Skills of the Future – 2030

Overview of Skills of the Future

Students completing kindergarten in 2018 will graduate from high school in 2030. As the work and workplace of the future change, so will some of the skills students need for success in postsecondary activities. In *Work of the Future – 2030*, Gribben, Becker, and Dickinson (2018) described research related to potential changes in the workplace and forecasts of jobs of the future. Although we do not know with certainty what types of jobs will be available in the future, researchers and business analysts use trends to predict the types of jobs and skills that they expect high school graduates will need for employment in the future (e.g., Grover, 2018; Lara, 2018; McKinsey & Company, 2017; P21, 2016).

This review follows that of the *Work of the Future – 2030* and answers a range of questions about the landscape of postsecondary skills in 2030. What skills will students need following graduation from high school in 2030? Are there skills common across jobs? What skills do secondary students need either for matriculation into college or entering the workforce?

Skills high school graduates in 2030 will need to succeed along postsecondary pathways must correspond to the jobs of the future. Technology is expected to play a large role in future jobs. With the advent of the digital age, there is a recent emphasis on skills required to use and interact with new devices and applications. Employers will need programmers and innovators to develop new technologies to tackle more difficult challenges and improve efficiency and cost effectiveness. High school graduates of 2030 will likely find themselves part of an increasingly diverse and dispersed workforce. As the workplace and postsecondary institutions become more distributed and global, employees and students will need facility with collaboration tools as well as socio-emotional skills for working with diverse colleagues. Jobs will continually evolve to meet changing demands and to incorporate innovations. Employees will need to adapt and embrace life-long learning. Automation will replace some jobs and disrupt certain industries; future jobs are likely to require complex problem solving and troubleshooting which are not easily automated. Skills that enable individuals to work with and use technology, communicate with others, and continually adapt and learn will be necessary for the high school class of 2030.

In this literature review of the skills of the future, we provide a brief introduction to college *and* career preparedness. We present a structure for organizing the discussion of skills of the future followed by research on each of the skills. Similar to the *Work of the Future – 2030* literature review, we include projections of shifts in future skills. We discuss skills expected to increase in demand through 2030 and new skills expected to be added. The report concludes with a summary of themes of skills for the future.

Integrated Framework for Postsecondary Preparedness

There has been much discussion and work looking at college and career preparedness either by bifurcating college and career preparedness or by assuming them to be the same (ACTE, 2010; Conley, 2011; National Center for O*NET Development, 2018; P21, 2016). In addition, global statements frequently are made about preparedness without considering context. Patelis (2018) has proposed an integration of popular career and college preparedness frameworks to address the limitations in other organizing schemes to cover both career and college.

Focusing on the skills at the intersection of career and college preparedness, we use a unified framework to represent postsecondary preparedness. This offers a way of thinking about the overlapping nature of the skills needed for career and college in a more integrated manner rather than as separate or redundant constructs. The National Research Council (NRC, 2011; Pelligrino & Hilton, 2012) organized postsecondary skills into three categories: cognitive, intrapersonal, and interpersonal. These clusters encompass knowledge and skills[42] needed for life after high school. To address the more complex and multidimensional skills of the future, however, we have added another category – blended skill sets.

As the NRC defined them, cognitive skills for the 21st century involve (a) cognitive processes and strategies, (b) knowledge, and (c) creativity. Cognitive processes and strategies encompass critical thinking, complex problem solving, and analysis and interpretation. Knowledge covers academic areas such as reading, writing, and science, technology, engineering, and mathematics (STEM). With the ubiquity of digital devices, skill in using or developing digital tools is an important addition to the set of cognitive skills of the future. Creativity includes innovation and creative skill sets.

Interpersonal skills, sometimes called social skills, require complex communication, teamwork, and collaboration. These range from communication and collaborative problem solving to cooperation and perspective taking. With expected increases in diverse and globally dispersed workplaces of the future, we have added cultural awareness and sensitivity to the interpersonal skills needed in the future.

Intrapersonal skills cover intellectual openness, and work ethic and conscientiousness. Intellectual openness includes adaptability, personal responsibility, and continuous learning. Work ethic and conscientiousness includes initiative, productivity, and professionalism.

The following sections look at the future of (a) cognitive skills, (b) interpersonal skills, (c) intrapersonal skills, and (d) blended skill sets. Table 1 presents a list of the skills within each of the categories. The skills discussed here are not intended to be comprehensive. Rather, we have focused the discussion on skills that figure most prominently in recent thinking of the future of work.

[42] Knowledge refers to what a person knows and understands. Skill refers to what a person can do.

Table 1. Postsecondary Preparedness Skills for 2030

Cognitive Skills	Interpersonal Skills	Intrapersonal Skills	Blended Skill Sets
Foundational Academics	Communication (including Listening, Conversation, and Persuasion)	Time Management	Learning Agility
STEM	Relationship Building	Efficiency	New Media
Critical Thinking	Cultural Sensitivity	Adaptability	
Complex Problem Solving	Understanding Other People's Perspectives		
Creativity	Collaborative Problem Solving		
Innovation	Social and Emotional Intelligence		
Digital Tools			
Statistical Literacy			
Computational Thinking			

Cognitive Skills

Foundational Academics

Basic skills in education, namely literacy and numeracy, are well defined, taught, and measured. They are foundational to the acquisition of knowledge and skills (Peterson et al., 2001) and the performance of most tasks (e.g., Durak & Saritepeci, 2018). Economic research shows that improving basic skill proficiency has a dramatic effect on important societal outcomes, such as wage growth (McIntosh & Vignoles, 2001) and social development (Hanushek & Woessmann, 2008), further demonstrating the criticality of these skills to important outcomes.

