The Future of Learning:
**Education in the Era
of Partners in Code**

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A New Era of Partners in Code

We are rapidly entering a new era in which our economy, our institutions, and our societal structures – indeed, the very bedrock of our lives – are shifting at an accelerating pace. This new era promises to change learning so dramatically that both the ways in which education prepares learners and the reasons why people pursue learning could look drastically different than they do today.

Many factors are contributing to this era shift, among them new social norms, organizational approaches, and economic models. Above all, exponential advances in digital technologies are changing our world at an unprecedented pace.

Our devices are becoming increasingly smaller, more efficient, connected, and affordable. We do not just use them; we wear them as extensions of our bodies and adornments to ourselves. Data is captured in vast amounts, creating ever more detailed images of our realities, behaviors, and patterns. Increasingly sophisticated computational tools and algorithms are ushering in smart machines such as driverless cars; robots that work alongside humans; and digital helpers that can think, learn, anticipate our needs and wants, and even create art. Such developments are disrupting organizational and business models, reconfiguring civic relationships, and changing the role of employment in people's lives. They will also have a profound effect on how, when, and why people learn.

Over the next decade, our lives will become so inextricably linked with our digital companions that we will find ourselves living as **partners in code**, creating the next generation of human-digital co-evolution. Code will become increasingly ingrained in our lives. It will come to function as a sort of white noise in the background: always there and only noticeable when missing. The key challenge of the era of partners in code will be to define how people foster productive relationships with technology that leverage, elevate, and celebrate the unique contributions of our humanity so that we can thrive amid intensifying complexity.

Given the many possible futures that could unfold, the next decade represents a critical window of choice. As our partnerships with code take firmer shape, we need to be critically aware of and guide how they support and shape daily life, work, society, markets, and institutions. More specifically, we have many choices to make about what learning might look like and whether education supports everyone in navigating rapidly changing landscapes.

We urgently need to find the right approaches to education as the world around it changes. We invite you to explore the opportunities and challenges raised by this ten-year forecast and to consider what role you will play in shaping learning for the coming era of partners in code.

The next decade represents a **critical window of choice.**

Making Sense of Exponential Change

Imagine that you are climbing a staircase. You ascend at a steady rate, one step after another. You reach the top and look back at your path: 30 steps in a straight line that took you from one place to another. This type of linear change is normal to us because we see it every day. Whether we are climbing stairs, following a recipe, or watering a plant, clear cause-and-effect relationships abound, so our instinct is to apply that pattern to the world around us. Now imagine that, instead of taking one step at a time, you were climbing the stairs exponentially by doubling the number of steps you took each time. You would take one step, then another. Then you would take the next two at once. Then you would find yourself on step number eight, then step 16, all in the same amount of time it would have taken you to climb five steps one at a time.

If you actually took 30 exponential steps, you would have taken enough steps to circle the earth eight times.

This is the story of social, economic, and technological change in the 21st century. The rate at which new inventions, ideas, and marketplaces emerge and then become obsolete is accelerating, yet we often still think of ourselves as climbing a staircase, one step at a time, toward a faraway future. We are not following a clear path at a steady clip; we are speeding on an uncertain track at an exponential pace.

If education continues to advance one step at a time, it will fall exponentially behind the world for which it aims to prepare learners.

– Adapted from Peter Diamandis' illustration of exponential vs. linear change

Step 30: 1,073,741,824 ft
(Far enough to circle the earth eight times. At scale, that is much too tall to fit on this page.)

Step 28: 126,139,200 ft
(High enough to scale Mount Everest roughly 4,345 times.)

Step 1: 1 ft
(Far too small to appear here at scale.)

Step 10: 512 ft
(Almost as tall as the Washington Monument.)

Step 17: 65,536 ft
(Approximate height of a proposed 12-mile-high space elevator.)

Imagining Future Possibilities

What might we discover if we let ourselves imagine new possibilities for the future of learning? The future is not a fixed point, and the changes that will shape it are happening so quickly and in such complex ways that we could not predict it if we tried. We do have a say, though, in where we intervene, what we prioritize, and how we choose to act in the world, so we can and should consider what might unfold.

The provocations that form the core of this forecast suggest how five drivers of change might affect people, structures, and society in the context of learning. They represent possibilities, not predictions or preferred outcomes for which KnowledgeWorks would advocate. They are the result of observing present-day signals of change and imagining "What if?"

So ruminate on them and notice what new questions, ideas, and inspirations emerge. Study them, combine them, deconstruct them – do anything that will help you examine your assumptions, imagine alternative futures, and define your own plans for action. This is your opportunity to unleash your imagination about the future of learning and consider what you can and want to create.

Key Terms

Throughout this forecast, the terms below describe the complex factors that will interact to create a new learning landscape.

- **Drivers of change** are major societal shifts that will impact the future of learning. They combine multiple trends to identify broad patterns of change.

- **Impact layers** are areas where the drivers of change are likely to affect education.

- **Provocations** describe possibilities for how the drivers of change might affect education at each impact layer. Two "What if?" statements illustrate specific manifestations of what each provocation could look like.

- **Signals of change** are examples, or early indicators, of how each provocation is beginning to play out today.

Using This Forecast

The **overview poster** introduces the impact layers and drivers of change and illustrates how the provocations at their intersections might emerge.

For each impact layer, a **provocations card** provides full detail about those images of the future, including descriptions, two "What If" statements, and signals of change.

Additional cards describe opportunities and challenges in **shaping the future of learning** and **technologies to watch** as we enter the new era of partners in code.

As you unfold the pieces of this forecast, **let your imagination unfold too.**

KnowledgeWorks Forecast 4.0

The Future of Learning:
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KnowledgeWorks.

What might we discover if we let ourselves imagine new possibilities for the future of learning?

This forecast explores provocations at the intersection of **three impact layers** – **people**, **structures**, and **society** – and **five drivers of change**.

Where the drivers of change meet the impact layers, **provocations** suggest possibilities for what learning could look like in ten years. As you explore them, consider what role you might play in **shaping the future of learning**.

