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The Future of Jobs and Jobs Training

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By Lee Rainie and Janna Anderson

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As robots, automation and artificial intelligence perform more tasks and there is massive disruption of jobs, experts say a wider array of education and skills-building programs will be created to meet new demands. There are two uncertainties: Will well-prepared workers be able to keep up in the race with AI tools? And will market capitalism survive?

Machines are eating human jobs. And it's not just about jobs that are repetitive and low-skill. Automation, robotics, algorithms and artificial intelligence (AI) in recent times have shown they can do equal or sometimes even better work than humans who are [dermatologists](#), [insurance claims adjusters](#), [lawyers](#), [seismic testers in oil fields](#), [sports journalists](#) and [financial reporters](#), [crew members on guided-missile destroyers](#), [hiring managers](#), [psychological testers](#), [retail salespeople](#), and [border patrol agents](#). Moreover, there is growing anxiety that technology developments on the near horizon will [crush the jobs of the millions](#) who drive cars and trucks, analyze [medical tests and data](#), [perform middle management chores](#), [dispense medicine](#), [trade stocks and evaluate markets](#), [fight on battlefields](#), [perform government functions](#), and even replace [those who program software – that is, the creators of algorithms](#).

Multiple studies have documented that [massive numbers](#) of [jobs are at risk](#) as programmed devices – many of them smart, autonomous systems – continue their march into workplaces. A recent [study by labor economists](#) found that “one more robot per thousand workers reduces the employment to population ratio by about 0.18-0.34 percentage points and wages by 0.25-0.5 percent.” When Pew Research Center and Elon University’s Imagining the Internet Center asked experts in 2014 whether AI and robotics would create more jobs than they would destroy, [the verdict was evenly split](#): 48% of the respondents envisioned a future where more jobs are lost than created, while 52% said more jobs would be created than lost. Since that expert canvassing, the future of jobs has been at the top of the agenda at [many major conferences globally](#).

Several policy and market-based solutions have been promoted to address the loss of employment and wages forecast by technologists and economists. A key idea emerging from many conversations, including one of the lynchpin discussions at the World Economic Forum in 2016, is that [changes in educational and learning environments are necessary](#) to help people [stay employable](#) in the labor force of the future. Among the six overall findings in a new [184-page report](#) from the National Academies of Sciences, the experts recommended: “The education system will need to adapt to prepare individuals for the changing labor market. At the same time, recent IT advances offer new and potentially more widely accessible ways to access education.”

Jobholders themselves have internalized this insight: A 2016 Pew Research Center survey, “[The State of American Jobs](#),” found that 87% of workers believe it will be essential for them to get training and develop new job skills throughout their work life in order to keep up with changes in the workplace. This survey noted that employment is much higher among jobs that require an average or above-average level of preparation (including education, experience and job training); average or above-average interpersonal, management and communication skills; and higher levels of analytical skills, such as critical thinking and computer skills.

A central question about the future, then, is whether formal and informal learning structures will evolve to meet the changing needs of people who wish to fulfill the workplace expectations of the future. Pew Research Center and Elon’s Imagining the Internet Center conducted a large-scale canvassing of technologists, scholars, practitioners, strategic thinkers and education leaders in the summer of 2016, asking them to weigh in on the likely future of workplace training.

Some 1,408 responded to the following question, sharing their expectations about what is likely to evolve by 2026:

In the next 10 years, do you think we will see the emergence of new educational and training programs that can successfully train large numbers of workers in the skills they will need to perform the jobs of the future?

The nonscientific canvassing found that 70% of these particular respondents said “yes” – such programs would emerge and be successful. A majority among the 30% who said “no” generally do not believe adaptation in teaching environments will be sufficient to teach new skills at the scale that is necessary to help workers keep abreast of the tech changes that will upend millions of jobs. (See “About this canvassing of experts” on Page 37 for further details about the limits of this sample.)

Participants were asked to explain their answers and offered the following prompts to consider:

- What are the most important skills needed to succeed in the workforce of the future?
- Which of these skills can be taught effectively via online systems – especially those that are self-directed – and other nontraditional settings?
- Which skills will be most difficult to teach at scale?
- Will employers be accepting of applicants who rely on new types of credentialing systems, or will they be viewed as less qualified than those who have attended traditional four-year and graduate programs?

Several common expectations were evident in these respondents' answers, no matter how hopeful or fretful they were about the future of skills- and capabilities-training efforts. (It is important to note that many respondents listed human behaviors, attributes and competencies in describing desirable work skills. Although these cannot be classified as "skills" and perhaps cannot be directly taught in any sort of training environment, we include these answers under the general heading of skills, capabilities and attributes.)

A diversifying education and credentialing ecosystem: Most of these experts expect the education marketplace – especially online learning platforms – to continue to change in an effort to accommodate the widespread needs that are emerging. Some predict employers will step up their own efforts to train and retrain workers. Many foresee a significant number of self-teaching efforts by jobholders themselves as they take advantage of proliferating online opportunities.

Respondents see a new education and training ecosystem emerging in which some job preparation functions are performed by formal educational institutions in fairly traditional classroom settings, some elements are offered online, some are created by for-profit firms, some are free, some exploit augmented and virtual reality elements and gaming sensibilities, and a lot of real-time learning takes place in formats that job seekers pursue on their own.

A considerable number of respondents to this canvassing focused on the likelihood that the best education programs will teach people how to be lifelong learners. Accordingly, some say alternative credentialing mechanisms will arise to assess and vouch for the skills people acquire along the way.

A focus on nurturing unique human skills that artificial intelligence (AI) and machines seem unable to replicate: Many of these experts discussed in their responses the human talents they believe machines and automation may not be able to duplicate, noting that these should be the skills developed and nurtured by education and training programs to prepare people to work successfully alongside AI. These respondents suggest that workers of the future will learn to deeply cultivate and exploit creativity, collaborative activity, abstract and systems thinking, complex communication, and the ability to thrive in diverse environments.

One such comment came from **Simon Gottschalk**, a professor in the department of sociology at the University of Nevada, Las Vegas: "The skills necessary at the higher echelons will include especially the ability to efficiently network, manage public relations, display intercultural sensitivity, marketing, and generally what [author Dan Goleman](#) would call 'social' and 'emotional' intelligence. [This also includes] creativity, and just enough critical thinking to move outside the box."

Another example is the response of **Fredric Litto**, a professor emeritus of communications and longtime distance-learning expert from the University of São Paulo: “We are now in the transitional stage of employers gradually reducing their prejudice in the hiring of those who studied at a distance, and moving in favor of such ‘graduates’ who, in the workplace, demonstrate greater proactiveness, initiative, discipline, collaborativeness – *because* they studied online.”

Other respondents mentioned traits including leadership, design thinking, “human meta communication,” deliberation, conflict resolution, and the capacity to motivate, mobilize and innovate. Still others spoke of more practical needs that could help workers in the medium term – to work with data and algorithms, to implement 3-D modeling and work with 3-D printers, or to implement the newly emerging capabilities in artificial intelligence and augmented and virtual reality. **Jonathan Grudin**, principal researcher at Microsoft, commented, “People will create the jobs of the future, not simply train for them, and technology is already central. It will undoubtedly play a greater role in the years ahead.”

About a third of respondents expressed no confidence in training and education evolving quickly enough to match demands by 2026. Some of the bleakest answers came from some of the most respected technology analysts. For instance, **Jason Hong**, an associate professor at Carnegie Mellon University, wrote, “There are two major components needed for a new kind of training program at this scale: political will and a proven technology platform. Even assuming that the political will (and budget) existed, there’s no platform today that can successfully train large numbers of people. MOOCs [[Massive Open Online Courses](#)] have a high dropout rate and have serious questions about quality of instruction. They are also struggling with basic issues like identification of individuals taking the courses. So in short, we can train small numbers of individuals (tens of thousands) per year using today’s community colleges and university systems, but probably not more.”

Several respondents argued that job training is not a primary concern at a time when accelerating change in market economies is creating massive economic divides that seem likely to leave many people behind. An **anonymous scientific editor** commented, “Seriously? You’re asking about the workforce of the future? As if there’s going to be one? ... ‘Employers’ either run sweatshops abroad or hire people in the ‘first world’ to do jobs that they hate, while more and more unskilled and skilled people end up permanently on welfare or zero-hour contracts. And the relatively ‘job-secure’ qualified people who work in the ‘professions’ are probably a lot closer than they think they are to going over that same cliff. The details of how they earn their credentials aren’t going to be an issue.”

Most participants in this canvassing wrote detailed elaborations explaining their positions, though they were allowed to respond anonymously. Their well-considered comments provide insights about hopeful and concerning trends. These findings do not represent all possible points of view, but they do reveal a wide range of striking observations. Respondents collectively articulated five major themes that are introduced and briefly explained in the 29-page section below and then expanded upon in more-detailed sections that begin on Page 41 of this report. Some responses are lightly edited for style or due to length.

Five major themes about the future of jobs training in the tech age

HOPEFUL THEMES

Theme 1 The training ecosystem will evolve, with a mix of innovation in all education formats

- More learning systems will migrate online. Some will be self-directed and some offered or required by employers; others will be hybrid online/real-world classes. Workers will be expected to learn continuously
- Online courses will get a big boost from advances in augmented reality (AR), virtual reality (VR) and artificial intelligence (AI)
- Universities still have special roles to play in preparing people for life, but some are likely to diversify and differentiate

Theme 2 Learners must cultivate 21st-century skills, capabilities and attributes

- Tough-to-teach intangibles such as emotional intelligence, curiosity, creativity, adaptability, resilience and critical thinking will be most highly valued
- Practical, experiential learning via apprenticeships and mentoring will advance

Theme 3 New credentialing systems will arise as self-directed learning expands

- While the traditional college degree will still hold sway in 2026, more employers may accept alternate credentialing systems as self-directed learning options and their measures evolve
- The proof of competency may be in the real-world work portfolios

CONCERNS

Theme 4 Training and learning systems will not meet 21st-century needs by 2026

- Within the next decade, education systems will not be up to the task of adapting to train or retrain people for the skills most prized in the future
- Show me the money: Many doubts hinge upon a lack of political will and necessary funding
- Some people are incapable of or uninterested in self-directed learning

Theme 5 Jobs? What jobs? Technological forces will fundamentally change work and the economic landscape

- There will be many millions more people and millions fewer jobs in the future
- Capitalism itself is in real trouble

PEW RESEARCH CENTER, ELON UNIVERSITY'S IMAGINING THE INTERNET CENTER, 2017

The following section presents a brief overview of the most evident themes extracted from the written responses, including a small selection of representative quotes supporting each point. Some responses are lightly edited for style or due to length.

Theme 1: The training ecosystem will evolve, with a mix of innovation in all education formats

These experts envision that the next decade will bring a more widely diversified world of education and training options in which various entities design and deliver different services to those who seek to learn. They expect that some innovation will be aimed at emphasizing the development of human talents that machines cannot match and at helping humans partner with technology. They say some parts of the ecosystem will concentrate on delivering real-time learning to workers, often in formats that are self-taught.

Commonly occurring ideas among the responses in this category are collected below under headings reflecting subthemes.

More learning systems will migrate online. Some will be self-directed and some offered or required by employers; others will be hybrid online/real-world classes. Workers will be expected to learn continuously

Most experts seem to have faith that rapid technological development and a rising wariness of coming impacts of the AI/robotics revolution are going to spur the public, private and governmental actions needed for education and training systems to be adapted to deliver more flexible, open, adaptable, resilient, certifiable and useful lifelong learning.

Jim Hendler, a professor of computer science at Rensselaer Polytechnic Institute, predicted, “The nature of education will change to a mix of models. College education (which will still favor multi-year, residential education) will need to be more focused on teaching students to be lifelong learners, followed by more online content, in situ training, and other such [elements] to increase skills in a rapidly changing information world. As automation puts increasing numbers of low- and middle-skill workers out of work, these models will also provide for certifications and training needs to function in an increasingly automated service sector.”

Michael Wollowski, an associate professor of computer science at the Rose-Hulman Institute of Technology, commented, “We will definitely see a vast increase in educational and training programs. We will also see what might be called on-demand or on-the-job kind of training programs. (We kind of have to, as with continued automation, we will need to retrain a large portion of the workforce.) I strongly believe employers will subscribe to this idea wholeheartedly; it increases the overall education of their workforce, which benefits their bottom line. Nevertheless, I am a big believer in the college experience, which I see as a way to learn what you are all about, as a person and in your field of study. The confidence in your own self and your abilities cannot be learned in a short course. It takes life experience, or four years at a tough

college. At a good college, you are challenged to be your best – this is very resource-intensive and cannot be scaled at this time.”

Justin Reich, executive director at the Massachusetts Institute of Technology (MIT) Teaching Systems Lab, observed, “Educators have always found new ways of training the next generation of students for the jobs of the future, and this generation will be no different. Our established systems of job training, primarily community colleges and state universities, will continue to play a crucial role, though catastrophically declining public support for these institutions will raise serious challenges.”

David Karger, a professor of computer science at MIT, wrote, “Most of what we now call online learning is little more than glorified textbooks, but the future is very promising. ... No matter how good our online teaching systems become, the current four-year college model will remain dominant for quite some time. ... Online teaching will increase the reach of the top universities, which will put pressure on lesser universities to demonstrate value. One potential future would be for those universities to abandon the idea that they have faculty teaching their own courses and instead consist entirely of a cadre of (less well paid) teaching assistants who provide support for the students who are taking courses online.”

A few respondents said already established institutions cannot be as fully successful as new initiatives. **Jerry Michalski**, founder at REX, commented, “Today’s educational and training institutions are a shambles. They take too long to teach impractical skills and knowledge not connected to the real world, and when they try to tackle critical thinking for a longer time scale, they mostly fail. The sprouts of the next generation of learning tools are already visible. Within the decade, the new shoots will overtake the wilting vines, and we will see all sorts of new initiatives, mostly outside these schooling, academic and training institutions, which are mostly beyond repair. People will shift to them because they work, because they are far less expensive and because they are always available.”

Barry Chudakov, founder and principal at Sertain Research and StreamFuzion Corp., says education has been liberated because, thanks to digital innovation, everyone can embed learning continuously in their everyday lives. He wrote, “The key to education in the next 10 years will be the understanding that we now live in a world without walls – and so the walls of the school (physical and conceptual) need to shatter and never go up again. In the (hopefully near) future, we will not segregate schooling from work and real-world thinking and development. They will seamlessly weave into a braid of learning, realization, exposure, hands-on experience and integration into students’ own lives. And, again, the experience of being a student, now confined to grade school, secondary school and university, will expand to include workers, those looking for

work, and those who want or need to retrain – as well as what we now think of as conventional education. One way we will break down these walls – we are already doing so – will be to create digital learning spaces to rival classrooms as ‘places’ where learning happen[s]. Via simulation, gaming, digital presentations – combined with hands-on, real-world experience – learning and re-education will move out of books and into the world. The more likely enhancement will be to take digital enhancements out into the world – again, breaking down the walls of the classroom and school – to inform and enhance experience.”

An **anonymous respondent** echoed the sentiment of quite a few others who do not think it is possible to advance and enhance online education and training much in the next decade, writing, “These programs have a cost, and too few are willing to sacrifice for these programs.” More such arguments are included in later sections of this report.

Online courses will get a big boost from advances in augmented reality (AR), virtual reality (VR) and artificial intelligence (AI)

Some respondents expressed confidence in the best of current online education and training options, saying online course options are cost-effective, evolving for the better, and game-changing because they are globally accessible. Those with the most optimism expect great progress will be made in augmented reality (AR), virtual reality (VR) and AI. While some say 2026 will still be “early days” for this tech, many are excited about its prospects for enhancing learning in the next decade.

Edward Friedman, professor emeritus of technology management at the Stevens Institute of Technology, wrote, “Already, today there are quite effective online training and education systems, but they are not being implemented to their full potential. These applications will become more widely used with familiarity that is gained during the next decade. Also, populations will be more tech-savvy and be able to make use of these systems with greater personal ease. In addition, the development of virtual reality, AI assistants and other technological advances will add to the effectiveness of these systems. There will be a greater need for such systems as the needs for new expertise in the workforce [increase] and the capacity of traditional education systems proves that it is not capable of meeting the need in a cost-effective manner.”

The **president of a technology LLC** wrote, “Training, teaching are all going online, partly because of high costs of campus education.”

Richard Adler, distinguished fellow at the Institute for the Future, predicted, “AI, voice-response, telepresence VR and gamification techniques will come together to create powerful new

learning environments capable of personalizing and accelerating learning across a broad range of fields.”

Ray Schroeder, associate vice chancellor for online learning at the University of Illinois, Springfield, commented, “It is projected that those entering the workforce today will pursue four or five different careers (not just jobs) over their lifetime. These career changes will require retooling, training and education. The adult learners will not be able to visit physical campuses to access this learning; they will learn online. I expect that we will see the further development of artificially intelligent teaching specialists such as [‘Jill Watson’ at Georgia Tech](#), the virtual graduate assistant who was thought to be human by an entire class of computer science students. I anticipate the further development and distribution of holoportation technologies such as those developed by Microsoft using [HoloLens](#) for real-time, three-dimensional augmented reality. These teaching tools will enable highly sophisticated interactions and engagement with students at a distance. They will further fuel the scaling of learning to reach even more massive online classes.”

Fredric Litto, an professor emeritus of communications and longtime distance-learning expert from the University of São Paulo, replied, “There is *no* field of work that cannot be learned, totally or in great part, in well-organized and administered online programs, either in traditional ‘course’ formats, or in self-directed, independent learning opportunities, supplemented, when appropriate, by face-to-face, hands-on, practice situations.”

Tawny Schlieski, research director at Intel and president of the Oregon Story Board, explained, “New technologies of human/computer interaction like augmented and virtual reality offer the possibility of entirely new mechanisms of education. ... Augmented and virtual reality tools ... make learning more experiential, they engage students with physical movement, and they enable interactive and responsive instructional assets. As these tools evolve over the next decade, the academics we work with expect to see radical change in training and workforce development, which will roll into (although probably against a longer timeline) more traditional institutions of higher learning.”

Universities still have special roles to play in preparing people for life, but some are likely to diversify and differentiate

Many respondents said real-world, campus-based higher education will continue to thrive during the next decade. They generally expect that no other educational experience can match residential universities’ capabilities for fully immersive, person-to-person learning, as well as mentoring and socializing functions, before 2026. They said a residential university education helps build intangible skills that are not replicable online and thus deepens the skills base of those who can

afford to pay for such an education, but they expect that job-specific training will be managed by employers on the job and via novel approaches. Some say major universities' core online course content, developed with all of the new-tech bells and whistles, will be marketed globally and adopted as baseline learning in smaller higher education locales, where online elements from major MOOCs can be optimally paired in hybrid learning with in-person mentoring activities.

Uta Russmann, communications/marketing/sales professor at the FHWien University of Applied Sciences in Vienna, Austria, said, "In the future, more and more jobs will require highly sophisticated people whose skills cannot be trained in 'mass' online programs. Traditional four-year and graduate programs will better prepare people for jobs in the future, as such an education gives people a general understanding and knowledge about their field, and here people learn how to approach new things, ask questions and find answers, deal with new situations, etc. – all this is needed to adjust to ongoing changes in work life. Special skills for a particular job will be learned on the job."

Frank Elavsky, data and policy analyst at Acumen LLC, responded, "The most important skills to have in life are gained through interpersonal experiences and the liberal arts. ... Human bodies in close proximity to other human bodies stimulate real compassion, empathy, vulnerability and social-emotional intelligence. These skills are imperative to focus on, as the future is in danger of losing these skillsets from the workforce. Many people have gained these skills throughout history without any kind of formal schooling, but with the growing emphasis on virtual and digital mediums of production, education and commerce, people will have less and less exposure to other humans in person and other human perspectives."

Isto Huvila, professor at Uppsala University, replied, "The difference between educating to perform and educating to make the future is the difference between vocational [education] and higher (university) education. ... Spending four years at a university is not only about learning skills but about *bildung* (self-cultivation) and socialising in a group that is capable of fostering collaboration much better than an ad hoc group of people. But this does not mean that alternative means and paths of learning and accreditation would not be useful as ... complementary to the traditional system that has limitations as well."

Dana Klisanin, psychologist/futurist at Evolutionary Guidance Media R&D, wrote, "Educational institutions that succeed will use the tools of social media and game design to grant students' access to teachers from all over the world and increase their motivation to succeed. ... Online educational programs will influence the credentialing systems of traditional institutions, and online institutions will increasingly offer meet-ups and mingles such that a true hybrid educational approach emerges."

Theme 2: Learners must cultivate 21st-century skills, capabilities and attributes

Will training for skills most important in the jobs of the future work well in large-scale settings by 2026? Respondents in this canvassing overwhelmingly said yes, anticipating that improvements in such education would continue. However, many believe the most vital skills are not easy to teach, learn or evaluate in any education or training setting available today.

Tough-to-teach intangible skills, capabilities and attributes such as emotional intelligence, curiosity, creativity, adaptability, resilience and critical thinking will be most highly valued

Dozens of descriptive terms were applied by respondents as they noted the skills, capabilities and attributes they see as important in workers' lives in the next decade.

While coding and other "hard skills" were listed as being easiest to teach to a large group in an online setting, "soft," "human" skills were seen by most respondents as crucial for survival in the age of AI and robotics.

Devin Fidler, research director at the Institute for the Future, predicted, "As basic automation and machine learning move toward becoming commodities, uniquely human skills will become more valuable. There will be an increasing economic incentive to develop mass training that better unlocks this value."

Susan Price, a digital architect at Continuum Analytics, commented, "Increasingly, machines will perform tasks they are better suited to perform than humans, such as computation, data analysis and logic. Functions requiring emotional intelligence, empathy, compassion, and creative judgment and discernment will expand and be increasingly valued in our culture."

Tiffany Shlain, filmmaker and founder of the Webby Awards, wrote, "The skills needed to succeed in today's world and the future are curiosity, creativity, taking initiative, multi-disciplinary thinking and empathy. These skills, interestingly, are the skills specific to human beings that machines and robots cannot do, and you can be taught to strengthen these skills through education. I look forward to seeing innovative live and online programs that can teach these at scale."

Ben Shneiderman, professor of computer science at the University of Maryland, observed, "Students can be trained to be more innovative, creative and active initiators of novel ideas. Skills of writing, speaking and making videos are important, but fundamental skills of critical thinking,

community building, teamwork, deliberation/dialogue and conflict resolution will be powerful. A mindset of persistence and the necessary passion to succeed are also critical.”

Louisa Heinrich, founder at Superhuman Limited, commented, “Lateral and system-thinking skills are increasingly critical for success in an ever-changing global landscape, and these will need to be re-prioritised at all levels of education.”

An **anonymous technologist** commented, “Programming and problem solving, learning how to work with artificial intelligence and robotics will become more important, and more and more workers will be replaced by software/hardware-based ‘workers.’ Automation will reduce the need for the current workforce, and the divide between the upper class and the lower class will continue to eat the middle class.”