As work evolves over the coming decades, literacy and numeracy will remain important, although the way they are used may change. For example, tasks requiring basic literacy and numeracy, such as data entry and cashiering, will likely become automated, thereby reducing the demand for these skills by as much as 25% from 2016 to 2030 (Bughin et al., 2018). As work becomes less structured and predictable and more team- and project-based, literacy will remain critical for effective acquisition and communication of information. For example, the demand for more advanced literacy and numeracy skills, such as are used in analytic and communications activities, is expected to increase by almost 10% (Bughin et al., 2018).

Other academic areas beyond literacy and numeracy include mathematics and science. These have become increasingly important and are often grouped together with technology and engineering to form their own category of Science, Technology, Engineering, and Mathematics (STEM).

STEM

Skills in the STEM areas are frequently included in discussions of the future of work. While great effort is currently being put into projecting and developing STEM skills for the future, the concept of STEM as an educational discipline dates to at least two National Science Foundation reports in the 1990s (Advisory Committee to the National Science Foundation Directorate for Education and Human Resources, 1996; 1998). Since that time, researchers worldwide have attempted to define STEM skills and strategies for developing them in the current, and future, workforce.

While many of these discussions project shortages of STEM skills, other research suggests that there is both a shortage and a surplus of STEM skills, driven by occupational and geographic mismatches between individuals' skills and specific job openings. STEM is a very broad concept and not all skills within it are equal in demand. Xue and Larson (2015) noted that, due to the heterogeneous nature of STEM, some skills are in short supply. These include very rare skill sets (e.g., Ph.D.-level nuclear engineering), as well as more common (e.g., data science, software development) and overlooked STEM skills (e.g., skilled trades). Xue and Larson also identified surpluses of STEM skills, such as biomedical and chemical engineering, as well as geographical variation in supply and demand (e.g., software engineering skills are in high demand in California).

Other researchers point out that basic STEM literacy will be critical even for non-STEM jobs. In fact, some definitions of basic skills include STEM literacy as a basic skill or assume that most job candidates will have at least basic proficiency with STEM skills (Cunningham & Villaseñor, 2016; Roberts & Bybee, 2014; Zeidler, 2014) due to its perceived relevance for a world of technology-immersive work.

There is disagreement regarding the profile of skills defining STEM. Some definitions delineate specific STEM disciplines along with associated higher-order cognitive skills. Carnevale, Smith, and Melton (2011) and Jang (2015) empirically identified the skills associated with STEM occupations using the Occupational Information Network (O*NET[43]) taxonomy. O*NET classifies its nearly 1,000 occupations into 5 job zones describing how much preparation (education) is required, job climate (e.g., working conditions, recognition, independence), and potential for future growth. Results of the STEM occupation crosswalk included a wide range of skills including both content knowledge (e.g., math, chemistry, and other scientific and engineering fields) and a broader set of cognitive skills relevant to the future of work (e.g., complex problem solving, deductive and inductive reasoning, mathematical reasoning, and facility with numbers).

Other definitions focus on the interdisciplinary components of STEM as they apply across disciplines and occupations:

> *STEM skills and knowledge are interdisciplinary in nature, being based on the integration of the formerly discrete disciplines of science, mathematics, engineering and technology. The aim of STEM skills is to enhance people's competency in work and/or life and more generally respond to societal demands on technology.*
>
> *STEM skills belong to the group of technical skills. They are a combination of the ability to produce scientific knowledge, supported by mathematical skills, in order to design and build (engineer) technological and scientific products or services. Although STEM skills overlap with basic and higher order cognitive skills, they merit separate treatment in a policy-oriented context in order to target specific requirements in the education and labor market. STEM skills and knowledge*

[43] O*NET (https://www.onetonline.org/) is developed under the sponsorship of the U.S. Department of Labor/Employment and Training Administration (USDOL/ETA).

cannot be directly measured by current discipline-specific classifications. (Siekmann & Korbel, 2016)

Siekmann's (2016) "House of STEM" model integrates these perspectives. The "House of STEM" includes basic numeracy, literacy, and socioemotional (e.g., curiosity) skills as a foundation for the kinds of technical and higher-order cognitive skills identified by Carnevale et al. (2011).

In addition, other researchers advocate for broader conceptualizations of STEM that include skills from the arts and humanities (i.e., STEAM). These models reflect the importance of visual and verbal communication to both the discipline-specific technical skills and the higher-order cognitive skills comprising the House of STEM (Land, 2013). For example, modern approaches to data analytics rely heavily on data visualization, a skill that clearly draws upon the arts. The arts also help develop higher-order cognitive skills, such as critical thinking, creativity, perspective taking, and divergent thinking, that are critical to scientific advancement and innovation (Daugherty, 2013; Kahn & Zeidler, 2016). These researchers caution that focusing solely on a narrow definition of STEM skills may not adequately prepare us for the future.

Critical Thinking

Critical thinking is important for learning and for evaluating new information (Mumford, Peterson, & Childs, 1999), making it vital to performing work that does not follow prescribed rules (i.e., work that is not likely to be automated). In a future world of work characterized by expanding technology and artificial intelligence, humans' unique capacity for critical thinking will set them apart from machine learning algorithms (Barnett, Lawless, Kim, & Vista, 2017; Pistrui, 2018). In fact, job recruiters across the major industries have identified critical thinking skills among the less common, but more desired skills among business school graduates (Levy & Cannon, 2016).

