National Assessment Governing Board

Ad Hoc Committee on Measures of Postsecondary Preparedness

Thursday, November 15, 2018

2:00 – 4:00 pm

Finalizing Recommendations

AGENDA

2:00 – 2:10 pm	Welcome and Overview of Committee's Charge *Terry Mazany, Committee Chair*	
2:10 – 2:30 pm	Reflections on the Young Adult Expert Panel Meeting *Terry Mazany*	*(summary provided separately)*
2:30 – 3:45 pm	Discussion Draft Recommendations Report & Operational Implications *Terry Mazany* *Peggy Carr, Associate Commissioner NCES*	*(draft report provided separately; draft appendix attached)*
3:45 – 4:00 pm	**ACTION:** Committee Decision to Finalize Recommendations and Report them to the Board *Terry Mazany*	

Table of Appendices

Appendix A. Charge to the Committee

Resolution: The Executive Committee's Charge to the Ad Hoc Committee on Measures of Postsecondary Preparedness

Whereas, on November 18, 2016, the National Assessment Governing Board unanimously approved the Strategic Vision to guide its work through the year 2020; and

Whereas, the Strategic Vision established a Board priority (SV#10) to *"Develop new approaches to measure the complex skills required for transition to postsecondary education and career"*; and

Whereas, on August 3, 2017, the Governing Board Chair created the Ad Hoc Committee on Measures of Postsecondary Preparedness to pursue this priority; and

Whereas, the Governing Board Chair tasked the Executive Committee to establish the charge to guide the Ad Hoc Committee on Measures of Postsecondary Preparedness;

Therefore, the Executive Committee resolves that:

1. **The Ad Hoc Committee on Measures of Postsecondary Preparedness shall review existing research, collect expert testimony, and prepare recommendations for the Governing Board's consideration to achieve Strategic Vision priority #10.**

2. **While the current legislation guiding the National Assessment of Educational Progress (P.L. 107-279) should provide parameters for the approaches to accomplish this priority, the Ad Hoc Committee on Measures of Postsecondary Preparedness may consider options that could require amendments to current legislation.**

3. **The Ad Hoc Committee on Measures of Postsecondary Preparedness will report its recommendations to the Governing Board no later than the November 2018 Board meeting.**

Appendix B. Exploratory Approach Overview

To address its charge, the National Assessment Governing Board's Ad Hoc Committee on Measures of Postsecondary Preparedness considered the trends that most likely will shape the future, and thereby shape the skills and knowledge that students will need to develop. Through meetings with expert panels and commissioning focused research papers, conducted with the support of its contractor HumRRO, the Committee pursued the answers to the following three research questions:

1. ***Work of the future (readiness for what?):*** What are we, as a nation, preparing students for? Changes in the workplace are not only inevitable, but are accelerating, driven by technological advances, demographic shifts, and social changes. The growing prevalence of self-driving vehicles, the more widespread use of robots, and advances in artificial intelligence are signs of existing innovations poised to dramatically change the jobs available to young Americans. Young Americans hold different expectations about work, and the ways in which people connect and communicate with each other are all changing. How will the workplace change given these emerging technologies? How will our communities change given these trends?

2. ***Requisite skills for future work (skills for what?):*** With a better understanding of the future workplace, we can better understand the skills that young Americans will need to succeed. But should we consider more than just workplace skills? What about skills like citizenship and financial literacy? How do these skills factor into the question of measuring postsecondary preparedness?

3. ***Measures of preparedness (measures for what?):*** Finally, what metrics exist to capture the skills that young Americans will need in the workplace, for their roles in their communities, and in their personal lives? Can such metrics include data from sources in addition to or instead of assessments? Additionally, what metrics do not exist but are needed to help the nation better understand if students are prepared as they exit high school, regardless of which paths they take—through college or other postsecondary learning experiences or directly to the workforce?

The following pages summarize the key findings from the various research and expert consultations; more detailed summaries are provided in the subsequent appendices.

Appendix C. Summary Answers for Research Questions

Work of the Future – Readiness for What? (Q1)

Students beginning their K-12 education in 2017 are on course to graduate in 2030. Upon graduating high school, these students will face many choices for pursuing work and further learning. Traditionally, high school graduates have chosen between enrolling in postsecondary education or directly entering the workforce. Of 2017 high school graduates, for example, 67% enrolled in a postsecondary institution, 22% entered the work force, and 11% did neither.[1] Postsecondary education has typically been a four-year college, two-year college, or technical school. Entry-level jobs are those that permit the employee to enter the workforce with little experience or education, often with the goal of moving onto a career path through valuable on-the-job experience. The military is an alternate pathway, providing training, experience, and a job; some choose to make serving in the military their career.

While similar options will remain for the graduates of the future, marked differences are anticipated as well. Current projections suggest that enrollment in degree-granting postsecondary institutions will increase by 2026[2], whereas participation in the work force among 16-24-year old Americans will decline during a similar time frame[3]. The lines between postsecondary education and work may also become blurred, as universities and corporations expand their partnerships[4] to offer new educational opportunities and employers begin to develop their own training and credentialing programs.[5]

Students will also likely continue to move in and out of, and between, postsecondary institutions[6] and work experiences; the curve and length of individual pathways will reflect personal needs, interests, and goals. And though they will vary in their timelines, each pathway will eventually lead to some form of work and for most a career, typically as part of the paid labor force. But what will the work of the future look like?

The graduates of 2030 will need to be prepared for a postsecondary experience that may look very different from that for which their parents and teachers were prepared. Although jobs that sound quite familiar to us now (e.g., teacher, veterinary technician, lawyer, engineer) will likely still be widely available, it is impossible to predict the range of specific jobs that will be available and sought-after more than a decade from now. Trends such as globalization, automation, and "big data" point to major changes in the world of work, both in terms of the available jobs and the work environment in which those jobs will be carried out.

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[1] United States Department of Labor. (2018). Economic News Release. *Table 1. Labor force status of 2017 high school graduates and 2016-17 high school dropouts 16 to 24 years old by school enrollment, educational attainment, sex, race, and Hispanic or Latino ethnicity, October 2017.* Retrieved from https://www.bls.gov/news.release/hsgec.t01.htm

[2] National Center for Education Statistics (2018). *Projections of education statistics to 2026*. Retrieved from https://nces.ed.gov/pubs2018/2018019.pdf

[3] United States Department of Labor. (2017). Career Outlook. *Projections of the labor force, 2016-26*. Retrieved from https://www.bls.gov/careeroutlook/2017/article/projections-laborforce.htm?view_full

[4] Smith, P. (2018). *Alternative pathways: A complex upheaval is unfolding but not a 50 percent failure rate*. Retrieved from https://evolllution.com/managing-institution/higher_ed_business/alternative-pathways-a-complex-upheaval-is-unfolding-but-not-a-50-percent-failure-rate/

[5] Bagley, R. (2017). *The future of jobs training: 2 promising career prep pathways*. Retrieved from http://www.gettingsmart.com/2017/06/future-jobs-training-promising-career-pathways/

[6] U.S. Government Accountability Office (2017). *Higher education: Students need more information to help reduce challenges in transferring college credits*. Retrieved from https://www.gao.gov/products/GAO-17-574?utm_medium=email&utm_source=govdelivery

Technology linking employers and employees will allow geographically dispersed people to vie for the same job, leading to an environment in which American workers will compete with others from around the globe.[7] Once hired, they will be part of an increasingly dispersed and diverse work force. Advancements in communications technology will continue to bridge this distance, allowing for collaboration across space and time. Work of the future will often be contract-based, and workers for the future will need to be prepared to work as part of cross-cultural and mixed-discipline teams. With this increase in contract work, work environments will be more fluid, with individuals able to determine their own schedule and/or work space.

Automation will reduce the number of human workers needed to perform routine tasks in some fields, while creating new job descriptions in other fields and adding jobs directly related to the machines used to automate work[8]. Many customer service and middle management positions are expected to disappear as increasing numbers of transactions are completed via automated functions, thereby reducing the need for cashiers, clerks, and similar service providers, as well as those who would supervise them.[9] Jobs relating to transportation and logistics, office and administrative support, manufacturing, and service are also expected to decline due to increased automation.[10] At the same time, increasing numbers of workers will rely on artificial intelligence to assist them in their jobs. Humans and machines will collaborate to make decisions in the future world of work.[11] Humans will also be responsible for designing and servicing these automated technologies.