Some who are pessimistic about the future of human work due to advances in capable AI and robotics mocked the current push in the U.S. to train more people in technical skills. An **anonymous respondent** commented, “Teach a billion people to program and you’ll end up with 900,000,000 unemployed programmers.”

An **anonymous program director for a major U.S. technology funding organization** predicted, “We will see training for the jobs of the past, and for service jobs. The jobs of the future will not need large numbers of workers with a fixed set of skills – most things that we can train large numbers of workers for, we will also be able to train computers to do better.”

Among the many other skills mentioned were: process-oriented and system-oriented thinking; journalistic skills, including research, evaluation of multiple sources, writing and speaking; understanding algorithms, [computational thinking](#), networking and programming; grasping law and policy; an evidence-based way of looking at the world; time management; conflict resolution; decision-making; locating information in the flood of data; storytelling using data; and influencing and consensus building. A few people mentioned that young adults need to be taught how to have face-to-face interaction, including one who said they “seem to be sorely lacking in these skills and can only interact with a cellphone or laptop.”

Practical experiential learning via apprenticeships and mentoring will advance

Because so many intricacies of the workplace – the human, soft and hard – are learned on the job, respondents said they expect apprenticeships and forms of mentoring will regain value and evolve along with the 21st-century workplace.

D. Yvette Wohn, assistant professor of information systems at the New Jersey Institute of Technology, wrote, “Formalized apprenticeships that require both technical skills and interpersonal interaction will become more important.”

Ian O’Byrne, an assistant professor of literacy education at the College of Charleston, replied, “In the future we’ll see more opportunities for online, personalized learning. This will include open, online learning experiences (e.g., MOOCs) where individuals can lurk and build up capacity or quench interests. I also believe that we’ll see a rise in the offering of premium or pay content that creates a space where one-to-one learning and interaction will allow mentors to guide learners while providing critical feedback. We will identify opportunities to build a digital version of the apprenticeship learning models that have existed in the past. Alternative credentials and digital badges will provide more granular opportunities to document and archive learning over time from traditional and nontraditional learning sources. Through evolving technologies (e.g., blockchain), this may provide opportunities for learners to document and frame their own learning pathways.”

An **instructional designer** with 19 years of experience commented, “The pattern I’m seeing is toward individualized learning – almost on the level of tutoring or apprenticeship. We’ve seen again and again that the broader the audience focus, the less the course seems to deliver. As for what the skills of the future are, they’ll be specialized to their fields with a university degree assumed to be a certificate in the ability to learn more about a particular subject specialty. You may get a degree in computer software development, but the truth is that you still need to be taught how to write software for, say, the mortgage company or insurance company that hires you. The key to the future will be flexibility and personal motivation to learn and tinker with new things.”

Theme 3: New credentialing systems will arise as self-directed learning expands

As they anticipate the appearance of effective new learning environments and advances in digital accountability systems, many of these experts believe fresh certification programs will be created to attest to workers’ participation in training programs and the mastery of skills. Some predict that many more workers will begin using online and app-based learning systems.

While the traditional college degree will still hold sway in 2026, more employers may accept alternate credentialing systems, as learning options and their measures evolve

Charlie Firestone, communications and society program executive director and vice president at The Aspen Institute, replied, “There will be a move toward more precise and better credentialing for skills and competencies, e.g., badging and similar techniques. Employers will

accept these more as they prove probative. And online learning will be more prevalent, even as an adjunct to formal classroom learning. New industries such as green energy and telemedicine will increase new employment opportunities. Despite all of these measures, the loss of jobs from artificial intelligence and robotics will exceed any retraining program, at least in the short run.”

Sam Punnett, research officer at TableRock Media, wrote, “I suspect employers will recognize the new credentialing systems. Particularly those certificates awarded for studies in emerging disciplines (currently data science appears ‘all the rage’) and those that reflect an upgrade of previously acquired skills. Traditional credentials will continue to hold value, but I believe they will be considered in light of a candidate’s perceived ability in ‘learning how to learn.’ The four-year degree and subsequent graduate studies will continue to be less of a guaranty towards employment without work experience. ... Certificates are being viewed more favourably, and many universities are lagging in their connection between their pedagogies and working-world requirements.”

William J. Ward, a university communications professor, @DR4WARD, commented, “Higher Education is doing a poor job of preparing students with the skills they need to succeed in the workforce. Online and credentialing systems are more transparent and do a better job on delivering skills. People with new types of credentialing systems are seen as more qualified than traditional four-year and graduate programs.”

The proof of competency may be in the real-world work portfolios

Many workplaces place a higher value on real-world work portfolios than they do on a degree or certification, yet their hiring systems – including AI bots programmed to scan resumés – still use the commonly accepted credentials as a basis for interviewing candidates. Some respondents hope to see change.

A **software engineering and system administration professional** commented, “The reliability of the traditional educational system is already being questioned – in some fields it’s considered common sense that certifications and degrees mean little, and that a portfolio, references, and hands-on interviews are much more important for assessing a candidate’s ability. The unfortunate reality is that many HR departments still post job listings saying degrees and certifications are required, as a way of screening candidates. Both of those cost a lot of money, and neither mean a lot for a candidate’s competence. I hope this will change (both job listings and quality of degrees/certifications), but don’t see it happening soon.”

Meryl Krieger, career specialist at Indiana University, Bloomington’s Jacobs School, replied, “Credentialing systems will involve portfolios as much as resumés – resumés simply are too two-

dimensional to properly communicate someone’s skillset. Three-dimensional materials – in essence, job reels – that demonstrate expertise will be the ultimate demonstration of an individual worker’s skills. I see credentialing as a piece of a very complex set of criteria; these will also incorporate an individual’s ability to communicate and work with teams (huge in employer requests for new employees), which can more readily be documented and tracked through online portfolio tools than through traditional resume formats. Thus, the educational and training programs of the future will become (in their best incarnations) sophisticated combinations of classroom and hands-on training programs. The specific models will necessarily be responding to individual industry requirements.”

Jeff Jarvis, a professor at the City University of New York Graduate School of Journalism, wrote, “Schools today turn out widget makers who can make widgets all the same. They are built on producing single right answers rather than creative solutions. They are built on an outmoded attention economy: Pay us for 45 hours of your attention and we will certify your knowledge. I believe that many – not all – areas of instruction should shift to competency-based education in which the outcomes needed are made clear and students are given multiple paths to achieve those outcomes, and they are certified not based on tests and grades but instead on portfolios of their work demonstrating their knowledge.”

While the first three themes found among the responses to this canvassing were mostly hopeful about advances in education and training for 21st-century jobs, a large share of responses from top experts reflect a significant degree of pessimism for various reasons. Some even say the future of jobs for humans is so baleful that capitalism may fail as an economic system. The next themes and subthemes examine these responses.

Theme 4: Training and learning systems will not meet 21st-century needs by 2026

A large share of respondents predicted that online formats for knowledge transfer will not advance significantly in the next decade. The 30% who expressed pessimism were often deeply doubtful about the capabilities of current education systems to *adapt*, to pivot to respond to new challenges as quickly as necessary. Interestingly, being able to adapt and respond to looming challenges was seen by nearly everyone in this canvassing as one of the most highly prized future capabilities; these respondents especially agree that it is important, and they say that our human institutions – government, business, education – are not adapting efficiently and are letting us down. Many of them say that current K-12 or K-16 education programs are incapable of making adjustments within the next decade to serve the shifting needs of future jobs markets.

Among the other reasons listed by people who do not expect these kinds of transformative advances in job creation and job skill upgrading:

- It may not be possible to train workers for future skills, for many reasons, including that there will not be any jobs to train them for or that jobs change too quickly.
- There is no “political will,” nor is there evidence leaders will provide funding, for mass-scale improvement in training. Several observed that if education advances cannot be monetized with the appropriate profit margin, they are not moved forward.
- Many workers are incapable of taking on or unwilling to make the self-directed sacrifices they must to adjust their skills.
- The “soft” skills, capabilities and attitudes respondents assume will be necessary in future workers are difficult to teach en masse or at all, and they question how any teaching scheme can instill such sophisticated traits in large numbers of workers.

Some among the 70% of respondents who are mostly optimistic about the future of training for jobs *also* echoed one or more of the points above – mentioning these tension points while hoping for the best. Following are representative statements tied to these points and more from all respondents.

Within the next decade, education systems will not be up to the task of adapting to train or retrain people for the skills likely to be most prized in the future

Thomas Claburn, editor-at-large at Information Week, wrote, “I’m skeptical that educational and training programs can keep pace with technology.”

Andrew Walls, managing vice president at Gartner, wrote, “Barring a neuroscience advance that enables us to embed knowledge and skills directly into brain tissue and muscle formation, there will be no quantum leap in our ability to ‘up-skill’ people. Learning takes time and practice, which means it requires money, lots of money, to significantly change the skill set of a large cohort.”

B. Remy Cross, assistant professor of sociology, Webster University, commented, “Lacking a significant breakthrough in machine learning that could lead to further breakthroughs in adaptive responses by a fully online system, it is too hard to adequately instruct large numbers of people in the kinds of soft skills that are anticipated as being in most demand. As manufacturing and many labor-intensive jobs move overseas or are fully mechanized, we will see a bulge in service jobs. These require good people skills, something that is often hard to train online.”

John Bell, software developer and teacher at Dartmouth College, replied, “Even today, access to information is not the limiting factor in skills education for anyone who can go online. ... While there have been generational gains in the developments of online communities, a large-scale educational experience (either MOOC or on-demand broadcasts) will not be able to duplicate that.”

Stowe Boyd, managing director of Another Voice and a well-known thinker on work futures, discussed the intangibles of preparing humans to partner with AI and bot systems: “While we may see the creation and rollout of new training programs,” he observed, “it’s unclear whether they will be able to retrain those displaced from traditional sorts of work to fit into the workforce of the near future. Many of the ‘skills’ that will be needed are more like personality characteristics, like curiosity, or social skills that require enculturation to take hold. Individual training – like programming or learning how to cook – may not be what will be needed. And employers may play less of a role, especially as AI- and bot-augmented independent contracting may be the best path for many, rather than ‘a job.’ Homesteading in exurbia may be the answer for many, with ‘forty acres and a bot’ as a political campaign slogan of 2024.”

Luis Miron, a distinguished university professor and director of the Institute for Quality and Equity in Education at Loyola University in New Orleans, wrote, “Bluntly speaking, I have little confidence in the educational sector, K-16, having the capacity and vision to offer high-quality online educational programs capable of transforming the training needs of the wider society. The most important skills are advanced critical thinking and knowledge of globalization affecting diverse societies – culturally, religiously and politically.”

Pamela Rutledge, director of the Media Psychology Research Center, wrote, “The core assumptions driving educational content are not adapting as fast as the world is changing. Traditional models train people to equate what they do with who they are (i.e., what do you want to *be* when you grow up) rather than to acquire critical thinking and flexible skills and attitudes that fit a rapidly changing world. We have traditional institutions invested in learning as a supply-side model rather [than] demand-side that would create proactive, self-directed learners. This bias impacts the entire process, from educators to employers. It is changing, but beliefs are sticky and institutions are cumbersome bureaucracies that are slow to adapt. New delivery systems for skills related to technology will be more readily accepted than traditional ones because they avoid much of the embedded bias. ... Successful education models will begin developing ‘mixed methods’ to leverage technology with traditional delivery and rewrite certification processes with practice-relevant standards.”

Justin Reich, executive director at the MIT Teaching Systems Lab, observed, “There will continue to be for-profit actors in the sector, and while some may offer choice and opportunity for students, many others will be exploitative, with a great[er] focus on extracting federal grants and burdening students with debt than actually educating students and creating new opportunities.”

Show me the money: Many doubts hinge upon lack of political will and necessary funding

John Paine, a business analyst, commented, “The competing desires 1) to make educational activity available to all and 2) to monetize the bejeezus out of anything related to the internet will limit the effectiveness of any online learning systems in a more widespread context.”

danah boyd, founder of Data & Society, commented, “I have complete faith in the ability to identify job gaps and develop educational tools to address those gaps. I have zero confidence in us having the political will to address the socio-economic factors that are underpinning skill training. For example, companies won’t pay for reskilling – and we don’t have the political power to tax them at the level needed for public investment in reskilling. Furthermore, we have serious geographic mismatches, underlying discriminatory attitudes, and limited opportunities for lower-[to] mid-level career advancement. What’s at stake are not simply skills gaps – it’s about how we want to architect labor, benefits and social safety nets. And right now, we talk about needing to increase skills, but that’s not what employers care about. It just sounds nice. When computer science graduates from CUNY and Howard University can’t get a job, what’s at stake is not skills training.”

Some people are incapable of or uninterested in self-directed learning

Among the future worker capabilities with the highest value in these respondents’ eyes are the ability to adapt, or “pivot,” and the motivation to up-skill as needed. Many respondents emphasized that the most crucial skill is that people have to learn how to learn *and* be self-motivated to keep learning.

David Bernstein, a former research director, wrote, “The most important skills needed to succeed in the workplace will be flexibility and the ability to adapt and continuously learn. ... My biggest concern with self-directed learning is that it requires a great deal of internal motivation. And I am not confident that individuals will find their way, just as those who enter college today don’t know what they want to be when they grow up, often until after they graduate. So everyone will still need some basic skills (interpersonal communications, basic arithmetic, along with some general culture awareness) [so] they can have that flexibility. ... Any 3-year-old can use their parent’s smartphone or tablet without reading the manual. What I worry about is how well they will adapt when they are 35 or 55.”

Calton Pu, professor and junior chair in software at the Georgia Institute of Technology, wrote, “The most important skill is a meta-skill: the ability to adapt to changes. This ability to adapt is what distinguished *Homo sapiens* from other species through natural selection. As the rate of technological innovation intensifies, the workforce of the future will need to adapt to new technology and new markets. The people who can adapt the best (and fastest) will win. This view means that any given set of skills will become obsolete quickly as innovations change the various economic sectors: precision agriculture, manufacturing 4.0, precision medicine, just to name a few. Therefore, the challenge is not only to teach skills, but also how to adapt and learn new skills. Whether the traditional programs or new programs will be better at teaching adaptive learning remains to be seen.”

Cory Salvesson, learning systems and analytics lead at RSM US, responded, “The nature of work today, and in future, is such that if people want to keep increasingly scarce well-paying jobs, they will *need* to educate themselves in an ongoing manner for their whole lives.”

Some of these experts say those who aren’t motivated to continue to learn and grow will be left behind.

Scott Amyx, CEO of Amyx+, said online training is advancing and will continue to evolve, but, “The education system is at an inflection point. Many ambitious federal and state programs have fizzled, to produce dismal to no statistical change in the caliber of K-12 education. ... It’s those less-educated and less-skilled who are most sensitive to technological displacement. Online mediums and self-directed approaches may be limited in effectiveness with certain labor segments unless supplemented by human coaching and support systems.”

Beth Corzo-Duchardt, a professor at Muhlenberg College, replied, “Self-directed study is [a] variable that changes the alchemy of teaching and learning. It is true that most online courses require self-direction. Indeed, when I advise students, I don’t recommend that students take online courses unless they have demonstrated an aptitude for self-direction. But in-person courses may also be self-directed. This works well for some students but not others. Students who are self-directed often have had a very good foundational education and supportive parents. They have been taught to think critically and they know that the most important thing you can learn is how to learn. And they are also more likely to come from economic privilege. So, not only does the self-direction factor pose a problem for teaching at scale, the fact that a high degree of self-direction may be required for successful completion of coursework towards the new workforce means that existing structures of inequality will be replicated in the future if we rely on these large-scale programs.”

Theme 5: Jobs? What jobs? Technological forces will fundamentally change work and the economic landscape

Among the 30% of respondents who said they did not think things would turn out well in the future were those who said the trajectory of technology will overwhelm labor markets, killing more jobs than it creates. They foresee a society where AI programs and machines do most of the work and raise questions about people's sense of identity, the socio-economic divisions that already distress them, their ability to pay for basic needs, their ability to use the growing amount of "leisure time" constructively and the impact of all of this on economic systems. It should also be noted that many among the 70% who expect positive change in the next decade also expressed some of these concerns.

There will be many millions more people and millions fewer jobs in the future

Cory Doctorow, activist-in-residence at MIT Media Lab and co-owner of Boing Boing (boingboing.net), responded, "It's an article of faith that automation begets more jobs [than it] displaces (in the long run); but this is a 'theory-free' observation based on previous automation booms. The current automation is based on 'general purpose' technologies – machine learning, Turing complete computers, a universal network architecture that is equally optimized for all applications – and there's good reason to believe that this will be more disruptive, and create fewer new jobs, than those that came before."

Glenn Ricart, Internet Hall of Fame member and founder and chief technology officer of US Ignite, said, "Up to the present time, automation largely has been replacing physical drudgery and repetitive motion – things that can and should improve the quality of people's work lives. But in the next decade or two, there is likely to be a significant amount of technological innovation in machine intelligence and personal assistants that takes a real swipe out of the jobs we want humans to have in education, health care, transportation, agriculture and public safety. What are the 'new jobs' we want these people to have? If we haven't been able to invent them in response to international trade pacts, why are we sure we will be able to create them in the future?"

Richard Stallman, Internet Hall of Fame member and president of the Free Software Foundation, commented, "I think this question has no answer. I think there won't be jobs for most people a few decades from now, and that's what really matters. As for the skills for the employed fraction of advanced countries, I think they will be difficult to teach. You could get better at them by practice, but you couldn't study them much."

Jennifer Zickerman, an entrepreneur, commented, “The problem of future jobs is not one of skills training – it is one of diminishing jobs. How will we cope with a workforce that is simply irrelevant?”

Capitalism itself is in real trouble

Nathaniel Borenstein, chief scientist at Mimecast, replied, “I challenge the premise of this question [that humans will have to be trained for future jobs]. The ‘jobs of the future’ are likely to be performed by robots. The question isn’t how to train people for nonexistent jobs, it’s how to share the wealth in a world where we don’t need most people to work.”

Paul Davis, a director based in Australia, predicted, “Whilst such programs will be developed and rolled out on a large scale, I question their overall effectiveness. Algorithms, automation and robotics will result in capital no longer needing labor to progress the economic agenda. Labor becomes, in many ways, surplus to economic requirements. This ... shift will dramatically transform the notion of economic growth and significantly disrupt social contracts; labor’s bargaining position will be dramatically weakened. The nature of this change may require the world to shift to a ‘Post Economic Growth’ model to avoid societal dislocation and disruption.”

John Sniadowski, a systems architect, replied, “The skill sets which could have been taught will be superseded by AI and other robotic technology. By the time the training programs are widely available, the required skills will no longer be required. The whole emphasis of training must now be directed towards personal life skills development rather than the traditional working career-based approach. There is also the massive sociological economic impact of general automation and AI that must be addressed to redistribute wealth and focus life skills at lifelong learning.”

Tom Sommerville, agile coach, wrote, “Our greatest economic challenges over the next decade will be climate change and the wholesale loss of most jobs to automation. We urgently need to explore how to distribute the increasing wealth of complex goods and services our civilization produces to a populace that will be increasingly jobless in the traditional sense. The current trend of concentrating wealth in the hands of a diminishing number of ultra-rich individuals is unsustainable. All of this while dealing with the destabilizing effects of climate change and the adaptations necessary to mitigate its worst impacts.”

Some of these experts projected further out into the future, imagining a world where the machines themselves learn and overtake core human emotional and cognitive capacities. **Timothy C. Mack**, managing principal at AAI Foresight, said, “In the area of skill-building, the wild card is the degree to which machine learning begins to supplant social, creative and emotive skill sets.”

Responses from additional key experts regarding the future of jobs and jobs training

This section features responses by several more of the many top analysts who participated in this canvassing. Following this wide-ranging set of comments on the topic, a much more expansive set of quotations directly tied to the set of four themes begins on Page 40.

‘There will be a parallel call for benefits, professional development and compensation that smooths out rough patches’ in an ‘on-demand labor life’

Baratunde Thurston, a director’s fellow at MIT Media Lab, Fast Company columnist and former digital director of The Onion, replied, “Online training and certification will grow significantly in part due to the high expense of formal higher education along with its declining payoffs for certain occupations. Why go \$100,000 in debt for a four-year university, when you can take a more targeted course with more guaranteed income generation potential at the end? From the employer perspective, this type of learning will only grow. We are creating a system of on-demand labor akin to ‘cloud-based labor’ where companies ‘provision’ labor resources at will and release them at will, not by the year or month but by the job, labor unit, or small time unit, including minutes. The automation of human labor will grow significantly. And having a workforce trained in discrete and atomizable bits of skills will be seen as a benefit by employers. This of course is a terrible, soulless, insecure life for the workers, but since when did that really change anything? There will also be a parallel call for benefits, professional development, and compensation that smooths out the rough patches in this on-demand labor life, but such efforts will lag behind the exploitation of said labor because big business has more resources and big tech moves too fast for human-scale responses of accountability and responsibility. To quote Donald Trump, ‘Sad!’ ”

We will see much more personalized, adaptive forms of education

Doc Searls, journalist, speaker and director of Project VRM at Harvard University’s Berkman Klein Center for Internet & Society, wrote, “I don’t expect the evolution of work in the connected world to require ‘new educational and training programs.’ Instead, I expect we’ll see much more adaptive forms of education, especially of the self-made kind. Look at Linux and open-source development. The world runs on both now, and they employ millions of human beings. Many, or most, of the new open-source programmers building and running our world today are self-taught, or teach each other, to a higher degree than they are educated by formal schooling. Look at Khan Academy and the home-schooling movement, both of which in many ways outperform formal institutional education. The main qualification for programming work isn’t a degree. It’s proven capability. This model for employment of self and others will also spread to other professions. (By

the way, I don't like the term 'job.' It demeans work, and reduces the worker to a position in an org. chart.) The great educator [John Taylor Gatto](#), who won many awards for his teaching and rarely obeyed curricular requirements, says nearly all attempts to reform education make it worse. We are by nature learning animals. We are each also very different: both from each other and from who we were yesterday. As a society we need to take advantage of that, and nurture our natural hunger for knowledge and productive work while respecting and encouraging our diversity, a fundamental balancing feature of all nature, human and otherwise.”

'We will likely see a radical economic disruption in education, using new tools and means'

Jeff Jarvis, professor at the City University of New York Graduate School of Journalism, wrote, “At a roundtable on the future convened by Union Square Ventures a few years ago, I heard this economic goal presented: We need to see the marginal cost of teaching another student fall to zero to see true innovation come to education, allowing change to occur outside the tax-based (and thus safe) confines of public education. I don't think we'll ever reach zero; MOOCs are not the solution! But we will likely see a radical economic disruption in education – using new tools and means to learn and certify learning – and that is the way by which we will manage to train many more people in many new skills.”