Glaser (1985) viewed critical thinking as a process involving careful consideration of a problem through the application of logical inquiry methods. McPeck (2016) identified the critical features of critical thinking, six of which distinguish critical thinking from other higher cognitive skills:

1. Involves the evaluation of statements/evidence and the methods used to derive them
2. Is limited in application to the context of a specific discipline, field, or problem; it cannot be learned or applied in the abstract
3. Does not require the thinker to reject established norms or ideas
4. Is informed by evidence but requires judgment
5. Includes active problem solving, not just evaluation
6. Is not redundant with logic or rationality.

Complex Problem Solving

In recent years, employers have consistently rated problem solving as the most essential competency for career preparedness (National Association of Colleges and Employers, 2017; Thompson, 2016). CEOs from across industries and around the globe expect work environments to continue to grow in terms of complexity (IBM, 2010), and complex problem solving is anticipated to replace physical abilities and core skills in a wide variety of jobs of the future (World Economic Forum, 2016). Thirty-six percent of all jobs are expected to require complex problem-solving as a core skill by 2020 (Thompson, 2016). The ability to address complex problems is particularly important in work environments characterized by rapid change (Middleton, 2002).

Complex problems are those that involve multiple goals along with many possible courses of action, all of which may shift in an environment that is dynamic (Fischer, Greiff, & Funke, 2012). Complex problem solving includes not only cognitive, but also emotional and motivational elements. It is a dynamic process in which the pathway to the solution might be more informative about the problem solver than reaching the solution itself (Dorner & Funke, 2017).

Creativity

U.S. CEOs are looking for employees with creativity (Ryan, Sapin, Rao, & Ampil, 2018). Creativity is a skill often identified as important in a rapidly changing workplace, and a capability that machines do not possess. But the assumption that creativity is a purely human skill has been challenged. Early creativity assessments measured divergent thinking or resistance to functional fixedness. These assessments included tasks such as presenting an object and asking the examinee to generate as many uses of that object as possible, within a specified timeframe. Individuals who generated a larger number of unique uses, regardless of elegance or complexity, received higher scores. This task measured the ability to generate novel, or heretofore nonexistent, ideas.

One technique for creating novel ideas is to simply produce combinations of familiar ideas. For example, a common brainstorming exercise to generate ideas for creative writing is to create index cards---either electronic or physical---each with a noun or adjective, and then pick two or three cards at random to create an unusual combination to spark an original idea. Computers are certainly well suited to this sort of rapid, rote activity. However, while this approach demonstrates an ability to generate novel ideas it may result in nonsensical combinations.

Boden (2003) builds upon this definition of creativity as “the ability to come up with ideas or artifacts that are novel *and valuable*” (emphasis added). Similarly, Mumford (2003) describes creativity as “new and useful.” Under this framework, creativity requires the generation of unique ideas as well as the ability to evaluate those ideas. Evaluating creative ideas is a complex and domain-specific task that requires a wealth of information. Not only must this conceptual space include sufficient details about the field to evaluate whether ideas are sensible, but metrics are necessary to assess the value of an idea. These values are specific to content domains and may change over time.

Frey and Osborne (2013) point out that research literature reveals examples of software generating and evaluating creative solutions. For example, Harold Cohen produced a drawing program, AARON, in the mid-1970s in an attempt to answer the question, “What are the minimum conditions under which a set of marks functions as an image?” Over decades, AARON evolved into an extensive producer of visual art with an internal feedback system that has been displayed in art galleries (Cohen, 1995).

Similarly, David Cope produced the initial version of the Experiments in Music Intelligences (EMI) software program in the early 1980s to analyze the style of a given musical composer (e.g., Bach, Mozart, Prokofiev) and then generate an original composition in the same style (da Silva, 2003). This software required domain-specific knowledge of tone systems, phrase structure and length, rhythm, movement structure, etc. and the ability to evaluate the balance between unity and variety.

Despite these domain-specific examples of computer generated creative products, Frey and Osborne (2013) conclude that “it seems unlikely that occupations requiring a high degree of creative intelligence will be automated in the next decade” (p. 26).

Brynjolfsson and McAfee (2011) suggest that the combination of current economic trends, specifically job growth trends and wage stagnation at the median range, provides opportunities for creative entrepreneurs. While increased technology may eliminate some career paths, it also opens potential paths to create ways to use technology to support mid-skilled workers and add value.

Innovation

The Future Laboratory conducted a study to identify trends in workplaces, employers, and employees (Unum United, 2014). They interviewed a range of experts from its Futures100 network—including academics, authors, scientists, and social scientists—and also surveyed 1,000 employees for their perspectives on the trends identified via these interviews. Respondents indicated that future workplaces will be people-centric and will foster innovation. Employees will need to blend skills and disciplines.

Innovative employees can only thrive in an organization that accepts innovative ideas. While innovation has been touted for years as an important trend, recent studies call specifically for “responsible” or “disciplined” innovation. Sull (2015) appeals for the implementation of a simple set of rules to serve as constraints in the innovation process. He acknowledges that despite guardrails designed to manage innovation, some failures are still inevitable, but that incorporating discipline serves to increase efficiency and improve the odds of successful innovations. He characterizes an appropriate set of simple rules as (a) few in number, (b) applicable to a well-defined activity or decision (rather than a broad corporate principle that is too vague to be actionable), (c) tailored to the culture and norms of the organization, and (d) sufficiently flexible to allow creativity and discretion. He suggests that an organization might employ rules for various purposes, including to select innovations, define how to innovate, and help community members innovate together. He cites successful innovators ranging from Zumba Fitness to the Defense Advanced Research Projects Agency (DARPA).