Large quantities of data collected in real time will create job opportunities in data management and analytics, leading to expanded opportunities for those who can analyze and mine these data into information.[12] Data collection mechanisms will be seamlessly integrated into all parts of life, and jobs will require a broad range of employees to use data. Due to this unprecedented access to real-time data, organizations will change quickly to meet the demands of the markets in which they function. [13]

Job descriptions of the future will not be organized around clearly defined job titles, but rather around accumulated skills and experiences. Employers will leverage data to identify employees

[7] Basu, K. (2016) *Globalization of labor markets and the growth prospects of nations*. Retrieved from https://openknowledge.worldbank.org/bitstream/handle/10986/23929/Globalization00prospects0of0nations.pdf?sequence=1&isAllowed=y

[8] Atkinson, R. D., & Wu, J. (2017). *False alarmism: Technological disruption and the U.S. labor market, 1850-2015*. Retrieved from: http://www2.itif.org/2017-false-alarmism-technological-disruption.pdf?_ga=2.117549709.544738862.1522704813-61893732.1522704813

[9] Andrew, P., Ip, J., & Worthington, J. (2014). *Fast forward 2030: The future of work and the workplace*. Retrieved from file:///C:/Users/edickinson/Downloads/CBRE_Genesis_FAST_FORWARD_Workplace_2030_Full_Report_E.pdf

[10] Frey, C. B., & Osborne, M. A. (2013). *The future of employment: How susceptible are jobs to computerisation?* Retrieved from: https://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

[11] PwC. (2018). *Workforce of the future: The competing forces shaping 2030*. https://www.pwc.com/gx/en/services/people-organisation/workforce-of-the-future/workforce-of-the-future-the-competing-forces-shaping-2030-pwc.pdf

[12] Ross, A. (2016). The industries of the future. New York, NY: Simon & Schuster.

[13] Breu, K., Hemmingway, C., Bridger, D., & Strathern, M. (2002). Workforce agility: the new employee strategy for the knowledge economy. *Journal of Information Technology 17*, 21–31.

who possess the experiences and skills specific to the job at hand.[14] Potential employees will market themselves as uniquely qualified for the specifics of a project via online talent platforms and social media. Careers will be built out of freelance arrangements or other such "gigs".[15] Even those who opt for a more traditional career will likely hold around 12 jobs,[16] either within one organization or across several organizations, over the course of their life. This will necessitate a continuous process of education and training throughout these future workers' careers.[17] Employers of the future will likely demand and incentivize on-going and just-in-time skill development to meet changing workforce needs.

Changes in the world of work have implications for postsecondary education as well. The graduates of 2030 will vary in terms of their high school experiences. Some will leave high school with college credits, Associate's degrees and/or industry certifications, equipped with academic and job-specific knowledge and skills. Some will have paid work experience under their belts, in addition to or in lieu of service learning or other unpaid work experiences. Many will weigh decisions regarding what pathway is the best fit given their financial situation, their family's needs, and their own goals, interests, and perceived abilities. Postsecondary institutions will need to use available data to make appropriate placement decisions, and then offer individualized instruction and a variety of student-focused services and support structures to ensure that students persist and ultimately graduate with competency in specific and generalized skills. Further, postsecondary institutions will need to adapt to meet the needs of an agile workforce that will be seeking opportunities for lifelong learning through additional credentials or courses designed to build new, or enhance existing, job skills.

Requisite Skills for Future Work – Skills for What? (Q2)

With this vision of the work of the future in mind, the skills needed to thrive in such an environment become apparent. Foundational academic skills, such as literacy and numeracy will continue to be valued and valuable in the postsecondary world of 2030. However, postsecondary success will also require a range of other cognitive, interpersonal and intrapersonal skills, as well as essential life skills. Cognitive skills include facility with technology, digital skills, computational thinking, and statistical literacy. Interpersonal skills include problem solving, communication, collaboration and cultural sensitivity. Intrapersonal skills include time management and flexibility. Essential life skills include financial and health literacy, as well as citizenship skills.

Cognitive Skills

Facility with technology will be in demand for jobs at all levels. Routine tasks formerly performed by humans may be taken over by robots or other technological advancements[18], leaving the human worker to service the technology or collaborate with the technology to complete more

[14] Lazarus, K. (2017). *Machine learning: Revolutionizing how employers find and hire the best talent.* Retrieved from https://www.hrtechnologist.com/articles/recruitment-onboarding/machine-learning-revolutionizing-how-employers-find-and-hire-the-best-talent/

[15] Intuit. (2016). *Dispatches from the new economy: The on-demand economy worker study*. Retrieved from: https://intuittaxandfinancialcenter.com/wp-content/uploads/2017/06/Dispatches-from-the-New-Economy-Long-Form-Report.pdf

[16] U.S. Department of Labor. (2018). National Longitudinal Surveys. *Frequently asked questions*. Retrieved from https://www.bls.gov/nls/nlsfaqs.htm#anch41

[17] PwC. (2018). Workforce of the future.

[18] Ibid.

complex tasks. Employers will continue to increasingly seek individuals with computational thinking and digital skills to interact with data and new and emerging technologies.[19]

Basic digital skills will be essential for developing other skills. Education and on-the-job training will increasingly be delivered via digital platforms and will incorporate virtual reality simulations more frequently.[20] More advanced digital skills include those required to create and use digital tools. The creation of digital tools, such as artificial intelligence and machine learning, requires STEM, analytic, and computational thinking skills. Employers will need programmers and innovators to develop new technologies to tackle more difficult challenges and improve collaboration, efficiency, and cost effectiveness.

Data management and analysis skills will also be in demand across job categories as data become more accessible and easier to distribute and share.[21] Computational thinking and statistical literacy skills will be sought after as employers seek those who can effectively use, visualize and manipulate, and draw conclusions from data. Statistical reasoning skills will also be in demand as new technologies require humans who are able to train machine learning algorithms, explain how they work, and keep them operating.[22]

Interpersonal Skills

Regardless of the specific technical skill, workers of the future will not only need to possess such skills, but also will need to effectively apply those skills to real world problems. Problem-solving is an essential preparedness skill, one that will be required in more than one-third of jobs by the time the class of 2030 graduates high school.[23] Employers and postsecondary educational institutions will seek graduates who are able to identify and select among many courses of action, and to do so in a dynamic work environment. Persistence in the face of uncertainty, and the ability to handle failure and identify next steps when things don't go as planned, will also be essential for future postsecondary success.

Working as part of the dispersed and diverse workforce of the future will require communication and collaboration skills. Communication in the future world of work will require the ability to work with emerging communication technologies, along with the more traditional elements of communication such as listening and engaging in conversation. 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.[24] Conversation skills are important because they

[19] Grover, S. (2018). *The 5th 'C' of 21st century skills? Try computational thinking (not coding)*. Retrieved from: https://www.edsurge.com/news/2018-02-25-the-5th-c-of-21st-century-skills-try-computational-thinking-not-coding

[20] Gasparevic, D. (2018). *Why virtual-reality training for employees is catching on*. Retrieved from https://www.shrm.org/resourcesandtools/hr-topics/technology/pages/why-virtual-reality-training-for-employees-is-catching-on.aspx

[21] Kauflin, J. (2017). *The five most in-demand skills for data analysis jobs*. Retrieved from https://www.forbes.com/sites/jeffkauflin/2017/07/20/the-five-most-in-demand-skills-for-data-analysis-jobs/#ff958f02c7ce

[22] Wilson, H. J., Daugherty, P., & Morini-Bianzino, N. (2017). *The jobs that artificial intelligence will create*. Retrieved from http://ilp.mit.edu/media/news_articles/smr/2017/58416.pdf

[23] Thompson, C. (2016). The top 10 skills that will be in demand by all employers by 2020. Retrieved from https://www.businessinsider.com/wef-report-skills-workers-need-2016-1

[24] Nowogrodski, A. (2015). *Why listening might be the most important skill to hire for*. Retrieved from: https://www.fastcompany.com/3042688/why-listening-might-be-the-most-important-skill-to-hire-for

contribute to an organization's shared understandings, which may be critical for agile decision-making. [25]

Working collaboratively to solve problems will be an essential skill of the future, and will require building relationships, maintaining sensitivity to cultural differences, and seeing others' perspectives. Forging positive relationships in the workplace will be key for an individual's job satisfaction and will be an essential building block in the creation of a productive work environment. In the context of the workplace, cultural sensitivity includes working effectively alongside someone from a different cultural background who may approach workplace behaviors differently. Coworkers from different cultural backgrounds may engage in different behaviors and hold different work-related values, and culture-based misinterpretations can have implications for the success of collaborative efforts.[26] Perspective taking involves awareness of others, regulating one's emotions and empathy, and correctly interpreting what others are trying to communicate.