The Impact Layers

People:
Educators and learners
re-imagine their roles and
interactions.

Structures:
Teaching and learning systems
morph to achieve resilience.

Society:
Alternative value sets
and diverse perspectives
transform education.

Drivers of Change

These **major societal shifts** are pointing the way toward a new era of **partners in code**.

Optimized Selves

Discovering new human horizons

Scientists are unlocking new insights into our brains, emotions, and biological systems even as wearable devices, sensors, and complex computational tools are enabling people to understand themselves in new ways. In tracking and analyzing behaviors such as sleep, exercise, nutrition, work, and social interactions and in using cognitive and affective tools to optimize performance and overcome biological limitations, we will deepen our self-knowledge and expand possibilities for human accomplishment and purpose. What follows is an expansion of individual and collective human identity, with broader awareness of how we construct and manage our digital, gendered, emotive, and biological selves. Expanding human horizons will usher in the potential for greater focus on individual development in education.

Labor Relations 2.0

Negotiating new machine partnerships

From factory and warehouse settings to hospitals, law firms, and taxi services, smart machines are performing tasks that once formed the core of middle class work. As artificial intelligence and machine learning improve, automation will proliferate among the non-routine, complex cognitive tasks of knowledge professionals. Sophisticated algorithms and software are already streamlining the coordination of micro-tasks and dispatching services. The key challenge and opportunity for meaningful employment will be to redefine the unique human contribution in the workplace. Where will humans deploy smart machines to achieve greater human insight and wisdom, and where will we be dispatched to perform menial tasks? The choices we make about articulating smart machine partnerships at work will shape the purpose of education.

Alternate Economies
Finding the right niche

New kinds of economies – including the sharing, artisanal, matching, and maker economies – are changing how we create value, sometimes out of choice and sometimes out of necessity. With under-employment already pronounced and with many Millennials constrained by student debt, more people are finding their participation in the consumer economy limited. At the same time, both the desire for authenticity and meaningful engagement and growing concern about the sources and ethics of food, goods, and services are driving the pursuit of experiences and interactions that align with personal value sets. As the pace of change accelerates, new forms of exchange and value creation will proliferate. Individuals will move in and across multiple intersecting economies, finding purpose, meaning, and remuneration where they can and seeking educational approaches that fit their needs and outlook.

Smart Transactional Models
Creating self-managing institutions

As part of a growing open culture movement, the authority to distribute assets, access permissions, and gain rights to resources is shifting from hierarchical institutions to communities. At the same time, innovations in encryption technologies are ushering in more transparent and distributed models for structuring transactions. Together, these developments promise to reconfigure institutions by enabling both the development of flexible value webs comprised of many organizations and individuals and the creation of distributed autonomous organizations that operate with minimal, if any, management. Smart contracts that automatically execute the terms of agreements once specific conditions are met promise to bypass layers of administration and expand possibilities for true local control of schools, school districts, and other institutions.

Shifting Landscapes
Innovating in volatile conditions

A key priority in the coming decade will be creating strategies and structures for navigating turbulence. New relationships with work, including a possible redefinition of the role that wage labor plays in people's lives and what constitutes a job, will emerge, but the interim period of transition will require creative solutions as individuals and communities struggle to adapt. Growing income polarization and the threat of rapid technological unemployment may spur social experiments such as universal basic income and novel subsistence strategies such as service bartering and collaborative social good projects. Environmental volatility, including resource depletion, extreme weather, severe drought, and sea level rise, will also catalyze bold actions. Learning and re-learning will help individuals adapt and could contribute directly to the search for effective solutions.

The Future of Learning: **Education in the Era of Partners in Code**

As **drivers of change** meet **impact layers**, imagine how exponential changes might ripple and unfold. What role would you like to play in shaping the future of learning?

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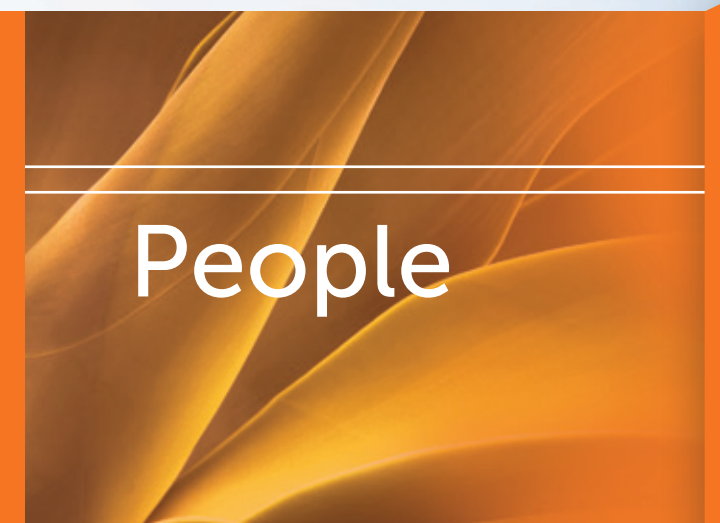
People

People + Optimized Selves
Designing for Flow
What if...

...Educators used **visual feedback tools** that showed the engagement levels of every student in order to help them excel at challenges while avoiding boredom and frustration?

...All educator preparation programs included **training in game design, neuroscience, and emotion science** so as to provide a broad design palette for creating compelling learning environments?

People + Labor Relations 2.0
Educator Swarms
What if...

...Every child had a **"learning pit crew"** of caring adults, peers, and personal machine/digital partners that responded to immediate needs while optimizing for long-term success?

...**Learning partner placement agencies** helped families of all socio-economic backgrounds find and develop supportive learning relationships?

People + Alternate Economies
Post-Bubble Sheet Metrics
What if...

...Individuals and student teams earned **personal impact scores** for working to address real-world problems?

...**Contribution portfolios** demonstrating evidence of learners' development and passions were used as the primary assessment of learning?

People + Smart Transactional Models
Custom Learning Contracts
What if...

...Each learner had a **Smart Learning Fast Pass** that unlocked learning opportunities as the student was ready for them and transferred money from learner-controlled funding allotments to providers?