A corporate reputation for innovative thinking also can attract new employees. Brown and Martin (2015) describe the success of Innova Schools, which brought affordable education to Peru. Innova drew upon the results of a stakeholder study to develop a technology-enabled education system that valued the “guide on the side” rather than the traditional “sage on stage” model of instruction. Invited, ongoing feedback from school leaders, teachers, and parents helped to introduce continuous improvements, some of which were fundamental shifts from the expected outcomes. This approach resulted in scalability and job growth. The authors note that “Because Innova had a reputation for innovation, teachers wanted to work there, even though it paid less than the public [school] system” (p. 9).

Digital Tools

While the construct of skill with digital tools is not well defined, there are two aspects of digital skills that are unique: the skills required to (a) create and (b) use digital tools. The creation of digital tools, such as artificial intelligence and machine learning, requires STEM, analytic, and computational thinking skills. More specific digital skills, such as web development, are likely to rapidly evolve with the advent of new technologies, methods, and languages.

Basic digital skills are useful for developing other skills. For example, some medical training now relies on virtual reality simulations (e.g., Azarnoush et al., 2015), including to assess trainee performance (Dubin, Smith, Julian, Tanaka, & Mattingly, 2017). Virtual reality is also being used therapeutically, such as to develop emotional skills in children with autism spectrum disorders (Lorenzo, Lledó, Pomares, & Roig, 2016).

Statistical Literacy

Many expected changes in the nature of work relate to enhanced access to, and use of, data to make decisions. While some basic statistical processes can be automated with algorithms and machine learning, Gal (2002) argued that citizens must have a basic understanding of the concepts underlying statistical reasoning and terminology to interpret data, evaluate sources, and make decisions, including:

1. Basic statistical and mathematical methods and terminology
2. Foundational statistical concepts, such as probability and variability
3. Inferential reasoning
4. World knowledge, to aid interpretation and evaluation of findings.

Several trends will lead to increased demand for employees in all occupations who can (a) effectively use data, (b) understand how to visualize and manipulate data, and (c) draw conclusions from data. First, data are becoming more accessible. Brynjolfsson and McAfee (2011) pointed out that "Information doesn't get used up even when it's consumed…. and once a … body of information is digitized …. it can be copied infinitely and perfectly, and distributed around the world instantly and at no additional cost. This is nothing like the economics of traditional goods and services" (p. 73). The ubiquity of data and the relative ease with which it can be distributed and shared opens the possibility of extensive data analytics. Bonney et al. (2009) discussed the role of such "citizen scientists" in the advancement of both educational and scientific outcomes.

Second, access to new technology has further increased the importance of statistical literacy. Big data, artificial intelligence, and machine learning play an increasing role in daily life. While these technologies will replace some existing human tasks, they are expected to create new skill requirements, such as the ability to train algorithms (e.g., generating models for machine learning used in automated item scoring or image recognition used for automated driving), explain how they work, and keep them operating (Wilson, Daugherty, & Morini-Bianzino, 2017). Statistical reasoning skills will underlie all of these roles.

Finally, statistical literacy can also require specific skills, such as data visualization (Fox & Hendler, 2011). Hampton and colleagues (2017) created a taxonomy of skills for data-intensive research that includes five skill areas (data management and processing, software skills, analysis skills, data visualization, and communication and collaboration for results dissemination). While their focus was on environmental science, this taxonomy applies equally to work in other research-oriented domains as well.

Computational Thinking

Computational thinking can be thought of as a special case of analytical thinking, one that draws specifically on the ability of computers to abstract and automate problem solving (Wing, 2008). It is now pervasive in most analytical disciplines (Beheshti et al., 2017).

Hu (2011) defined computational thinking as:

> *…thinking to solve problems, automate systems, or transform data by constructing models and representations, concrete or abstract, to represent or to model the inner-working mechanism of what is being modeled or represented as an information process to be executed with appropriate computing agents. Such thinking is necessarily:*
>
> - *logical, to capture what is essential to the models or representations;*
> - *algorithmic, to step-wise define or refine operational processes;*
> - *scientific, to gain understanding of models' capabilities, learn how to use them with maximum efficiency, and explore the effects of the computation in the original problem domain.*
> - *mathematical, to be able to show the correctness of algorithms, specify precisely the functionality of a software system, measure the quality of what we do in a process of computation, and deal effectively with the complexity of the models and representations by exploring more effective and efficient alternatives;*
> - *analytical, to model with purpose, assumptions and viewpoints, evaluate and adjust the models and representations by prototyping, and study their implications and consequences;*
> - *engineering-oriented, to design the models and representations against known constraints and practical concerns, and to plan, execute, manage, and evaluate the process of computation in order to improve our capability and maturity level; and*
> - *creative, to model the unthinkable.*

It is important to note that computational thinking is not synonymous with coding or programming skills, but encompasses understanding of computational concepts, practices, and perspectives (Lye & Koh, 2014). Psycharis (2018) argued that computational thinking integrates mathematics, computer science and knowledge in one or more subject areas to solve complex problems. In measuring criterion validity of the Computational Thinking Test, Román-González, Pérez-González, and Jiménez-Fernández (2017) found statistically significant correlations between computational thinking and spatial, reasoning, and problem-solving abilities.

Interpersonal Skills

Communication

Communication is, at its core, an exchange of information, whether linguistic or non-linguistic, and is widely considered a key competency in both postsecondary education and workplace contexts (Brink & Costigan, 2015). Effective communication, defined as the ability to synthesize and transmit ideas, is among the critical skills needed by employees at all levels of organizations (American Management Association, 2012). Communication in the future world of work will require the ability to work with emerging technologies, along with the more traditional elements of communication such as listening, initiating and engaging in conversation, and persuading others.

