Framework Overview

Education

Intel® Skills for Innovation Framework

A framework to transform education to empower students to become the next generation of innovators

"Today, because knowledge is available on every Internet-connected device, what you know matters far less than what you can do with what you know. The capacity to innovate — the ability to solve problems creatively or bring new possibilities to life — and skills like critical thinking, communication and collaboration are far more important than academic knowledge."[1]

– Tony Wagner
Harvard Graduate School of Education, Senior Research Fellow at the Learning Policy Institute

Education Systems Have Reached an Inflection Point

The competencies required for success in the global workforce are being redefined, thanks to the Fourth Industrial Revolution. Workplaces today demand that workers come prepared with new ways of thinking and solving problems. Education leaders are seeking to foster future-ready technology skills in ways that feel as natural to students as learning math and language skills.

Additionally, the COVID-19 pandemic has dramatically accelerated technology use around the world as educational institutions have pivoted to sustain learning during stay-at-home orders. A variety of classroom-, remote-, hybrid-, and blended-learning environments are being deployed, each with unique challenges for educators and learners alike. The experience has brought into sharp focus the need for built-in, long-term, resilient systems, as chronicled by a recent UNESCO International Bureau of Education report.[2] These moves toward greater access, flexibility, robustness, and equity are a good start, yet most of them happened without much foresight and need a more robust integration of technology into a future-ready education system.

As workplace requirements shift, employers, governments, and their citizens are calling for education systems—and the way they use technology—to better prepare students for the future.

The Intel® Skills for Innovation (Intel® SFI) Framework answers the call. It guides decision makers and educators in adopting technology and creating learning opportunities that actively engage students in all types of learning environments. By inspiring teachers and learners to reach their full potential through a technology-supported, skills-based approach, the Intel SFI Framework empowers them to build their skills anywhere and maximize outcomes that prepare them for a changing world.

Embracing the Fourth Industrial Revolution

Computers and automation emerged in the 1960s and were rapidly integrated into all aspects of our lives. Today, complex, new technologies connect our physical, digital, and biological worlds. We see rapid changes in nearly every aspect of the economy and our lives, from manufacturing to supply chains to our own homes. From using artificial intelligence in medicine (e.g., to analyze X-rays) to performing quality checks on manufacturing lines to applying data science in optimizing farming practices to maximize yields, every industry will be transformed by integrating digital technologies.

All of this, taken together, is called the Fourth Industrial Revolution. It arrived a mere 60 years after the advent of the Third Industrial Revolution. Compare that to the First Industrial Revolution, when mechanization based on steam power evolved over more than 100 years.

Acceleration of Technology Invention

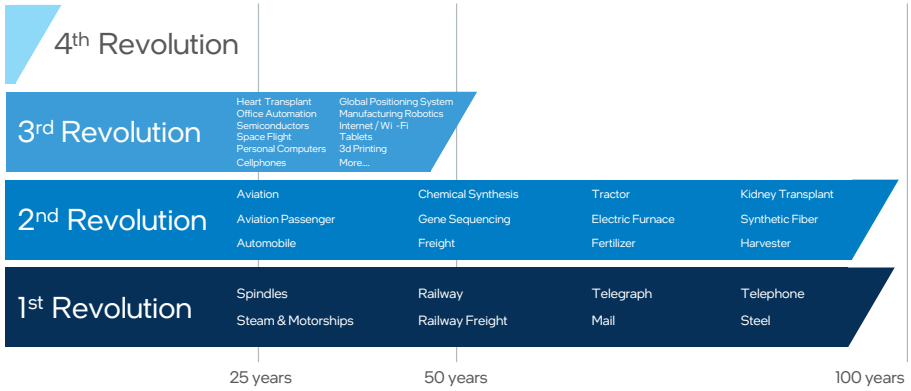


Figure 1. This graph illustrates the acceleration of technology invention.

There is no question that the digital universe is growing exponentially—and at a blistering pace. The rapidly accelerating pace of emerging technologies drives the equally urgent need to adapt our educational systems to the economies and job sectors of the future. Today's students will face a dynamic technological landscape when they enter the job market. This means we must not only teach them current technologies but we must also teach them new ways of thinking and problem-solving using new technologies.