Intrapersonal Skills

The fluidity of work arrangements in the future will necessitate time management skills, as individuals work on multiple project teams or juggle multiple gigs. Time management requires a variety of skills: 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 the individual entrepreneur's personal success will depend upon it.

Flexibility and adaptability will also be essential skills, whether as an independent contractor providing services to multiple clients or as a career employee adjusting to changing roles and expectations in a dynamic environment. In fact, flexibility and adaptability, particularly in the context of interpersonal communication, are among the uniquely human skills that may prevent some occupations from becoming fully automated.[27] In addition to being key to specific careers, flexibility will also be integral to managing 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.

Life Skills

Finally, graduating high school students will be best prepared for postsecondary success if they have acquired essential life skills. Skills such as financial literacy, and health and wellness literacy will help to ensure that decisions are made with long term implications in mind, setting the stage for continued success. Finally, high school graduates of 2030 will require citizenship skills, understanding the relations between individuals and society, the organization of the state

[25] Heidema, P. J. (2017). *Why you need crucial conversation skills*. Retrieved from: https://www.linkedin.com/pulse/why-you-need-crucial-conversation-skills-paul-j-heidema/
[26] Sherman, F. (2018). *Cultural sensitivity skills in the workplace*. Retrieved from: http://smallbusiness.chron.com/cultural-sensitivity-skills-workplace-20375.html
[27] Sawhney, M. (2018). *As robots threaten more jobs, human skills will save us*. Retrieved from https://www.forbes.com/sites/mohanbirsawhney/2018/03/10/as-robots-threaten-more-jobs-human-skills-will-save-us/#e8ad0f53fce6

and how democracy functions, and the roles and responsibilities of the individual in the world around them.[28]

Measures of Preparedness – Measures for what? (Q3)

Postsecondary preparedness is a culmination of in-school and out-of-school experiences leading up to high school graduation. It is a multi-faceted concept that will require a multidimensional measurement approach. Currently, there is no uniform and comprehensive measure of postsecondary preparedness. NAEP measures academic preparedness for college without remediation with its reading and math assessments, but this does not address the wide range of skills discussed above. Existing measures such as NAEP assessments of academic skills will need to be combined with other existing data sources and will likely need to draw on new data sources or innovative measurement approaches, to gain a full picture of the state of postsecondary preparedness.

NAEP assesses a wide range of content areas at grade 12, including civics, economics, foreign language, geography, math, reading, science, technology and engineering literacy, U.S. history, and writing. The NAEP civics frameworks, for example, outline "intellectual skills" such as analyzing and evaluating, taking, and defending positions, along with participatory skills such as interacting, monitoring, and influencing. [29]These intellectual skills may align with several interpersonal skills outlined above (e.g., communication, collaboration). Similarly, the technology and engineering literacy assessment frameworks outline three practices (understanding technological principles, developing solutions and achieving goals, and communicating and collaborating) that may reflect some of the described technical, intrapersonal, and interpersonal skills.[30] NAEP also administers complex and interactive item types that may tap into skills beyond the academic skills measured. For example, a reading item may tap into cultural awareness skills, or a writing item may tap into effective communication skills. Finally, students who participate in NAEP are also encouraged to complete a student survey, which collects information about students' educational experiences.[31]

NAEP also collects data as part of the High School Transcript Study. This study is designed to reflect a nationally representative sample of U.S. schools and a sample of students that is representative of the graduates from each participating school.[32] Data collected include the courses taken during high school, high school credits earned (including those earned in middle school), and final course grades. Information about course-taking patterns are not only informative about academic skills to which students have been exposed, but also provide indirect information about other important skills such as persistence and time-management.

Other data sources outside of NAEP, such as data regularly collected by or stored at state education agencies, may also be useful in informing our understanding of postsecondary preparedness. Participation in education and work experiences, from course attendance, to maintaining employment, to engaging in volunteerism or service learning experiences can

[28] UNESCO. (2010). *Citizenship education for the 21st century*. Retrieved from http://www.unesco.org/education/tlsf/mods/theme_b/interact/mod07task03/appendix.htm
[29] NCES. (2015). *What does the NAEP civics assessment measure?* Retrieved from https://nces.ed.gov/nationsreportcard/civics/whatmeasure.aspx
[30] NCES. (2018). Technology and Engineering Literacy (TEL) Assessment. Retrieved from https://nces.ed.gov/nationsreportcard/tel/
[31] NCES (2018). Survey Questionnaires. *Questionnaires for students, teachers, and school administrators*. Retrieved from https://nces.ed.gov/nationsreportcard/experience/survey_questionnaires.aspx
[32] NCES (2018). High School Transcript Study. Retrieved from https://nces.ed.gov/nationsreportcard/hsts/

provide evidence of individuals' development of important preparedness skills that can be aggregated to higher levels. Data embedded in these education and work experiences are another potential source of preparedness data. For example, experiences with technology, individual portfolios, or team projects are elements of applied educational and work experiences that yield information about relevant skills.

Data from assessments administered at the state level could also be mined for relevant information. For example, performance tasks designed to reflect real-world contexts may provide insight into blends of skills, such as problem-solving within an academic content area. Computer-based assessments could be a source of data on digital skills. Performance-based assessments may tap into persistence, problem solving skills, and analytical thinking skills.

New and emerging technological resources present additional opportunities to gather data from education and work experiences. Micro-credentials, also known as digital badges, are earned upon completion of a short course, administered online or in a more traditional classroom setting. In the future, blockchain technology may allow parties to record transactions and maintain a permanent digital record of them, which could be used to document achievements within a particular organization or program.[33]

Current Context/National Need

NAEP has been a leader in understanding and communicating what the nation's students know and can do for decades. It has recently been argued that the timing is right for expansion of 12th grade NAEP testing, citing the need for trustworthy data on college and career readiness, and for a data source that would allow states to compare themselves to one another and to the country as a whole.[34] With its well-established infrastructure, NAEP is in a unique position to gather postsecondary preparedness data at the state level. NAEP data, along with other NCES data sources, will inform those interested in postsecondary preparedness policy, and will be useful to states as they work with industry and business partners to expand job opportunities, and to support local-level efforts to prepare students for life after high school. These data will also be of use to postsecondary education providers and employers as they seek to ameliorate gaps in preparedness, and to inform the public about how prepared high school graduates are for their next steps.

Over half of states have developed definitions of *college and career readiness*.[35] In a large majority of these states, a single definition is used to describe readiness for college and readiness for career, and some address preparedness for postsecondary life more broadly. Some of these definitions focus on academic skills necessary to enter credit-bearing college courses without remediation or to successfully complete postsecondary job training program that will lead to a career that can support a family. Others describe additional skills beyond the academic, such as communication and collaboration. A very small number also include activities such as lifelong learning and civic engagement. Although there has been a substantial amount of work done at the state level, there are still states that have not developed a formal definition. Further, the existing state-level definitions are varied enough to make comparisons among the states confusing. NAEP is in a unique position to lead the charge in collecting data to inform a

[33] Iansiti, M. & Lakhani, K.R. (2017). *The truth about blockchain*. Retrieved from https://hbr.org/2017/01/the-truth-about-blockchain
[34] Finn, C.E. (2018). *Time for twelfth grade state-level NAEP*. Retrieved from https://edexcellence.net/articles/time-for-twelfth-grade-state-level-naep
[35] American Institutes for Research. (2014). *Overview: State definitions of college and career readiness*. Retrieved from https://ccrscenter.org/sites/default/files/CCRS%20Defintions%20Brief_REV_1.pdf

common understanding and, by extension, identifying the most essential elements of postsecondary preparedness.

Appendix D. Expert Panel: Industry

Notes of the Expert Panel Meeting Representing Industry
February 22, 2018

National Assessment Governing Board
Ad Hoc Committee on Measures of Postsecondary Preparedness

As part of meeting the charge of the Ad Hoc Committee on Measures of Postsecondary Preparedness, HumRRO organized and facilitated a meeting with industry experts. The purpose of this meeting was to get input from leaders and experts in industry about (a) the jobs that will exist in 2030, (b) the skills that these jobs will require, and (c) the measures/indicators that would be needed to provide a status of elementary and secondary students with respect to these skills.