...**A universal student record** made it possible for comprehensive student data to follow each learner throughout the education lifecycle?

People + Shifting Landscapes
Extreme Educators
What if...

...Neighborhoods **locally sourced their own educators** by identifying promising local candidates and funding their professional development and placement in local schools?

...Community members and organizations received targeted, intensive trainings in focused skill, subject, and critical issue areas to form a highly trusted and effective **distributed teaching corps**?

Structures

Structures + Optimized Selves
Learning Biomes
What if...

...**Learning pathway designers** helped learners cultivate their ideal learning conditions?

...**Smart learning environments** used data from wearable devices to tailor learners' surroundings and resources to their needs?

Structures + Labor Relations 2.0
Fluid Schools
What if...

...**Smart support rankings** evaluated learning providers using holistic criteria such as wellness promotion, social-emotional support, safety, and culture?

...School governance evolved such that **learning ecosystem trustees** from many kinds of organizations collaborated to steward an area's learning resources?

Structures + Alternate Economies
Artisanal Education
What if...

...Learning resources were **tagged by origin, values, and impact** the way grocery stores tag locally grown food today?

...**Educator guilds** cultivated craft learning experiences for small groups of learners?

Structures + Smart Transactional Models
Autonomous Administration
What if...

...**Algorithmic management** replaced significant numbers of central office positions?

...Smart contracts connected learners with **distributed transportation systems, food service, and other supports** that enabled them to pursue learning experiences beyond the walls of traditional schools?

Structures + Shifting Landscapes
Resilient Learning Ecosystems
What if...

...The health of an education organization or system were measured by the **strength of its relationships with varied partners**?

...**Public funding for community-wide learning venues** such as museums, libraries, and parks were viewed as being an integral part of the investment in public education?

Society

Society + Optimized Selves
Label-Free Learning
What if...

...Schools and families tailored learning to every aspect of a learner's **self-defined identity**?

...Funding were customized to pay for each student's **personalized learning pathway**?

Society + Labor Relations 2.0
Readiness Redefined
What if...

...Schools taught **robot relations** as a new form of digital literacy?

...Public funding for a **lifetime of education** enabled people of all ages to move in and out of learning as their needs dictated?

Society + Alternate Economies
New Benefactors
What if...

...You could **invest your 401k** in your local learning ecosystem?

...**Corporate and venture investments** replaced property taxes as a significant source of school funding?

Society + Smart Transactional Models
Self-Improving Learning Ecosystems
What if...

...School systems improved via **automatic updates**, the way mobile devices and apps do?

...School boards shared authority via **distributed participation** in resource allocation and ecosystem stewardship?

Society + Shifting Landscapes
Educating for Impact
What if...

...Schools taught learners how to embrace complexity and approach **wicked problems** that can be managed but not necessarily resolved?

...**School social impact scores** became critical metrics for attracting funding, partnerships, and community engagement?

Optimized Selves

Labor Relations 2.0

Alternate Economies

Smart Transactional Models

Shifting Landscapes

Provocations: People

Explore what might happen when **educators and learners** re-imagine their roles and interactions.

Designing for Flow
| New tools and practices informed by neuro- and emotion science will help educators design learning experiences and develop rich feedback to help learners engage in high-performance flow experiences that optimize learning. For example, advances in wearables, self-tracking technologies, and brain-computer interfaces will provide deep insight into learning. In addition, expanded notions of self will contribute to creating new opportunities to engage learners at their most personal and deepest levels. Increased focus on improving performance through development of the whole self will facilitate sustained intrinsic motivation and deep immersion in learning.

People + Optimized Selves

What if...

? ...Educators used **visual feedback tools** that showed the engagement levels of every student in order to help them excel at challenges while avoiding boredom and frustration?

? ...All educator preparation programs included **training in game design, neuroscience, and emotion science** so as to provide a broad design palette for creating compelling learning environments?

Signals of Change:

▸ **Thync**: This wearable device uses neurosignaling to shift an individual's mood to calmer or more energetic states depending on preference and goals. thync.com

▸ **Institute for Applied Neuroscience**: Researchers are translating the latest science about how the mind works into insight about how to increase motivation to learn, avoid information overload, and manage student-teacher communication. appliedneuro.org/about.html

▸ *More Than Human*: In this book, Ramez Naam discusses brain interface technologies that allow people to modify their cognition and develop neural connections to other humans that point toward the emergence of a collective consciousness. rameznaam.com/more-than-human

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Provocations: People

Explore what might happen when **educators and learners** re-imagine their roles and interactions.

Educator Swarms | Personalized learning will move beyond tailoring pacing

and curricular resources, toward dynamic curation of customized learning relationships with an expanding range of learning partners that encourage learner reflections and other metacognitive practices. Flexible configurations of human educators and mentors, along with digital learning coaches and companions, will be coordinated seamlessly to support learners' short- and long-term needs and help all students reach their goals. Lifetime personal learning bots will leverage artificial intelligence and machine learning to grow with their human partners, providing smart support and feedback.

**People +
Labor
Relations 2.0**

What if...

? ...Every child had a **"learning pit crew"** of caring adults, peers, and personal machine/digital partners that responded to immediate needs while optimizing for long-term success?

? ...**Learning partner placement agencies** helped families of all socio-economic backgrounds find and develop supportive learning relationships?

**Signals of
Change:**

▶ **"Mentors in the Connected Age: As Invaluable as Ever"**: MacArthur's 2015 Digital Media and Learning conference highlighted a theme of the transformative power of meaningful mentors for learners of color and disenfranchised youth. medium.com/@mimikocruz/mentors-in-the-connected-age-as-invaluable-as-ever-f37c9be07e2a

▶ **Brightspace**: As an integrated learning management system, BrightSpace creates personalized and adaptive learning pathways that grow with learners' progress and point to possible resources and learning experiences. In the future, these pathways could include diverse learning ecosystem resources from the community-based and informal learning sectors. brightspace.com

▶ **Personal Robot Group, MIT**: Social robots, such as DragonBot, are designed to be learning companions and catalysts. spectrum.ieee.org/automaton/robotics/artificial-intelligence/mit-dragonbot-evolving-to-better-teach-kids

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Provocations: People

Explore what might happen when **educators and learners** re-imagine their roles and interactions.