Over time, "traditional" jobs will continue to decline while jobs that require different—often technology-based—skillsets will increase. We are already facing a global shortage of workers in STEM fields. With technology being infused in ever-more professions, the need is greater than ever. Unless and until education and job training adapt to our changing world, this shortage will only intensify. However, the importance of adopting skills-based learning goes beyond just mitigating the current worker shortage; it is a critical foundation that will empower today's students to create previously unimagined solutions to some of our world's most challenging problems.

The Jobs Landscape in 2025

Source: The Future of Jobs Report 2020,World Economic Forum, 2020, http://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf

Figure 2. Forecasts show we will gain more jobs than we lose in the next few years; those new jobs require different technology skills.[3]

The growing skills gap cannot be addressed by simply increasing the number of devices used in education. Instead, the Fourth Industrial Revolution calls for us to transform *how technology is used* in education to address the skills gap.

In addition, successful workers of the future will thrive on change: they will need to constantly learn and imagine new ways of responding to the challenges that come their way. Educators use Bloom's Taxonomy[4]—which orders skills by increasing cognitive complexity—to classify learning objectives and outcomes that move students to higher-order cognitive abilities. In future-ready classrooms, technology should foster teachers' and students' active engagement in developing skills, and the technology needs of educators and students increase as students acquire ever-more complex skills.

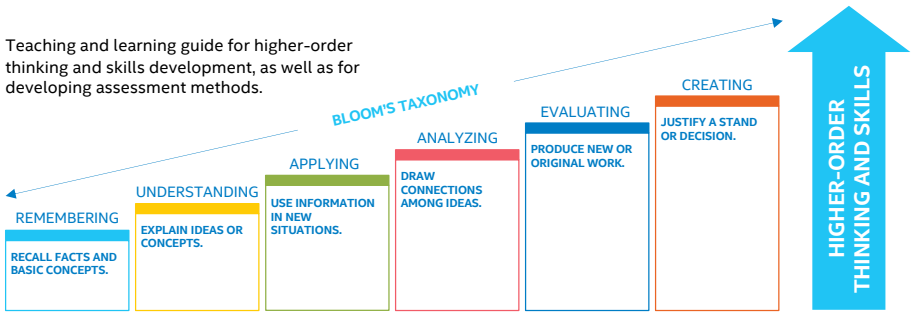


Figure 3. Bloom's Taxonomy orders skills by increasing cognitive complexity.

Intel Skills for Innovation Framework Promotes Skills-based Learning

Intel has developed the Intel SFI Framework in response to the growing demand for a technological transformation in education. Intel's vision for education embraces critical skills for students' future success and reinvents the role of technology to ensure that educators and learners are equipped to meet the challenges of a rapidly changing world. **Intel SFI puts technology at the center of building advanced learning skills, rather than simply using technology to provide access to existing educational content**.

To see this shift in concrete terms, consider two examples of using technology in learning:

- **Scenario 1:** Students make online flashcards to drill math concepts. They may find the process more engaging and learn better because they are using technology, but the application is limited to improving accessibility of the content. The students' learning is *enhanced* using technology. In Bloom's terms, technology helped the students to improve the process of remembering.

In the Intel SFI Framework, technology is used not only to enhance but also to *transform* what and how students learn.

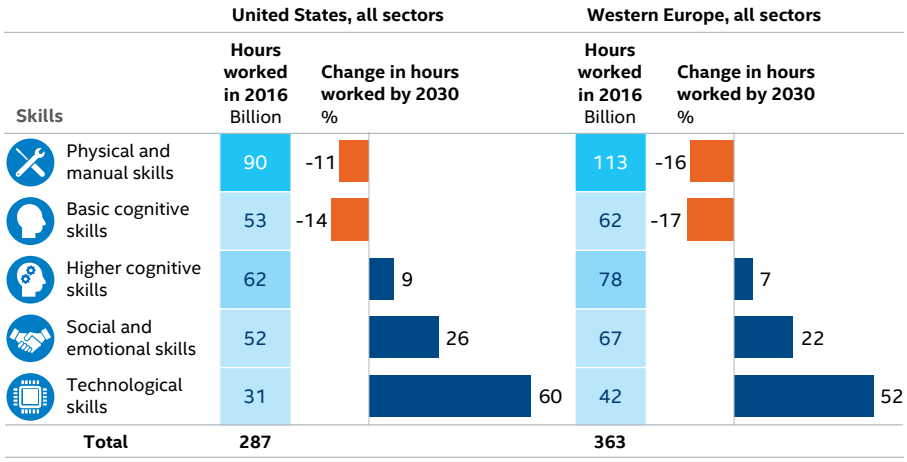
- **Scenario 2:** Intel has created a unit on the mathematics of pandemics, in which high school students learn how to visualize data to help researchers and policy makers better understand how a virus behaves and how epidemics spread. Students learn about the importance of global health security to pandemic prevention while acquiring and practicing a number of future-oriented skills: arithmetic and geometric progressions, design thinking, and data science—all while learning the tools of spreadsheet software and Geographic Information Systems (GIS). The students gain skills, and their learning is *transformed* using technology. In Bloom's terms, technology helped the students to improve on the understanding, applying, and analyzing processes.