Listening

Listening has been identified as the most important oral communication skill for successful job performance across a range of workforce samples (Brink & Costigan, 2015). Listening can be categorized into four major types:

1. Active- giving full attention when others are speaking
2. Involved- giving most of one’s attention to the speaker’s words and intents
3. Passive- Receiving information rather than being an equal partner in an exchange
4. Detached- Withdrawn from the speaking-listening exchange such that one is the object of the message rather than the receiver (Pearce, Johnson, & Barker, 2003).

Active listening, in particular, is sought after by potential employers as it helps to create a positive work culture and supports collaboration, which in turn spurs innovation (Nowogrodski, 2015). An active listener fully concentrates on what is being communicated and provides both verbal and nonverbal feedback in response. Examples of verbal feedback include providing positive reinforcement, remembering prior details, asking relevant questions, paraphrasing what the speaker has said, and requesting clarification. Examples of nonverbal feedback during active listening include smiling, making eye contact, maintaining posture, mirroring facial expression, and maintaining focus (SkillsYouNeed, 2018).

Conversation

Conversation among team members, whether virtual or face-to-face, is anticipated to be an expanding feature of future jobs (Gribben, Becker, & Dickinson, 2018). Conversation skills are important because they contribute to an organization’s shared understandings, which may be critical for the agile decision-making that is characteristic of the workforce of 2030 (Heidema, 2017). Conversing skill has been rated among the most important oral communication skills, typically rated between listening and presentation in terms of importance for job success (Brink & Costigan, 2015). Employers seek employees with conversation skills because they will contribute positively to the workplace culture by promoting dignity and increasing motivation (Macaulay, 2014).

Conversation goes hand-in-hand with listening, such as knowing when it’s time to listen and when it’s time to talk, and gauging one’s delivery based on mindful listening to the other person’s message (Macaulay, 2014). Conversation skills also include staying organized, and being strategic about the information one both conveys and takes away from the interaction (Coplin, 2003). In the digital age, workers are increasingly engaging in multiple communications, often simultaneously, and therefore run the risk of tuning out important conversations as they seek to filter all of the information received. The ability to engage in authentic conversations on social media platforms therefore becomes a skill of its own (Lombardi, 2014).

Persuasion

Persuasion is a uniquely human skill, one that is expected to withstand the wave of increased automation (Luckin, Baines, Cukurova, Holmes, & Mann, 2017) and one that is increasingly in demand (Deloitte, 2016). Also, as the future world of work will be characterized by increasing diversity and geographic dispersion, the ability to persuade people from a variety of backgrounds will be valued in the workplace (Martin, 2010).

> Persuasion is an important skill for any job role that involves managing customer or client relationships, or managing other employees (Dellaert & Davydov, 2017).
>
> Persuasion skills include (a) making an assessment of the individual or group one is trying to persuade, (b) establishing rapport with them, (c) communicating the benefits of the proposed course of action, (d) actively listening to any counterarguments, (e) clearly presenting counterpoints to these arguments, (f) recognizing any limitations of the original course of action, (g) modifying the course of action as needed, (h) reaching terms with the person being persuaded, and (i) following up to ensure that they are still on board with the agreed upon course of action (Doyle, 2018).

Relationship Building

As the workplace of the future relies more and more on teams, both virtual and in-person, relationship building skills become more valuable. Building relationships has benefits for employees, teams, leaders, and organizations, such as building trust, boosting morale, and improving decision making (Pauleen, 2004). The ability to forge positive relationships in the workplace is key for an individual's job satisfaction, and is an essential building block in the creation of a collaborative work environment.

Relationship building is characterized by listening to others and encouraging them to share their thoughts and feelings (Lievens & Sackett, 2012). Communication skills therefore play a major role in relationship building, but also key are things such as following through on commitments and being considerate of others' feelings and perspectives (Tingum, 2018). Relationship building skills are characterized by willingness to share one's knowledge and expertise; providing quality feedback to others; supporting others' work while also bringing in others to help with their own work; and engaging in ongoing, friendly interactions inside and outside the workplace (Garfinkle, 2018).

Cultural Sensitivity

Cross-cultural competency will be a core skill in most organizations of the future, as employees will need to be able to identify shared values to work effectively with increasingly diverse coworkers (Davies, Fidler, & Gorbis, 2011). In the context of the workplace, cultural sensitivity includes the ability to work effectively alongside someone from a different cultural background who may approach workplace behaviors differently (Sherman, 2018). Culture-based misinterpretations can have implications for the success of collaborative efforts (Blanding, 2012).

Coworkers from different cultural backgrounds may engage in different behaviors and hold different work-related values. For example, employees from individual-oriented cultures may approach work tasks differently than someone from a group-oriented culture (Heggertveit-Aoudia, 2012), which may influence behaviors such as how employees participate in meetings, the amount of time they spend socializing, and whether they provide feedback or otherwise publicly express opinions (Knight, 2015). Increased cultural sensitivity could help mitigate such differences.

At its most basic level, cultural sensitivity requires knowledge and understanding of other cultures (Lutz, 2017). Cultural sensitivity may also involve taking an interest in another culture, recognizing cultural differences, and then changing one's own behavior to show respect for the other culture (Hammer, Bennett, and Wiseman, 2003). Recognition of one's own biases is also an element of cultural sensitivity (Loue, Wilson-Delfosse, & Limbach, 2015).

Understanding Other People's Perspectives

Increasing levels of collaboration among diverse teams in the workplace will boost the value of perspective taking as a job skill. Perspective-taking refers to the ability to take on another person's point of view. It is an active and goal-directed process that involves trying to understand the thoughts, and feelings of another, as well as the motivations behind them (Parker, Atkins, & Axtell, 2008).