Post-Bubble Sheet Metrics

| As educators work to prepare learners for new economic realities, they will create assessments that measure applied mastery, real-world impact, and social-emotional development. Educators and learners will focus their interactions on realizing personal potential and demonstrating meaningful competencies. Purpose-driven learning will link classroom experiences to real-world challenges and authentic stakeholder organizations and will elevate the role and status of students and educators in communities. Individuals will learn to evaluate their potential for unique contribution, which will be a key skill for navigating the complex mix of economic opportunities that they will encounter.

People + Alternate Economies

What if...

? ...Individuals and student teams earned **personal impact scores** for working to address real-world problems?

? ...**Contribution portfolios** demonstrating evidence of learners' development and passions were used as the primary assessment of learning?

Signals of Change:

Ashoka Changemaker Schools: This international network of schools organizes curriculum in ways that foster empathy, teamwork, leadership, and problem-solving so as to develop ChangeMakers who find their voices and make a positive impact on the world. startempathy.org/schools

GlassLab: This game design company embeds "not-so-standardized assessment" within its games, helping teachers observe learning in action and also track and report on an expanded range of skills using learning analytics and visual dashboards. about.glasslabgames.org/research

Gallup Student Poll: This national survey is one of several emerging tools to measure student hope, well-being, engagement, and emotional health, all reported to be determinants of academic success. gallupstudentpoll.com

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Provocations: People

Explore what might happen when **educators and learners** re-imagine their roles and interactions.

Custom Learning Contracts | New encryption technologies

will enable smart contracts that allow learners and parents to set up agreements around a whole host of functions, from secure payments to learning experience access to autonomous transportation. As learners and their families use smart contracts to access experiences and resources across more distributed and diverse learning ecosystems, their learning journeys will become more personalized and more supportive of their distinct interests, needs, and aspirations.

**People +
Smart
Transactional
Models**

What if...

? ...Each learner had a **Smart Learning Fast Pass** that unlocked learning opportunities as the student was ready for them and transferred money from learner-controlled funding allotments to providers?

? ...**A universal student record** made it possible for comprehensive student data to follow each learner throughout the education lifecycle?

Signals of Change:

Learning Record Store: This system for storing and reporting learning data and experiences across platforms can be used in conjunction with the experience application interface (xAPI) to capture both formal and informal instances of learning. tincanapi.com/learning-record-store

Paris Pass: This integrated fast pass enabling visitors to experience Paris seamlessly includes priority entry to popular museums and tourist destinations as well as unlimited access to bus and metro transportation in key city zones. partner.viator.com/en/2548/tours/Paris/Paris-Pass/d479-2036PARIS

Lucy: Part of the electronic medical records system, Epic, Lucy is a personal health record that allows participants to take their health history and records to any institution for improved continuity of care. epic.com/software-phr.php

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Provocations: People

Explore what might happen when **educators and learners** re-imagine their roles and interactions.

Extreme Educators

Extreme Educators | Social, economic, and environmental turbulence will test the limits of traditional teaching approaches and will strain school models that prove inflexible or unable to meet the needs of learners in the most extreme socio-economic conditions. Drawing upon the principles and practices associated with designing for extreme affordability and making use of improvisation and continuous improvement techniques, a practice of extreme teaching will emerge. Educators employing it will pioneer bootstrapped yet effective teaching and learning strategies and organizational delivery models.

People + Shifting Landscapes

What if...

? ...Neighborhoods **locally sourced their own educators** by identifying promising local candidates and funding their professional development and placement in local schools?

? ...Community members and organizations received targeted, intensive trainings in focused skill, subject, and critical issue areas to form a highly trusted and effective **distributed teaching corps**?

Signals of Change:

Roses in Concrete Community School: This K-8 school in East Oakland, California, aims to function as a center of health amid the neighborhoods around it and to create a model for community-responsive teaching and teacher training that prioritizes the needs of students and families. rosesinconcrete.org

The Granny Cloud: Grannies are volunteers of all ages and backgrounds who use Skype to enable self-organized learning in Sugata Mitra's seven Self-Organized Learning Environment Labs in Latin America and India. Grannies pose challenges, support children's inquiry, and provide encouragement and social-emotional support to learners in poverty-stricken communities. theschoolinthecloud.org/library/resources/being-a-skype-granny

Providence After School Alliance (PASA): In coordinating a collaborative system of year-round extended learning opportunities for middle and high school students, PASA partners with over 70 community-based organizations that provide programs and involves teachers from Providence Public School District in collaborative professional development and instruction with community-based educators. mypasa.org

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Provocations: Structures

Envision how **teaching and learning systems** might morph to achieve resilience.

Learning Biomes | Education innovation will focus on fostering responsive learning climates through the cultivation of effective group learning cultures and the customization of learning environments for individuals. Attention to factors such as emotional intelligence, social awareness, and the gender spectrum will contribute even as ubiquitous sensors and sophisticated feedback loops make it possible to optimize physical and digital environments for learning in response to individual needs. By creating tailored personal and shared learning overlays, augmented and virtual reality tools will increasingly meld those environments and enable learners to make use of new forms of immersive experience.

Structures + Optimized Selves

What if...

? ...**Learning pathway designers** helped learners cultivate their ideal learning conditions?

? ...**Smart learning environments** used data from wearable devices to tailor learners' surroundings and resources to their needs?

Signals of Change:

▷ **RULER**: This program from the Yale Center for Emotional Intelligence promotes positive, pro-social learning climates by helping everyone in a learning community practice emotional intelligence and by helping teachers manage their emotions in support of curricular objectives. ei.yale.edu/ruler

▷ **Gender Spectrum**: This nonprofit organization seeks to create gender sensitive and inclusive environments for all children and teens. genderspectrum.org

▷ **Sensory Stories**: This museum exhibit uses virtual reality and other technologies to immerse visitors in interactive, multi-sensory narrative experiences. wired.com/2015/04/three-wild-sensations-frontier-storytelling

KnowledgeWorks®

Provocations: Structures

Envision how **teaching and learning systems** might morph to achieve resilience.