We were fortunate to assemble an exceptional panel of experts and leaders. The panel members included **Ms. Paula Collins**, Texas Instruments, **Mr. Marcelino Ford-Livene**, Intel Corporation, **Dr. Scott Heimlich**, Amgen Foundation, **Dr. Chauncy Lennon**, JPMorgan Chase, and **Mr. Reginald McGregor**, Rolls-Royce Corporation.

The meeting was held on February 22, 2018 in Alexandria, Virginia. An overview of the National Assessment Governing Board and the charge of the Ad Hoc Committee on Measures of Postsecondary Preparedness, along with the agenda and logistical information for the meeting were sent to the panelists in advance.

Thanos Patelis (HumRRO) opened the meeting and after quickly informing the group of some logistics, Terry Mazany provided an overview and led the attendees through introductions. Then, Thanos Patelis facilitated the meeting around the three areas of inquiry involving (a) the jobs of 2030, (b) the skills that they will require, and (c) the measures/indicators that will be important to provide. Finally, Terry Mazany offered some concluding comments. The agenda and the list of all attendees is in Appendix A.

The purpose of this document is to provide information on the themes and comments made by the panelists. The information in this report is meant to provide insight into the rich conversation and comments provided by the expert panelists.

The Future of the Workplace and Work

- The titles of the jobs in 2030 cannot be predicted. However, the jobs of the future will require many skills and will be driven by globalization, artificial intelligence, and “big data”.
    - Globalization will change the workplace, from the types of jobs available (i.e., global competition for jobs) to working on cross-cultural teams.
    - Workplace integration will increase (e.g., working across disciplines instead of in silos by discipline).
    - The pace of automation and existence of the internet enable rapid access to information which will affect what employees do on the job and their job descriptions. The use of the internet and automation will only increase.
    - Employers should embrace new methods of communication, driven by the next generation. For example, hiring managers may not be familiar or may be uncomfortable with the latest communication modes of those applying for jobs. Rather than allowing that to impact negatively on job applicants, employers should

acknowledge the differences as innovation or trends to monitor. Job applicants may also need to be attuned to this dynamic.
    - Technology will be at the forefront. For example, JP Morgan Chase is a "tech company that also loans money"; they do not consider themselves primarily a financial institution.
    - Complicated tasks can be handled by automation (which will replace some jobs). Employees of the future will need to work with automated equipment and employees will be needed to design and service the automation.
    - Complex tasks will take human thought (and these types of jobs will remain and additional ones will be added in the future).
- There is and likely there will continue to be a duality in the job descriptions of the future: academic skills and college degree required versus high school diploma and training and apprenticeship experience required. Panelists noted they come from the academic skills track and although they acknowledge the diploma-training track, they suggested consulting with experts in that area for a more detailed picture of what the future holds for those not following the 4-year college track.
    - Need to hire the person with the right skill set, not the person with the most qualifications (who may be overqualified and a poor fit for the work). This is sometimes a tendency when college-graduate hiring managers put more emphasis on college degree, the background they come from and perspective they bring to their job, than is warranted by the demands of the job being filled.
    - Most jobs that do not require a 4-year college degree, will require additional training, such as a 2-year college degree, technical training, or post-secondary education and/or training leading to certification.
    - Employer provides job skills (e.g., specific knowledge and procedures), while employee brings workplace competencies to the job (see competencies in the skills needed in the future). More job-related training will be provided by the employer, such as in-house mini-MBA programs provided by large corporations.
    - Continuous learning will be required to keep up with change. The employer will support or provide the training or education; the employee must participate to keep pace.
- Panelists indicated the need for initiatives to empower students, especially those who are "at-risk" and do not have role models, with an understanding of the labor market and expose them to employment options. Suggestions for empowering students so they are ready for post-secondary steps to meet their goals:
    - Help them define pathways to jobs.
    - Assist in setting goals; define an individual's "*north star*".
- Employer/employee relationships will change.
    - More contract work will emerge, which allows workers to dictate own schedule and/or workplace.
- Office space will be different.
    - For example, if employees come to the office, they will use a laptop and choose a work space area plugging into the network. The exact location may vary and will be more fluid than today.

Skills Needed in the Future

- Panelists described the need for employees to be able to apply skills, which defines competencies. Having a skill is not sufficient. Must know how to apply the skill to real world problems.
- The skills that were highlighted were as follows:
    - Ability to collaborate with people and machines, as the workplace incorporates more technology and automation as well as more collaboration.
    - Ability to interact with technology in jobs at all levels. Career Technical Education (CTE) can provide skills and certification for certain jobs.
    - Data skills are in demand - *data is the new oil*.
    - Less focus on job-specific content skills and more on workplace competencies:
        - Critical thinking, effective communication, collaboration, adaptability, problem solving, creativity, integrity, community/workplace citizenship, agility, learning disposition, persistence, attitude, interest.
    - Able to handle failure – *know what to do when the button fails*.
- Need power skills and experience, especially for at-risk students, to navigate the job market and succeed in entry-level positions – resume writing, oral communication, working on teams, basic reading/writing and mathematics ability.

Measures of Skills in the Future

- Consider measuring post-secondary readiness skills in grade 8.
- Maintain traditional knowledge measures (i.e., reading, mathematics).
    - Some went as far as to say that these measures of academic skills should not be removed and any other measures should be added.
- Design-build skills can be measured by persistence. Do you persist until object is built?
- Measure *application* of skills at grade 12. Can students demonstrate their skills (versus showing their knowledge of skills)?
- Add new measures tapping workplace requirements. Be creative in measuring skills (e.g., use certificates or credentials). Leverage CTE curriculum and measures.
    - In the interview process for candidates, hiring managers will give a problem to solve. Therefore, such metrics that demonstrate process and results of solving problems would be helpful.
- Need measures on collaboration, empowerment, and creativity.
- Tie relevancy of measures to industry and align with education. Do this regionally so that measures of preparedness are informative to:
    - students (do they have the skills needed for jobs in their community?),
    - industry (do local job applicants have the skills needed for jobs being offered in their community?),
    - educators (are they preparing students for post-secondary opportunities in their community?), and
    - policy makers (does the local workforce have the skills that industry in their community require?).
- While this may not be the Governing Board's responsibility, students should be given the ability to develop digital portfolios, including coursework and experiential activities, in school to demonstrate their skills and achievements. This would be helpful to employers.
- The measures must keep evolving as the type of work and required skills change over time.

- One interesting observation was that the panelists described job training interventions for at-risk youth with measures of program success embedded as artifacts of the experience. Did the participant build something? While the final product might not have been their initial design, the focus was on the creative process and the ability to troubleshoot problems as well as to persist in developing the final product.

Appendix A: Meeting Agenda and Attendees

Expert Panel Meeting
National Assessment Governing Board
Ad Hoc Committee on Measures of Postsecondary Preparedness

February 22, 2018 | Agenda

11:00 to 11:05 AM **Start Meeting**
Thanos Patelis, Facilitator, HumRRO

11:05 to 11:15 AM **Welcome and Introductions**
Terry Mazany, National Assessment Governing Board Member
Chair, Ad Hoc Committee on Measures of Postsecondary Preparedness

11:15 AM to 12:00 PM **Work of the Future**
Thanos Patelis, Facilitator, HumRRO

Guiding Questions:

- *What do you see as the type of jobs graduating high school seniors will have in 2030?*
- *Compared to jobs now, what kind of trends do you see emerging for jobs in 2030?*
- *Do you foresee any differences of jobs by industry or do you expect similar trends to occur for all jobs?*
- *What do you see as expectations of employers for these students?*
- *How do you envision the hiring process to be?*
- *What role will postsecondary institutions play in training and preparing students for these jobs?*

12:00 to 12:15 PM **Break to get lunch**

12:15 to 1:00 PM **Skills for the Work of the Future**
Thanos Patelis, Facilitator, HumRRO

Guiding Questions:

- *What types of skills will graduating high school seniors need to have in 2030 in order to get the jobs in 2030?*
- *What would you consider pre-requisite skills vs. skills that can be acquired on the job?*
- *What role will postsecondary institutions play in training these skills?*
- *What would a hiring manager in 2030 look for in prospective hires?*

1:00 to 1:45 PM **Measures of these Skills Associated with Work of the Future**
Thanos Patelis, Facilitator, HumRRO

Guiding Questions:

- *What measures do you see being used to represent these skills?*
- *What metrics would provide helpful information in the aggregate about the skills of graduating high school seniors?*

1:45 to 2:00 PM **Final thoughts and concluding remarks**
Terry Mazany, National Assessment Governing Board Member
Chair, Ad Hoc Committee on Measures of Postsecondary Preparedness