Situational awareness and personal awareness are two key components of perspective-taking. Situational awareness refers to understanding the context in which another person is acting. Personal awareness refers to understanding what the other person brings into that context (Goulston & Ullmen, 2013). Other building blocks of perspective-taking include being aware of others, regulating one's emotions and empathy, being able to successfully "read" other people, and correctly interpreting what others are trying to communicate (Campbell, 2016).

Collaborative Problem Solving

The demand for collaborative problem-solving skills is anticipated to experience high levels of growth in the future. It is defined as the ability to engage effectively with two or more people to solve a problem through shared understanding and effort, and pooled knowledge and skills (Luckin, Baines, Cukurova, Holmes, & Mann, 2017). Collaboration will be key as increasingly complex problems will not be solved by one specific field of expertise, but rather will require working with others from different disciplines (Davies, Fidler, & Gorbis, 2011). Collaborative problem solving was recently added to the skills measured by the Program for International Student Assessment (PISA), a reflection of its significance as a desired skill. As the workplace of the future will be characterized by increasing amounts of teamwork, being able to collaborate to solve problems will be a highly desired skill (Thompson, 2016).

Collaborative problem solving is not only useful for completing job tasks; it is also applicable to maintaining a positive work environment. Managers may use collaborative problem solving to resolve issues among employees by engaging in collaborative discussions to reach a common understanding of the problem at hand and to negotiate a solution (Bernstein & Ablon, 2011).

Social and Emotional Intelligence

Emotional intelligence (EI), sometimes referred to as social and emotional intelligence, refers to an individual's capacity to recognize one's own and others' emotions, use this knowledge to inform thinking and behavior, and adapt to meet goals. The concept has had a controversial history since the mid-1990s. Multiple definitions of EI—and various measures associated with each definition—exist today. Some studies have found positive correlations between EI scores and job performance and leadership skills; other studies find no unique contribution of EI to these outcomes beyond correlations accounted for by general intelligence and measures of generally accepted personality traits. We do not delve into the history and nuances of EI here, but instead summarize literature regarding EI's perceived place among the skills needed in the workplace of the future.

Frey and Osborne (2013) conferred with experts in machine learning to determine the binary likelihood (i.e., yes/no) of automating 70 occupations based on their O*NET characteristics. These occupations were selected from the full suite of 702 O*NET detailed occupations based on confidence in the automation rating. Authors then used statistical modeling approaches to estimate the probability of automating the remainder of the occupations. After extensive analysis, the authors conclude "…as technology races ahead, low-skill workers will reallocate to tasks that are non-susceptible to computerization— i.e., tasks requiring creative and social intelligence. For workers to win the race, however, they will have to acquire creative and social skills" (p. 45).

Using a very different approach, PricewaterhouseCoopers (PwC; 2018) began a collaboration with the Said Business School in Oxford in 2007 to map influential business factors. The study authors postulated four "worlds of work" to emerge by 2030 in which potential workplace scenarios are described in four quadrants defined by two dimensions: fragmentation vs. integration and collectivism vs. individualism. The authors developed descriptions of each scenario, including a timeline of milestones between 2020 and 2030, major characteristics of the quadrant, implications for workers, what the workforce will look like, and organizational challenges. Following a discussion of all four worlds, they predict the following about jobs: "Automation will not only alter the types of jobs available but their number and perceived value. By replacing workers doing routine, methodical tasks, machines can amplify the comparative advantage of those workers with problem-solving, leadership, EQ (Emotional Intelligence), empathy and creativity skills" (p. 30). PwC commissioned a survey of 10,000 individuals in China, India, Germany, the U.K., and the U.S. and found that 76 percent of respondents agreed or strongly agreed that they had emotional intelligence.

Intrapersonal Skills

Time Management

Time management skills encompass a variety of specific abilities: estimation of effort, scheduling, prioritizing, delegation, and monitoring a to-do list, among myriad others. An individual with strong time management skills can not only project the amount of time and effort a given task will require, but also inhabit the mindset to meet deadlines and, perhaps as importantly, recognize when a deadline cannot be met and adapt accordingly.

While employers have historically valued employees with solid time management skills, in the expanding gig economy[44] the individual entrepreneur's personal success depends upon it. When multiple gigs are underway, the ability to schedule and complete each gig as though it was the individual's only job is critical. In a very dynamic environment where freelancers and hiring agencies are mixed-and-matched in various combinations for specific tasks, the entrepreneur cannot rely upon the understanding of a long-time employer who is familiar with the individual's work and is sympathetic when projects fall behind. Task matching search engines such as Upwork (www.upwork.com), TaskRabbit (www.taskrabbit.com), or Gigwalk (www.gigwalk.com) collect customer satisfaction data and use this feedback to determine whether to match entrepreneurs to future tasks. Poor ratings due to a lack of effective time management could prevent further assignments.

Efficiency

Similar to time management skills, traditionally employers have valued efficient employees. For the 21st annual survey of CEOs worldwide, PwC interviewed 1,293 CEOs in 85 countries, including 104 from the United States, in October and November of 2017 (Ryan, Sapin, Rao, & Ampil, 2018), U.S. CEOs are hiring for broadly relevant digital skills and collaborative, creative, and efficient work styles.

In a gig economy, however, efficiency is particularly important. The individual entrepreneur may face challenges of scalability. At the extreme, the artisan who produces hand-made items can

[44] A gig economy refers to a labor market characterized by the prevalence of short-term contracts or freelance work as opposed to permanent jobs.

only produce so much; the individual service provider can only manage a limited number of clients or tasks. In order to scale up—which may be necessary in order to obtain a livable wage—the entrepreneur must be efficient.