The current education system is perpetuating the shortage of talent

Cory Doctorow, activist-in-residence at MIT Media Lab and co-owner of Boing Boing ([boingboing.net](#)), responded, “There is, for the immediate and medium term, a huge shortage of IT talent, of course – especially security researchers and professionals. In part, this is driven by the legal and educational framework that takes a zero tolerance approach to the 'hacking' that kids historically engaged in on their way to becoming security researchers. If a kid today hacks her school's censoring firewall to look at a blocked site, she is expelled (and possibly arrested), not streamed into an [Advanced Placement] computer science class. We also have a poorly constituted math curriculum for understanding 'algorithms' (which is really understanding the statistics of machine learning models). An earlier and more enduring focus on stats and statistical literacy – which can readily be taught using current affairs, for example, analyzing the poll numbers from elections, the claims made by climate change scientists, or even the excellent oral arguments in the Supreme Court Texas abortion law case – would impart skills that transferred well into IT, programming and, especially, security.”

Most important skill at the moment of the 'Cambrian Explosion of robotics' is adaptability

Amy Webb, futurist and CEO at the Future Today Institute, commented, “Gill Pratt, a former program manager of the Defense Advanced Research Projects Agency (DARPA), recently warned of a [Cambrian Explosion of robotics](#). About 500,000 years ago, Earth experienced its first

Cambrian Explosion – a period of rapid cellular evolution and diversification that resulted in the foundation of life as we know it today. We are clearly in the dawn of a new age, one that is marked not just by advanced machines but, rather, machines that are starting to learn how to think. Soon, those machines that can think will augment humankind, helping to unlock our creative and industrial potential. Some of the workforce will find itself displaced by automation. That includes anyone whose primary job functions are transactional (bank tellers, drivers, mortgage brokers). However, there are many fields that will begin to work alongside smart machines: doctors, journalists, teachers. The most important skill of any future worker will be adaptability. This current Cambrian Explosion of machines will mean diversification in our systems, our interfaces, our code. Workers who have the temperament and fortitude to quickly learn new menu screens, who can find information quickly, and the like will fare well. I do not see the wide-scale emergence of training programs during the next 10 years due to the emergence of smart machines alone. If there are unanticipated external events – environmental disasters, new pandemics and the like – that could devastate a country’s economy and significantly impact its workforce, which might catalyze the development of online learning opportunities.”

A lot of knowledge can be imparted by machines and doesn’t require ‘human interaction’

Mike Roberts, Internet Hall of Fame member and first president and CEO of the Internet Corporation for Assigned Names and Numbers (ICANN), responded, “MOOCs and related efforts are in their infancy, so ‘yes,’ there will [be] considerable expansion as more is learned about what works and what doesn’t work. These developments are contributing to a crisis of self-confidence in higher ed, where traditional scholarship is being challenged on many fronts, including the basic definition of ‘education.’ Human brains are complex, and it becomes tiresome to see simplistic approaches to education issues. Generally, an ‘educated’ person possesses a level of knowledge about the world that allows him or her to use analytical skills – induction, deduction, probability, etc. – to arrive at conclusions that guide behavior. The jury is very much out on the extent to which acquisition of knowledge and reasoning skills requires human interaction. We now have empirical evidence that a substantial percentage – half or more – can be gained through self-study using computer-assisted techniques. The path forward for society as a whole is strewn with obstacles of self-interest, ignorance, flawed economics, etc. If one believes in [‘the singularity,’](#) it doesn’t matter, because human-machine symbiosis will bury the problem!”

‘What should people know to be informed participants in a democracy?’

Judith Donath of Harvard University’s Berkman Klein Center for Internet & Society replied:

“A lot has been written about the need for STEM [science, technology, engineering and mathematics] education. Here I want to focus on other areas.

1) Teaching and Healing: As computers, robots and other machines take over many jobs, we need to reposition the social status of jobs that involve interpersonal care: day care, teachers, nurse, elderly, coach. The issue is not just training but cultural re-evaluation of teaching and healing as highly respected skills. While technology can assist with this work, we mustn't lose sight of the importance of human connections as an end in and of themselves.

2) Craft and Repair: For the benefit of both the individual and the environment, we need to strongly support learning design, craft, building, repair. Few of us make anything we use – from the building we live in to the objects we own – and these things are mostly manufactured as cheaply as possible, to be easily bought, discarded, and bought again, in a process of relentless acquisition that often brings little happiness. Education here should be integrated into everyday life, not just for when one is 'in school.' E.g., much rental housing is in bad repair, with tenants waiting weeks, months, years for even simple fixes – a running toilet, broken lights, a hole in a wall. Very easily accessible learning for how to fix these things themselves (and making it economically rewarding, in the case of a common good) – is a simple, basic example of the kind of ubiquitous craft learning that at scale would be enormously valuable. Some of this can be taught online – a key component is also online coordination.

3) An Informed Citizen: What should people know, what skills should they have, to be informed participants in a democracy? Certainly science and technology are important, but we need to refocus liberal education, not ignore it. History, in all its complexity. Critical thinking – how to debate, how to recognize persuasive techniques, how to understand multiple perspectives, how to mediate between different viewpoints. Key skill: how to research, how to evaluate what you see and read.”

'Learning in private is selfish. Public learning is becoming the norm.'

David Weinberger, a senior researcher at Harvard University's Berkman Klein Center for Internet & Society, said, “Judging from what we're seeing happening now on the web, it seems likely that many of [the innovative platforms] will be peer-to-peer. Sites like Stack Overflow for software engineers demonstrate a new moral sense that learning in private is selfish. Public learning is becoming the norm.”

Most of the focus will be on childhood education for the world

Brad Templeton, chair for computing at Singularity University, wrote, “We will see the start of these technologies, but they will not be widespread at the hard problem of adult retraining in 10 years. Instead, most focus will be on childhood education for the poorer sectors of the world. The

most important skill, flexibility, won't be taught easily this way, but must become a focus of K-12 education.”

Look at what MOOCs have done already

John Markoff, former senior writer at The New York Times, said, “We have now passed through the first generation of MOOCs, and a new generation of online learning technology is beginning to emerge. Udacity is a good example of the trajectory. Sebastian Thrun was one of the inventors of the MOOC concept. After starting a company to pursue the idea, he pivoted, focusing specifically on skill-oriented education that is coupled directly to the job market.”

The internet fosters innovation

Vint Cerf, vice president and chief internet evangelist at Google and an Internet Hall of Fame member, noted, “The internet can support remote training and learning. These need not be MOOCs. Even mobiles can be sources of education. I hope we will see more opportunities arising for sharing this kind of knowledge.”

The main teaching goal: ‘We will make you better than a robot. We let you cooperate with robots.’

Marcel Bullinga, trend watcher and keynote speaker @futurecheck, replied, “The future is cheap, and so is the future of education. I saw an ad already for \$1,000 bachelor’s-level training – with an app, of course. Schools and universities will transform in the same way as shops have done in the past 10 years from analog/human-first to digital/mobile/AI-first. New online credential systems will first complement, then gradually replace the old ones. The skills of the future? Those are the skills a robot cannot master (yet). Leadership, design, human meta communication, critical thinking, motivating, cooperating, innovating. In my black-and-white moments I say: Skip all knowledge training in high schools. Main teaching goal: ‘We enable you to survive in an ever-changing world with ever-changing skills and not-yet-existing jobs of the future. We make you better than a robot. We let you cooperate with robots. We build your self-trust. We turn you into a decent, polite, social person. And most importantly, we do *not* mix education with religion – never.’”

Acceptance and quality of training programs ‘will map to existing systemic biases’

Anil Dash, entrepreneur, technologist, and advocate @AnilDash, predicted, “These credentials will start to become widespread, but acceptance and quality of the training programs will map to the existing systemic biases that inform current educational and career programs.”

The most essential deep learning will not come from online systems

Henning Schulzrinne, Internet Hall of Fame member and professor at Columbia University, wrote, “Training programs have had the problem that short-duration generic programs are often not very effective except as a way to incrementally add very specific skills (‘learn how to operate the new industry-specific tool X in a week’) to the existing repertoire. The subject-matter-specific part of a B.S. degree in a technical or scientific field takes at least two years, often more, and these are high-intensity, full-time years, often without other responsibilities such as family, mostly for students at an age where learning is still natural and easy. A large part of this time is spent not in a classroom but becoming fluent through monitored practice, including group work, internships and other high-intensity, high-interaction apprentice-like programs. It is hard to see how workers can afford to spend two years without income support while still fulfilling their ‘adult’ responsibilities such as taking care of their family or elderly parents. There are possibilities for adding limited skill sets to otherwise qualified workers, e.g., the ability to program in Python for somebody who already has an economics degree, increasing their ability to get their work done. The MOOC-style programs have shown themselves to be most effective for this ‘delta’ learning for practicing professionals, not turning a high school graduate into somebody who can compete with a college graduate.”

We may soon be at the point where ‘adaptive algorithms learn jobs faster than humans’

Jamais Cascio, distinguished fellow at the Institute for the Future, responded, “We will certainly see attempts to devise training and education to match workers to new jobs, but for the most part they’re likely to fall victim to two related problems. **1)** The difficulty of projecting what will be the ‘jobs of the future’ in a world where the targets keep shifting faster and faster. Jobs that seem viable may fall victim to a surprising development in automation (see, for example, filmmaking); new categories of work may not last long enough to support large numbers of employees. **2)** We’re in an era of general-purpose computing, which means that our systems are not physically or procedurally limited to a narrow type of work. Automation and semi-automation (e.g., self-checkout stands) don’t need to completely eliminate a job to make it unable to support large numbers of workers. As learning systems improve, we will soon (if we’re not already) be at a point where adaptive algorithms can learn new jobs faster than humans.”

‘Very unlikely’ that a new training regime will be successful

Kate Crawford, a well-known internet researcher studying how people engage with networked technologies, wrote, “We clearly need new educational and training programs to address the [deepening precarity of the labor market](#). But to make it ‘successful,’ in that the right training could be developed to make it possible that everyone will have jobs, is very unlikely.”

New information flows will require new ways to think about education and learning

Paul Jones, clinical professor and director at the University of North Carolina, replied, “We learn more today by training and information sipping than in the past. Training is useful but not the end of education – only a kind of education. As for sipping: you need not know the name of every bear to know you should avoid bears. Yet the continual construction of knowledge and cultures requires more from us. So far, training formally as in Kahn Academy and Lynda.com are unarguably effective for continual updates for basic skills. No programmer or developer could keep up without the informal training of Stack Overflow. Wikipedia hasn’t destroyed bar trivia, but it has made a dent in our conversational expertise. Who played guitar lead on “All or Nothing”? No need for debate. A little information sip will let us know. We’re fine and informed – but not educated or learned. But what is left out? Collaborative construction of knowledge in new areas, deeper investigation into known areas, and the discovery of entirely new areas of knowledge. This is our challenge: how to create wisdom from knowledge, not just jobs from training and information.”

‘We need to think about co-evolving work and workers’

Bob Frankston, internet pioneer and software innovator, commented, “This is a nuanced question. We trained generations of people to be ‘phone operators’ by making it easy to operate the phone (aka, dialing). Today programming is increasingly become a trade. The problem with many websites is not so much the training of the programmers as much as getting managers and C-level people who understand the new concepts of a world being redefined by software. And that’s even more true for policymakers. We need to think about co-evolving work and workers. And, as always, critical thinking will remain the biggest challenge.”

Beware the model of for-profit learning

Frank Pasquale, author of “The Black Box Society: The Secret Algorithms That Control Money and Information” and professor of law at the University of Maryland, said:

“The biggest danger for the United States educational system is premature vocationalism. Rigorous science and humanities courses help students learn how to learn. Skills training all too often does not. Of course, it can complement core academic courses, and is likely to be part of a lifetime of learning for those switching occupations. But turning high school and college into narrow vocational education programs would make their graduates more vulnerable to robotic replacement, not less. We need to invest in higher education, shoring up support for traditional universities and colleges, lest they eventually become bastions for reproduction of an elite, leaving the rest of society to untested experiments or online programs. Online learning is a good complement for existing colleges – but cannot replace them. Online-only programs emphasize the upside of high-tech approaches, but rarely

grapple with the downside. Big-data surveillance will track the work students do, ostensibly in order to customize learning. Get stuck on a lesson? Just keep interfacing with a keyboard, camera and perhaps haptic sensors. Or perhaps IM some reserve army of tutorial labor via digital labor platforms like Mechanical Turk or TaskRabbit. Want to prove you aren't faking exams? Just let cameras record your every move and keystroke – perhaps your eye movements and facial expressions, too.

“With new platforms, Silicon Valley has lured some universities into giving away lectures for free. The colleges think they're establishing good karma with the public, but disrupters hope for a more chaotic endgame: students deciding to watch free courses, then proving their credentials to certifiers who give out 'badges' to signify competence in a skill set. The certifiers most likely won't be burdened with any of the teaching, research, community service, counseling (career or otherwise), recreation, social events, extracurriculars or other long-standing features of residential university communities. They will just verify that student X can do task Y. It could be a very profitable business. If students pay less for actual instruction by experts, they have more money to spend on badges. This is the for-profit model – shift money away from instruction and amenities and toward administrator salaries and marketing. Unburdened by legacy staff and faculty, 'ed tech' firms could muster a just-in-time workforce to develop new educational technologies. Investors could continue 'unbundling' the university into least-cost providers of content units, student surveillance, and badge-granting. That vision may draw capital, but it probably won't be attractive to many students. There are serious worries about rapid centralization and reuse of student data by under-regulated firms. For instance, black-boxed instructional technology is often run by algorithms that can't be accessed by the students it is assessing.”

School systems should leverage the same tools society and industry are using to transform their practice

Tom Ryan, CEO of eLearn Institute Inc., said, “The degree and perhaps the prestige of the institution gets you the first interview, but it is your ability to do good work that keeps the job and move[s] you to the next level. How individuals develop the skills will be less important [than] having the skills. As mastery learning evolves, so will our performance-based assessment systems, providing universities and businesses a greater set of evidence and qualifications than is currently available. Our traditional educational systems are burdened by 'legacy' bureaucratic practices that don't contribute to mastery of learning and distract from great teaching and learning. People in rural areas don't have physical access to [a] higher education campus or highly skilled trainers. Current job responsibilities don't allow flexible work schedules to seek skills to improve their position. K-12 teachers are constantly pulled from class time with students for professional

development or during class are required to take attendance, [complete] grade assessments, fill out grade checks, practice fire drills – all degrading quality teaching time. If online systems just removed these barriers they would be a great benefit, but there is so much more these systems can offer. Many of the new skills necessary for jobs of the future require digital skills to be successful. Too often education leaders and politicians make unilateral decisions about the interaction between teacher and learner instead of building and maintaining an environment for great teaching and learning to take place. Large school systems can't scale major improvements in current systems without leveraging the tools that society and industry are using to transform their practice.”

The people creating new jobs don't have time to think about what kind of workers they will need in the future

Barry Chudakov, founder and principal at Sertain Research and StreamFuzion Corp., replied:

“One serious drawback to fast-tracking needed educational and training programs: the people who are creating the jobs of the future have so little time to reflect and gain perspective on the people they will need – and how adding these people to their corporate culture changes that culture. These entrepreneurs are so busy building technology infrastructures, filing patents, testing beta incarnations of ideas and processes – not to mention navigating the thicket of regulations and restrictions that surround many emerging technologies and industries – that they simply don't have time to look around and see the implications of the changes their companies are creating. ...

“In the near future, we will explode the notion of education as a rite of passage for youth happening within the walls of an institution. Educational institutions will not disappear, but they will change in ways that make them almost unrecognizable by today's models. ... Just as Pokemon Go lifts people out of their chairs into real-world environments to explore imaginary captures, we will change learning from a passive to an active, dynamic experience. Three dynamics that will affect all learning and retraining efforts: 1) Newer tools are changing our sense of identity. 2) We are moving from the fixed point of view that the book gave us to a multiple, simultaneous narrative of flow in a networked environment. 3) Again, since what we think is what we think through, we are applying that logic of visual presentation to our presentation (and sense) of self. ...

“The first skill needed to succeed in the workforce of the future will be the ability to understand, manage and manipulate data. Everyone in a technology-based profession will

need to be a quant [[quantitative analyst](#)] or keep up with the quants. Because all human processes and activities can now be quantified, and there is considerable exploration and technology development in the application of quantification to everything from our sleep patterns and shopping habits to our emotions and online behaviors, many new and important business models are emerging from quantification and the learning algorithms that drive it.

“The second, and much more important, skill needed to succeed in the workforce of the future will be the ability to find meaning and value in data combined with the problem, condition, or opportunity the data is outlining. Said simply, the greatest skill will be the ability to think through the cloud of facts, data, experience and strategic direction that products and services require. Design thinking or visual thinking will be a critical part of managing a data-driven world. Data mining and management can be taught effectively. Thinking, problem-solving, reflection and visioning are difficult to teach at scale.”

‘We need real education (not job-focused) and opportunities’ for diverse pathways

Elisabeth Gee, professor at Arizona State University and author of “What Video Games Have to Teach Us About Learning and Literacy,” commented, “First, many jobs of the future won’t require workers with a lot of training. ... Second, degrees and credentials have been increasingly promoted by institutions more driven by profit than an interest in preparing students in any meaningful way for employment. If the government doesn’t step in to restrict such institutions, we’ll continue to see students graduate with huge debt and little prospect of decent employment. Lastly, we don’t need large-scale training of workers – we need real education (not job-focused) and opportunities for people to pursue diverse pathways for career development and lifelong learning.”

The greatest thinker of the 21st century will understand more about how she thinks, learns

Patrick Tucker, technology editor at Defense One and author of “The Naked Future,” observed:

“Online education offers the opportunity to gather data on student performance continuously, or telemetrically. ... What telemetric education offers is the opportunity to continuously and constantly evaluate a student to gain a much more comprehensive understanding of ability, retention of information, even how other behaviors and factors such as time of day, other calendar items, nutrition, amount of time on *Pokemon Go*, influence learning. It offers a more true moving score. ...

“Learning will become easier and much more of it will happen outside of school settings, all of which will diminish the importance of schools and teachers as we know them today. But platforms like Coursera can amplify the talents of gifted and effective instructors and reduce the cost of education in the coming decade for all. Some schools and colleges will thrive and prosper at a level not seen in their history. But they will do so only by transitioning away from today’s classroom model toward something else, like data-driven skills workshops at the high school level and startup incubators or problem-solving workshops at the college level. ...

“We may be conflicted about replacing classes with platforms, but if we are to be honest with ourselves, we know that we can’t prepare coming generations for the challenges of a technological and globalized economy the same way we prepared previous generations to be factory workers. The greatest thinker of the 21st century, [whoever] he or she is, will understand more about how she thinks and learns than any student in any previous generation, and all before ever stepping foot inside a schoolhouse. Imagine for a moment the power of knowing beforehand how well you would perform on a test. Laura Matzen of Sandia National Laboratory and some of her colleagues have demonstrated that the brain’s electrical activity, detectable via electroencephalogram (EEG), predicts how well studied material has been incorporated into memory, and, thus, how well a subject will perform on memory tests. Telemetric education also offers the opportunity for everyone to raise his or her hand and be heard. That opportunity doesn’t come easily in a crowded classroom – especially not for women or minority students, many of whom feel that if they ask the wrong question or display ignorance, they’ll confirm some unflattering, broadly held perception about their social group.”

‘We need more of an emphasis on the fundamental purposes of education, not ‘skills’

David Golumbia, associate professor of digital studies at Virginia Commonwealth University, commented, “As an educator, I am completely unconvinced by the current rhetoric that says our educational system is unable to meet the needs of current or future workforces. This whole argument is a sham meant to attack the fundamental purpose and basis of education. Most empirical evidence shows that the premises of this question are incorrect: most ‘high-skilled’ jobs of the sort implied here have an oversupply of qualified talent. We need more of an emphasis on the fundamental purpose of education, not on ‘skills.’ ”

Few skills require personal instruction from an expert; all may be automated

Stephen Downes, researcher at the National Research Council of Canada, commented:

“We will see educational and training programs that can successfully train large numbers of workers, because for the most part mechanisms will be in place that enable them to train themselves.

“Within 10 years, we should be beginning to see that the idea of ‘providing’ training education or training is misguided, because it’s overly expensive and less effective than self-managed learning. I find it interesting, even, that the question itself presumes that skills must be ‘taught.’ ‘Which of these skills can be taught effectively via online systems?’ It’s not that the skills are taught, per se, but rather [that] the skills are learned. A wide range of activities may enable skills to be learned – especially multidisciplinary skills, such as critical thinking or social interaction – without specifically teaching those skills.

“There are very few skills that require specific and personal instruction from an expert to learn – frankly, I can’t think of any – which means that within 10 years we should at least be able to countenance the possibility that all, or nearly all, educational programs may be automated. Of course, they will continue to require the time and participation of the individual learner, and in many cases, social interaction with other learners, but the labor-intensive learning industry we have developed to this point will not be required. I see no major objections to this argument: **1)** It may be argued that personal interaction is required in order to get to know a student, and therefore anticipate what they need. However, in 10 years it will be arguable (and probably demonstrable) that your own computer networks will know you better than any individual instructor could, even an instructor who worked with you your entire life. Sure, there are disasters like the Facebook news stream, but people are already amazed at how much Google knows about them. And we know that with enough data analytics can outperform humans even in complex tasks. **2)** It may be argued that personal interaction is required in order to evaluate a student’s level of achievement. Most actual assessment (not to be confused with multiple-choice tests) in school or professional programs is based on expert recognition. The submitted behavior (an essay, performance in surgery, piloting an aircraft in a simulation) is not assessed according to whether a set of indicators is achieved (this would possibly be a necessary, but never a sufficient, condition). The expert looks at the overall behavior and assesses whether that competency has been met. The expert is serving as a proxy for the community at large. With modern communications technology, this proxy is no longer required.

“Through the course of any given day, as a person goes through various activities, they interact with dozens of other people, either in person or through online interaction. Each person responds to them in some way, not by testing them, but by (for example) engaging

them in conversation, asking questions, following advice, etc. These responses, over time, form a comprehensive (and constantly changing) assessment of the person.”

What about the future of jobs training for ‘artilects’?

An **anonymous postdoctoral fellow at Rice University’s Humanities Research Center** observed, “So much has been said and challenged over the past three decades about online education. I’d like to answer this by asking a different set of questions which address recent developments in robotics and artificial intelligence. How will autonomous factories in Chicago, U.S., share what they’ve learned with factories in Pingdingshan, China? What credentialing system will self-driving cars require? How will artificially intelligent laborers learn the skills needed to run a household, business, government institution, or political organization? When will universities allow artilect [[nonhuman artificial-intelligence](#)] students to enroll in their traditional undergraduate and graduate degree programs, and how would students learn the more ephemeral skills like critical thinking from a thinking machine?”