Attendees

Expert Panelists:

- Paula Collins, Texas Instruments
- Marcelino Ford-Livene, Intel Corporation
- Scott Heimlich, Amgen Foundation
- Chauncy Lennon, JPMorgan Chase
- Reginald McGregor, Rolls-Royce Corporation

Governing Board Members:

- Terry Mazany, Chair, Ad Hoc Committee on Measures of Postsecondary Preparedness
- Honorable James E. Geringer, Former Governor of Wyoming, Cheyenne, Wyoming
- Carol Jago, Associate Director, California Reading & Literature Project at UCLA, Oak Park, Illinois
- Dale Nowlin, Teacher and Mathematics Department Chair, Bartholomew Consolidated School Corporation, Columbus, Indiana
- Honorable Beverly Perdue, Former Governor of North Carolina, New Bern, North Carolina
- Linda P. Rosen, Chief Executive Officer, Change the Equation, Washington, DC
- Chasidy White, Director of Strategic Initiatives, Office of the Superintendent, Montgomery, Alabama

Governing Board Staff Members:

- Bill Bushaw, Executive Director
- Lisa Stooksberry, Deputy Executive Director
- Lily Clark, Assistant Director for Policy & Research
- Laura LoGerfo, Assistant Director for Reporting & Analysis
- Munira Mwalimu, Executive Officer & Contracting Officer
- Sharyn Rosenberg, Assistant Director for Psychometrics
- Angela Scott, Management & Program Analyst

HumRRO Staff Members:

- Monica Gribben, Senior Staff Scientist
- Deirdre Knapp, Vice President, Assessment and Evaluation in Education and the Workplace
- Jackson Millard, Research Associate
- Thanos Patelis, Principal Scientist

Expert Panelists

Paula Collins
Vice President, Worldwide Government Relations
Texas Instruments

Paula J. Collins is vice president of Worldwide Government Relations for Texas Instruments where she leads the Company's advocacy activities in the United States and abroad. She joined Texas Instruments in 1999 as Director of Government Relations and managed the Company's legislative and public policy activities on a wide range of issues, including immigration, funding for basic research and education.

Ms. Collins came to Texas Instruments with extensive government, corporate and business association experience. After serving as a legislative assistant on Capitol Hill, she joined American Express Company, where for ten years she directed the Company's legislative activities on a wide range of public policy issues including a number of trade initiatives. In 1993, she joined the Business Roundtable where she worked closely with corporate leaders to develop and implement public policy campaigns on international trade, budget and workforce initiatives. From 1995-1997, she directed international trade relations at Eastman Kodak Company and from 1997-1999 was a principal with The Fratelli Group, a strategic communications firm where she played an active role in the development and implementation of comprehensive public affairs strategies for several coalitions on trade and telecommunications issues.

Ms. Collins is a graduate of Yale University and attended the Program for Management Development at Harvard Business School. She is an active participant in her church and local civic organizations, and is a member of several professional organizations. She is a member of the Board of Directors and Executive Committee of the Information Technology Industry Council, and chairman of the Board of the Task Force on American Innovation.

Marcelino Ford-Livene
General Manager, Global Programs and Alliances
Intel Corporation

Marcelino Ford-Livene is the General Manager of Global Programs and Alliances for Intel's Worldwide Corporate Affairs Group. In this capacity, he leads the organization charged with designing the framework and strategic plan for identifying and prioritizing win-win strategic alliances, relationships and partnerships with various global industry, government and special interest groups that advance the strategic direction of Intel's Diversity and Inclusion Initiative. Prior to this role, Ford-Livene was the General Manger of New Channels and Advanced Advertising for Intel Media, where he led the organization charged with programming, licensing and distributing new format television channels and advertising-supported video-on-demand programming. He was also responsible for advertising sales, advertising operations, audience research and data analytics for Intel Media's OTT services. He also co-authored patents on TV viewership analytics and advanced advertising behavioral targeting. Prior to Intel, he was a senior member of TV Guide's corporate development and planning team. He has also held senior positions with the U.S. Federal Communications Commission in Washington, DC. He served as Special Counsel for New Media Policy for Chairman William E. Kennard and as Senior Counsel and Director of Media Strategic Analysis for the FCC's Office of Strategic Planning under Chairman Michael Powell. Ford-Livene was the Division Chairman of the Interactive Media Division for the American Bar Association's Forum on the Entertainment and Sports Industries from 2006 to 2013. He also served for eight years on the board of the TV Academy, the organization that awards the prestigious Primetime Emmy for creative excellence in the television industry. He was also the TV Academy's Board Secretary and a member of its Executive Committee from 2010 to 2013. He is currently the Co-Chairman of the TV Academy's Diversity Committee and a founding board member of the Digital Diversity Network. Corporate boards that Ford-Livene has served on include Delivery Agent in San Francisco, CA and TRA Global, which was acquired by TiVo. Ford-Livene earned a B.A. in economics from UC San Diego, a J.D./M.B.A. from the University of Illinois and has completed an Executive Leadership Program at Harvard Business School.

Scott Heimlich
Vice President, Amgen Foundation

Scott M. Heimlich is vice president of the Amgen Foundation. He is responsible for the strategic management and direction of the Foundation's science education portfolio, including the development and oversight of key initiatives at the K-12 and higher education levels. He was the principal architect and continues to lead the Amgen Scholars Program, the Foundation's largest initiative providing undergraduates with access to research opportunities at premier educational and research institutions across the world. Under his leadership, the Amgen Biotech Experience transformed from a local program into a multi-site, international initiative bringing biotechnology lab experiences to over 80,000 secondary students a year. With these and many other initiatives, the Foundation's commitment to science education recently surpassed the $125 million milestone.

Prior to joining Amgen in 2005, he served in positions at the University of California, Los Angeles, Los Angeles Pierce College, University of Southern California, and a junior high school in Japan. He holds a bachelor's degree, master's degree, and doctorate in education from the University of California, Los Angeles.

Chauncy Lennon
Managing Director and Head of Workforce Initiatives
Global Philanthropy
JPMorgan Chase & Co.

Chauncy Lennon leads JPMorgan Chase & Co.'s initiatives to promote economic opportunity through investments in workforce practice, innovation, and policy. These include New Skills at Work, a $250 million global initiative to support demand-driven workforce systems that promote prosperity for workers and industries; New Skills for Youth, a $75 million initiative to increase the number of young people who complete career pathways that begin in high school and end with postsecondary degrees or credentials aligned with good-paying, high-demand jobs; The Fellowship Initiative, a program providing young men of color with learning experiences that help them achieve their education and career potential; and a $17 million investment in Summer Youth Employment Programs in US cities to help underserved youth obtain the skills necessary to build lasting careers.

He serves on the New York City Workforce Development Board, the College Promise Campaign Advisory Board, and the Neighborhood Trust Financial Partners Board.

He joined JPMorgan Chase from the Ford Foundation, where his grant-making focused on promoting economic advancement for low-income workers by improving access to workforce development and work support programs. Prior to the Ford Foundation, he was senior vice president for Asset Building at Seedco, a national workforce development intermediary. He also has extensive experience researching the mobility patterns of the working poor. He earned his Ph.D. in anthropology from Columbia University, master's degree from the University of Chicago and bachelor's degree from Williams College. He has taught urban studies at Columbia's School of International and Public Affairs and Barnard College.

Reginald McGregor
Manager, Research & Technology Strategy Group
Rolls-Royce Corporation

Reginald McGregor, Manager of Engineering Employee Development and STEM Outreach at Rolls-Royce Corporation. He is a Mechanical Engineer with over 15 years' experience in various engineering roles. He spent over 8 years in early career development managing the engineering co-op; high school internship and graduate development programs. Reginald holds BS in Mechanical Engineering, MBA and currently completing a MS in Technology Leadership and Innovation. He is very active in workforce development and STEM education and serving the community. Reginald enjoys reading, outdoor activities and spending time with family.

Reginald serves on several boards and committees including the Governor-appointed Region 5 Works Council, President of the Lawrence Township School Board, Indiana STEM Advisory Council, STEMx National Advisory Board, Purdue Engineering Education Industrial Advisory Council, Marion County Superintendents STEM Coalition, Indiana Chamber of Commerce K-12 and Workforce Committees, Million Women Mentor Steering Committee, Indiana Afterschool Network Board, and EmployIndy Youth Committee.