Efficiency can be instantiated in a variety of ways in a gig environment. In some job markets, the individual entrepreneur may add staff and delegate work in order to increase production; however, in the examples just cited—creator of artisanal handmade items or tasker such as a personal shopper or errand runner—adding staff may not be feasible. Alternatively, the worker may use technology to offload mundane or repetitive tasks and free up time for more creative or complex work, requiring human skills. For example, subscribing to a task-matching search engine is an efficient way to seek work, relative to searching for opportunities and applying individually for each. Thirdly, a worker may leverage innovation or creativity to complete tasks more efficiently.

Adaptability

One of the common concerns about the future workplace is that automation will obviate the need for humans to perform large categories of jobs. Certainly, computerization and robots have been demonstrated to be effective replacements for humans in predictable, repetitive environments such as assembly line work. Further, AI has been successfully deployed to rapidly and accurately process large amounts of data to detect patterns and make complex, data-informed decisions. More recently, AI learning systems have been trained to determine optimal ways to conduct certain processes, and monitor their own ongoing effectiveness for further improvement. In this way, automated systems have the capacity for selected adaptability.

Many jobs, however, are less well-suited to automation. Autor and Dorn (2013) note that as computerization has become increasingly affordable, low-skill workers have shifted from routine tasks to the service industry. They contend that these service occupations are somewhat immunized against automation due to their reliance upon a combination of factors including direct physical proximity and flexible interpersonal communication.

In addition to adaptability being key to specific careers, adaptability will also be integral to the projected evolving career path an individual will undertake over the course of a working lifetime. As companies demand upskilling or reskilling, the adaptable employee will be at an advantage. McKinsey (2017) conducted interviews with experts from industry and academia for the April 2017 Digital Future of Work Summit in New York. Experts included professors and executives from NYU, C3 IoT, New America, WorkMarket, LinkedIn, Arena, and McKinsey Global Institute (MGI). MGI partner Susan Lund opined “For young people today, what’s clear is that they’re going to need to continue to learn throughout their lifetime. The idea that you get an education when you’re young and then you stop and you go and work for 40 or 50 years with that educational training and that’s it—that’s over. All of us are going to have to continue to adapt, get new skills, and possibly go back for different types of training and credentials. What’s very clear is that what our kids need to do is learn how to learn and become very flexible and adaptable” (p. 2).

Finally, in a gig economy the successful entrepreneur must be prepared to provide services to multiple employers in a variety of environments. Being able to adapt to technical and administrative requirements will serve the independent contractor well.

Blended Skill Sets

Learning Agility

Learning agility is a skill necessary for the development of skills of the future. It involves many of the skills required for the work of the future, including adaptability, tolerance for ambiguity, communication and listening skills (Eichinger & Lombardo, 2004), but applies them to the development of other skills. DeMeuse, Dai, and Hallenbeck (2010) indicate that learning agility is related to past experience, self-awareness, and the ability to handle complexity. Mueller-Hanson, White, Dorsey, and Pulakos (2005) relate learning agility to adaptability.

New Media

New media refers to the emerging means of communication with large groups of people, and includes the internet, as well as more recent interactive, digital platforms through which more and more people access and consume information (Wynne, 2017). With increasing globalization and dispersion of the workforce, and with a growing number of employers creating and maintaining a new media presence, the ability to effectively navigate in this environment will become an increasingly valued skill (Gribben, Becker, & Dickinson, 2018).

Several core competencies have been identified as essential for participating in new media (Jenkins, Purushatma, Weigel, Clinton, & Robison, 2009). These include:

1. Play- the capacity to experiment with one’s surroundings as a means of problem-solving
2. Performance- the ability to adopt alternative identities to improvise or discover new things
3. Simulation- the ability to interpret and construct dynamic models of real world processes
4. Appropriation- the ability to sample and repurpose media content in meaningful ways
5. Multitasking- the ability to scan one’s environment and focus in on the key details
6. Distributed cognition- the ability to have meaningful interactions with tools that expand mental capacities (e.g., calculator, Wikipedia)
7. Collective intelligence- the ability to pool and compare knowledge with others to achieve a common goal
8. Judgment- the ability to assess how reliable and credible various information sources are
9. Transmedia navigation- the ability to follow stories and information across multiple media
10. Network- the ability to search for, synthesize, and distribute information
11. Negotiation- the ability to travel across diverse communities, recognizing and respecting differing perspectives, and understanding and following alternative norms
12. Visualization- the ability to translate information into visual models and to understand the information that other visual models are conveying

Projections of Shifts in Future Skills

Skills Expected to Increase in Demand

Literature on trends in workforce skills typically does not include information to determine the rate of the trend. Thus, it is difficult to identify which skills are expected to increase in demand. In the next sections, we present skills that have been deemed critical for the future workforce and show evidence of expected increase in demand. Based on projections of work in the future, there is evidence of expected increase in jobs demanding the following subset of future postsecondary skills.

Complex Problem Solving

Futurist Cynthia Wagner (2011) forecasts a limitless supply of future problems to solve. Educators consider critical thinking and complex problem solving a core skill for students (Lara, 2018; P21, 2016) in part because employers increasingly seek workers with complex problem solving skills. Employers have consistently rated complex problem solving as the most essential competency for career preparedness (National Association of Colleges and Employers, 2017). The ability to address complex problems is particularly important in work environments characterized by rapid change (Middleton, 2002).

Computational Thinking

Opportunities to learn how to code, especially for girls (see girlswhocode.com) amidst efforts to achieve gender parity in the computer science industry, have exploded in popularity (Bourque, 2016). Games that teach programming logic are being marketed for children as young as four-years-old (see Kodable.com). Hackathons offer monetary awards and bragging rights, spurring innovative design and problem solving. However, Grover (2018) argues that not everyone will become a computer programmer. Computational thinking – the “ability to translate vast amounts of data into abstract concepts and to understand data-based reasoning” (Davies, Fidler, & Gorbis, 2011, p. 10) – should be taught to every student (Grover, 2018).