This unit is one example of how curricula can be adapted to build future-ready skills while also engaging students in current, real-world scenarios at a deeper level. When technology enables higher-order thinking skills, students learn not just new skills but new modes of learning and thinking that prepare them to be the workforce of tomorrow.

Skills Required for the Workforce of the Future

According to a 2018 report by The McKinsey Global Institute, job markets of the future will increasingly rely on higher-order thinking skillsets such as higher cognitive, social-emotional, and technological skills.[5]

More Social, Emotional and Technological Skills



Note: Western Europe; Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. Numbers may not sum due to rounding.

Source: McKinsey Global Institute workforce skills model; McKinsey Global Institute analysis

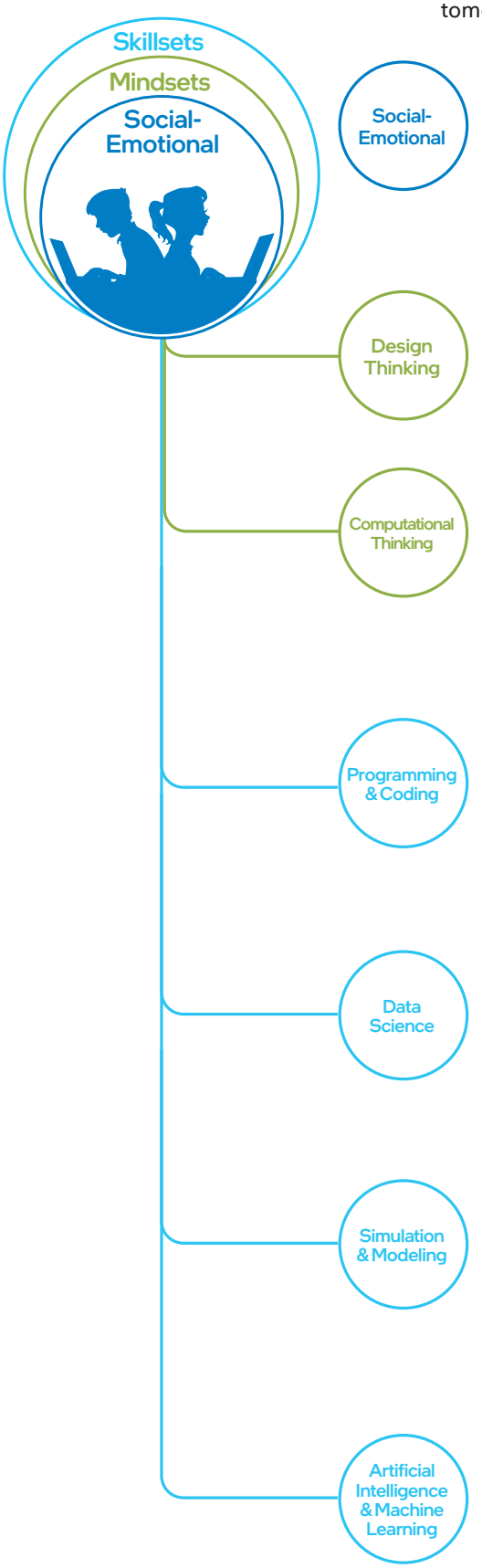
Figure 4. Hours spent using physical and manual skills are forecast to decrease 11-16 percent from 2016 to 2030, while time spent using technological skills will increase by up to 60 percent.