About this canvassing of experts

The expert predictions reported here about the impact of the internet over the next 10 years came in response to one of eight questions asked by the Pew Research Center and Elon University's Imagining the Internet Center in an online canvassing conducted from July 1 to Aug. 12, 2016. This is the seventh “[Future of the Internet](#)” study the two organizations have conducted together. For this project, we invited nearly 8,000 experts and members of the interested public to share their opinions on the likely future of the internet, and 1,537 responded to at least one of the questions we asked. This particular report covers responses to one of five questions in the canvassing. Overall, 1,408 people responded. Some 684 of them gave answers to the follow-up question asking them to elaborate on their answers about the future impact of algorithms.

In the next 10 years, do you think we will see the emergence of new educational and training programs that can successfully train large numbers of workers in the skills they will need to perform the jobs of the future?

The answer options were:

Yes – 70%

No – 30%

Then we asked: Please also consider addressing these issues in your response. You do not have to consider any of these. We have added them because we hope they might prompt your thinking on important related issues: What are the most important skills needed to succeed in the workforce of the future? Which of these skills can be taught effectively via online systems – especially those that are self-directed – and other nontraditional settings? Which skills will be most difficult to teach at scale? Will employers be accepting of applicants who rely on these new types of credentialing systems, or will they be viewed as less qualified than those who have attended traditional four-year and graduate programs?

The web-based instrument was first sent directly to a list of targeted experts identified and accumulated by Pew Research Center and Elon University during the previous six “Future of the Internet” studies, as well as those identified across 12 years of studying the internet realm during its formative years. Among those invited were people who are active in global internet governance and internet research activities, such as the Internet Engineering Task Force (IETF), Internet

Corporation for Assigned Names and Numbers (ICANN), Internet Society (ISOC), International Telecommunications Union (ITU), Association of Internet Researchers (AoIR), and Organization for Economic Cooperation and Development (OECD). We also invited a large number of professionals and policy people from technology businesses; government, including the National Science Foundation, Federal Communications Commission and European Union; and think tanks and interest networks (for instance, those that include professionals and academics in anthropology, sociology, psychology, law, political science and communications), as well as globally located people working with communications technologies in government positions; technologists and innovators; top universities' engineering/computer science departments, business/entrepreneurship faculty, and graduate students and postgraduate researchers; plus many who are active in civil society organizations such as the Association for Progressive Communications (APC), the Electronic Privacy Information Center (EPIC), the Electronic Frontier Foundation (EFF) and Access Now; and those affiliated with newly emerging nonprofits and other research units examining ethics and the digital age. Invitees were encouraged to share the canvassing questionnaire link with others they believed would have an interest in participating, thus there was a "snowball" effect as the invitees were joined by those they invited to weigh in.

Since the data are based on a nonrandom sample, the results are not projectable to any population other than the individuals expressing their points of view in this sample. *The respondents' remarks reflect their personal positions and are not the positions of their employers; the descriptions of their leadership roles help identify their background and the locus of their expertise.* About 80% of respondents identified themselves as being based in North America; the others hail from all corners of the world. When asked about their "primary area of internet interest," 25% identified themselves as research scientists; 7% as entrepreneurs or business leaders; 8% as authors, editors or journalists; 14% as technology developers or administrators; 10% as advocates or activist users; 9% as futurists or consultants; 2% as legislators, politicians or lawyers; and 2% as pioneers or originators; an additional 25% specified their primary area of interest as "other."

More than half the expert respondents elected to remain anonymous. Because people's level of expertise is an important element of their participation in the conversation, anonymous respondents were given the opportunity to share a description of their internet expertise or background, and this was noted where relevant in this report.

Here are *some* of the key respondents in this report:

Robert Atkinson, president of the Information Technology and Innovation Foundation; **Fred Baker**, fellow at Cisco; **Naomi Baron**, a professor of linguistics at American University; **danah**

boyd, founder of Data & Society; **Stowe Boyd**, managing director of Another Voice; **Marcel Bullinga**, trend watcher and keynote speaker; **Randy Bush**, Internet Hall of Fame member and research fellow at Internet Initiative Japan; **Jamais Cascio**, distinguished fellow at the Institute for the Future; **Barry Chudakov**, founder and principal at Sertain Research and StreamFuzion Corp.; **David Clark**, Internet Hall of Fame member and senior research scientist at MIT; **Cindy Cohn**, executive director at EFF; **Anil Dash**, entrepreneur, technologist, and advocate; **Cathy Davidson**, founding director of the Futures Initiative at the Graduate Center of the City University of New York; **Cory Doctorow**, writer, computer science activist-in-residence at MIT Media Lab and co-owner of Boing Boing; **Judith Donath**, Harvard University's Berkman Klein Center for Internet & Society; **Stephen Downes**, researcher at the National Research Council of Canada; **Bob Frankston**, internet pioneer and software innovator; **Oscar Gandy**, professor emeritus of communication at the University of Pennsylvania; **Marina Gorbis**, executive director at the Institute for the Future; **Jeff Jarvis**, a professor at the City University of New York Graduate School of Journalism; **Jon Lebkowsky**, CEO of Polycot Associates; **Peter Levine**, professor and associate dean for research at Tisch College of Civic Life; **Mike Liebholt**, senior researcher and distinguished fellow at the Institute for the Future; **Rebecca MacKinnon**, director of Ranking Digital Rights at New America; **John Markoff**, author of "Machines of Loving Grace: The Quest for Common Ground Between Humans and Robots" and senior writer at The New York Times; **Jerry Michalski**, founder at REX; **Andrew Nachison**, founder at We Media; **Frank Pasquale**, author of "The Black Box Society: The Secret Algorithms That Control Money and Information" and professor of law at the University of Maryland; **Demian Perry**, director of mobile at National Public Radio; **Justin Reich**, executive director at the MIT Teaching Systems Lab; **Mike Roberts**, Internet Hall of Fame member and first president and CEO of ICANN; **Michael Rogers**, author and futurist at Practical Futurist; **Marc Rotenberg**, executive director of EPIC; **David Sarokin**, author of "Missed Information: Better Information for Building a Wealthier, More Sustainable Future"; **Henning Schulzrinne**, Internet Hall of Fame member and professor at Columbia University; **Doc Searls**, journalist, speaker and director of Project VRM at Harvard University's Berkman Klein Center for Internet & Society; **Ben Shneiderman**, professor of computer science at the University of Maryland; **Richard Stallman**, Internet Hall of Fame member and president of the Free Software Foundation; **Brad Templeton**, chair for computing at Singularity University; **Baratunde Thurston**, a director's fellow at MIT Media Lab, Fast Company columnist and former digital director of The Onion; **Patrick Tucker**, technology editor at Defense One and author of "The Naked Future,"; **Steven Waldman**, founder and CEO of LifePosts; **Jim Warren**, longtime technology entrepreneur and activist; **Amy Webb**, futurist and CEO at the Future Today Institute; and **David Weinberger**, senior researcher at Harvard University's Berkman Klein Center for Internet & Society.

Here is a selection of some of the institutions at which respondents work or have affiliations:

AAI Foresight, Access Now, Adobe, Altimeter Group, The Aspen Institute, AT&T, Booz Allen Hamilton, California Institute of Technology, Carnegie Mellon University, Center for Digital Education, Center for Policy on Emerging Technologies, Cisco, Computerworld, Craigslist, Cyber Conflict Studies Association, Cyborgology, Dare Disrupt, Data & Society, Digital Economy Research Center, Digital Rights Watch, DotTBA, EFF, EPIC, Ethics Research Group, European Digital Rights, Farpoint Group, Federal Communications Commission, Flipboard, Free Software Foundation, Future of Humanity Institute, Future of Privacy Forum, FutureWei, Gartner, Genentech, George Washington University, Georgia Tech, Gigaom, Gilder Publishing, Google, Groupon, Hack the Hood, Harvard University's Berkman Klein Center for Internet & Society, Hewlett Packard Enterprise, Human Rights Watch, IBM, InformationWeek, Innovation Watch, Institute for Ethics and Emerging Technologies, Institute for the Future, Institute of the Information Society, Intelligent Community Forum, International Association of Privacy Professionals, ICANN, Internet Education Foundation, Internet Engineering Task Force, Internet Initiative Japan, Internet Society, NASA's Jet Propulsion Laboratory, Karlsruhe Institute of Technology, Kenya ICT Action Network, KMP Global, The Linux Foundation, Lockheed Martin, Logic Technology Inc., MediaPost, Michigan State University, Microsoft, MIT, Mozilla, NASA, National Institute of Standards and Technology, National Public Radio, National Science Foundation, Neustar, New America, New Jersey Institute of Technology, The New York Times, Nokia, Nonprofit Technology Enterprise Network, New York University, OpenMedia, Oxford Martin School, Philosophy Talk, Privacy International, Queensland University of Technology, Raytheon BBN Technologies, Red Hat, Rensselaer Polytechnic Institute, Rice University's Humanities Research Center, Rochester Institute of Technology, Rose-Hulman Institute of Technology, Semantic Studios, Singularity University, Social Media Research Foundation, Spacetel, Square, Stanford University's Digital Civil Society Lab, Syracuse University, Tech Networks of Boston, Telecommunities Canada, Tesla Motors, Department of Defense, US Ignite, UCLA, UK Government Digital Service, Unisys, United Steelworkers, University of California, Berkeley, University of California, Irvine, University of California, Santa Barbara, University of Copenhagen, University of Michigan, University of Milan, University of Pennsylvania, University of Toronto, Vodafone, We Media, Wired, Worcester Polytechnic Institute, Yale University, York University.

Complete sets of for-credit and anonymous responses to the question can be found here:

http://www.elon.edu/e-web/imagining/surveys/2016_survey/future_jobs_training.xhtml

http://www.elon.edu/e-web/imagining/surveys/2016_survey/future_jobs_training_credit.xhtml

http://www.elon.edu/e-web/imagining/surveys/2016_survey/future_jobs_training_anon.xhtml

Theme 1: The training ecosystem will evolve, with a mix of innovation in all education formats

To a striking degree, the experts who answered “yes” – that new ways of teaching and learning will successfully emerge for job skills advancement – focused on how trainers, educators and employers will innovate new ways to implement and partner with technology to provide solutions that enhance outcomes. Many of the hopeful respondents predicted that the education ecosystem would sort itself out such that different kinds of learning needs would be met in different kinds of learning systems. They said that, while universities will play important roles, they expect that by 2026 traditional classroom education will be successfully paired with the expansion of online learning programs like Massive Open Online Courses ([MOOCs](#)), which will evolve to include elements of augmented and virtual reality, artificial intelligence, and gamification.

One typical summary assessment came from **Bryan Alexander**, president of Bryan Alexander Consulting and an expert on how technology can transform education. He wrote, “There are plenty of forces coming together to make [successful training of large numbers of workers for jobs of the future] happen. Businesses continue to demand more training of new employees, and charge the education system with making it happen. Governments are frantic to boost training in what they often see as a knowledge economy, seeking to spark their own version of Silicon Valley. New alternatives to traditional education keep appearing, from coding academies to MOOCs (still happening, especially beyond the U.S.) to automated tutors (think [Duolingo](#)). Depressed salaries and wages combine with anxieties about students’ loans to drive students into focusing like lasers on economic payoffs from learning. Countervailing forces are not strong enough to oppose these drivers. ... Technical challenges are falling, especially as mobile devices continue to grow and the populace is increasingly comfortable with distance learning as one part of online life. We should watch for new forms of online learning at scale.”

Below are some key subthemes that tie into the overarching thought that existing training systems will continue to improve and new ones will emerge, evolve and succeed in the next decade.

More elements will migrate online. Some will be self-directed, some offered or required by employers; others will be hybrid online/real-world classes. Workers will be expected to learn continuously

A majority of the respondents in this canvassing expect that formal education systems – K-12, community colleges, universities, postgraduate programs – will maintain some traditions while taking on new roles. They predict that – due to the high costs of higher education – other nonprofit and for-profit organizations will fill more specialized training roles and supplemental

foundational education elements while many employers provide their own training programs and/or require workers they hire to train on their own to up-skill and become certified in certain specialties. They expect that savvy workers will be self-motivated to take advantage of always-available educational material online.

Jon Lebkowsky, CEO of Polycot Associates, replied, “We’re evolving and perfecting tools for training and education that can be enhanced by technology, and in some cases can be completely online. We can see signs of emergent innovation in educational systems and technology. We can also foresee a demand for more and better training, which implies the probability of a robust marketplace outside the traditional academic paths.”

Nigel Cameron, president and CEO of the Center for Policy on Emerging Technologies, “Huge. No question, next-gen MOOCs using VR will move to center stage, delivering zero marginal cost training/education in many sectors, including the lower and middle components of postsecondary education. Perhaps a breakout will come from the community college sector. Interpersonal collaboration, communication, entrepreneurship ... may well offer the best surviving jobs.”

Laura Stockwell, digital strategy consultant and owner of Strat School, replied, “We are already seeing the emergence of online training and education systems that are training people, and people are choosing these approaches over traditional schooling options. That is not to say universities will go away, but they will transform, as they already have begun to do. Research also points to a majority of the workforce being freelance in the next 10 years and there being less stigma around job-changing. That means that people will rely less on employers for training and advancement and will take training and job advancement into their own hands. As for qualifications, the best universities teach people to think, but many do not leave with the skills they need for the workplace. It may be that degrees are still valuable for teaching ‘how’ to think while training programs teach more skills-based programs. Or – in an ideal world – learning how to think and analyze occurs in high school. Being able to think and analyze will be critical with so many jobs being taken over by computers.”

Garland McCoy, president of the Technology Education Institute, wrote, “The internet is uniquely suited for individualizing education so that you can successfully move significant numbers through educational programs.”

An **anonymous engineer at Neustar** observed, “We are rapidly improving our ability to effectively train people over the internet, and that will be used to substantially improve all kinds of skills at a scale and cost that has not been achievable with more primitive, in-person training, or less-effective self-directed training.”

George McKee, a retiree, observed, “High-quality, free education sources such as Coursera and MIT’s Open CourseWare already allow anyone to acquire as much knowledge as they are capable of assimilating. Top-rank colleges will remain important, not for their direct educational value, but for the personal relationships that they enable among the managing and governing classes.”

Simon Gottschalk, a professor in the department of sociology at the University of Nevada, Las Vegas, gave a comprehensive answer in which he predicted four-year colleges will eventually “fade over time.” He wrote, “Coding, big-data analysis capacities, efficient management of resources, abstract and logical thinking, rapid response, the ability to think across information systems, etc. will be necessary skills in one of the sectors of this new workplace. In another [area], the necessary skills will include obedience, rapid response, efficient management of customers/simple services/machines, ability to maintain order, security, to confront emergencies, etc. ... While online education bestows competence in a particular topic, mastery necessitates face-to-face education and learning with/from someone. Mastery is in turn perhaps necessary for evolutionary creativity. Hence different sectors of the workforce will get different types of education – depending on the functions they are to fulfill in it. The preference of four-year college graduates over online students depends on the workplace in question and the position they are applying for. In any case, this preference will also probably fade over time.”

Mary Chayko, a professor of communication and information at Rutgers University, responded, “We are already seeing the rapidly growing popularity of such nontraditional training programs as professional certifications, post-baccalaureate certificates, coding boot camps, etc. They are becoming indispensable in training a workforce whose technical skills must be almost constantly updated. While nontraditional curricula are most easily kept current and relevant, traditional four-year and graduate programs will continue to excel at providing broader context and deeper understandings regarding technology and its consequences. Employers will value applicants trained in diverse settings – traditional and nontraditional, face-to-face and digital – who can respond nimbly to constant change.”

Sunil Paul, entrepreneur, investor and activist at Spring Ventures, observed, “Yes, it’s obviously already happening with Khan, Coursera, Lynda, Udacity and the avalanche of other ed-tech companies. Silicon Valley sees that the mass-production education of high school and college is broken. At Sidecar, we hired one of the top performers from a code academy. He had an undergraduate degree in international relations that took four years. But after three months in a code academy and a few years mentorship by senior developers, he became one of our top software engineers.”

Robert Matney, COO at Polycot Associates, wrote, “Self-paced and asynchronous Learning Management Systems (LMS) will not replace ‘meatspace’ educational and occupational instruction, but it will grow to significantly supplement it.”

Dan McGarry, media director at the Vanuatu Daily Post, said, “Most of the most powerful tools will be crowdsourced. People will begin to come to terms with the limits of their own predictive capabilities and will learn to design and improve learning systems iteratively.”

Marcus Foth, professor of interactive and visual design at Queensland University of Technology, wrote, “I suspect that the mass educational approach of MOOCs will be tempered with more sophisticated peer-to-peer connected learning that traverses online and physical realms. The trend in new types of spaces (maker spaces, incubation spaces, co-working spaces, etc.) seems to give rise to a new form of [Bauhaus](#). Maybe Bauhaus 2.0?”

Marc Rotenberg, executive director of EPIC, wrote, “We can anticipate more effective and immersive techniques for online training and education. Credentialing will remain important, but there will also be new forms of evaluation to assist employers.”

Kevin Novak, CEO of 2040 Digital and previously chief digital officer for the U.S. Library of Congress, replied, “The internet has created many opportunities for education and skill enhancement outside of our traditional education systems. A majority of knowledge gain is now self-directed. Higher education institutions continue to expand their online offerings towards self-direction while attempting to retain some form of the older models. The younger generations and their aptitude for technology will continue to expand their use of self-direction and individual knowledge gain. Organizations seeking to increase or improve staff skills should recognize the trends in the marketplace and adapt.”

Daniel Wendel, research associate at the MIT Scheller Teacher Education Program, replied, “The rapid evolution of technology is quickly outpacing our ability to teach it within the constructs of traditional educational systems. However, human needs and cognition and the ways in which people learn have not changed and will not change nearly as quickly. We, as a society, will certainly be forced into new models of education in which stale knowledge is quickly expunged and methods of thinking and doing displace facts as the primary focus of instruction and testing. However, the massive online systems of today (and even the next decade) lack many of the features of school that are necessary for normal cognitive development. Over time, I believe such online resources will become ‘modules’ that can be ‘plugged in’ to a new education system that keeps in place many of social constructs of current schools. What advocates of the MOOC movement miss is that education is much more complicated than knowledge transfer, and has implications for social

development, family life, childcare, community formation, and more. Only when those other aspects are considered will the overall ‘feel’ of education begin to noticeably change.”

Jim Warren, longtime technology entrepreneur and activist, responded, “We have already seen *some* of those kinds of programs, both legitimate ones and costly legal scams of questionable (at best!) value. We *will* see *much* more of both of these – probably (hopefully) including some amount of legal oversight/control of those that have little (or no!) value; sort of like the minimal nutritional information that has (finally!) been forced on Big Foods. However, there are – and will continue to be – *major* areas of education/learning/teaching where skills and competency can be taught/shared online only in *very* limited ways (if at all).”

Shannon Tucker, an assistant dean of instructional design and technology at the University of Maryland, commented, “President Obama’s initiative ‘[CS for All](#)’ is an important first step in educating a generation on the technology skills necessary to participate in a technology-centric society. Funding and supporting this initiative provides an opportunity for industry and nonprofit organizations to support training of our K-12 students, but also educators, parents, and others involved in the educational pipeline to develop technology skills to support this initiative. However, encouraging sustained participation, supporting a wide range of educational needs and learning preferences will be a significant problem.”

Laurie Orlov, principal analyst at Aging in Place Technology Watch, replied, “The new training will be online – and filled with video – likely for licensing of work that includes serving an older population – see Penrose Senior Care Auditors, for example:
<https://penroseseniorecareauditors.com/>”

Janice R. Lachance, interim president and CEO of the Better Business Bureau Institute for Marketplace Trust, responded, “Online learning is a welcome and useful tool for today and tomorrow’s workforce. ... [It] is critical for just-in-time skills or continuing professional development. In this day and age, no one can stop learning, and new competencies and knowledge will always be required. Online learning is the key to career progression and simply keeping up. I believe employers are willing to accept online certificates and degrees, especially from reputable sources. Employers don’t always know how to hire for today’s workplace demands, and a certificate in a particular subject can be the difference between getting a job offer and being a runner-up. This acceptance by employers will pressure online educators to better their offerings. Competition in the online learning environment, along with pressure from employers, will require educational outlets to up their game and offer quality courses.”

Adrian Schofield, an applied research manager, commented, “From schools to universities, from agriculture to manufacturing, more of the learning techniques will be delivered through personal devices, with the technology able to measure the level of understanding and to deliver the content appropriately. Assessment systems will keep pace, so that employers will be able to evaluate applicants’ abilities at the interview stage (or even before then).”

James Hinton, truck driver and writer, predicted, “The next decade will see positive growth in terms of educational opportunities and education thanks to the Internet. I previously worked as a writer for a search engine optimization company whose largest client was a consortium of famous traditional colleges (for example, the University of California, Davis) who were breaking into offering advanced degrees in 100% online settings. The thing that impressed me about this was that a pharmacist in a remote location such as Salmon, Idaho, could achieve a doctor of pharmacy (Pharm.D) without having to quit her job and move away. While the effect of this may be relatively minor for urban centers, for rural, less-developed areas this could be an injection of lifesaving blood, reversing the trend of young, ambitious people leaving for lack of educational opportunity. It’s quite the exciting development.”

Helmut Kremer, professor of information systems at the Technical University of Munich, observed, “It will be more than MOOCs: It will be the use of individualized tutoring for learners and personalized learning journeys that can be thought that way beyond purely technical skills. Using audio instead of typing for interaction will also help. However, the classical universities (at least the top ones and the cheap ones) will stay, since they serve additional purposes other [than] learning (other purposes are networking, socialization, etc.)”

M.E. Kabay, professor of computer information systems at Norwich University, wrote, “We already have the technology in place to reach a significant portion of the globe’s population even in developing countries – smartphones. Asynchronous online education at simple levels of awareness and training can support massive improvements in technical competence and in creativity. At a basic level, everyone needs to be able to learn new concepts, vocabulary and skills to continue contributing to a changing world – changing demographically, culturally and physically (think global warming and overpopulation). Clearly *reading* is one of the most important skills, and online courses can help people learn this essential skill. Similarly, increasing technical vocabularies is achievable using simple online training tools. Effective online examination of acquired skills will support the effort to improve individuals and organizations. The most difficult skills include critical thinking and evaluation of multiple sources of information, some of them contradictory, in the absence of a known correct result. The acceptance of online training and education will evolve as evidence accumulates of correlations between such processes and metrics rooted in real-world evaluations.”

Peter Morville, president of Semantic Studios, said, “I’ve been a skeptic of ‘distance education’ for a long time, but we’re finally starting to see online learning approaches that work. Our teenage daughter learned to code a responsive website (HTML and CSS) using Code Academy, and she’s now using Khan Academy to study for the new SAT. These learning tools really work, and they will disrupt traditional education.”