Communication

Using government job-growth projections, the Pew Research Center identified the fastest growing occupations and skills and preparation requirements for working in those fields (DeSilver, 2016). Nine of the top 10 fastest growing occupations, with projected growth of 5.2% to 13.1% in the ten-year period 2014 to 2024, require job preparation (i.e., formal education, on-the-job training, and prior related experience), interpersonal skills (e.g., communication), or both.

Cultural Sensitivity and Communication

According to Davies, Fidler, and Gorbis (2011), ease and sensitivity in working with culturally diverse colleagues will become an important skill for all workers, not just those who work in global corporations. Employers are increasingly recognizing the value of cultural competence and communication skills among new hires (Vozza, 2016), especially when those skills are needed to perform future jobs that involve interaction on a global scale.

Collaborative Problem Solving

The demand for collaborative problem-solving skills is anticipated to experience high levels of growth in the future (Thompson, 2016). In recent years, employers have consistently rated collaboration among the top competencies needed for career preparedness, and recognize it as the top attribute for setting apart a potential employee’s resume (National Association of Colleges and Employers, 2017). Industry strategists expect collaboration to be a top business objective in the workplace of the future (Bowles, 2018; P21, 2016). Virtual collaboration (Davies, Fidler, & Gorbis, 2011) will be more in demand as multifaceted problems are too complex to be solved within one discipline or organization (e.g., climate change) and necessitate working on virtual teams. Working on collaborative teams allows for skills gaps to be bridged and increases efficiency (Boyer, 2017).

Social and Emotional Intelligence

Davies, Fidler, and Gorbis (2011) declared social and emotional intelligence as one of ten skills critical for success in the future workforce. The Partnership for 21st Century Learning (2016) includes interpersonal skills as a key skill for students to learn before graduation from high school and embarking on postsecondary pathways.

Adaptability

Business trends indicate a need for more employees who are comfortable adapting to frequent changes to their work and the workplace (Davies, Fidler, & Gorbis, 2011; McKinsey & Company, 2017; P21, 2016). As organizations are required to respond quickly to changes in an increasingly globalized and technologically advanced world, employers will seek an agile workforce capable of responding to unanticipated change with speed (Breu, Hemingway, Strathern & Bridger, 2002). Workers of the future may be expected to rotate among a variety of roles and tasks (Wadors, 2017). With increasing contract and gig positions expected in the future (Yaraghi & Ravi, 2016), individuals will rely on their adaptability skills as they move from one job to another. Additionally, adaptability skills will facilitate keeping up with changes in technology. Adaptive thinking is a key to innovation and creative problem solving (Davies, Fidler, & Gorbis, 2011).

New Skills Expected to Emerge

While information about specific future jobs was scarce, prediction of new skills is non-existent. Using projections of new jobs requiring creativity and social and emotional intelligence, we can extrapolate the need for skills drawing on creativity and social and emotional skills. Increases in artificial intelligence (AI) applications may lead to a need for new skills combining knowledge of AI and other skills to further the research, development, and integration of AI into the workplace.

When futurists discuss workplace skills they tend to focus on combinations of current skills, such as skills in multiple subject-area domains (see transdisciplinarity in Davies, Fidler, & Gorbis, 2011) or skill in cognitive and non-cognitive areas (e.g., analytical and interpersonal skills). By 2030, some new jobs will likely demand completely new skills that we cannot yet imagine and therefore currently cannot describe or label.

Summary of Themes of Skills for the Future

When it comes to skills for the future, the types of jobs offered and changes to workplace processes will be the major drivers of skills needed to enter the workforce. By extension, skills for jobs needing postsecondary education or training require skills for success in school as well as job-specific and cross-career skills. Although change is expected in the world of work, the amount and direction of change is unknown. However, this review of relevant literature points to some overarching themes that provide a solid base for making predictions about career skills that students who entered kindergarten in 2017 will need in 2030 when they graduate from high school. Careers will likely look very different from those their parents were prepared for, particularly in terms of the number of jobs and variety of skills needed across and within those jobs over their lifetime.

Jobs of the future like those of today will require a mix of cognitive, interpersonal, and intrapersonal skills. The specific set of skills and which ones are most important will vary depending on the pathway a student follows. Increasingly, blended skill sets (e.g., learning agility and new media) will be needed. Fields that had previously been quite separate may be blended in new ways, requiring combinations of skills not seen before. Existing jobs may be blended with new technologies to create positions we have never seen (think: space junk recyclers) and requiring new skills or blended skill sets.

Industry believes “data is the new oil.” To meet the expected rise in demand for employees to work with data, employers will seek individuals with skills related to manipulating, analyzing, interpreting, and illustrating data.

High school graduates of 2030 will set out on career pathways characterized by change. Whether they work independently through the gig economy, or move among multiple employers or across multiple departments or projects, workers of the future will likely need to be adaptable and agile as they will be asked to respond quickly to unanticipated changes. They will need to draw upon cross-cultural and virtual collaboration skills as they find themselves part of an increasingly diverse and dispersed workforce. Workers will become lifelong learners as jobs continually evolve to meet changing demands and to incorporate the latest innovations.

With some sense of what the future holds, a key next step to ensuring that students graduate high school in 2030 prepared for success in their postsecondary pathways is to measure the skills needed to perform the jobs of the future. Assessing future postsecondary skills provides a metric for understanding and monitoring how prepared the next generation is for life after high school.

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