In response to these shifting needs, Intel created this new framework based on the following set of principles and approaches:

- Flexibility in augmenting curriculum with technology activities and content, so curriculum planners and educators can easily adapt to changes and the whole system enables "anywhere learning"
- Teachers function as facilitators in acquiring knowledge and skills, not the "sages on stage" who impart knowledge and content
- A focus on developing higher-order thinking skills with students taught complex cognitive processes—such as computational and design thinking—that prepare them to be self-driven innovators, creators, and problem solvers
- Emphasis on integrating hands-on technology activities into both existing curriculum and real-world scenarios to better prepare students to solve real-world problems.

Empowering Today's Students to Become Tomorrow's Innovators

Using the Intel SFI Framework, educators are coached on how best to integrate technology into their programs and plans to help students develop their cognitive, technical, and social-emotional skills. Having the right technology tools, with reliable, manageable, and secure access means students can practice skill-building activities from anywhere. These tools help them analyze, evaluate, and create using the information they learn; develop advanced skills; and prepare for the jobs of the future.



The Intel SFI Framework focuses on key competencies needed in the workplace of tomorrow:

Social-Emotional Skills: Social-emotional skills are crucial life skills, including how to deal with one's self, others, and relationships, and how to work effectively. Social-emotional skills help with developing sympathy and empathy for others and with maintaining positive relationships; these skills are crucial in all areas of life, including the workplace. Students acquire and hone these skills in collaborative learning environments where teachers operate as facilitators and students learn how to direct their own learning and practice persistence, collaboration, and tolerance, among other skills.

Design Thinking: Design thinking encompasses practical methods and processes through which proposals for design concepts (new products, buildings, machines, etc.) are developed. Students can learn design thinking through projects that incorporate empathy, ideation, and collaboration, in addition to project definition and prototyping. New ideas can lead to a deeper understanding of a problem and trigger more and better solutions.

Computational Thinking: Computational thinking engages logical analysis and design using computer science tools. It is not necessarily about a way to create a result but, rather, a cognitive strategy for deriving a *better* result by expressing problems and their solutions in ways that computers or computing tools, like robots, could execute. Students can be introduced to it through learning experiences that guide them in breaking down a problem into smaller parts (decomposition), using abstractions and pattern recognition to represent the problem in multiple ways, and finally tackling the problem through a series of ordered steps (algorithms).

Programming and Coding: With so many jobs having technological elements, it will be crucial for workers to move from being mere technology *users* to being technology *creators*. An element of using technology to create is learning how to craft a computational solution to solve a problem. Students can be exposed to this skillset through learning experiences that teach them how to create their own code (either in a written form or with drag-and-drop, pre-defined code blocks), work in teams to collaborate and define the task at hand, and refine their work through multiple iterations.

Data Science: Data science is an interdisciplinary field that uses scientific methods, algorithms, and systems to extract knowledge and insights from structured and unstructured data. It employs techniques and theories drawn from mathematics, statistics, computer science, and information science. With the increasingly vast amounts of data that are generated daily, the ability to generate insights from data will be essential. Students can be exposed to this skillset by practicing data wrangling, data visualization, data modeling, and statistical analysis methods.

Simulation and Modeling: Nearly everything produced today starts with a digital design, often simulated using computational science before ever being built, to support timely and cost-efficient decision-making in the production process. Simulation can be used in training to create virtual environments. Understanding the thinking and technologies behind simulation and modeling is critical to student skills. Students can be exposed to such skills through learning experiences that enable them to define problems, constrain variables, develop models, and engage in model verification and optimization activities.

AI/Machine Learning: Artificial intelligence (AI) refers to any technique that uses computers to mimic human intelligence. Machine learning (ML) is a subset of AI in which computers can perform a specific task by relying on patterns and inference instead of using explicit instructions. Both AI and ML are already being used widely for applications such as email filtering and computer vision; it is expected that more and more tasks will be performed with AI and ML in the future. Students can acquire this skillset through experiencing machine learning models, performing computer vision tasks, processing natural languages, and implementing robotics.

"The need to know the capital of Florida died when my phone learned the answer. Rather, the students of tomorrow need to be able to think creatively: they will need to learn on their own, adapt to new challenges and innovate on the fly."