Fluid Schools

| School formats will continue to shift from fixed structures largely organized around administrative convenience to fluid network- and relationship-based formats reflecting learners' needs, interests, and goals. New uses of algorithms and artificial intelligence will provide a host of tools for tailoring school structures and for matching learners with the educators and learning experiences that best support their learning. In addition, people's increasingly ad hoc relationships with organizations will intensify demand for flexible schools and customized learning environments that push beyond traditional organizational constraints and limited customization.

Structures + Labor Relations 2.0

What if...

? ...**Smart support rankings** evaluated learning providers using holistic criteria such as wellness promotion, social-emotional support, safety, and culture?

? ...School governance evolved such that **learning ecosystem trustees** from many kinds of organizations collaborated to steward an area's learning resources?

Signals of Change:

▷ **Fusion Academy**: This private school for grades 6-12 tailors one-to-one education for each individual student, varying the pace of instruction and the style of teaching and enabling students to customize their class schedules and begin a new semester at any time of year. fusionacademy.com

▷ **Acton Academy**: This growing network of self-paced, multi-age learner micro schools supports elementary through high school students in finding and fostering their passions and mastering core academic and 21st century skills through computer simulations, Socratic discussions, project quests, and apprenticeships. actonacademy.org

▷ **Modern Guild**: This online apprenticeship platform matches high school and college students with career experts in support of self-discovery and career exploration. modernguild.com

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Provocations: Structures

Envision how **teaching and learning systems** might morph to achieve resilience.

Artisanal Education | Learners and their families will be increasingly conscious consumers and architects of learning, seeking out educational approaches that fit their values and lifestyles. An abundance of options will proliferate, increasing pressure on public systems and challenging established approaches to quality assurance and funding. In addition, concern about sourcing and ethics will lead to increasing scrutiny of the origins of curriculum, the values of educators, and the interests of those who determine educational approaches and policies. Finding one's niche in the education landscape will become both more complex and potentially more rewarding.

Structures + Alternate Economies

What if...

? ...Learning resources were **tagged by origin, values, and impact** the way grocery stores tag locally grown food today?

? ...**Educator guilds** cultivated craft learning experiences for small groups of learners?

Signals of Change:

▷ **AltSchool**: This student-driven and technology-enabled K-8 school format helps students craft flexible learning journeys that reflect their interests and make use of diverse community assets. It is attempting to create a new market for students who fit its approach. altschool.com

▷ **Millennium School**: This approach to independent middle schools seeks to optimize learning for the integral development of early adolescents who want to make a positive impact on the world. It is partnering with nationally recognized educators, psychologists, and business leaders to co-create a network of local communities using the approach. millenniumschool.org

▷ **The Spread of Homeschooling**: From school year 1999-2000 to 2012-2013, the percentage of school-age children who were homeschooled doubled, from 1.7 to 3.4 percent. Among them, 10 percent were black students, who represent one of the fastest growing demographics in homeschooling due to concerns about institutional racism and stereotyping. wired.com/2015/02/silicon-valley-home-schooling, theatlantic.com/education/archive/2015/02/the-rise-of-homeschooling-among-black-families/385543

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Provocations: Structures

Envision how **teaching and learning systems** might morph to achieve resilience.

Autonomous Administration | Education administration will shift from managing discrete organizations to facilitating seamless collaboration across diverse learning ecosystems. Distributed organizational models will supplant traditional hierarchies even as many management functions become automated. Algorithms will match services with learners' needs and help maximize the use of resources, and insights from artificial intelligence will replace or augment human decision making. In addition, smart contracts will help K-12 schools and districts and higher education institutions execute agreements around the allocation and management of resources, monitor security, conduct ongoing evaluation, and track compliance.

Structures + Smart Transactional Models

What if...

? ...**Algorithmic management** replaced significant numbers of central office positions?

? ...Smart contracts connected learners with **distributed transportation systems, food service, and other supports** that enabled them to pursue learning experiences beyond the walls of traditional schools?

Signals of Change:

Holacracy: This alternative organizational structure being used by companies such as Zappos and Medium replaces traditional hierarchies with self-governing teams that distribute authority across the organization. fastcompany.com/3044352/the-secrets-of-holacracy

AI-Assisted Hiring: Some start-ups and established headhunting firms are experimenting with incorporating artificial intelligence into hiring by using data to match candidates with job requirements, potentially reducing human bias and increasing diversity. nytimes.com/2015/06/26/upshot/can-an-algorithm-hire-better-than-a-human

Self-Executing Wills: In one of the early uses of smart contracts, Blockchain Apparatus is developing a product enabling anyone to create a digital will whose administration will be executed by code upon verification against data held in the Social Security Administration's Death Master File. coinspeaker.com/2015/04/14/blockchain-apparatus-brand-new-voting-system-8724

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Provocations: Structures

Envision how **teaching and learning systems** might morph to achieve resilience.

Resilient Learning Ecosystems
| As communities and individuals struggle to adapt to shifting conditions, learning ecosystems comprised of many kinds of organizations and resources will help the education sector adapt to changing needs. Standalone structures will be increasingly susceptible to system shocks, and funding for public infrastructure such as public schools could decline in many places as tax bases get disrupted. In the context of such challenges, cultivating flexible value webs and enabling learners to move smoothly among them will be key strategies for resilience.

**Structures +
Shifting
Landscapes**

What if...

? ...The health of an education organization or system were measured by the **strength of its relationships with varied partners**?

? ...**Public funding for community-wide learning venues** such as museums, libraries, and parks were viewed as being an integral part of the investment in public education?