Appendix E. Expert Panel: Higher Education

Notes of the Expert Panel Meeting Representing Higher Education April 19, 2018

National Assessment Governing Board *Ad Hoc* Committee on Measures of Postsecondary Preparedness

As one step in addressing the charge of the *Ad Hoc* Committee on Measures of Postsecondary Preparedness, HumRRO organized and facilitated a meeting with a select group of higher education innovators. The purpose of this meeting was to elicit input from leaders and experts in higher education about (a) the jobs that will exist in 2030, (b) the skills that these jobs will require, and (c) the measures/indicators that would be needed to determine the status of elementary and secondary students with respect to these skills.

We were fortunate to assemble an exceptional panel of experts and leaders. The panel members included **Dr. Sarah DeMark**, Vice President of Academic Programs, Western Governors University; **Dr. Pradeep Kotamraju**, Bureau Chief, Career and Technical Education, Division of Community Colleges and Workforce Preparation, Iowa Department of Education; **Mr. Michael Morsches**, Dean of Learning Enrichment and College Readiness, Moraine Valley Community College; **Dr. Yvette Mozie-Ross**, Vice Provost for Enrollment Management and Planning, University of Maryland, Baltimore County; and **Dr. Holly Zanville**, Senior Advisor for Credentialing and Workforce Development, Lumina Foundation. Also, in attendance were some Governing Board members, Governing Board staff members, and HumRRO staff, listed in Appendix A.

The meeting was held on April 19, 2018 in Chicago, Illinois. An overview of the National Assessment Governing Board and the charge of the *Ad Hoc* Committee on Measures of Postsecondary Preparedness, along with the agenda and logistical information for the meeting were sent to the panelists in advance of the meeting.

Thanos Patelis (HumRRO) opened the meeting and after quickly informing the group of some logistics, Terry Mazany, *Ad Hoc* Committee Chair, set the stage for the role of NAEP in the future, given the impact of technology on work as well as the economic and global context in which students enter the post-secondary world. He led the attendees through introductions. Thanos Patelis facilitated the meeting around the three areas of inquiry involving (a) the jobs of 2030, (b) the skills these jobs will require, and (c) the measures/indicators needed to measure these skills. Finally, Terry Mazany offered some concluding comments. The agenda and the list of all attendees is in Appendix A.

The purpose of this document is to summarize the themes and comments made by the panelists. The information in this report is meant to provide insight into the rich conversation and comments provided by the expert panelists.

The Future of the Workplace and Work

With experts representing higher education, the discussion of the future of the workplace and work focused on pathways to work, primarily through postsecondary education and training.

- Postsecondary institutions need to create pathways to develop agile employees who are open to lifelong learning.
- Lifetime or continuous learning will become the norm. Employees will need to continue to learn from different providers, from colleges/universities to specific training courses to experiential opportunities, throughout their lives. Information technology (IT) workers already face this with a variety of certifications for specific technology tools and applications. Highly-regulated occupations will likely be the last ones to make changes.
- Postsecondary institutions need to partner with employers to identify education and training needs so that graduates possess the knowledge and skills needed for jobs.
    - Look to IT which is leading the way in defining job requirements and credentials for employees.
    - One of the panelists described a keynote presentation by the CEO from Chegg, Dan Rosensweig, describing the current disconnect between expectations and responsibilities of employers, higher education, and students. He illustrated this by placing each of the stakeholders at the vertices of a triangle with arrows facing outward indicating a lack of working together rather than arrows pointing inward, toward each other, signaling collaborative planning and working together toward similar goals.
    - Educators can be resistant to business models.
- There are still barriers to postsecondary education. Although community colleges have an open policy (in some states students do not need a high school diploma to enroll in community college), students may find it difficult to pursue their desired major or to matriculate. Prerequisites and competitive admission in selected programs (e.g., healthcare) are barriers to entry.
    - Similarly, some 4-year colleges guarantee admission to those with associate's degrees, but cannot guarantee admission into specific programs due to enrollment capacity and accreditation requirements such as completion of specific coursework.
    - Some community college graduates are not prepared for 4-year colleges and universities because their 2-year institutions have limited qualification requirements for instructors and low standards for their graduates. Both of these factors could be a barrier to continued education.
- More individualization in postsecondary education requires "policy by anomaly."
    - In developmental education, need to identify what students need and how to get it to them. Placing students on paths matching their goals raises retention rates.
- Strong partnerships are needed between 2- and 4-year institutions of higher education to facilitate students' transfer between schools.
    - High school graduation projections show Hispanics are the fastest growing group[36] and many of this group begin their postsecondary studies in community college.
    - Many students are graduating from high school with associate's degrees obtained through early middle college programs and dual enrollment.
- Colleges and universities must provide different, perhaps individualized, services to students who enter at different points on the pathway to a 4-year degree. Historically, 18-year-old high school graduates enter as freshmen with new-student services and support structure

[36] See Bransberger, P., & Michelau, D. R. (2016). *Knocking at the college door: Executive summary*. Boulder, CO: Western Interstate Commission for Higher Education.

for the first year or two. Institutions are now called on to help a select group of high school graduates entering college with associate's degrees, yet perhaps still needing wraparound services due to their youth (compared to the services offered to 20-year-old or older students transferring to a 4-year program with an associate's degree). Other students may start and stop their education multiple times and attend several institutions before graduating.

- To prepare students for future jobs, we need vertical and horizontal articulation. For horizontal articulation, students need technical, academic, and employability skills (e.g., grit, self-understanding). For vertical articulation, the key is determining at what age/grade to start. High school staff say it needs to start in middle school; middle school staff say it needs to start in elementary school.
- Need a mechanism to validate training and experience as part of the pathway to a degree. More and more high school graduates are already working through the gig economy. Other students have jobs and families while attending college.
    - Look to the military; they validate training as credits.
    - Western Governors University (WGU) provides micro-credentials or badges as students achieve milestones to show them the skills and knowledge attained as they work toward their bachelor's degree.
    - Give students the ability to curate their work and educational experiences.
- There is tension between an integrated approach providing a broad range of skills (academic, technical, and employment-oriented) and the business need for a narrow, specific set of skills to meet a skill shortage. One is too esoteric, the other too pragmatic.
- Post-secondary institutions will not be the destination, but a vehicle for certifying student competencies.
- Expect the acquisition and use for knowledge and skills to flip. Currently, knowledge is the base foundation provided by formal education and we obtain skills as needed. In the future, skills will be the base and we will obtain knowledge as needed.

Skills Needed in the Future

- Don't teach students to do what a robot can do better.
    - Robots are better than humans at pattern recognition, repetitive tasks, etc. but they are not able to understand nuance of language, social relationships, or creativity.
    - It will be important for humans to connect domains.
    - McKinsey has developed a list of human skills such as empathy, planning, creativity, common sense, sense making, novel thinking, nuance of language, social relationships, etc.[37]
- In addition to content or professional knowledge, students need:
    - practical transition skills
    - key learning skills and cognitive strategies
    - strong foundation of self-understanding and engagement strategies
    - critical thinking
    - affective mindset and skills
    - meta learning
    - financial literacy
    - information technology literacy
    - health and wellness literacy.
- Schools can provide learning and workplace skills.

[37] See Chui, M., Manyika, J., & Miremadi, M. (2016). *Where machines could replace humans—and where they can't (yet)*. McKinsey Global Institute. https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/where-machines-could-replace-humans-and-where-they-cant-yet

    - College experience courses for high school students.
    - WGU offers eight synchronous online sessions with a small, facilitated cohort on skills such as self-efficacy, communication, and learning styles. In a pilot test with at-risk students, there were significant positive outcomes: performance in courses as well as retention increased. Some of the skills, including leadership and communication, were identified by the medical profession as ones missing in graduates. These skills not only make graduates better job candidates but also more resilient students.
- Consider where or why skills are needed to build awareness of how skills fit into work.
- Four-year institutions look for grit or persistence as a necessary skill for student success. Students with a solid academic foundation and grit should be able to succeed, whereas students with a strong foundation of academic knowledge and no grit may not be able to handle the rigor of college.
- Class attendance is the best predictor of success, as evidenced both by anecdote and research. Some colleges require attendance and initiate interventions if students do not attend class.
    - There is a question of how to measure attendance for online courses. One approach is to look at student engagement using interaction data from Learning Management Systems (LMS).
- Students need to learn how to get "unstuck" when in a challenging situation.
- Employers are looking for people who can work across left and right brains and are able to work with technology.