– Anthony Chivetta
Software Developer, Darwin OS

Getting from Where You Are to Where You Want to Be

As education planners build a vision and identify steps to reach it, it helps to keep a couple of important concepts in mind:

The first is adaptability. A **future-oriented model shifts educational planning from short-term fixes to long-term visions**. Intel SFI is designed to transform systems to become future thinking.

A second, related concept is robustness. Technology resources must be easy to access and use, adaptable to a variety of workloads and learning modalities, and able to withstand the test of time. New technologies need to deliver reliable, secure access to learning resources and help ensure richer experiences that build skills for tomorrow.

It is inevitable that roles will evolve as part of transforming education systems. Decision makers, educators, and students will all see their practices shift as the framework is implemented, and a change in one aspect of the learning environment will impact the rest of the system. Decision makers who first agree on a vision can more proactively manage change as curricula and learning environments are adapted to meet new learning modalities. As students increasingly become self-directed learners rather than simply information consumers, educators will become facilitators and coaches, developing students' higher-level cognitive skills and often using technology to make it happen. Considering these evolving reciprocal relationships while planning can help set up the system for long-term success.

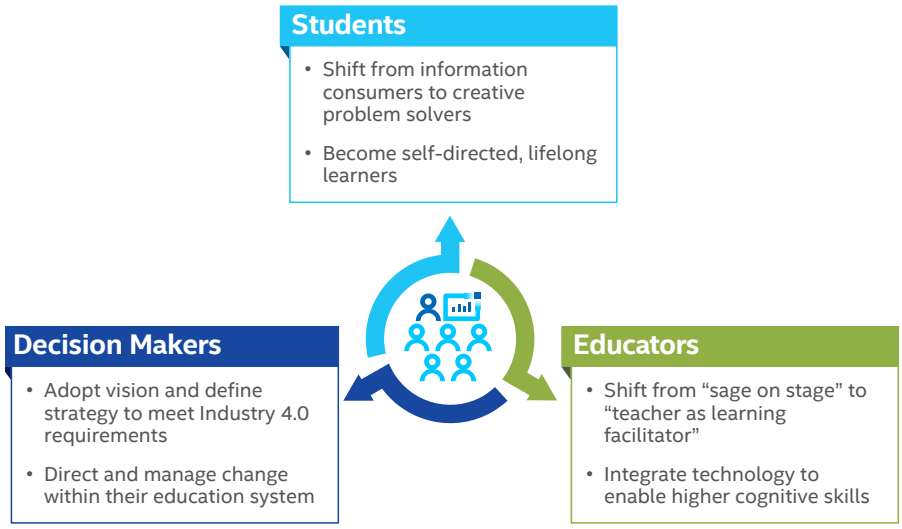


Figure 5. Participants in learning environments will all see their roles shift as the framework is implemented.

The Intel SFI Framework provides technology recommendations as well as tools to support decision makers and educators as they develop and implement a vision for enriching curriculum and designing the learning environment to meet skill-building goals.

Our approach is built on a model designed to empower students with new skills, to enable teachers with new resources to support learning, and to describe the infrastructure capabilities and environments that education systems require to transform education to meet the needs of the Fourth Industrial Revolution.

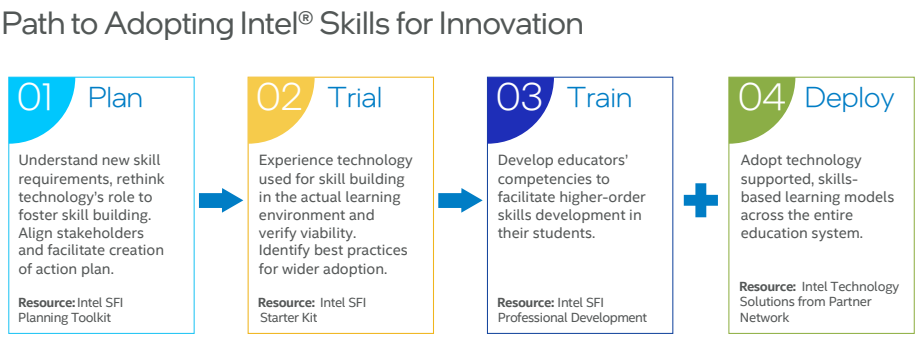


Figure 6. Intel provides support along the multi-step path to integrating Intel® Skills for Innovation into an educational system.

