that – they are only used to seeing a basketball court on TV. "It's like a CITY." "There are so many things to do." "I spoke with a real professor who showed me what engineers do!" For many students, it is their first opportunity to realize there is something to their life beyond the four walls they are living in.

The most telling evidence of this is the reaction when other people find out about what I do for a living. The CIC is in its 34th year now, and so we've had plenty of time for children to come full circle and grow up well beyond their school years. We have more than 300,000 adults who were in the CIC at some time in their childhood. They may not remember anything else they did in fourth grade, but they do remember the details of what they invented for the Invention Convention (and even what their friend invented). Some days I feel like a small-town doctor who has delivered everyone in town over 34 years.

For the teachers, the CIC is the most fun thing they do all year. Would you rather teach students to memorize spelling words or help them build something of their own design? CIC gives the teachers an opportunity to bring creativity into the classroom, and as such our program has always been teacher driven. Our curriculum enables teachers to address the needs of a standard education while bringing true creativity into the classroom. The CIC program allows teachers to "have their cake and eat it too."

What is different about the CIC program is that while we have a lot of rules and guidelines – shape, format, policy for how it works – we don't enforce any of them. We have suggestions and advice, but not mandates. Those putting on the program interpret the program as is best for their own school's circumstances and environment.

In school, before school, after school, weekends.

One grade, some grades, all grades.

One of the unique approaches of the CIC is its Judging Circles – peer review by other students as the inventors present their projects. We have materials that prescribe how to do the Judging Circle in their local school Invention Convention. But the reality? Some schools do it our way, in a tight U-shaped table format, some have it is scattered all over the cafeteria, some invite parents to take part, some invite other non-inventing students to ask questions during judging. Sometimes it is a circus and chaotic, but the parents love it, judges love it, and importantly, students love it; the inventors always get to show off their stuff, and to the people who matter the most to them. For this reason the CIC program works in every school. We give them the North Star, but they can choose their own path to it.

In the end, the strength of the Invention Convention is not the invention itself, but in the process the student goes through to create the invention. Since the inventions are designed and made by children, 99% of them are silly. No one would ever buy them. The real value is that we are teaching children how to solve problems. All good jobs for humans in the future are about problem solving. If you only push a button to do a task, robots will take that job. In the schools that run CIC programs, it is typically a science teacher coordinating it, but sometimes a history teacher, or an art teacher, and I've even seen a band leader in charge. I met with the band leader before he signed on and explained what we do: "We take things from all over the place and put them together in a way that solves a problem." His reply? "OMG, this is exactly what I do. I have all these kids making their own sounds that we put together into a composition, something that is great sound. We are inventing music. This is what I do all the time." Now

he is running the CIC program in the music room and I am going to take credit for everything that his students will ever do in their lives.

I am very happy!

The Connecticut Invention Convention (CIC) is an award-winning, internationally recognized, 501(c)(3) educational organization started in 1983 as part of the Connecticut Educators Network for the Talented and Gifted. The program is open to K–8 students statewide, and is designed to develop, encourage, and enhance critical thinking skills through invention, innovation, and entrepreneurship. For more info, please visit www.ctinventionconvention.org