Measures of Skills in the Future

- Employers offer performance-based pay for high-value, high-priority credentials supporting ability to use skills.
    - Students may demonstrate their skills through portfolios.
    - Use blockchain[38] to document achievements and portfolio.
- Need new types of student assessment.
    - Current assessments focus too much on knowledge and not enough on skills, character, and meta learning.
    - Students take most current assessments working alone rather than in teams. Need authentic assessments of team work with hands-on performance components.
- Leading-edge assessments use simulation and are more applied, with problem solving scenarios that assess whether you can use knowledge.
- Create dashboards for parents and students to see skill attainment, including credentials.
- Use micro credentials and then stack those credentials to meet employer-relevant needs.
- There is a tension between broad versus specific measurement of skills.
- Include all stakeholders in identifying what and how to measure skills.
- Measuring college or postsecondary readiness is different than college or postsecondary success.
- Some postsecondary institutions use transcripts, others don't.
    - Transcripts could provide an opportunity to leverage high school data for postsecondary instructors to know what students have done prior to college and to personalize postsecondary instruction.
    - Expect seat time to be a less helpful measure from an industry perspective. They will be interested in a "transcript" with learning opportunities, perhaps using blockchain technology.

[38] For information about blockchain: https://hbr.org/2017/01/the-truth-about-blockchain

  - For transcripts to be useful to instructors, need a way to standardize them.
  - Need to include attendance on transcript.
- Metrics of academic rigor exist with validity evidence provided to support their value in predicting college outcomes.
- Concern with the shelf life of measures such as SAT or ACT, course grades, etc. Are high school results as valid for older, returning students?
- Metrics should include student employment.
- Measures of service learning are needed.

Reflections

Terry Mazany offered four reflections on the discussion:

1. We need to project all of the allied trends in society to 2030. Work is shifting to a gig economy. This will be the reality for 16- to 18-year-olds in 2030. We need to factor the expected changes in the economy of 2030 into the skills required to work in the future. Data is the new oil. Micro-credentialing and digital badges will more and more populate transcripts and portfolios.
2. There will be several paradigm shifts: (a) knowledge/skill flip, (b) everything has a developmental progression except technology, (c) the nontraditional student of today will be the traditional student of tomorrow, (d) students will be agents for themselves, and (e) a world where trust is collapsing in every venture except nonprofit ventures – blockchain as a key to build this trust.
3. We are in-between systems. We need to maintain an ecological perspective of each part of the system and look at the reciprocal changing role of employers.
4. The role of NAEP: We need to align NAEP with the requirements of Every Student Succeeds Act (ESSA), such as conditions of learning. This might be done by back-mapping the requirements of ESSA with what NAEP provides.

Appendix A: Meeting Agenda and Attendees

Expert Panel Meeting
National Assessment Governing Board
Ad Hoc Committee on Measures of Postsecondary Preparedness

April 19, 2018 | Agenda

11:00 to 11:05 AM **Start Meeting**
Thanos Patelis, Facilitator, HumRRO

11:05 to 11:15 AM **Welcome and Introductions**
Terry Mazany, National Assessment Governing Board Member
Chair, Ad Hoc Committee on Measures of Postsecondary Preparedness

11:15 AM to 12:00 PM **Work of the Future**
Thanos Patelis

Guiding Questions:

- *What do you see as the postsecondary pathways that high school seniors graduating in 2030 will be choosing among?* (11:15-11:40)
- *Compared to now, what kind of trends do you see shaping postsecondary education in 2030?* (11:40-12:00)

12:00 to 12:15 PM **Break to get lunch**

12:15 to 1:00 PM **Skills for the Work of the Future**
Thanos Patelis

Guiding Questions:

- *How have postsecondary entrance expectations changed in recent years?* (12:15-12:40)
- *What types of competencies and content knowledge will graduating high school seniors need to be prepared for postsecondary pathways in 2030?* (12:40-1:00)

1:00 to 1:45 PM **Measures of these Skills**
Thanos Patelis

Guiding Questions:

- *What measures do you see being used for these competencies?; What will require new or updated measurement tools?* (1:00-1:20)
- *What metrics would provide helpful information in the aggregate about the competencies of graduating high school seniors?* (1:20-1:45)

1:45 to 2:00 PM **Final thoughts and concluding remarks**
Terry Mazany

Attendees

Expert Panelists:

- Sarah DeMark, Vice President of Academic Programs, Western Governors University
- Pradeep Kotamraju, Bureau Chief, Career and Technical Education, Iowa Department of Education
- Michael Morsches, Dean of Learning Enrichment and College Readiness, Moraine Valley Community College
- Yvette Mozie-Ross, Vice Provost for Enrollment Management and Planning, University of Maryland, Baltimore County
- Holly Zanville, Senior Advisor for Credentialing and Workforce Development, Lumina Foundation

Governing Board Members:

- Terry Mazany, Chair, Ad Hoc Committee on Measures of Postsecondary Preparedness
- Dale Nowlin, Teacher and Mathematics Department Chair, Bartholomew Consolidated School Corporation, Columbus, Indiana
- Alice Peisch, Legislator, Massachusetts House of Representatives, Wellesley, Massachusetts
- Chasidy White, Director of Strategic Initiatives, Office of the Superintendent, Montgomery, Alabama

Governing Board Staff Members:

- Bill Bushaw, Executive Director
- Lisa Stooksberry, Deputy Executive Director
- Lily Clark, Assistant Director for Policy & Research

HumRRO Staff Members:

- Monica Gribben, Senior Staff Scientist
- Sunny Becker, Principal Staff Scientist
- Thanos Patelis, Principal Scientist

Expert Panelists

Sarah DeMark, Ph.D.
Vice President of Academic Programs
Western Governors University

Sarah DeMark joined nonprofit Western Governors University (WGU) in September 2014, and serves as the Vice President of Academic Programs, responsible for leading WGU's portfolio strategy as well as the design and development of the university's competency-based degrees, curriculum and assessments. This portfolio includes more than 50 programs, 600 courses, and nearly 1000 assessments.

Prior to joining WGU, DeMark spent more than 15 years at leading IT companies, serving in various leadership roles where she oversaw the strategy and execution of the design, development, and deployment of certification and curriculum-based assessment portfolios. Previously, she was an independent consultant working with state and local school districts, as well as working with The College Board on SAT and AP program evaluation.

DeMark is published in numerous journals and books and is a sought-after speaker. DeMark currently sits on ANSI's Personnel Certification Accreditation Committee, which serves to validate whether certification programs adhere to standards.

DeMark earned a Ph.D. in Educational Psychology (Measurement, Statistics, & Methodological Studies) from Arizona State University. DeMark earned B.S. degrees in both Elementary Education and Psychology from Vanderbilt University.

Pradeep Kotamraju, Ph.D.
Bureau Chief, Career and Technical Education
Division of Community Colleges and Workforce Preparation
Iowa Department of Education

Dr. Pradeep Kotamraju is currently the Bureau Chief, Career and Technical Education, Division of Community Colleges, Iowa Department of Education. As Iowa's State Director for Career and Technical Education (CTE), he has leadership responsibility in managing those secondary and community college CTE programs that are funded through the Carl D. Perkins federal program. Previous to his current position as the Iowa CTE State Director, Dr. Pradeep Kotamraju has served the Deputy Director, National Research Center for Career and Technical Education (NRCCTE), University of Louisville, Louisville, Kentucky. Prior to that, he served as the System Director, Perkins, at the Minnesota State Colleges and Universities, Office of the Chancellor. Dr. Kotamraju has worked in several senior administrative positions in higher education and workforce development agencies in Minnesota.

Dr. Kotamraju has written several publications and monographs, and made numerous presentations, in the area of student success in career and technical education, workforce development in the United States, and, in the area of economic progress in the developing world. His research has included the examination of a variety of labor market information and workforce development issues that connect occupations, skills and careers, as individuals transitioned back and forth between employment and education. Dr. Kotamraju has been invited to participate on several statewide, regional and national committees that have focused on CTE programs, budget and finance, and accountability. Some of these committees have had even broader focus that places CTE right front and center when it comes to connecting education, workforce development, and economic development.

Before working in the public sector, Dr. Kotamraju taught college- and university-level Economics and Statistics at several higher education institutions in Minnesota and Kentucky. Dr. Kotamraju holds a Ph.D. in Economics from the University of Illinois. He received his Masters Degree in Economics from George Washington University, and his Bachelors in Economics from the University of Delhi, India

Michael Morsches
Dean of Learning Enrichment and College Readiness
Moraine Valley Community College

Michael Morsches has worked in higher education for more than thirty years. His primary focus has been on developmental education and the transition from high school to college.