Plan. The process begins with a series of workshops where education decision makers and stakeholders come together to assess the current state of their environment, align stakeholders to a common vision, and craft a detailed action plan. Intel created the Intel SFI Planning Toolkit to facilitate the planning process. The Toolkit offers a series of presentations, discussions, exercises, and insights from existing programs, together with hands-on experience with lesson plans for skill building, to help stakeholders deepen their understanding of the new skills requirements; align those requirements with their curriculum goals; and rethink the role of technology in education to foster building these new skills.

Trial. The next step is to conduct a trial in a real school environment. This proof of concept is conducted for a limited period of time to allow planners, educators, and students to experience technology for skill building in a real school environment, evaluate viability, and identify best practices for wider adoption of the model across the education system. The Intel SFI Starter Kit, a growing set of ready-to-use lesson plans mapped to different grade levels, together with curriculum mapping guidance and hardware and software technology recommendations, is ready to support planners, schools, and teachers as they integrate skill building into their curriculum.

Train. The Intel SFI Framework supports educators as they assume their role as the leaders of digital learning experiences and facilitators of future skill building. Intel SFI Professional Development provides 60 hours of e-learning to support educators as they build new competencies, guiding them through creating new lessons and modifying existing lessons for remote learning. It inspires teachers to embrace skill-building activities and new ways of teaching that help students build future-ready skills.

Deploy. When the time comes to roll out the new, skills-focused vision broadly, Intel offers a wide range of resources and solutions to support a successful deployment at scale. These include a robust network of partners that can help implement solutions tailored to fit the needs and goals of your specific education environment. Please talk to your Intel representative to discuss the unique deployment help available.

The Intel SFI Framework allows decision makers and educators to understand, experience, and implement their unique vision for technology-supported, skills-based learning across their education system. It is a highly customizable approach designed to empower students to reach their full potential, build future-ready skills, and be prepared for the Fourth Industrial Revolution.

Ready to Get Started?

It is safe to assume that change will be the only constant as educational and workplace transformations accelerate. Technology is tightly woven into the very fabric of our world. Tomorrow's job market will require more higher-order thinking, social-emotional, and technological skills than ever before. Education systems must ensure digital access and equity to make anywhere learning possible.

In this fluid environment, how can you ensure that students are prepared to be thinkers and actors in this ever-evolving workforce? And how can you equip your educators to facilitate this effort?

The Intel SFI Framework is designed to support educational systems throughout the world in enriching curricula, shifting pedagogy, and developing future-ready learning environments. Are you ready to take the next step? We are. For more information about how to apply the Intel SFI Framework to your educational environment, please contact skillsforinnovation@intel.com.

About Intel® Skills for Innovation Framework

Intel Skills for Innovation Framework empowers today's students to become tomorrow's innovators. Using this framework, educators can integrate technology into their programs and plans to build skills of the future, and help students develop their cognitive, technical, and social-emotional skills.

Having the right technology tools, with reliable, manageable, and secure access, enables students to practice skill-building activities from anywhere. These tools help them analyze, evaluate, and create using the information they learn, develop advanced skills, and prepare for the jobs of the future.

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[1] Thomas L. Friedman. "Need a Job? Invent It," New York Times, March 31, 2013: https://www.nytimes.com/2013/03/31/opinion/sunday/friedman-need-a-job-invent-it.html?_r=0

[2] Conrad Hughes, *Some Implications of COVID-19 for Remote Learning and the Future of Schooling*, (UNESCO International Bureau of Education, 2020), https://unesdoc.unesco.org/ark:/48223/pf0000373229

[3] Saadia Zahidi et al. The Future of Jobs Report 2020, (World Economic Forum, 2020), http://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf

[4] "Bloom's Taxonomy," *Wikipedia*, last modified July 5, 2020, https://en.wikipedia.org/wiki/Bloom's_taxonomy

[5] Exhibit from "Skill shift: Automation and the future of the workforce", May 2018, McKinsey Global Institute, www.mckinsey.com. Copyright © 2020 McKinsey & Company. All rights reserved. Reprinted by permission

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