Lee McKnight, associate professor at Syracuse University’s School of Information Studies, observed, “The ‘future’ is the present for the cloud industry. Amazon makes more profit from its cloud offerings than the entire rest of the business – and of course offers plentiful online tools for students/prospective customers of any age and location to train themselves up. The wide availability of free education and training tools from all major cloud vendors for those seeking to join the growing numbers of workers with those advanced skills shows this future is here. Especially since university offerings of courses on distributed and cloud computing are narrowly focused in computer science departments, workers and industry have had to train themselves. However, more intensive faculty interaction, whether online or off, will still help researchers and advanced students, and hence future workers, learn the more broad-based critical analytic skills cloud industry leaders need. I fully expect many more universities to offer cloud management and cloud architecture courses as we do at the Syracuse University School of Information Studies, to meet the needs for hundreds of thousands of professionals with such training.”

An **anonymous director at a nonprofit technology network** said, “I see a huge emergence of on-demand (self-guided) training in areas that it has not traditionally been. For example, this type of education has traditionally been used in the professional space for mandatory trainings in the area of human resources – things such as ‘blood-borne pathogens,’ etc. We have seen a massive growth in personal learning (DIY, self-help, etc.) on platforms like YouTube, [Udemy](#), and others. The next step is for the self-guided side of professional development to catch up to these two areas. Things like learning management systems will allow to individuals to gain skills in areas they want to advance in, not just areas they are required to pass a certification for.”

An **anonymous open-source technologist** commented, “We will surely see the emergence of new training programs – in fact, we must. Modern commerce relies on increasingly specialized and in some cases arcane knowledge (Linux, machine learning, virtual machines, blockchain, etc.) that has to be widely distributed to achieve sufficient scale for sustainability. We already seem to lack engineers in many domains. Training people of all kinds with these needed skills will lead to greater productivity, and the danger is of stagnation without these people.”

A **senior futurist and strategic foresight consultant** wrote, “I refer to these as micro colleges. By 2030, the average person entering the workforce had better plan to reboot their career six times throughout their working life. This type of training will become very popular.”

Scott McLeod, associate professor of educational leadership at University of Colorado, Denver, said, “Some of the key skills needed for the workforce of the future include the abilities to be a critical thinker, a problem-solver, and an effective communicator and collaborator, often across global contexts and within technology-infused environments. Many of the subskills necessary to do these things well can be taught through various online mechanisms. These subskills’ preparation environments will be particularly effective if, while they are being learned, the subskills are immediately put to use by being combined with opportunities to make a difference in the real world rather than remaining relegated to artificial, ‘classroom’-limited assignments.”

An **anonymous respondent** replied, “I earned a graduate degree entirely online, fully accredited by the accepted organization of my field. It was a wonderful experience and I can't help but see how more and more educational experiences will happen online. You can reach more people with fewer resources. As Western society operates more as a knowledge-and-service economy rather than a making-stuff-based economy, specialized knowledge will become the norm. Learning skills necessary in knowledge work is fit for distance, asynchronous and self-directed learning. Programming, computer software and hardware engineering, IT job skills can be learned in this new way. Some fields, such as medicine and business, will benefit from hybrid training programs, both traditional and nontraditional. Overall, as our economy changes, training styles will change. While in-person learning and serendipitous discovery of new knowledge can never be replaced, it can certainly be augmented with new learning systems.”

An **anonymous professor at New York University** pointed out that for many technical professions, a full and very successful set of diverse training options, many of them online only or hybrid classroom/online, is already available, writing, “This is not really a prediction, since it's there now, for programmers. [General Assembly](#), [Flatiron School](#), etc., are the new trade schools.”

An **anonymous social scientist** agreed that for many fields, online cutting-edge training resources are already fully available and deemed to be valuable. He said, “We are already there! What we haven't done is align what skills we need from workers with the future of work itself. We wait years for skilled workers to matriculate through broad, expensive graduate curricula and it's not clear whether they/we needed 1% or 99% of that for the wait and cost. The wider availability of such training expands the geographic reach of the potential workforce, it rewards curiosity without such steep financial penalty, and it removes us from the notion that a new science, for example, will grow and persist. It allows the learning space to grow, adapt and recede as new ones emerge.”

Daniel Menasce, a professor of computer science at George Mason University, said value will continue to be found in online *and* traditional settings, writing, “The workforce of the future will be mostly service-oriented. To be successful, workers will have to be competent in their technical areas and must have good people skills, time-management skills and basic management skills. Some of the technical skills, such as learning about a specific product, can be taught effectively via online systems at larger scales. But I still believe teaching fundamental concepts is better suited for classroom environments in which the instructor can have a close interaction with students and tailor the explanation to the needs of specific students. My opinion is informed by more than four decades of teaching experience and by my experience of having taught online and in classroom settings. The nontechnical skills I mentioned above are even less suited for being taught via online systems. Employers recognize that most employees have to be trained on the job. Therefore, they want employees who can learn as opposed to employees who have been taught a canned set of skills but have a harder time learning new ideas and concepts. In that respect, I believe that traditional four-year and graduate programs will still be preferred. In summary, online systems can be used for training, while traditional university programs are better suited for education.”

Some respondents pointed out that there have been well-established corporate training programs of various types for decades and said they expect these to be more refined but not necessarily offered online.

John Perrino, a digital and creative communications associate at George Washington University, predicted, “Expect more boot-camp-style programming training programs and corporate sponsorship to build feeder programs of specially trained students from all walks of life. Online courses are great for building and reinforcing new skills, but do not expect them to be as valued as specially created and selective boot camp programs.”

There was pushback against the corporate boot camp approach. An **anonymous respondent** commented, “Unless incentives change, the gap between the vision of Jefferson and the vision of an obedient boot camp will keep growing in conflict – more coding and myopia, less creativity.”

Another **anonymous respondent** remarked, “I expect employers to continue to under-invest in their workers, and continue the trend of requiring higher and higher bars in terms of education, experience and personal connections for any sort of position that isn't the most disposable.”

An similarly critical attitude about corporate training was expressed by an **anonymous respondent** who said, “The ‘skills gap’ is an effect of corporations abandoning their historical responsibility to train their employees, trying to push career-specific training onto universities or individuals, with the result that those who already have the resources available to train themselves

are rewarded, those without resources are penalized, and taxed university budgets are further taxed to make up for savings accrued by corporations while having their educational missions compromised. The framing of the question does not allow this answer.”

Several respondents mentioned the importance of matching people to the best programs to suit their needs in the ever-evolving training and education marketplace. **Terry Langendoen**, an expert on information and intelligent systems based at the U.S. National Science Foundation, wrote, “Such programs will certainly continue to emerge. However, the real question is whether they ‘will’ (not ‘can’) succeed. The most important skills are computational and inferential, and at this level of abstraction these are the same types of skills that have been needed since the start of the industrial revolution. The current educational and training frameworks have largely been developed in response to this need, not only in science and engineering, but also in humanities and the arts. It’s fair to say that no single type of program has been shown to be adequate; many types of programs have been and will continue to be needed because of the wide variation in people’s abilities and inclinations to develop the requisite skills, and the really hard problem is to match individual learners to the programs that will be most effective in developing their skills.”

Many respondents observed that throughout the history of “work,” smart people have stayed ahead in the game via a learning ethic they practice regularly. At a time of accelerating change, this has become crucial. **Travis Allison**, business owner and consultant at CampHacker, commented, “The most important skill will be the ability to continuously learn – that will be very easy to encourage online as we take the lessons of attention-driving behavior from Facebook and other successful social networks and apply them to education.”

People with some level of expertise by the millions have been creating their own how-to training tutorials and videos online, many of them open-source and free. An **anonymous university professor in internet studies** observed, “YouTube is already there with the how-to videos. The ‘crowd’ is already there, helping out.” And an **anonymous internet governance activist** based in Kenya noted, “Kenyan braiders now learn West African methods from You Tube and use such skills for gainful employment.”

Joan Noguera, professor at the University of Valencia Institute for Local Development, Spain, replied, “A lifelong learning approach will be definitively needed to accompany workers in the process of gaining the new skills that they will need to gain continuously as technology and the information society quickly evolve.”

Demian Perry, director of mobile at NPR, commented, “Maintaining relevance in the modern workplace will require continuing education, not as a replacement but as a supplement to the more

foundational learning (in logic, philosophy and organized thought) that comes with a traditional four-year or graduate program.”

Ryan Hayes, owner of Fit to Tweet, wrote, “I see the relationship between learning and working as becoming a lifelong process, versus the system we have today where we learn in an environment separate from work for many years and then we work in an environment separate from learning for many years. I wear a lot of hats as an entrepreneur, but one of the areas that I spend considerable time is in using technology to train my team to pivot quickly to new processes as our business and industry (social media) changes rapidly. It’s not just onboarding new employees, it’s ensuring that our whole team is constantly growing and adapting, and that will become necessary in more industries as the rate of change picks up.”

Online courses will get a big boost from advances in augmented reality (AR), virtual reality (VR) and artificial intelligence (AI)

Some respondents expressed confidence in the best of the existing online education and training options, saying online course options are cost-effective, evolving for the better, and game-changing because they are so accessible globally. Those with the most optimism about the future of mass skills education generally believe great progress will be made in online training for effective learning because they expect to see rapid implementation of advances in augmented reality (AR), virtual reality (VR) and artificial intelligence (AI). An **anonymous chief marketing officer at a major provider of educational materials** replied, “Many investments are being made and experiments being run in the area of skills training, and there is every reason to believe that a blended model, heavy on self-paced instruction and exercises, will continue to expand. Virtual reality will find its most practical application in the area of skills training, so that we will ultimately be able to teach ourselves skills that once required expensive hands-on experience to master.”

Katharina Anna Zweig, a professor at Kaiserslautern University of Technology, Germany, wrote, “Many groups are currently working on blending the real environment with a virtual environment in which information and learning instructions will be blended in whenever it is meaningful and useful for the person to learn it. We will need to be careful that those machines support learning of the individual and do not replace it by their omnipresence. However, I am optimistic that we will be able to design teaching environments that will optimally motivate everyone to learn more.”

Vance S. Martin, instructional designer at Parkland College, commented, “If we think of it as ‘training,’ then yes, I believe this is achievable at scale and online. With greater bandwidth and VR

and AR, it will be possible to train people in Alaska and Texas how to install and repair Tesla Powerwalls or work on self-driving electric vehicles. Studies from Roy Pea at Stanford or Robb Lindgren at [the University of Illinois at Urbana, Champaign] have shown how simulations can improve ‘training.’ If we think about the ‘skills’ people will need in the future, this could refer to soft skills like communication, interpersonal relations or public speaking. These are more difficult to train using asynchronous or synchronous online classes, MOOCs or presumably coming versions with AR/VR. So we may have technically capable employees who need on-the-job training in how to operate in the workplace.”

Chris Zwemke, a web developer, said, “The skills needed in the next decade will not be different than the skills needed today: understanding of systems and complex machinery and ... artisanal hand work for manufacturing higher and higher quality goods. Perhaps the best (if not only) use for virtual reality outside of children’s games. Virtual reality stands to add a tactile mode of large-group learning to join visual and audio. The teaching of these skills will be effectively the same, except rather than expensive physical classrooms with limited real-world application (due to cost), virtual reality will be able to simulate the best-, worst- and standard-case scenarios at much less cost. The [remote] learning over an internet connection rather than at a center of education ... will make it easier for educators to evaluate and assist more student[s] equally.”

An **anonymous web and mobile developer** replied, “As technologies like VR and AR are becoming more common, training and education will use [these] tools. I can image a Google Glass-like device where users have a step-by-step wizard to help starting to use new equipment, or where school children are using VR headsets to travel in space and time to different countries and different ages, enriching their learning experiences.”

Peter Brantley, director of online strategy at the University of California, Davis, predicted, “There will be a greater ability to reach people who are seeking training and learning through video tools, particularly immersive technologies, such as AR and VR. However, these will be expensive to produce and difficult to evaluate the outcomes in, particularly in terms of retained learning. Some hybrid forms will continue to be seen as essential as learning evolves.”

Mary K. Pratt, a freelance journalist who covers enterprise technologies, said, “It seems that nearly any topic can have at least portions taught online; only hands-on skills would need something more. The growth in virtual and augmented reality could create more virtual hands-on educational opportunities, however; we already see such uses in the medical space where computers and 3-D printing help train doctors or help them prepare for complex procedures. This kind of approach will likely move into other disciplines.”

Marina Gorbis, executive director at the Institute for the Future, predicted, “It will be easy to learn specific skills with the help of various tools (including virtual reality) that could guide workers in situ to understand how to use machinery or design things. As we embed information into physical spaces and objects, potentially the whole world becomes a classroom. You can point to a plant and learn its genus, origin, etc. Point to a building to learn its history or demographics of the place. *Pokemon Go* is an early signal of what is possible when we overlay context-specific information in physical places. I imagine similar applications will emerge for educational purposes. While specific skills will be relatively easy to learn, the skills for critical thinking and sense-making – which are essential to success – will be harder to learn, as these require deeper understanding, reflection and thinking that is not skill-specific and beyond particular disciplines.”

Ed Dodds, digital strategist at Convergence, replied, “VR and virtual world 3-D object-based training will allow simulation-based education to be more effective.”

Steven Polunsky of Spin-salad.com agreed, writing, “Increasing interactivity, 3-D, and virtual reality will expand the number of jobs susceptible to computer-based learning. Universities and private startups will compete for this audience.”

A share of these experts expect that artificial intelligence systems will be incorporated. For instance, **Ken Koedinger**, professor of human-computer interaction and psychology at Carnegie Mellon University, responded, “We will increasingly have technology support for ‘expertise transfer.’ Experts will be able to teach computers their skills. And these computers will act as intelligent tutoring systems to help others acquire these skills.”

An **anonymous senior fellow at the University of California, San Diego** is one of many who agree that AI-based adaptive learning systems will ramp up learning results. He observed, “Many jobs that require human interaction are hard to train without elements of the traditional hands-on approach. However, many skills can be taught better by systems that are adaptive to the learning style of the student, and with increased augmentation of human tutors by AI we can get faster and more personalized feedback to help students learn.”

An **anonymous director of a major U.S. university’s futures initiative** added, “Adaptive learning is getting better all the time. IBM’s partnership with Blackboard will be a beginning. AI-trained teaching assistants will be a help. For some skills in some areas (statistics, coding), adaptive online learning works exceptionally well for some people in some situations. Hybrid learning augments the benefits.”

An **anonymous technologist** commented, “Currently online learning is hit or miss. Artificial intelligence with training will allow people to have training aimed at their comprehension levels. As online training becomes more credible, employers will accept [it] as work experience.”

An **anonymous software-testing engineer** said, “The combination of VR and AI is going to come into its own as a method of training more workers. The single most important skill for workers is knowing how to learn.”

Jannick B. Pedersen, futurist and impact investor at DareDisrupt, expects that such advances will allow online learners to enroll in training settings that individual students can experience as if they are in fully functioning one-on-one teacher-learner situations, “AI/neural networks will result in the emergence of learning systems resembling those of one-teacher-one-student,” he predicted, adding, “Use of ‘gamified’ learning approaches will improve learning impact and skill absorption.”

Scott Amyx, CEO of Amyx+, wrote, “Online educational platforms (K12.com, online universities, YouTube DIY videos, Scratch MIT) are setting the pace and tone for a new era of learning for children and adults. We have witnessed a wide spectrum of subjects being taught via online systems, from core curriculum to advanced AI and machine learning courses.”

Michael Dyer, a computer science professor at the University of California, Los Angeles, said, “Most difficult to scale are those skills that require human interaction (e.g., medical skills involving patients), but within 20 years robust virtual reality and AI software agents will make even these kinds of skills easily scaled up for online learning. ... Within the next 20 years, credentialing will be more common than 4-5[-year] degree programs, in terms of the number of people using credentialing.”

An **anonymous senior technology security architect** disagreed with the AI enthusiasts, commenting, “Success won’t be the result of new educational or training programs, at least not dramatically different from what’s available now. Slapping a VR headset over a Second Life-style lecture hall isn’t innovation. Some improvements here are only going to be incremental. More importantly, these don’t scale well, as development of course material and recruiting good instructors both remain fairly intractable to technological solutions. And I’m sorry, but I don’t believe mind chatbots are going to replace lecturers anytime soon.”

Universities still have special roles to play in preparing people for life, but some are likely to diversify and differentiate

Quite a few of the invited respondents who submitted comments in this canvassing work at a university or have had fruitful university experiences, so it should come as no surprise that they had insights to share about the values such an education bestows upon those who can afford the cost and the time to enjoy a residential college experience with face-to-face mentoring.

Larry Gallagher, organizational insight analyst at Stanford University, commented, “The skills that are cited as most important – creative problem-solving, collaboration, skilled communication – are not easily taught in isolation via online methods. There will always be a need for collaborative, face-to-face interactions as an integral part of learning. ... I do believe that the deeper learning (again, collaboration, skilled communication, and the like) can enhance the performance of almost any worker, and opens up the possibility of creative improvements within the workplace itself. That is, a business can benefit from having a thoughtful, agile workforce, one that is constantly on the lookout for how to do things better. These are attitudes that are best inculcated beginning in kindergarten and nurtured through continuous modeling in the K-12 and higher education systems.”

Karen Blackmore, lecturer in information technology at the University of Newcastle, commented, “While online educational and vocational training exists and increases, the capacity to communicate using a multichannel approach, to engage and work effectively in teams, and interpersonal skills remain key skills for our future workforce. Indeed, as we move to a global workforce, the ability to communicate within and across cultural boundaries is critical. While intrinsical skills are required, the holistic approach currently afforded by traditional undergraduate programs is difficult to teach at scale.”

Richard Forno, senior lecturer of computer science and electrical engineering at the University of Maryland, Baltimore County, replied, “We already see a trend toward online procurement of technical and task-oriented training to fill critical jobs in many fields, such as IT. That’s fine, but if such narrowly tailored efforts do not foster the development of other competencies (i.e., teamwork, critical thinking, writing well, understanding contexts) needed to be a capable professional – what most two- and four-year universities provide – this process will provide trained technicians to fill the many immediate ‘job’ opportunities, but not necessarily the well-rounded foundation needed for a cohesive long-term career path. There is so much more to being a competent working professional than just ‘technical skills,’ you know!”

An **anonymous professor at City University of New York** wrote, “With texts, developing online content and developing cutting-edge curricula, I see a variety of clear differences between the kind of instruction available through, for example, online videos, and the kind of learning environment we try to create in a college, one that includes the development of the individual’s sense of identity, high-level information discrimination, ethics and more.”

Rob Smith, software developer and privacy activist, responded, “Clearly there are many skills that require practice and direct feedback to learn successfully, and it’s obvious that these will be less well-suited to an online environment than some others. ... I suspect we’ll see universities focusing more on these foundational skills with options for specifics such as individual programming languages or development environments being moved online. This would increase choice for students, form the basis of a lifelong career of learning and could perhaps differentiate the more committed and able students from the rest. It might also help employers to become more accepting of online training. A job candidate with a good foundational degree from a good university and lots of additional credits for online learning might be expected to rate more highly (in terms of qualifications if not actual ability) than one with just online qualifications but is lacking the foundations. Or perhaps vice versa, depending on what the job is. In summary, I think online courses are here to stay and will proliferate. Companies and universities will make more use of them. And this is generally a good thing, because it would help people to tailor their education more closely to their abilities, interests and the type of job they want (ditto for employers). Perhaps it would go some way to solving some of the problems we face with the university system particularly in places like the U.S. and (increasingly) the UK.”

David Karger, a professor of computer science at MIT, wrote, “Computers can currently do a pretty good job of teaching calculation (by giving and checking lots of calculation exercises) or facts (with automated flash cards) or language (by giving and checking lots of translation exercises). But computers can or will soon be able to calculate, remember and translate for us. It’s much harder for computers to engage in abstract thinking, design a new product, compose a convincing argument on a topic or make art, but those are also things we haven’t yet figured out how to *teach* using computers. But as I mentioned above, these are all things that people can teach each other, and the web provides a powerful medium to connect teachers to learners. No matter how good our online teaching systems become, the current four-year college model will remain dominant for quite some time. Partly because of credentialing, but also because four-year colleges involve far more than teaching. College has encouraged us to stretch our notion of adolescence, thus 22 is the new 18. Those four years are a time when our coddled children are slowly eased into adulthood in an environment that gives them more independence than true children but far more support than adults have historically needed. We aren’t going to take that away. Even if we do away with the teachers and physical courses, this age group will continue to migrate to large

residential blocks full of people just like them so they can build social bonds and learn how to be adults away from their parents.”

The high costs of residential universities are still expected to continue to inspire new alternatives that may prove attractive enough to draw many learners and thus cut down on future overall enrollment numbers.

Peter Eckart, a respondent who did not share additional identifying details, commented, “I don’t know what shape this will take, but I do know that the current higher education system is economically unsustainable. New training models will start at the lower end of the scale (activities/work that take less time to train) and then scale up as we figure out what works.”

Daniel Berleant, author of “The Human Race to the Future,” wrote, “Educational technology using computers for distance and self-paced instruction will continue to thrive and advance. The high cost of instruction will continue to exert pressure to reduce costs using computer technology, resulting in steady advances in that direction. Ultimately, the teaching profession will face progressively decreasing job opportunities as automation continues to encroach.”

Joshua Segall, a software engineer, replied, “We will see new methods of learning driven by increased cost of university tuition. They will be better at focused skill training and self-taught tactical skills. They will be poor at teaching critical thinking, strategy, and social skills such as communications skills and good management.”

Some respondents mentioned the divide between the elite who can afford a university education and those who cannot. **Tse-Sung Wu**, a project portfolio manager at Genentech, observed, “We are already seeing the proliferation of traditional teaching systems into the internet, with MOOC courses offered by leading American universities. The peril is that this may create a two-tiered educational system: one for the masses, online only; and one of the elite, at higher price, in-person. Not surprisingly, the skills that are most difficult to teach using these technologies are anything that is hands-on, requires face-to-face nonverbal communication, or otherwise is related to the provision of in-person services. These so-called soft skills are culturally and geographically specific, and, using current technology, probably aren’t easily taught except in person. Secondly, in a sophisticated, post-industrial economy such as the U.S., EU and other wealthy economies, the role of marketing, customer service, user-experience design and delivery is increasingly important. Think of how you can find a piece of home furnishing at Restoration Hardware and be inspired of its provenance and manufacture: ‘This birdhouse is made one by one by a group of fisher folk on the Andaman Sea who have been passing this craft mother to daughter for generations.’ Compare it to the same exact item at Target for a tenth of the price. Like design, these will be the high-value

tasks, while engineering and manufacturing continues to be commoditized. So it depends on the application: I can imagine a multinational corporation willing to employ a poor Bangladeshi educated only in a MOOC offered by MIT if she's only going to code. But if you want this person to design and oversee the retail experience of upper-middle-class Shanghai, you'll end up with someone from an elite school, who had in-person interactions and, more importantly, the face-to-face relationships that led them to you."