Signals of Change:

▷ **LRNG**: This national U.S. effort to surface and connect cities' many resources helps youth of all backgrounds develop curiosity, resilience, and 21st century skills. lrng.org

▷ **The Tiny Schools Project**: This initiative of 4.0 Schools supports entrepreneurs in testing new types of schools at small scale before attempting to extend their reach, with ten to fifteen students and their families giving high-frequency feedback on pilots that challenge fundamental assumptions about how school works today. medium.com/future-of-school/4-ways-to-do-tiny-schools-3c3be62a3688

▷ **Next-Gen Learning Hubs**: Six U.S. regions are building off cities' assets and bringing together partners to create innovative student-centered learning ecosystems. nextgenlearning.org/regional-funds-breakthrough-schools-0

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Provocations: Society

Imagine how **alternative value sets and diverse perspectives** could transform education.

Label-Free Learning
| A "no-labels learning" movement will rise amid growing recognition that the sub-categories once set up to help increase equity in education might actually act as barriers to making truly personalized learning available for all learners. As this movement pushes to put individual learners' needs front and center, an abundance of granular data will provide new insights into patterns of behavior, making grade levels, sub-categories, ZIP codes, and some other types of predetermined identifiers recede in importance. Flexible student groupings will reflect real-time needs, and new forms of learner protections and quality assurance will emerge.

Society + Optimized Selves

What if...

? ...Schools and families tailored learning to every aspect of a learner's **self-defined identity**?

? ...Funding were customized to pay for each student's **personalized learning pathway**?

Signals of Change:

Competency Education: This approach moves away from seat time and toward flexible structures and individual pacing that support students in displaying mastery of academic content regardless of grade level, socio-economic background, or perceived abilities. ed.gov/oii-news/competency-based-learning-or-personalized-learning

Adaptive Learning: This educational method uses software to recommend and modify curricular materials in response to learners' performance and unique needs. thejournal.com/articles/2014/05/14/adaptive-learning-are-we-there-yet.aspx

Fluid Identity: Indicating a shift toward more fluid concepts of identity and away from predetermined labels, Facebook has added 51 new gender identity options, while Google Plus has added a "custom" option. thedailybeast.com/articles/2014/02/15/the-complete-glossary-of-facebook-s-51-gender-options.html, androidcentral.com/google-plus-adds-new-options-gender-identity

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Readiness Redefined

| The changing nature of work will bring to the fore a societal debate about the role of people in the workplace and what it means to be career-ready. Reflecting this debate, the K-12 sector will no longer push students toward post-secondary options that might not adequately prepare them for the new world of work. Instead, education at all levels will prepare learners continually to reskill and upskill and to know how to partner constructively with machines.

Society + Labor Relations 2.0

What if…

? …Schools taught **robot relations** as a new form of digital literacy?

? …Public funding for a **lifetime of education** enabled people of all ages to move in and out of learning as their needs dictated?

Signals of Change:

➤ **Entrepreneurial Millennials**: The U.S. Chamber of Commerce Foundation reports that one-half to two-thirds of Millennials are interested in entrepreneurship and that 27 percent are already self-employed, signaling a move towards autonomous learning, re-learning, and reskilling in order to be a successful entrepreneur. uschamberfoundation.org/millennial-generation-research-review

➤ **Computerized Jobs**: An Oxford University report estimates that 47 percent of U.S. jobs could be lost over the next two decades as computers increasingly take over cognitive tasks in areas that once seemed immune to automation, such as management, science, engineering, and the arts. futuretech.ox.ac.uk/sites/futuretech.ox.ac.uk/files/The_Future_of_Employment_OMS_Working_Paper_1.pdf

➤ **Higher Education Alternatives**: New entrants into higher education are offering low-cost, on-demand learning that typically takes months rather than years to complete; for example, Refractor offers multi-week boot-camp style classes in web development, and General Assembly offers classes that students can complete in three months on topics such as web development and app building. refactoru.com, generalassemb.ly

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New Benefactors

New Benefactors | Tired of searching for educational options that they feel no longer work for their children, more and more highly empowered individuals will create their own schools, school models, and learning communities. At the same time, systemically motivated education pioneers will appeal to funding sources not typically seen in public education. As diverse actors take the lead in creating new educational approaches, both innovation and risk tolerance will increase. A renewed belief in collective responsibility for education could emerge, but there could also be scope for personal agendas to determine educational approaches.

Society + Alternate Economies

What if...

? ...You could **invest your 401k** in your local learning ecosystem?

? ...**Corporate and venture investments** replaced property taxes as a significant source of school funding?

Signals of Change:

Ad Astra: Feeling that his children's needs were not being met at their regular school, SpaceX and Tesla founder Elon Musk set up his own school called Ad Astra, which teaches Musk's children and 14 other elementary school students, mostly from SpaceX employees' families. businessinsider.com/elon-musk-creates-a-grade-school-2015-5

New Civic Funding: Salt Lake County and Chicago have launched deals to extend access to high-quality early childhood education through social impact bonds that repay lenders only if students participating in the funded programs show positive academic results. Similarly, the community investment group Neighborly sold its first Civic Microbonds to support California's San Leandro Unified School District, offering a two percent return for a minimum of a $500 year-long investment. governing.com/blogs/bfc/gov-social-impact-bonds-early-childhood-education-utah.html, payforsuccess.org/resources/city-chicago-announces-5th-us-pay-success-program, blog.neighborly.com/news/neighborly-introduces-civic-microbonds/

A Platform for Meaningful Learning: With educators in the lead, Summit Public Schools and Facebook have been partnering to build a Personal Learning Platform that they plan eventually to offer for free to any school in the U.S. that wants it. edsurge.com/news/2015-09-03-facebook-goes-back-to-school

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Self-Improving Learning Ecosystems

Self-Improving Learning Ecosystems | As new transactional models enable new structures and institutions, new data flows, and new forms of management and administration, learning ecosystems will use broad feedback to improve themselves automatically and continuously. At the same time, they will increasingly distribute participation beyond a few people in positions of authority. Decision-making will expand such that everyone in a learning ecosystem – and therefore everyone in the community – sees themselves as an empowered decision maker.

Society + Smart Transactional Models

What if...

? ...School systems improved via **automatic updates**, the way mobile devices and apps do?

? ...School boards shared authority via **distributed participation** in resource allocation and ecosystem stewardship?

Signals of Change:

Algorithm as Board Member: Deep Knowledge Ventures has appointed an algorithm named VITAL as a board member. VITAL will help make decisions by poring over large amounts of data involving prospective companies' financial history, clinical trial data, and intellectual property, casting its vote based on which companies look like successful investments. businessinsider.com/vital-named-to-board-2014-5

Machine Managers: Ride coordination service Uber relies on machines to do many of the tasks often associated with middle management. Its drivers are dispatched by an application programming interface (API) that tells them which routes to take and initiates payment. If a driver's ratings slip or a driver breaks the rules, the API will also fire the driver to ensure that Uber is constantly improving. ridesharingdriver.com/fired-uber-drivers-get-deactivated-and-reactivated

Ethereum: This development platform based on blockchain technology supports the creation of decentralized applications, including distributed autonomous organizations whose governance is widely distributed across a large group of stakeholders or is handled automatically by artificial intelligence. ethereum.org

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Educating for Impact

| As landscapes become increasingly volatile, the need to help young people think innovatively and navigate complexity will become increasingly pronounced. This need will create a societal expectation that education should support learners in pursuing learning journeys that embrace complexity, lead to deep knowledge, and set them up to initiate and anticipate change. Students will come to be seen as innovators and problem solvers who actively shape the world around them as part of their education.

Society + Shifting Landscapes

What if...

? ...Schools taught learners how to embrace complexity and approach **wicked problems** that can be managed but not necessarily resolved?

? ...**School social impact scores** became critical metrics for attracting funding, partnerships, and community engagement?

Signals of Change:

▶ **The Thiel Fellowship**: This program seeks to help young people bring some of their most ambitious projects to life by giving them a $100,000 grant and providing mentorship so as to allow them to focus on their research, work, and self-education instead of attending a college or university. thielfellowship.org

▶ **Singularity University**: This benefit corporation aims to help individuals, institutions, and businesses understand exponential technologies and explore how they might apply them to solve humanity's grand challenges and positively impact the lives of billions of people. singularityu.org

▶ **Middlebury College's Center for Social Entrepreneurship**: This center encourages students to apply their learning beyond the classroom by providing opportunities for them to identify and address real-world problems through ventures created with the help of staff, mentors, and community partners. mcse.middlebury.edu

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Shaping the Future of Learning

The coming era of partners in code holds **many possibilities for learners and learning**.

Some of those possibilities present opportunities or threats – or both at once – for different stakeholders. Others raise dilemmas that we will need to manage but which we might not be able to resolve. Some of the issues on the horizon appear below.

Purpose

The purpose of education will be challenged by new value propositions and socio-economic realities.

While education contributes to many facets of people's lives, the linear trajectory from cradle to career could be disrupted by the changing nature of work and by fluid learning pathways. How will education support people in pursuing new forms of career readiness while also fostering human development and pursuit of personal meaning? What core competencies will help people succeed amid new machine partnerships and shifting landscapes? Pursuing traditional ideals about education could cause established institutions to persist without truly meeting the needs of learners and society. As we redefine education for the emerging era, deeply held societal narratives about education may need to change, and the purpose of education could vary for different learners or for different learning ecosystems. Will education find a new balance between reinforcing civic life and encouraging individual success?

Equity

Equity is not a given and will be a major design challenge for future learning ecosystems.

The coming decade could bring increasing challenges in making learning ecosystems equitable for all learners, and new divides could emerge as technology-driven automation of work changes the relationship between humans and machines in the workplace and redefines careers. Equity issues could also arise if the uneven adoption or biased development of new technologies limits access to innovations for some populations. Will learning ecosystems struggle to support all learners well, or will the developments on the horizon make it easier to find effective solutions? Will a separate ecosystem of customized education emerge only for privileged individuals or relatively wealthy school districts, or will new entrants and approaches raise the bar for making personalized learning and high-quality options available to all learners? Increasing automation could reduce bias and ensure equitable allocation of resources if those whom we entrust to write the foundational algorithms and smart contracts are both technically skilled and culturally sensitive. Ensuring that learners have appropriate ownership of their own data could be critical to preventing traditional inequities from being reinforced in new ways.

Learner Responsibility

Learners and their families will have more options but also more responsibility for their learning journeys.

As the learning ecosystem continues to expand and to disintermediate from traditional institutions, learners and their families will have greater choice about how, when, and where to pursue learning. With that choice will come greater responsibility for evaluating and selecting options. Learners and their families will need to navigate potentially more rewarding but increasingly complex learning landscapes. In so doing, they may need to advocate for access to the learning experiences, resources, and supports that best reflect their needs, interests, and goals. Given that the capacity to navigate abundant options will vary for a wide range of reasons – including time, available resources, and level of understanding – learning ecosystems and providers will need to consider ways of providing effective guidance and support to prevent splintering that could all too likely correspond with current socioeconomic divides. Educators and educational institutions will also need to explore how and when to share more distributed authority over learning with their clients.

Governance Structures

Reframing governance structures will help balance systemic and grassroots innovations.

Given the tendency for technological and social developments to unfold faster than societal institutions can respond, educational policy frameworks and governance structures will likely struggle to keep up with the accelerating pace of change and could end up responding to crises rather than facilitating new directions and creative innovations. Data privacy, security, and permissions will need special attention as new layers of information surround learning. Will policymakers and governing boards cling to traditional approaches, or will they incent innovation while finding appropriate ways to manage risk and ensure quality? Attempts to stave off change or preserve current systems could backfire by making education less able to help learners prepare for new ways of living and working.

Catalytic Roles

New catalytic roles will be needed to combat institutional inertia.

Today's educational institutions could struggle to adapt to the changing landscape, with many finding their value propositions out of sync with new realities or their resources misaligned with needs. New entrants, organizational models, technology platforms, funding methods, and educational missions could offer more relevant approaches or adapt more nimbly to accelerating change but could bring less expertise in some areas. How many of today's schools, colleges, and universities will close, and how will those that survive support learning, development, and the communities in which they operate? Will some stakeholders cling to current systems even if their effectiveness declines or attempt to block change to preserve established community institutions? Both current institutions and new entrants will need to decide how best to contribute to educational value webs as organizational structures loosen, new forms of coordination emerge, and societal expectations change.