One respondent sees a move to more online opportunities as a way to route around some inequities. An **anonymous software architect** said, "Education needs to be re-democratized. This exclusivity ... has to stop. It breeds contempt for those who 'didn't make it into the best (or any?) university' by those who do. Inequality is directly related to the ability to become educated, which is clearly out of reach for most Americans today, at least those without the financial means or those willing [to] sell their souls for loans (indentured servitude, anyone?!). No, only the scrappy will survive. The already-comfortable will become increasingly more uncomfortable as the rich get richer and everyone else gets poorer – as the boiling frog analogy goes, most won't notice until it is too late. Education is the key."

Some respondents said universities do not gear up quickly enough to provide the education necessary for many workers – especially those who are rapidly displaced (even after a university education) by automation. An **anonymous developer** commented, "Employers will continue to move to just-in-time training as old skills are replaced by new ones. Traditional four-year training programs are an anachronistic 'coming of age' ritual unsuited to the needs of continuous training of an aging workforce. Already over 100 million people in the USA are not working, and they can't all go back to college."

Theme 2: Learners must cultivate 21st-century skills, capabilities and attributes

Will training for the skills likely to be most important in the jobs of the future work be effective in large-scale settings by 2026? Respondents in this canvassing overwhelmingly said yes, anticipating improvements in such education will continue. However, when respondents answered the question, “Which of these skills can be taught effectively via online systems?” most generally listed a number of “hard skills” such as fact-based knowledge or step-by-step processes such as programming or calculation – the types of skills that analysts say machines are taking over at an alarming pace right now. And then, when asked, “What are the most important skills needed to succeed in the workplace of the future?” while some respondents mentioned lessons that might be taught in a large-scale setting (such as understanding how to partner with AI systems or how use fast-evolving digital tools) most concentrated on the need for “soft skills” best developed organically, mentioning attributes such as adaptability, empathy, persistence, problem-solving, conflict resolution, collaboration and people skills, and critical thinking.

Tough-to-teach intangibles such as emotional intelligence, curiosity, creativity, adaptability, resilience and critical thinking will be most highly valued

Many who mentioned the value of soft skills also noted that they are difficult to teach and difficult to evaluate in a clear-cut, objective manner in any setting, and a majority of these people said today’s MOOCs are not as effective as real-world settings in cultivating them. An **anonymous professor of information and history at one of the largest U.S. state universities** wrote, “It’s crucial to realize that students don’t just need skills, they need knowledge as well, and especially education in how evidence and data are gathered and processed, how to assess the quality of evidence, and [how to use] global frameworks that make sense of evidence/data and place them in a correct context. These things are very difficult to teach in a classroom, and nearly impossible to teach in large, anonymous, online settings.”

Overall, as these respondents foresee a big re-sorting of workplace roles for machines and humans, they expect that the jobs-related training systems of the future will often focus on adding or upgrading the particular capabilities humans can cultivate that machines might not be able to match.

An **anonymous respondent**’s terse description of top future skills was echoed by many dozens of others in this study: “Learning will, in itself, become important. The skill to continue to learn will be important in all jobs.”

Susan Mernit, CEO and co-founder at Hack the Hood, explained, “At Hack the Hood, the tech-inclusion nonprofit I lead, the most valuable skill we teach low-income young people of color, ages 16-25, is that they have the ability and the discipline to learn harder and harder things – the most critical skill for the emerging workplace. Research shows that for our cohorts a blend of online and real-world learning is an effective mix.”

George McKee, a retiree, predicted, “As always, the most important skills will be the ability to learn and organize new things and to discriminate sense from nonsense. Public schools will continue to fall behind in their ability to foster these skills in large populations.”

Meryl Krieger, career specialist at Indiana University, Bloomington’s Jacobs School, replied, “The most important skills in the workforce of the future are 1) transferrable skills and 2) training in how to contextualize and actually transfer them. These are really hard to teach at scale, but then the workforce of the future is something we are barely coming to have the dimmest perceptions about.”

Jessica Vitak, an assistant professor at the University of Maryland, observed that the most-needed skills are capabilities that have always had value, writing, “As much as people like to imagine the future being heavily reliant on robots and high-tech gadgets, I don’t see too much of the workforce shifting dramatically in terms of the skills required to complete tasks.”

Many other participants in this study said highly valued strengths of human character will be necessary to partner with technology in jobs of the future. An **anonymous respondent** wrote, “The increasing reach of data, automation and eventually AI will force those jobs that remain to require even greater human touch.”

Susan Price, a digital architect at Continuum Analytics, expanded on that point, explaining, “People will continue to prefer and increasingly value human nurses, teachers, writers, artists, counselors, ethicists and philosophers. This shift has been apparent over the past 20 years or so. As we have come to prefer ATMs over tellers and travel apps over travel agents, our patronage of other ‘human contact’ specialists such as counselors and therapists, personal trainers, manicurists, and massage therapists has increased. Example: People skills in user interface and experience design will be increasingly in demand, but will greatly benefit from artificial intelligence and machine learning for usability evaluations and testing. Another example: The role of truck drivers will need to evolve as they are replaced with self-driving transports. There will remain the need for humans to manage transportation tracking and auditing, perform problem-solving, and to occupy stakeholder contact roles such as sales and customer-support communication.”

Trevor Hughes, CEO at the International Association of Privacy Professionals, replied, “Training will indeed be an important part of preparing the workforce for our digital future, but it won’t be easy. Many of the skills of the future are *hybrid* skills – requiring expertise or fluency across some of our traditional domains. Take privacy as an example. Any digital economy professional needs to understand privacy and how it creates risk for organizations. But that means grasping law and policy, business management, and technology. Modern professionals will need to bridge all of these fields.”

An **anonymous respondent** replied, “The two trends with the most hype right now are AI and VR. Let’s assume that these technologies will have a large impact on the nature of the future work. The workforce of the future (that is not completely displaced by this tech) then needs the skills to utilize these technologies. Some broad skills I anticipate are interacting with machine learning systems, reasoning with underlying algorithms and embedded judgments, being comfortable delegating tactical decisions to those algorithms, etc.”

Michael Rogers, author and futurist at Practical Futurist, said, “In a rapidly changing work environment populated by many intelligent machines, we will need to train people from an early age in communication skills, problem-solving, collaboration and basic scientific literacy. Without those basics in place, occupational training is insufficient.”

The **anonymous director of evaluation and research** at a university ranked in the top 10 in the U.S. wrote, “Sure, Lynda.com and Udacity and others that can provide skills, just like the corporate training programs we use now. ... But those skills won't be the same as an *education* – as the habits of mind and social interleavings that make for the types of problem definition, interdisciplinary perspectives, and incisive thought that will be most needed – deep engagement with the stuff of distinctly human capabilities.”

Justin Reich, executive director at the MIT Teaching Systems Lab, observed, “The most important skills for the future will be the kinds of things that computers cannot readily do, places where human workers have a comparative advantage over computers. Two important domains of human comparative advantage are ill-structured problem solving and complex, persuasive communication. (Frank Levy and Richard Murnane’s ‘[Dancing with Robots](#)’ offers a nice summary of the research informing this position.) Ironically, computers are most effective at teaching and assessing routine tasks, the kinds of things that we no longer need human beings to do. Large-scale learning, which generally depends on automated assessment, is most effective at teaching the kinds of skills and routine tasks that no longer command a living wage in the labor market.”

An **anonymous CEO for a nonprofit technology network** argued that some “soft” skills can be taught, observing, “Many research reports have demonstrated that one of the most important skills in our developing workforce is reasoning and complex problem solving. The internet enables us to teach and practice these skills in a unique and appropriate way by connecting and engaging people across geographies, backgrounds, ages, etc.” And an **anonymous professor at the University of California, Berkeley** said, “I do think there will be a *lot* more online training in the future – and it will actually be more successful at teaching things that are not directly translatable to jobs (humanities subjects, such as art history, media studies, etc.) – the things that television documentaries are already good at teaching. I'm not sure that great writing skills or public speaking/presentation skills will be taught in this format.”

Alf Rehn, professor and chair of management and organization at Åbo Akademi University in Turku, Finland, responded, “The key thing to realize about skills and the future is that there is no one set of skills that we can identify as core or important. The future of skills is going to be one of continuous change and renewal, and any one special skill we can identify now will almost certainly be outdated in not too long. Creativity and critical thinking will be as important in the future as it is today, but beyond this we should be very careful not to arrogantly assume too much. And this is precisely why new programs, online and off, will be so crucial. Innovative, faster and more agile training systems will not only be helpful, they'll be critical.”

An **anonymous self-described “chief problem solver”** said the world needs problem solvers, writing, “Huge portions of the human condition can be effectively learned through one-to-many learning environments enabled through the internet. Many cannot. ... If you take a look at the prevalence of strong problem-solving skills in our society now versus 20 years ago, you'll notice that an overwhelming majority are now quite specialized in their particular areas of interest/work, but on average have less ability than their counterparts 20 years ago to adequately handle new/incongruous/conflicting information or tasks. Instead of figuring it out and thereby training up our ingenuity-focused skills, we now tend to simply Google someone else's answer. While this is ‘efficient’ in terms of getting to an adequate solution rapidly, it means that ... people are not able to handle new inputs, be flexible, or actually puzzle out new problems.”

Many participants mentioned the general categories of communication and people skills. An **anonymous respondent** summed it up, writing, “No matter what kind of hard skills one comes to the workplace with, at the end of the day things always seem to boil down to people and communication challenges.”

Micah Altman, director of research at MIT Libraries, wrote, “Given the increased rate of technical change and the regular disruptions this creates in established industries, the most

important skills for workforces in developed countries are those that support adaptability and which enable workers to engage with new technologies (and especially information and communication technologies) and to effectively collaborate in different organizational structures.”

Ryan Sweeney, director of analytics at Ignite Social Media, said, “The most crucial skills to succeed in the future are going to be the following: **1)** critical thinking [and] **2)** human engagement (people skills). Many technical skills can be taught or learned online. There is a decreasing need to memorize information since it’s at our fingertips. Being able to learn how to learn and having the ability to problem solve will guide a successful workforce in the future. Human engagement is just as important, and increasingly more so as we shut ourselves off from others and engage digitally. I wager empathy is harder to learn without physical interaction; however, continued discourse surrounding social issues around race, gender, etc. will help strengthen empathy. With that said, I think we would see benefit from physical schools focusing on human interaction and critical thinking with more trade-school-type offerings. Most everything else could be through online systems that could make higher education more affordable and accessible. Additionally, with virtual reality having a comeback moment, the technology for a more interactive class will be more present.”

An **anonymous technology analyst for Cisco Systems** commented, “The gig economy takes over, and micro-skill training will come to the fore. Debate is a most important skill that can be taught online, emphasizing the importance of preparation.”

Louisa Heinrich, founder at Superhuman Limited, commented, “We will have to launch massive re-education initiatives as technology continues to advance; if we do not, [there will be] strain on our social safety nets and even our social [fabric]. There are those who envision a post-work utopian society, but I don’t think we (as society) are culturally prepared for that. A large proportion of traditionally working-class jobs will be taken by robots or AIs, and that workforce will need to be re-trained. E-learning would be an ideal means of doing this at the trade and intermediate levels, enabled by widespread free broadband internet access and increasingly natural technology interfaces (VR/AR, voice input, natural language processing, etc.). Equally urgent is the need for our universities to stop behaving like factory farms churning out degrees mapped to job specs – as the business and technology landscape changes more and more rapidly, studying toward a specific job title and fixed skill set will become more and more untenable.”

An **anonymous respondent** observed, “The job of the future is the one that combines technical, operational, managerial and entrepreneurial skills.”

Axel Bruns, professor in the Digital Media Research Center at Queensland University of Technology, wrote, “Over the past decade there has been a substantial growth in generic digital literacies training, and this is now being replaced or enhanced by literacies training in specific areas and for particular purposes (social media literacy for communication professionals, data literacy for journalists, etc., to name just two particularly obvious fields). There has also been the emergence of a range of specialist positions that address the cutting edge of such literacies – under job titles such as data scientist or computational journalist, for instance. Across the creative industries, and beyond, the possession of such skills will increasingly serve as a differentiator between job applicants, and within organisational hierarchies in the workplace. Those who possess these skills are also more likely to branch out beyond their core disciplines and industries, as many such skills are inherently interdisciplinary and enable the worker to engage in a wider range of activities. Beyond generic digital literacies, some of the key areas I see as important are: **1)** platform-specific literacies, e.g., social media literacies; **2)** data science, i.e., the ability to gather, process, combine, and analyse ‘big data’ from a range of sources; **3)** data visualisation. Until the accreditation schemes for workers with these skills are standardised, which eventually they will be, we will continue to see leading workers in these areas ... be able to enter the workplace on the basis of their demonstrated expertise and track record rather than on the basis of formal accreditation. While there are many MOOCs and other online courses now purporting to teach these skills, it is important to point out that there is a substantial qualitative component to these skills – somewhat paradoxically, perhaps, especially where they deal with ‘big data’: the engagement with such large datasets is less about simply generating robust quantitative metrics and more about developing a qualitative understanding of what such metrics actually *mean*. Such an understanding is difficult to teach through semi-automated online courseware; direct teacher/learner interaction remains crucial here.”

An **anonymous vice president of product at a new startup** commented, “In a grand folly of correlation being mistaken for causation, we’re trying to pipeline all kids into college to try to juice their earnings, while steering kids away from practical technical skills like manufacturing tech that might be a better fit, opting instead to saddle them with student loans for a degree they won’t finish from a school that no employer will respect.”

An **anonymous principal consultant at a strategic-change organization** boiled it all down into two action steps. “Some new skills will be taught,” he wrote, “but not always the ones you might expect. ... The technical landscape is rapidly changing, and it is very difficult to anticipate exactly what is going to help prepare our children for the future. I see two important actions to consider: **1)** Build a foundation – basic computer and network literacy, together with critical thinking skills, without emphasizing specifics – this allows new technologies to be place[d] within an existing context, and assimilated more quickly. **2)** Let go of the past – my parents had to

learn how many bushels were in a peck, a piece of information that is largely irrelevant today. Similarly, we need to realize our children are entering a world where they have multiple computers at arm's reach at any time. Is long division worth learning when you always have a calculator? Is cursive worth learning if you type and text? We need to lose our nostalgia for how we learned, and equip our children with the most practical skills.”

The consultant said one more capability could be most critical: “An important skill for the workforce of the future is an ability to cultivate a strong network, so if your job disappears you’re able to quickly find a new role.”

Dave Howell, a senior program manager in the telecommunications industry, wrote, “I can see an industry in advising workers whose course and what subject [to choose] for the next technologically driven career shift. Fast learners and self-starters, the bright, who are ahead or early on the hype curve, will overcome deficiencies in training courses.”

Practical experiential learning via apprenticeships and mentoring will advance

Several experts wrote about the likelihood that apprenticeship programs will be refashioned offline and online via evolving application of human knowledge and technology tools. An **anonymous security engineer at Square** commented, “Never before in history has it been so easy for anyone to learn to become anything they want to be, and that will only continue to improve.”

Cory Salvesson, learning systems and analytics lead at RSM US, predicted, “There will be a big market for this: more self-directed or coached/mentored, project-based, online learning options that coexist with traditional brick-and-mortar university degree credentialing to make the labor market more agile, whether it wants to be or not.”

Will Kent, e-resources librarian at Loyola University-Chicago, replied, “Connecting the virtual to the physical will change everything. Anyone can learn anything online now. With the right kind of career or social positioning/privilege/luck/connections, users can sidestep traditional degree processes. For those in industries that still demand degrees as currency, the requirements for degrees will change, continuing education will become more embedded in the workplace or new types of evaluation will become more popular. Deliverable-based time constraints rather than 9-5, asynchronous offices/projects will be commonplace, and employers will have to make time for employees to self-educate or else they will fall behind. New credentialing systems will complement, not compete with, older iterations. One will not be favored above the other in practice (i.e., if you can do your work, no one will question how you learned what you learned).”

D. Yvette Wohn, assistant professor of information systems at the New Jersey Institute of Technology, wrote, “Knowledge can be acquired through massive online means, but skills will still require a small-group, personalized approach with much individual feedback. In the future, the technology will be advanced such that the modality – online or offline – is not the issue; rather, it is the size and intimacy of the learning environment that will matter. Formalized apprenticeships that require both technical skills and interpersonal interaction will become more important. As more people get degrees, university degrees will matter less, but that does not mean that higher education does not have its place. Schools that are able to provide a more holistic learning experience that does not focus on a specific skill but is able to provide students with an interdisciplinary and social experience will become more valuable.”

John B. Keller, director of e-learning at the Metropolitan School District of Warren Township, Indiana, wrote, “Online training will continue to improve, and ... any skills or knowledge updating that can reasonably be delivered online will be. That said, there will still be a need in many areas for verifiable performance of complex skills and behaviors that may not be possible to be accomplished algorithmically. Skills demanded in the future will include analysis of big data sets, interpretation of trends within historic contexts, clear and effective intercultural communication, design and systems thinking, as well as the ability to advance and advocate for distinctly human contributions to progress and the advance of culture. As more and more skills are broken down into repeatable processes, they will be handed off to technology and video as key transfer platforms. The demand for skills that cannot be easily transferred via online systems will ensure that experience, mentorship, coaching, apprenticeship and demonstrated proficiency all have prominent roles to play against a backdrop of online learning.”

An **anonymous respondent** wrote, “Online classes can teach prerequisite knowledge that can prepare workers for further hands-on training or apprenticeship.”

Polina Kolozaridi, researcher at the Higher School of Economics, Moscow, said, “The most important skills needed to succeed in the workforce of the future are process-oriented and system-oriented thinking, coding, etc. [I include] AI communication; ... 3-D modeling; understanding contemporary physics; basic and advanced critical thinking; history (especially work with different types of documents and evidences, partly journalistic skills); information management. Which of these skills can be taught effectively via online systems – especially those that are self-directed – and other nontraditional settings? I am sure that there will be a renaissance of old-school training systems, like reading groups, apprenticeship, etc. It will be an expensive and effective educational strategy for the top universities.”

Some respondents believe mentoring does not have to be in person – in the traditional face-to-face sense – to be one-to-one. In fact, they say the online world has already multiplied the number of available mentors in every subject.

Valerie Bock, VCB Consulting, former Technical Services Lead at Q2 Learning, responded, “To develop proficiency, we seem to need exposure to war stories of others who were there when the usual rules didn’t apply. MIT’s ... EdX platform has a code checker built in, which means well-structured classes can be created with automatically graded exercises supplemented by discussion forums where students can ask their questions and move past places where they are stuck. These courses actually provide the coaching learners need to become skillful. So yeah, coding is probably a skill that can be taught and credentialed effectively via a self-directed online course. In the meantime, a lot of coders learn their craft informally, by examining code written by others and asking questions about it. To me, the most promising application of the internet is the way it increases the number of potential mentors. Global organizations are already leveraging the asynchronous properties of online venues to put their subject matter experts in touch with mentees half the world away, spanning time and distance obstacles. ... People use the internet every day, informally, to learn bits and pieces that help them be more effective in the work (paid and unpaid) they do, sometimes by accessing content, but often by contacting other people. The value added to human welfare by parenting forums, elder care discussions, recipe exchanges, addiction-recovery communities and even stain-removal resources is deeply underestimated.”

Ed Dodds, digital strategist at Conmergence, added, “The global startup ecosystem and makerspace ecosystem will both be intersecting and growing in parallel. ... More intentional formal mentorship networks (guilds) are likely to proliferate.”

“What would help,” added an **anonymous respondent**, “is improving people’s efficiency at providing supports to others. Sort of Slack on steroids.”

Theme 3: New credentialing systems will arise as self-directed learning expands

A substantial share of these respondents addressed the query we posed about the future of credentialing. They generally expect a burst of activity on this front and think that a major catalyst will be the growing numbers of workers who teach themselves new job-related skills in self-administered online programs.

While the traditional college degree will still hold sway in 2026, more employers may accept alternate credentialing systems as learning options and their measures evolve

The respondents with the most optimism for advances in training opportunities in the next decade are also the most hopeful about the acceptance of alternate credentials as proof of job candidates' training.

Matt Hamblen, senior editor at Computerworld, said, "Credentials for online training will gain value, and more young people will grow more and more skeptical of traditional four-year and grad programs, definitely."

Micah Altman, director of research at MIT Libraries, wrote, "Over the last 15 years we have seen increasing success in making open course content available, followed by success teaching classes online at scale (e.g., Coursera, edX). The next part of this progression will be online credentialing. Starbucks' partnership with Arizona State University to provide large numbers of its employees with the opportunity to earn a full degree online is indicative of this shift. Progress in online credentialing will be slower than progress in online delivery, because of the need to comply with or modify regulation, establish reputation, and overcome entrenched institutional interests in residential education. Notwithstanding, I am optimistic we will see substantial progress in the next decade – including more rigorous and widely accepted competency-based credentialing."

Justin Reich, executive director at the MIT Teaching Systems Lab, commented, "New forms of for-profit certification, like programming boot camps and Code Academy, will present themselves as new and revolutionary, though they continue in a tradition of IT certification that goes back to Microsoft certificate programs and further back. New forms of certificates and credentialing will be accepted by employers in limited circumstances, especially those in which employers are involved in developing the certificate."

Dmitry Strakovsky, a professor at University of Kentucky, wrote, "Nano-degrees are already a part of our vocabulary. They will thrive in the future job environment. These will be taught

primarily online by for-profit certificate-granting institutions aligned with specific business or technology interests.” But, like many others, he sees universities surviving, noting: “The ... [u]pper-management echelons will be primarily filled with people who completed four-year nontechnical degrees. Critical thinking skills and media analysis are nearly impossible to teach at scale, and these allow future workers to imagine new jobs and new cultural paradigms.”

Barry Chudakov, founder and principal at Sertain Research and StreamFuzion Corp., commented, “There will be those who continue to see traditional four-year and graduate programs as both prestigious and essential for creating a certain corporate culture. But new types of credentialing, and especially self-training in emerging fields, for example programming or penetration testing done by ethical hackers, will become exceptionally valuable in the next decade. IBM Corp.’s Chairman, CEO and president, Ginni Rometty, recently said that cybercrime may be the [greatest threat](#) to every company in the world. Juniper Research recently predicted that the rapid digitization of consumers’ lives and enterprise records will increase the [cost of data breaches to \\$2.1 trillion globally by 2019](#), increasing to almost four times the estimated cost of breaches in 2015. So applicants will combine traditional credentialing systems – for example, a four- or six-year degree – with ongoing self-training.”

Ed Dodds, digital strategist at Conmergence, predicted, “Employers that do not [accept new credentials certification] will be shamed on Glassdoor and similar sites.”