Educator Roles

Opportunities abound for those who pioneer new educator roles and bridge gaps in value webs.

Educator roles are likely to diversify as learning ecosystems continue to expand, with new kinds of specialties emerging to create and guide learning experiences, ensure their effectiveness, and monitor effectiveness at the ecosystem level. Not all of those roles will be full-time jobs. Some of them might even be carried out by machine partners rather than by people. Will educator preparation, licensure, and professional development help educators contribute effectively to learning and earn fair pay, or will new education professionals have to navigate with limited support? Will unions provide leadership in defining and supporting new educator roles, or will they defend current employment structures to the potential detriment of teachers and learners? Some educator roles might need to focus on learning ecosystem stewardship so as to protect the interests of learners who might be at risk of getting disenfranchised from rewarding options.

Technology Use

The ways in which learners use technology could impact achievement and assessment.

While education and society have always made use of available technologies, the coming era will intensify the implications associated with the ways in which we choose to lean on technology to complete tasks for us versus using it to enhance our contributions. Given the amount of information and data that people will be managing at work and in life, we will become increasingly reliant on technology as a cognitive partner that helps us live and work effectively. How will we calibrate the delicate balance between using cognitive tools to manage the onslaught of information in our lives without letting technological mediation distract from human learning and our sense of individual accomplishment? Where should we let machines do tasks for which people are ill suited, and where should we focus our learning and other contributions? The ways in which we answer such questions will impact how we define and assess achievement.

These are just some of the issues on the horizon for education. You will undoubtedly see others at many levels of scale. **We need to grapple with such questions in order to anticipate and direct positive change.**

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Technologies to Watch

Below is a list of **key technologies** and **related innovations** that are contributing to the emerging era of partners in code. While not exhaustive, it provides a reference for understanding concepts highlighted throughout this forecast.

3D Printing, also known as desktop manufacturing, is a type of manufacturing in which the user "prints" 3D objects from digital files. Considered an additive type of manufacturing, 3D printing lays down successive layers of material to build up an object rather than using a subtractive process, such as the drilling and cutting found in traditional manufacturing techniques.

Algorithms are instructions that are written into software and produce outcomes when activated. For example, they might sort lists of data, find resources with particular attributes, or match users with services.

Artificial Intelligence (AI) is the capacity of computer systems or software to imitate or simulate intelligent human behavior. AI is increasingly coming to function as a utility embedded in many kinds of services rather than as a general purpose application with which users interact directly. For example, AI may be used in automated online customer service, software-generated news articles, and driverless cars.

Augmented Reality is an enhanced view of reality created by integrating in real time computer-generated sensory input, such as sounds, images, graphics, and video, on top of a user's physical surroundings.

Big Data is a broad term used to describe the extremely large and complex data sets that are being generated as we increasingly depend on and interact with our devices and the code inside them.

Biomanufacturing is the use of living, genetically modified organisms and cells to manufacture a product.

Blockchain is digital ledger technology that functions like a big spreadsheet whose pieces are stored across thousands of computers, making it more difficult to hack than centralized systems.

Bots are software applications that run automated tasks over the Internet with minimal human input and at a higher rate than a person could.

Co-presence Technologies use immersive audio and video experiences to create a feeling of being together across distance. Examples include an in-room hologram of a co-worker who is in another location or a robot with audio and video displays and sensors that can move around one place while being controlled by a person in another location.

Distributed Autonomous Organizations use blockchain technology and smart contracts to operate on their own according to a set of pre-determined conditions, without the need for ongoing human guidance.

The Internet of Things is a growing network of objects embedded with sensors, software, and connectivity so that they can transfer data over a network, often to other objects, without human or computer intervention. For example, cars made by Tesla Motors will automatically download software updates and will in some cases autonomously schedule a valet to pick up the car and take it to a Tesla Motors facility for repairs.

Machine Learning is a subset of artificial intelligence that focuses on the development of programs that teach themselves and learn from experience.

Nanotechnology is science, engineering, and technology that works at the level of atoms and molecules so as to take advantage of material properties that naturally occur at that scale. Nanotechnology helps make computing devices small, embedded, and wearable.

Predictive Analytics determine patterns, model behaviors, and predict outcomes by extracting and analyzing information from large data sets.

Smart Contracts are self-executing contracts stored on the blockchain that facilitate, verify, and automatically execute the terms of a contract once its pre-programmed conditions have been fulfilled. For example, they could be used for escrow transfers or employment contracts.

Virtual Reality is an immersive 3D environment or world produced by software and accessed by wearing accessories, such as a headset or special glasses, so as to create a sensory experience for the user and enable user interaction.

Wearable Technologies, also known as "wearables," are devices that can be worn by people and which typically include motion sensors and the ability to connect to the Internet. They are often used to track data related to health and fitness and are helping to fuel the quantified self movement, in which people seek to gain insights about themselves by tracking their own behaviors.

The key challenge of the era of partners in code will be to **define how people foster productive relationships with technology** that leverage, elevate, and celebrate the unique contributions of our humanity so that **we can thrive amid intensifying complexity**.

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This forecast was written by Katherine Prince and Jason Swanson of KnowledgeWorks and Andrea Saveri of Saveri Consulting, with contributions from Katie King of KnowledgeWorks and reviews by additional colleagues.

KnowledgeWorks is an Ohio-based non-profit social enterprise that works to foster meaningful personalized learning that enables every student to thrive in college, career, and civic life. KnowledgeWorks works on the ground with schools and communities through a portfolio of innovative education approaches, helps state and federal leaders establish the policy conditions necessary to prepare all students for success, and provides national thought leadership around the future of learning. To learn more about our strategic foresight work and access links for the signals of change in this forecast, see knowledgeworks.org/future-learning.

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