Marti Hearst, a professor in the School of Information at University of California, Berkeley, wrote, “The range of free learning materials available today are breathtaking; anyone who can read and has an internet connection can learn about just about any imaginable topic free of charge from excellent teachers for the first time in human history. There are some drawbacks from the current technologies, however. They require learners to be self-motivated and able to work on their own. Most of the work is virtual. The feedback is not personalized to the student.

“There is great excitement and energy in the research community at the intersection of computer science and learning science. The existence of enormous communities of online learners makes it possible to experiment with new technologies and teaching methods, and measure their effects, in a scale never before possible. Top researchers are innovating with new methods of helping make online learning more social, helping blend the online with the in-person classroom, with teachers on the ground working with material in the cloud, personalizing the feedback, and integrating physical activities with the virtual instruction.

“This will lead to at least two revolutions in learning. The first will be an unprecedented understanding of how people learn and how to teach well. The second will be the opportunity for

people around the world to get the education they need at an affordable price. In 10 years the issues around credentials and proof of learning will be worked out, and ... there will be seamless blends between online and in-person learning. In today's complex world, people want to be continually learning, and being able to take short courses when needed to fill in gaps, or longer sets of courses to learn a new topic or skill, without interrupting one's life, will become a regular part of life."

Timothy C. Mack, managing principal at AAI Foresight, said, "While by necessity the traditional postsecondary structures will have to adapt to changes in cultural and economic environment, the credibility and effectiveness of credentialing systems will always be in question, especially where they become vulnerable to 'gaming' by participants. In many settings, skill building will continue to be an experiential rather than a scholastic process."

Alexander Halavais, director of the master's degree of arts in social technologies program at Arizona State University, commented, "The key word here is 'training.' There will continue to be a differentiation between learning that happens best individually (and can therefore be scaled in an interactive/broadcast model), and those that are best learned in a community. The latter is also scalable, but the technologies for scaling learning communities are trailing technologies that allow for training. The growth of those online learning communities is going to be the more interesting story of the next 10 years. The success of these systems will rely on credentials that are transparent and demonstrate authentic learning. To the extent that such credentials emerge, they will complement (and sometimes replace) university degrees."

John Howard, creative director at LOOOK, a mixed-reality design and development studio, wrote, "MOOCs and the availability of training materials, tutorials, user groups and easy access to experts already [provide] the tools necessary to acquire and build proficiency with a variety of skills. More [and] more we will see credentials diminish in value as workers can show a track record of accomplishment in the amateur-gig full-time economic spectrum. This is already happening across a number of creative fields, as the cost of access to tools has put them within the reach of almost everyone."

Christine Maxwell, entrepreneur and program manager of learning technologies at the University of Texas-Dallas, said, "The most important skills are the ability to ask good questions, the ability to be flexible and work well with others – soft skills will be just as important as hard skills. Learning how to ask good questions can be taught online – but having a teacher who is not afraid to let his or her students follow their own curiosity will help greatly! Badging is already here – and employers will very definitely be accepting of these new credentialing systems, thank goodness."

Dana Klisanin, psychologist/futurist at Evolutionary Guidance Media R&D, wrote, “Cognitive and analytical skills will continue to be important, but we will see a rise in emphasis on the capacity to collaborate and communicate. By the end of the decade, employers will be as accepting of applicants with these credentialing systems as they are of those from traditional institutions; however, they will not surpass the prestige of traditional campus experience. Online educational programs will influence the credentialing systems of traditional institutions, and online institutions will increasingly offer meet-ups and mingles such that a true hybrid educational approach emerges.”

Mike O’Connor, now retired, wrote, “Online classrooms have advanced a lot since the early days. And the good ones can do a great job of developing crucial online collaboration and learning skills. ... Employers who only accept traditionally credentialed applicants are stupid. Speaking as an entrepreneur with several successes (and many failures) under his belt, I can testify that we hardly ever looked at traditional credentials when making key hires.”

David Banks, co-editor of The Society Pages of Cyborgology blog, commented, “Well-capitalized institutions and organizations will most likely offer certificate programs and other forms of credentialization as roles like social media manager and content developer become more standardized and social media companies become further entrenched in information gatekeeping systems. These will most likely supersede traditional universities that move too slowly for the interests of capital. This process will majorly follow Max Weber’s classic descriptions of bureaucracies and rationalized professional roles. Training will most likely be in-house (Facebook offering certified brand management courses) over the internet.”

Ansgar Koene, senior research fellow at the Horizon Digital Economy Research Institute, wrote, “The skills required for the workplace are currently undergoing rapid change. The education system is struggling to keep up with this. There is a general sense that the traditional model in which people go to school/university at the start of their life and then apply this learning throughout the rest of their life is no longer applicable. Instead, society has to move towards a model of lifelong learning. Online nontraditional settings will be an important part of this and are likely to become something that employers will encourage their workforce to engage with. This will stimulate acceptance of nontraditional credentials. Some of the most successful online courses that are already beginning to gain acceptance [are] in areas such as programming skills, especially the acquisition of new programming languages by people who already have programming experience. We might think of this as a ‘top-up’ course to bring people up to date with new developments in an area that they already have training in. These kinds of skills are likely to be most amenable for self-directed learning. Learning of fundamentals of areas of expertise will likely remain difficult to transfer to setting[s] where there is no direct interaction between teachers and

learners or peer groups of learners. The key skill will be ‘learning how to learn,’ and this itself is different depending on the topic area. One thing that is already happening is a decline in sharp discipline boundaries with employers, and research projects, increasingly looking for interdisciplinary people or teams. This trend will also strengthen the move towards nontraditional training.”

Mark Richmond, a systems engineer and educator, said, “While the availability of self-directed and self-paced training will continue to expand, the acceptance of such training as evidence of skill will become increasingly dependent on testing and demonstrated ability. The proliferation of certificates and online courses in general makes it difficult for anyone to assess their validity. Verifiable skills and work history will have an increased importance in making hiring decisions.”

Beth Corzo-Duchardt, an assistant professor at Muhlenberg College, replied, “The fast pace of technological innovation means that any educational program that successfully trains workers to succeed in future jobs must focus on fundamentals like critical thinking, self-directed learning, basic computer literacy and, in some fields, basic math, science and writing skills. In my opinion, the question prompt ‘Which of these skills can be taught effectively via online systems’ incorrectly equates online teaching with large-scale teaching. ... Smaller-scale vocational schooling (online and/or in person) would be a better avenue. Fundamental critical thinking skills can be successfully taught online. They cannot be taught at scale, whether online or in a big lecture taught by one professor, because the assignments and assessment strategies for such skills must be flexible to be effective, and that is impossible at scale. Many STEM basics can be taught effectively via large-scale online (or offline) systems. Others need to provide for hands-on experience. It is difficult to scale up physics or chemistry labs, but a blended model involving smaller labs could be successful. If I were advising employers about what to look for in credentialing systems, I would tell them that, whether the programs are traditional or nontraditional, employers should look into whether they are teaching the fundamental critical thinking skills that will enable their employees to learn new skills as their profession evolves. Online platforms like Lynda.com are very useful for training large groups [of] students on particular computer programs, or how to use particular audiovisual devices, so workers using these tools can constantly go back to these services to maintain their edge in the field. Employers would be smart to be open to hiring employees with general, rather than specialized skills, and to provide them with (and pay them for) participation in periodic large-scale online training. The jobs of the future, like the jobs of today, will require dynamic learners, ready and able to learn new skills periodically.”

Frank Odasz, president of Lone Eagle Consulting, wrote, “Mining raw human potential is the new Gold Rush. Teaching the innovation process as open-mindedness, watching and learning from the booming socioeconomic innovations globally online, is the key skill, so that everyone

functions as both learner and teacher, consumer and producer, all the time. ... Learning to effectively use online systems requires ‘learning by doing’ online. Specifically, teaching the benefits of effective online collaboration must be hands-on, as well as growing one’s ability to be self-directed, which is a self-esteem and self-confidence issue. Learning how we can grow our own self-esteem and contribute to such growth in others is a fundamental dynamic for successful mutual-support networks, as well as individual success. Teaching open-mindedness online is a challenge as everyone is different, and personalized learning requires individualized tweaks in the learning dynamics. This is where innovation in what best motivates individuals is a key variable. Example: Having taught teachers online for 30 years, Winston Churchill’s quote rings true, ‘We’re always ready to learn, never to be taught.’ ... Those without a predilection toward self-directed learning won’t engage freely in self-directed online lessons or actively explore global innovations for what’s already working for others like them. So, we start with teaching the love of learning hands-on, with lots of encouragement and tangible digital creation and collaborative-sharing outcomes. In a world where everything changes, how we can all keep up to the same instant of progress is the challenge, made possible once we’re all online. Airbnb.org quickly created millions of new home-based income streams without overt entrepreneurial risk-taking or requisite abilities for innovation. As millions of jobs will be replaced with smarter technologies, the need for ongoing peer support will increase, begging the creation of new metrics to mirror back what’s working best.”

Emmanuel Edet, legal adviser at the National Information Technology Development Agency of Nigeria, replied, “The most important skill for workers of the future is the ability to apply information technology in performing their duties. The skills that can be taught effectively in a large scale are basic self-taught courses that do not require practicals. Employers will accept these kinds of credentialing systems as they do today, except where the issue affects practical applications such as engineering.”

Paula Hooper Mayhew, professor of English and humanities at Fairleigh Dickinson University, commented, “The most important skill needed in the workforce of the future is reading literacy, followed closely by mathematical and information literacy skills, as well. As the global population grows and lives longer, women continue to lag behind men in literacy, although women’s lives are longer. Online programs that teach literacy skills are even now highly successful, but their use by men exceeds use by women, many of whom do not have access to a computer at home. Special programs are needed to put computers in areas largely restricted to women, areas like churches and synagogues, as well as in places where Muslim women congregate. The idea that graduates of online programs are less qualified than those who have had face-to-face instruction is still current, but will eventually be proved wrong. Over time, online higher educational programs and degrees will become distinguished from one another in terms of their proven value in the workplace.

Needless to say, not all online instruction is good or even adequate, but the market will inevitably react by vying to hire those with proven skills in higher educational areas of mastery.”

Fredric Litto, a professor emeritus of communications and longtime distance-learning expert from the University of São Paulo, replied, “The ‘less-qualified’ label will gradually fade away, as experience reveals the truth – much as always occurred with the introduction of new technologies and forms of work. It took a generation for health workers to realize they had to wash their hands before touching a new patient, so as to avoid passing on the previous patient’s problems.”

Chris Kutarna, fellow at the Oxford Martin School and author of “Age of Discovery,” wrote, “It makes sense to assume that, as new jobs emerge, new educational and training programs will appear to help people fill them. The larger questions are whether, as large segments of the service industry are automated, sufficient new jobs will appear to maintain full employment; and whether workers whose jobs are destroyed by this wrenching retooling are able to shift mid-career. If instead it takes a generation to accomplish the labor market’s shift into new industries, society will bear heavy adjustment costs. A transition beyond traditional credentialing systems is already well underway. Startups, and many small and medium businesses, are already finding that an applicant’s online reputation (for example in the coding community) is a more precise indicator of the roles and tasks he/she can successfully perform than formal degrees held. At the same time, complex organizations are going to rediscover the importance of broad intellectual development to enable good management-level decision-making and coping skills in increasingly complex and uncertain environments.”

An **anonymous respondent whose research career was spent at a major U.S.**

university replied, “It’s the rare parent of an athletically gifted child who would be disappointed if their son or daughter left college at the end of their freshman year to become a first-round draft pick for an NBA or WNBA team. To use the phrase of your question, that year spent in college ‘trained the student in the skills they need to perform a job’ – and the pro draft selection indicates that the training is complete. The ‘nontraditional’ prediction I would make for the next 10 years is that many STEM professions will follow the lead of the NBA in this way, and the college experience will evolve to support it, on both the undergraduate and graduate level. How long each student stays in school, and how they learn during their stay, will be customized for each student, and for each employer that recruits from the school. To keep the grandparents happy, new names for degrees of different lengths will be invented, and we’ll still have caps and gowns and commencement speeches. But for vocationally focused majors, I believe that in 10 years, only a fraction of those diplomas will be for today’s standard degree types.”

An **anonymous participant** said the new environment will force schools to update their methods, writing, “This question is emergent from an even more fundamental sea change that we’ll see develop in the next 10 years: the concurrent valuation of competencies and devaluation of credentials. That is, modular training and education focused on competencies will eventually become the de facto currency in the future job market. I see this as perhaps the most positive change of all, because credentials were only ever proxy indicators of competencies, and often they are poor indicators at that. A job market tuned to this new paradigm will exert pressure on universities and postsecondary schools to change their teaching methods and encourage students to be more than just knowledge sponges. The sciences and maths already do this to some degree but even right now an undergraduate thesis is elective at most universities. I see that changing in the next 10 years.”

Amy Zalman, principal owner at the Strategic Narrative Institute and professor at Georgetown University, wrote, “Yes, new educational and training programs will emerge. But in the next 10 years, it seems unlikely that the expedience with which we typically treat education of all sorts (in the United States) will go away. It will take a long time and a meaningful period of adjustment to align work, workers and employers, even as incremental changes – like employers accepting the differently credentialed and even instituting credentialing systems of their own – are made.”

An **anonymous digital media archivist** commented, “I do believe the higher education system is crumbling and that non-‘traditional’ programs will be honored as appropriate certification if the program is provided by an accredited or otherwise reputable source.”

Naomi Baron, a professor of linguistics at American University, observed, “A cluster of factors all lead to the same conclusion that online education will grow: the high cost of higher education, desire to make education available to a broader number of people, development of increasingly sophisticated online courses. Since so many traditional (and respected) institutions of higher learning already incorporate online learning into their curricula, either as individual courses or entire certificate or degree programs, I don’t worry that such credentials will be viewed as somehow less legitimate. (Online programs from for-profit organizations are sometimes a different story.) The biggest challenge will be to figure out what kind of learning best takes place face-to-face, what kind is suited to online contexts, and what kind benefits from a hybrid model. The answer can’t simply be that of convenience. We need to think about both intellectual content and what our educational goals are. There is a growing tendency in higher education to focus on skills and jobs. Too many institutions are tending to forget that a major purpose of higher education (at least of the liberal arts variety) is to prepare people for living, not to make a living.”

Some respondents were not hopeful for much progress in alternative forms of credit for learning in the next decade. “Higher education is very resistant to developing flexible, inexpensive alternatives to the traditional models of credentialing,” wrote an **anonymous director of an institute examining ethics and technology**, “and the business world doesn't ... appear ready to accept badgification.”

An **anonymous global consultant and computer scientist** said credentials will have less value in future than ever before, arguing, “The educational system is essentially equipped to instill conformity and utility to a corporatist system, with the bare minimum of focus on citizenry and ‘deep’ life skills. The future belongs to autodidacts, as the value of credentials is diluted by over-adoption and rapid turnover of skills.”

The proof of competency may be in the real-world work portfolios

In answer to this study’s prompt asking for opinions about the future of credentialing, many respondents mentioned that the most-trusted new employee is one who is proven to be able to perform in a real-world setting. An **anonymous respondent** noted, “In the future, people will be assessed by what they’ve built and not solely by the prestige of their university.”

An **anonymous professor at Florida State University** commented, “The highest costs [in credentialing] will be in quality evaluation. The key skills in communication, analysis, critical thinking, collaborative and team work may require some kinds of project-based or experiential learning, along with professional supervision and evaluation. If credentials are focused on specific learning outcomes and this is documented over time, they should be credible.”

An **anonymous respondent** predicted, “Hiring in technology fields will become based more on ‘what have you done for me lately?’ and the ability to show proof of successful projects will become more important. This is made difficult by the more secretive inclinations of companies, making even job titles more closely guarded and denied, let alone for portfolios to be assembled. Individuals requiring structure or personal attention in their workplace or training are less likely to succeed in education, job hunting and careers.”

Peter Eckart, a respondent who did not share additional ID details, commented, “There will be a rise in internships or probationary models of training and tryout, as employers take less and less responsibility for screening applicants and use the work itself as a final evaluative process.”

An **anonymous principal scientist for Adobe Systems** said, “You don’t get smart by taking a class.”

Theme 4: Training and learning systems will not meet 21st-century needs by 2026

Pew Research Center and Elon University’s Imagining the Internet Center have asked questions that relate to learning in several earlier canvassings in the “Future of the Internet” series. [The first was in 2004](#). In that study, 59% agreed and only 15% disagreed that the following scenario was likely by 2014: *“Enabled by information technologies, the pace of learning in the next decade will increasingly be set by student choices. In 10 years, most students will spend at least part of their ‘school days’ in virtual classes, grouped online with others who share their interests, mastery and skills.”* (Among those surveyed, 17% did not respond and 8% challenged the wording of the scenario.) The expectation by most experts in the 2004 canvassing was that by 2014, online learning systems would be regularly implemented daily by most students in the U.S., allowing them to make their own appropriate choices and learn at their own pace.

In this 2016 canvassing, again, most respondents – 70% – were optimistic that training and education will advance to advantage in the next decade. Among the 30% who disagreed, the reasons for pessimism were many. Some said the people and programs are not in place or the current legacy systems are too entrenched; some argued that the funding will not be made available; some said the technology will not advance enough to bring mass improvements in just a decade; others said that technology will move too fast for education and training systems to keep up; and some argued that the mass replacement of human work by faster, cheaper, more efficient technologies will make such training unnecessary or force a change in focus to training to live life well without a job. An **anonymous director of a major online human rights organization** wrote, “I think technology (particularly AI) is moving faster than rational thinking about our future workforce.”

Following are three major subthemes found among the statements of those who expressed such views.

Within the next decade, education systems will not be up to the task of adapting to train or retrain people for future jobs

Erhardt Graeff, a PhD researcher at the MIT Center for Civic Media, argued, “New jobs will demand increasingly sophisticated technical skills combined with creative problem-solving and adept teamwork. Some technical skills can likely be gained using MOOCs, personalized learning or future versions of these. However ... creative thinking, especially in teams, will be hard to develop at scale without new physical and digital infrastructures that create problem-solving contexts analogous to real-world cases. Learning how to learn and how to lead in online and offline

contexts and how to translate those ideas to practical problems must be placed at the core of new programs. Success will require huge public investment and a reimagining of what we value in education. This is hard; the problem and our responses cannot be reduced to pushing STEM or vocational training at scale. We can't throw out the important societal and civic role played by liberal education by chasing technical skills that might be obsolete in a few years. We will likely see companies take on a larger role of teaching technical skills to workers – workers who were hired because they were able to develop creative problem-solving and teamwork skills through (or in spite of) existing educational systems and personal experience.”

An **anonymous respondent** wrote, “Unless we see a radical shift toward flexibility – which is the polar opposite of anything we can expect – current paradigms have no ability to hold up to exponentially increasing technological change.”

David Durant, business analyst at UK Government Digital Service, wrote, “While there are many excellent online training opportunities, I do not believe that they will enable large numbers of people to attain the skills they need in order to gain future employment. Partly this is due to the fact the overall number of jobs that need to be undertaken by people will continue to fall (although perhaps not to become highly significant within the next 10 years). It is also because many of these jobs, such as those related to design, software or finance, can be undertaken anywhere via online mechanisms. This will lead to a continued process of those roles moving to where the work can be completed cheapest. Finally, for the subset of skills that can be acquired online we will see a situation where an increasing number of people will be competing for limited roles. It is the offline roles that cannot easily be performed by machines that will see the highest job security.”

David Sarokin, author of “Missed Information: Better Information for Building a Wealthier, More Sustainable Future,” observed, “Online learning is rapidly evolving, and the jury is still out in terms of its overall effectiveness. While new styles of programs will certainly emerge, the ability to engage and successfully train ‘large numbers’ of workers seems unlikely to me. For a longer time horizon, perhaps this will emerge as an important avenue of training.”

Oscar Gandy, professor emeritus of communication at the University of Pennsylvania, wrote, “As I see it, more and more opportunities for employment will be eliminated by automation (e.g., recent stories about the growth in ‘demand’ for all sorts of counseling, from health to economic investments). More and more presumably ‘safe’ occupations are being faced with a serious challenge from intelligent systems capable of doing more and more. Therefore, I don’t see the problem entirely, or even primarily, as one of continuing education. As to online education, my reading suggests that these programs are ‘not ready for primetime,’ in that the more demanding kinds of technologically oriented coursework seems to have an incredibly high dropout rate. I can

imagine that employers will, for many of these skill sets that are readily and reliably testable online, be willing to accept such employees, even as they are being recommended to them by algorithmic analysis.”

Cristóbal Palmer, technical director at ibiblio.org, wrote, “Higher education has been struggling for over a decade to respond and shift to the internet. Large institutions with high brand awareness are making significant shifts in fits and starts, but few new platforms (quick! name three MOOC brands that are still growing!) have gained traction. It is likely that more shifts and changes will occur, but it is also likely that they will only gain traction either through or in partnership with major established educational institutions.”

An **anonymous respondent** said, “I don’t think any decision-makers will even consider this issue as anything other than a talking point (if that much) within the next decade, let alone spend any useful amount of money or time trying to fix the problem. Especially not via job training – the current political climate seems allergic to the entire concept.”

Kjartan Ólafsson, head of the department of social sciences at the University of Akureyri, Iceland, wrote, “Educational institutions in general tend to be conservative and slow in developing in new directions.”

Jan Schaffer, executive director at J-Lab, commented, “There are jobs to be done in this country, and not all of them require new skills, but there is a lack of imagination in how to make them a priority and an unwillingness to pay for them. Clearly, today we lose jobs to much cheaper but not more skilled workers overseas.”

Marc Brenman, managing partner at IDARE, replied, “Online learning is relatively ineffective. Specific skills need to be identified and practiced. Self-direction only works for a small percent of people. It is very difficult to teach critical thinking, logic and evidence.”

Dudley Irish, a software engineer, wrote, “There are two issues. First, the most important skills required in the workplace are communication skills. So far, computer-mediated training does not seem to deliver on improvements in personal communication skills. I have not read of any techniques or technologies that suggest this is going to change soon. Second, the kind of skills that most people think are important (analytical, STEM-related skills) can be learned via computer-mediated training, but not by a large enough segment of the population. The segment of the population who can acquire these skills via computer-mediated training is already learning the skills, but this segment is not (according to the economists) big enough to meet the demand.

Attracting more people into STEM fields is going to mean creating training and work environments that are more attractive. No one seems to know how to do this.”

Marshall Kirkpatrick, co-founder of Little Bird, previously with ReadWriteWeb and TechCrunch, replied, “No, the future will require more soft skills, self-awareness, empathy, networked thinking and lifelong learning. Creating programs that can effectively teach large numbers of people those skills will take more than 10 years.”

Maria Pranzo, director of development at The Alpha Workshops, replied, “As someone who’s worked in nonprofit workforce development for 20 years, [I can tell you that] programs that teach employment skills are notoriously difficult to scale up.”

Nigel Cameron, president and CEO of the Center for Policy on Emerging Technologies, wrote, “Problems include the current fixation with STEM [courses tied to Science, Technology, Engineering, Math], which also covers more readily MOOC-able disciplines. Lower-end STEM qualifications are not going to be much in demand – cf. the scandal of for-profit schools churning out unemployable and poorer grads.”

Antero Garcia, an assistant professor at Colorado State University, sees the dark and bright side, noting, “Yes, digital tools will sustain labor markets in the future. However, I don’t see these digital tools developing powerful outcomes for leadership and creativity in and of themselves. That is, training programs will be developed for rote forms of labor that simply reinforce class-based stratification of individuals in society. On the other hand, rather than looking to new kinds of tools, the ways individuals are collaborating, socializing and innovating in online spaces like gaming communities, virtual worlds and via social activism on Twitter highlight training and skills development that are robust and could reshape what work and recruitment look like.”

Many of these experts say they are not sure they know what those future jobs will be or if there will be jobs to fill: **John Anderson**, director of journalism and media studies at Brooklyn College, wrote, “Considering that we have seen vast transformations across nearly every industrial sector over the last three decades, who’s to say that the ‘educational training programs’ set up today to ‘successfully train large numbers of workers in the skills they need’ will be even relevant in 10 years?”

Show me the money: Some doubts hinge upon lack of political will and necessary funding

Jeffrey Reynolds, IT manager, observed, “Too often any system that is created for training and job development has one of two inherent flaws: 1) It’s run by an underfunded agency and never

updated over time, quickly falling behind the needs of its customers. 2) It's run by a for-profit organization whose goal is to make cash, not actually improve society. We need more low-cost and free educational opportunities to allow our country to flourish. The days of driving people into debt in the hopes they can get a better job and get out of their debt [need] to end. Until we take the profit margin out of inherent necessities like education and training, we will continue to struggle to provide quality opportunities for all Americans."

Randy Bush, Internet Hall of Fame member and research fellow at Internet Initiative Japan, warned, "The payoff of education is too long-term for politics to favor it. The results are horrifying but inevitable in our current system of exceedingly short-term and short-sighted decision making."

An **anonymous respondent** wrote, "Public education is being systematically and deliberately defunded. This will not change."

Richard Lachmann, professor of sociology at the University at Albany, said, "Government spending is declining in most of the world. Until neoliberalism is reversed, we shouldn't expect new programs that have a significant effect."

Randy Albelda, professor of economics at the University of Massachusetts, Boston, commented, "Expansion of training programs that work requires funding. State and local governments are having a very hard time meeting the demands of the programs they already fund, and in fact funding for postsecondary education of any forms [has] mostly been cut. It is increasingly clear that MOOCs and other internet-based classes do not work that well. Unless there is real funding for real training, I do not see this happening. For-profits tend to have the funds to start these things up and can successfully find the right candidates, but we also know that these for-profits bilk students terribly and do not provide training that works. I teach in a classroom – real students, in a real college. I am happy to use technology (and do), but it does *not* replace face-to-face interactions in the classroom (and outside of it). Offloading (or uploading) education and training onto the web will not work unless it is complemented with brick-and-mortar classrooms and in-person (qualified and decently paid) instructors. Some employers will be happy to run through employees from anywhere. But in jobs that are worth having, employers do care about the quality of training. Elite institutions become shorthand for them. It is the public institutions that will be producing students that employers are uncertain about."

Karl M. van Meter, sociological researcher and director of the Bulletin of Methodological Sociology, Ecole Normale Supérieure de Paris, replied, "Of course there will be 'new educational and training programs,' but they already exist and are training and educating large numbers of people. New and different programs will continue to be developed and hopefully will reach larger

and more varied publics. This, however, will not change the difference between the U.S. system, in which education and training are a commodity to make money on and to be paid for by individuals or their families, and the system in many other countries, where education and training are considered national patrimony and paid for at least in part by the state. “Traditional’ education in this context then means human teachers, which, like human intelligence methods above, are more expensive, more time-consuming, and far less ‘profit-making’ than internet or other technical means of education or training.”

An **anonymous political science professor** replied, “The internet is above all a profit center. Education on the internet is no different. These programs will proliferate but won’t necessarily effect substantive change in the people signing up for them. Individualized, on-demand learning is too ‘easy’ to do much good.”

An **anonymous respondent** wrote, “We will indeed see the growth of new educational and training initiatives designed to give workers the skills they need for the new economy. There is a clear and growing market for such opportunities. But I am personally quite skeptical as to whether these new educational initiatives will actually live up to their billing. It is entirely possible that these new initiatives will take the form of for-profit educational schemes that extract money from scared workers while making promises that they do not meet.”

Julie Gomoll, CEO at Julie Gomoll Inc., said, “*Should* these programs emerge? Absolutely. But I have no confidence that necessary educational programs will be funded anytime soon.”

Vin Crosbie, an adjunct professor at Syracuse University, wrote, “In the next 10 years, we will see the emergence of new educational and training software and applications to train large numbers of workers in skills they need to perform the jobs of the future. But most, if not virtually all, of these new educational and training software and applications will gain little usage or traction, because neither corporate nor government willingness to fund such programs will develop. Corporate won’t fund retraining of the workers it lets go. Meanwhile, the political gridlock at the legislative level will stymie governmental funding of such programs.”

An **anonymous executive director at a major open-source internet software company** responded, “The central funding and market structures driving Western education today are not set up to adapt fast enough or creatively enough. Individuals and employers will respond by turning to self-learning, learning by doing, looking for evidence of skill in a manner that doesn’t rely on credentials. The mainstream education system will come under increasing pressure as the public realizes it’s failing.”

Ed Lyell, online education pioneer and professor of business and economics at Adams State University, predicts that a “replacement system” is more likely to succeed than education reform. He wrote, “These emerging new education and training systems are expanding. Khan Academy, MOOCs, and other technologies at near zero marginal cost make delivery of such learning available to all. More people will move to these alternatives, especially as the ‘badges’-type projects expand, giving acceptable and transferable credit and accountability for competency achievement. It is unfortunate that most of these new opportunities are outside of formal public or higher education, but those bureaucracies are more interested in protecting their status quo wasteful system than using new tools to make learning more effective and efficient. Shifting funding for K-12 and higher education to focus on competency obtained could incentivize formal education to use existing and emerging tools, especially fun-based simulation and role-playing learning models. The 18,000 school boards would have to change and put children’s learning ahead of adult job protection, and that is not likely without a governance change away from local control. Thus a replacement education system is more likely than reform of the current schools and universities.”

An **anonymous systems administrator in municipal government** wrote, “Typically we do not do anything unless it results in profit for someone somewhere. This will only occur if it provides profit for someone or if we are faced with a disaster-type situation.”

An **anonymous respondent** wrote that the goal of employers in offering training is to prepare employees to help them ‘maximize margins.’ The person commented: “Effective, online, algorithmically based learning technologies can be developed in the next 10 years that will adequately prepare individual learners in such a way as to keep them dependent on the employer for everything. In today’s out-of-control capitalist systems, employers have no interest in the employee beyond increasing the employers’ bottom line. Employers, like government, don’t really want employees who can think too much or know too much. They only want them to have the limited skill set and knowledge needed for the task at hand that the employer believes will maximize margins. And the employer wants to pay employees as little as possible to do that work. So their interest in complete control over the educational experience is of great importance. Their need for a linearly predictable outcome from the educational experience is in the employers’ best financial interest.”

Some respondents said those in power don’t want workers to possess the critical skills necessary for the future.

An **anonymous sociologist** wrote, “Literacy, critical thinking, collaboration and conflict resolution are the most critical skills needed for successful organizations. However, while valuable

for high-efficiency organizations, these skills are also dangerous to [those in] political control and may not be widely taught.”

An **anonymous senior software developer** replied, “The future belongs to our corporate and oligarchic overlords. Why would they want to make their serfs more capable of finding work, when a desperate serf works far more cheaply? Granted, better educational programs would benefit everyone, including the wealthy and powerful, but greed is demonstrably short-sighted and by definition the opposite of altruistic.”

T. Rob Wyatt, an independent network security consultant, wrote, “We will see the emergence of new educational and training programs that *can* successfully train large numbers of workers in the skills they will need to perform the jobs of the future; however, I am less confident that we will use them to their potential. The emergence of an agile yet deeply skilled workforce requires power structures and wealth feedback loops that thrive on change. Extended lifespans have produced an older ruling elite whose strategy to maintain power and wealth lies in ruthless preservation of the status quo. Meanwhile, the reigning Technorati lack both the temperament to govern and the political power to displace the gerontocracy. Finally, almost nobody gets that the shift from atoms to bits is a game changer, and those who do are exploiting it to grab as much power as possible. These are the group who most benefit from a deeply skilled and agile workforce but whose success depends most on flying under the radar.”

An **anonymous chief technology officer** observed, “We haven’t figured it out yet, and technology change is accelerating. We are probably going to reach a point where it will be cheaper and faster to write software to teach a robot to do the job than a human.”

Some people are incapable of or uninterested in self-directed learning

Most mass training today is found in massive online courses like those offered by [edX](#) and [Coursera](#), or in video series such as those offered on YouTube, by [Kahn Academy](#) and by [Lynda.com](#), or in learning communities such as [Code Academy](#) and [Stack Overflow](#). The success or failure of learners participating in well-built online training can nearly always be at least partially attributed to the interest level and dedication of the individual learner. In this canvassing, many who doubted the efficacy of online training pointed at the dropout rates in some MOOCs or noted MOOC critics’ arguments about the lack of full student engagement in such courses. **Erhardt Graeff**, a PhD researcher at the MIT Center for Civic Media, argued, “Not all learners will excel in self-directed, computer-based classrooms.”

A share of the respondents in this study said mass training cannot be successful because it will fail many people, leaving them behind, because not all learners have a sociocultural background or other traits or life experiences that developed within them the drive or the capacity for the type of self-motivated, independent learning necessary to participate in today's mass online training settings. Among the other reasons for failure to complete such training: Some people do not have the time to devote to training, some cannot afford to pay for it, some do not have the intellectual capacity.

David Lankes, professor and director at the University of South Carolina's School of Library and Information Science, explained why he thinks current mass-training methods expand a digital divide, writing, "The problem isn't with online, it's that since the time of Socrates we haven't figured out to have an effective educational dialogue with more than 10-20 people at a time. What I do see evolving in the next decade is an increased separation between the 'haves,' who can afford personalized highly interactive learning, and 'have nots,' who will be pushed to increasingly standardized drill-and-kill-style training."

An **anonymous communications and digital coordinator at an international global-good organization** commented, "The question is who will have the time to take these trainings. Most people who are poor are actually very busy trying to make ends meet. Many others are simply too depressed to have the necessary motivation. I hope the current trend of open and free education continues, but expect this trend will be mixed. For some subjects, the 'best' training will be put behind paywalls, once the industry 'matures.' With VR, I guess most skills will be trainable. But I'm not sure. Probably we will see a lot of augmented-reality coaching for tasks that are performed in the 'real world.' Eventually this will be automated for a lot of stuff."

Some argued that there is such high value in the self-discipline to participate in mass training that learning to work independently in online learning systems is a vital skill for future jobs that everyone should be encouraged to master.

An **anonymous civil engineer working in state government** said, "The hands-down most important trait for success will be self-motivation. There will be a number of ways to learn new skills, but a person will have to be motivated to seek them out rather than just following the traditional educational path of elementary/high school/college."

An **anonymous respondent** commented, "In the medium term, online systems will be essential to teaching us to cope with the flood of data and associated analytics. In the long term, emotional intelligence will become increasingly differentiating and important for the jobs that remain."

An **anonymous respondent** observed, “Individuals’ ability to succeed in the future will be determined by their ability to engage in lifelong learning and continually adapt to trends and to leverage new technology within their industry. ... Rewards will flow to those who can demonstrate synthesis of disparate knowledge to produce value.”

Most who do not see the current deficiencies in people’s capability for self-directed learning to be a problem explained that, because this is long recognized as essential areas of improvement in all types of education, those designing new approaches are going to work this all out in the next decade. The most-often-mentioned solution in this canvassing is the enhancement of education to make it more appealing, approachable and affordable, which most said will be aided greatly by developments in AI (including elements of gamification of education), AR and VR, a topic covered broadly in an earlier segment of this report. **Pamela Rutledge**, director of the Media Psychology Research Center, wrote, “Continued evolution of AR, VR and mixed realities will create rich learning environments that will help leverage content and achieve much of the social influence that encourages learnings (peer-to-peer and instructor-to-student).”

The ultimate human motivation is the instinct for survival. If there are far fewer jobs and more people competing for them in the future, some experts predict, people will be more dedicated to expanding their work capabilities. After all, at that point their only choice may be to do so or become irrelevant and unemployed.

A number of the respondents to this canvassing also say that business and government leaders must recognize the immediate necessity to seriously anticipate a future with fewer jobs and arrive at well-reasoned remedies or they could see capitalism undermine itself. Cheaper, faster, more-efficient algorithm-based solutions could take over the human workscape that underlies the consumer culture supporting everything, and those in positions of power may find that the great society they have built is in imminent danger of collapse.

Theme 5: Jobs? What jobs? Technological forces will fundamentally change work and the economic landscape

A noteworthy share of these respondents focused on the enormous systemic and structural realities that confront those trying to plan for the future of work and workers.

Many of the least hopeful in this expert canvassing look into the future and see a world where most of the work is done by robots and automated processes, as humans are replaced by algorithm-driven work solutions. Some of these people dismiss the idea that any kind of training ecosystem is likely to matter in a world where they believe fewer and fewer people will work.

A strong summary of this point of view was spelled out by an **anonymous programmer and data analyst**, who commented:

“The combination of nanotechnology and AI will actually reduce the number and type of jobs (as we currently understand the term). I foresee significant economic, social, cultural turmoil over the coming 10 to 20 years, with millions of people thrown out of work – with little to no ‘official’ jobs available for them.

“Instead, the notions of a [base living wage](#) will continue to churn as a topic until eventually implemented. Automated vehicles yield the elimination of school bus drivers, truck drivers, taxi cab drivers, the purchase of cars themselves (as opposed to Uber-style access and ‘pay for time used’). This, in turn, impacts police forces (no speeding or parking tickets) as their revenue streams diminish, fewer ER doctors and nurses (as the number of accidents decline), massive change in the auto insurance companies and mechanisms. 3-D printing of structures (houses, apartments, boats, cars, etc.) yields massive layoffs in the construction and manufacturing industries. 3-D printing itself dramatically reduces the need for factories in China, Korea, etc., which in turn reduces the need for freighters plying the oceans (and the ones that are left will be autonomous with little to no crew). Nano-drones and robotic support for farming will dramatically modify (reduce) the number of people employed in the agriculture sector. The list goes on and on.

“So 60 to 80 million Americans alone will be thrown out of work in the next two decades. There is nothing the vast majority of these people can be trained on that will replace the income/work they do today. This just scratches the surface on the types of massive change coming.”

There will be many millions more people and possibly millions fewer jobs globally in the future

Automated production of goods and services is seen as good business. Human workers are often less efficient; they are quirky and costly; and they can't work 24/7/365. In order to be competitive and survive, decision-makers in government and those who run for-profit and nonprofit enterprises turn to automated solutions.

An **anonymous software architect** wrote, "With automation of most tasks, even creative white-collar jobs, the unemployment situation will make education irrelevant. Train for what?"

Miles Fidelman, systems architect and policy analyst at the Protocol Technologies Group, observed, "The trend is pretty clear. We will need less 'workers' in the future. For a long time, science fiction presented us with visions of a world where machines did all the work, and people enjoyed leisure, artistic pursuits, etc. These days, a more dystopian reality is emerging – where a few party, a few more do a lot of work, and growing numbers search for work. We're going to need a fundamental reshaping of our economy, not training people for jobs that are simply not going to be there."

George McKee, a retiree, warned, "No amount of training or education will qualify untalented workers for the engineering and programming jobs that will remain after robotics and AI have automated most material production. Even in creative fields, the tournament properties of stardom will make the 'starving artist' the norm rather than the exception. The wealthy will continue to disdain the mass-market consumer and work to ensure that the redistribution of income that the lower and formerly middle classes require will not occur."

Shawn Otto, organizational executive, speaker and writer with ScienceDebate.org, commented, "We will see the emergence of new training programs, particularly an increase in virtual reality gaming-based training, and especially in coding. But this will be tempered by the emergence of AI/robotics moving into the knowledge sector, which has the potential to lead to the wholesale elimination of professional-class, non-managerial white-collar jobs. At the same time, robotics will move aggressively into sensor-based, world-navigation jobs like transportation – including taxis and trucking – and into other similar jobs, making the vision of what jobs there will be – or rather what form they will take – less certain."

Bart Knijnenburg, assistant professor in human-centered computing at Clemson University, predicted, "Companies will continue to require degrees for workers in regular 9-to-5 jobs. Such jobs will become a luxury. A lot of people will work in the [gig economy](#) with little or no official

training. I imagine 3-D printer operators running small-batch, highly specialized production lines. Service jobs will also become less well-regulated, opening them to self-taught workers, but also making them into gig-like jobs.”

Rick Dudley, a respondent who did not share additional identifying details, replied, “Automation will cause a huge net loss in jobs. Training can’t offset that. I’m a strong proponent of [Universal Basic Income](#). What are the most important skills needed to succeed in the workforce of the future? I don’t think the skills will be fundamentally different than they are now. But the shift in the West will continue to more specialized services, and the reality is that, eventually, we just hit [the] limit of average ability and huge percentages of people become effectively unemployable.”

An **anonymous engineering student** wrote, “Automation will replace entry-level jobs without creating new ones. New job training will be irrelevant, as the transition from labor to automation will be an exponentially accelerated one. The solution will be democratic socialism to redistribute money, as no one will have the buying power to purchase goods as [there] will not be enough jobs. This democratic socialist transition will lead us to the post-capitalism, post-scarcity society.”

“It will be impossible to maintain post-industrial levels of employment after the artificial intelligence revolution [is] already underway,” predicted another **anonymous respondent**. “Worst-case estimates predict 50% unemployment globally sometime in this century. This is not a problem of education – indeed, it is easier than ever before for someone to self-educate – rather, it is an inevitable stage in human civilization that must be managed by vastly increasing state-funded welfare (for example, a Universal Basic Income).”

An **anonymous respondent** observed, “Robotics and other technologies have been making strides and will continue to make strides in performing jobs traditionally done by humans (self-driving cars = transportation jobs). Yes, educational and training programs will become available, but that will become a short-lived reality at most, as artificial technology will become easier and more efficient to train.”

Dave Burstein, editor at Fast Netnews, responded, “Millions more will be trained, a ‘large number.’ Unfortunately, a much larger number will be displaced. Many, including older workers, will pay heavy prices.”

Additional **anonymous respondents** said:

- “Anything that can be taught in a ‘training program’ can be taught to and done by AI much more cheaply. ... The employment problem of the future won’t be giving people relevant skills for available jobs, it’s that there won’t be nearly as many jobs for humans.”
- “The future will be more automated than folks believe, and jobs will become a curious relic of history.”
- “Expect massive disruption due to the automation of labor. It will come so suddenly that a large number of people won’t even be able to afford internet access.”

Some participants in this canvassing speculated about the ways in which the lack of jobs for millions of human workers will alter people’s education and training needs.

David Krieger, director of the Institute for Communication & Leadership IKF, wrote, “Labor is a creature of the industrial age and will disappear with automation of production in all areas. Humans will no longer be divided into capitalists and workers, but will need to find a new self-definition based on creativity and meaning instead of labor and management. This will transform the purpose, position and forms of education. OER ([Open Educational Resources](#)), PLE ([personal learning environments](#)), learning analytics, etc., point in this direction. Data-driven personalization of services will make economies of scale irrelevant. Credentials from institutions will no longer be needed to guarantee knowledge and skills.”

Capitalism itself is in real trouble

The global business leaders of the highest-performing companies of the digital age run lean operations that require few employees. Apple, Alphabet (Google and its subsidiaries’ parent company), Facebook and other 21st-century tech business behemoths earn hundreds of billions running fairly autonomous technology operations with such small staffs that they are regularly mentioned in any discussion about a future with fewer jobs.

At a time when the median income in America is not advancing, the competitive instincts of those in leadership positions are seen by some of these experts as a threat to the general public’s overall economic, political and social welfare.

A share of participants in this study predict that human employment could diminish rapidly as efficiencies offered by emerging technologies cause these leaders to automate nearly everything in order to optimize outcomes.

An **anonymous professor at a U.S. university** wrote, “Trained workers are becoming obsolete; the goal of late-stage techno-capitalism is to eliminate them entirely in favor of automation. Since this process is self-defeating and unsustainable, large-scale production economies will eventually collapse. Future economies will be much smaller-scale, therefore workers will train on site. Guilds and apprenticeships will return.”

Stewart Dickson, a digital sculpture pioneer, wrote, “The idea of work needs to fundamentally change. We need to convert from the Kapitalist Pyramid to the post-scarcity, post-industrial society that we are fact living in. Basic Income: convert from wage slavery to Buckminster-Fullerian ‘[Livingry](#).’ It requires a global revolution now to do this. It is going to require generations for it to come about. 3-D printing is failing because of the failure to recognize that technology is only a tool. Creativity is what ultimately drives an economy. But creativity does not follow a business plan. Creativity is a luxury.”

An **anonymous respondent** pointed out that the world’s most successful businesses with the largest profits today employ very few people, and commented, “Tech and finance can generate lots of value, but are unlikely to generate mass employment. These are the economic drivers of the future, but not necessarily the employment drivers. Given the ability of tech to displace large numbers of workers, it remains unclear what the employment drivers of the future will be.”

An **anonymous respondent** argued, “The problem isn’t education. The problem is the 1% is not willing to pay a living wage.”

Karl Grindal, executive director at Cyber Conflict Studies Association, replied, “Will people be employed in the future? Yes. Will globalization and AI undermine the ability of workers in developed countries to acquire jobs that provide the same quality of life and security as their parents? Also yes.”

Mike Warot, a machinist at Allied Gear, replied, “We’re going to have to end up with a Basic Income, or revolution.”

Most of the people who were critical of capitalism preferred to remain anonymous in their comments. Following are a few additional points made by such respondents.

- “[Training will not work to prepare for the future] until we convince enough people that a neoliberal form of capitalism is against the overall goals of a healthy society. And I don’t see that happening.”

- “People with the capital to [advance education and training] would rather invest in robots/AI whose labor they own, instead of sharing profits with human workers.”
- “Training can be cheaper with automation. But the automation will ultimately be used to perform the jobs they’re teaching. They don’t want large numbers of workers. They want large numbers of consumers.”
- “If you’re not already an Eloi you’re probably doomed to be a Morlock.”
- “Following the establishment of the [precariat](#) will be the ‘unnecessariat.’ Most jobs of the future will be a) automated, b) outsourced, and c) won’t require special training.”

Acknowledgments

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