Michael currently serves as the Dean of Learning Enrichment and College Readiness at Moraine Valley Community College. He oversees the ABE/GED, ESL, developmental education, literacy volunteers, and tutoring programs. Michael has published numerous articles and handbooks on retention, student engagement, and teacher training in post-secondary institutions.

Yvette Mozie-Ross, Ph.D.
Vice Provost for Enrollment Management and Planning
University of Maryland, Baltimore County

Yvette Mozie-Ross, PhD, is Vice Provost for Enrollment Management and Planning at the University of Maryland, Baltimore County (UMBC). As Vice Provost, Dr. Mozie-Ross provides oversight and strategic planning for the areas of undergraduate admissions and orientation, financial aid and scholarships, academic and pre-professional advising, records and registration, and the student administration project (student information system). With a higher education career spanning over 25 years, she has served in numerous professional capacities including residence community director, coordinator of multicultural recruitment, assistant director for transfer recruitment and admissions, director of undergraduate admissions, and director of academic services (advising and registration). Dr. Mozie-Ross has served on various national and statewide committees and workgroups including the College Boards' Commission for Transfer Policy and Practice, and the Maryland Higher Education Commission's State Plan Writing Group on Access, Affordability and Completion. She has served on the university's Strategic Planning Steering Committee and is currently serving as a member of the governing board for the Baltimore Collegetown Network, a consortium of 13 colleges in Baltimore, Maryland. Dr. Mozie-Ross frequently lends her expertise, both nationally and internationally, in the area of data analytics and leveraging analytics for institutional transformation. Dr. Mozie-Ross earned her bachelor's degree from UMBC in 1988, her master's degree from University of Maryland University College in 1994, and her doctorate in Education Policy and Leadership at the University of Maryland, College Park in 2011. Her dissertation research examined the academic and background characteristics of high school graduates who identified teachers as influential in their choice of college. Dr. Mozie-Ross enjoys spending time with her husband of 22 years and their 20-year old son. Her pass-time interests include family genealogical research and running.

Holly Zanville, Ph.D.
Senior Advisor for Credentialing and Workforce Development
at Lumina Foundation

Holly Zanville is Senior Advisor for Credentialing and Workforce Development at Lumina Foundation. She leads a new portfolio on Worker and Employer Engagement that focuses on building the capacity of educators and employers to scale and spread the best ideas in training, credentialing, and other workforce development strategies linked to postsecondary learning opportunities; and examining issues around the future of work and learning. Her work includes cultivation of networks and partnerships essential to the emerging new postsecondary learning system including Credential Engine, quality assurance efforts to ensure that credentials stand for high-quality learning, and networks for research and industry sector engagement. She previously led Lumina's development of the national Connecting Credentials initiative, credential completion for returning adults with prior college/no credential, and statewide approaches to reverse-transfer degrees through the Credit When It's Due initiative. Zanville received her Ph.D. in Educational Administration from the University of Minnesota; MA in English from the University of Wisconsin-Madison, and BA in English and Biology from Lindenwood University.

Appendix F. Expert Panel: Futurists

Notes of the Expert Panel Meeting Representing Futurists

June 21, 2018

National Assessment Governing Board

Ad Hoc Committee on Measures of Postsecondary Preparedness

As one step in addressing the charge of the *Ad Hoc* Committee on Measures of Postsecondary Preparedness, HumRRO organized and facilitated a meeting with a select group of futurists.[39] The purpose of this meeting was to elicit input from thought leaders regarding the future of postsecondary education and work.

We were fortunate to assemble an exceptional panel of visionaries with a variety of perspectives. The panel members included **Randy Bennett**, Educational Testing Service; **Karen Cator**, Digital Promise; **David Conley**, EdImagine; **Alana Dunagan**, Clayton Christensen Institute; **Devin Fidler**, Rethinkery Labs, and **Nancy Lue**, Advanced Education Research and Development Fund on behalf of the Chan Zuckerberg Initiative and the Bill & Melinda Gates Foundation. Also, in attendance were several Governing Board members, Governing Board staff members, and HumRRO staff.

The meeting was held on June 21, 2018 in San Francisco, California. An overview of the National Assessment Governing Board and the charge of the *Ad Hoc* Committee on Measures of Postsecondary Preparedness, a "facebook" of attendees with brief biographic summaries, along with the agenda and logistical information for the meeting were sent to the panelists in advance of the meeting. Appendix A contains the agenda, list of attendees, and panelist biographies.

Terry Mazany, *Ad Hoc* Committee Chair, welcomed the futurists and set the stage for the role of NAEP in the future, given the impact of technology on work as well as the economic and global context in which students enter the postsecondary world. He led the attendees through introductions. Thanos Patelis (HumRRO) reviewed the agenda and stated the goals for the meeting.

To establish the perspectives of these varied experts, each panelist provided a 10-minute presentation of their initial thoughts regarding five discussion questions: (a) what are the trends you see that will define the future of learning and schools? (b) what are the trends you see that will define the future of work and the skills that will be most valued by employers of the future? (c) what are the most promising technologies that will redefine education? (d) what things are most likely to disrupt how we think about teaching and learning? and (e) what are the trends that most concern you, and why? Copies of the presentation slides are in Appendix B.

Following the presentations, Thanos Patelis facilitated deeper discussion about common themes and the five questions. Finally, Terry Mazany offered some concluding comments.

The purpose of this document is to summarize the themes and comments made by the panelists. The information in this report is meant to provide insight into the rich conversation and comments provided by the expert panelists.

[39] Although some panelists would not describe themselves as "futurists," per se, their careers all include the identification and evaluation of trends, as well as forecasting future conditions or developments.

Presentations

Randy Bennett described seven trends in the future of learning.

- Learning is increasingly technology-based with complex tasks (e.g., simulation and games).
- Materials and methods used in learning are only now catching up with cognitive science.
- Learning is more person-based, adaptive, and customized on different dimensions, to (a) allow accessibility to make learning more available to students with diverse learning types, (b) personalize in terms of competency level, (c) engage students effectively, and (d) give students greater agency over their learning goals.
- New constructs and competencies, such as socioemotional learning, citizenship and citizen engagement, and cross-cultural competency, are becoming more prevalent.
- Prior knowledge is critical when learning new information or developing new skills.
- There is a focus on cross-disciplinary skills such as communication and problem solving. However, contextual differences within disciplines are important considerations (e.g., problem solving in art differs from problem solving in science).
- Assessment embedded in instruction with automated analysis and feedback, allows for adjustment of instruction.

In addition to trends in the future of learning, Dr. Bennett described two trends of most concern.

- Personalization – There is concern that personalization could be used to exacerbate as much as ameliorate differences in opportunities and learning. For example, students from underrepresented groups could be routed toward basic skills classes.
- Embedding assessment in instruction – There is potential for embedded assessment in instruction for student learning, however conflating assessment for learning with assessment for accountability could be problematic, especially if used to make policy judgements.

Karen Cator provided the following perspectives regarding the five questions:

- Trends in the future of learning include: (a) personalization to accommodate variability in students through learning science, (b) more flexible learning to obtain and demonstrate competency, and (c) performance-based assessments leading to credentials for the changing global workforce.
- Trends in the future of work and skills include artificial intelligence (AI) which has the potential to disrupt many jobs. Employees will need deeper learning skills such as collaboration and social emotional skills. We should focus on what is uniquely human.[40]
- Technology can be used to augment human performance. For example, data from embedded assessment and improved diagnostics can provide more precise and accurate analyses of student knowledge and performance, helping teachers perform more effectively in the classroom.
- Learning science could be disruptive. People will have jagged profiles—different levels of competence across skills—based on individual differences and the contexts in which they apply the skills.
- Most concerning is disenfranchisement of teachers. As an example, one-third of current teaching jobs in St. Louis are vacant. Other areas of concern include limited resources in

[40] Ms. Cator recommended Jack Ma's presentation at the World Economic Forum on The Way We Teach; https://www.youtube.com/watch?v=pQCF3PtAaSg.

schools, increasing cost of higher education, limitations of current assessments, equity of access to quality learning activities, and the digital learning gap.

David Conley shared the following insights regarding the five questions:

- The future of learning includes the following trends: (a) taking the teacher out of the bottleneck role, thereby allowing students to work at their own pace and receive just-in-time learning; (b) providing more social learning; (c) using technology to identify learning patterns to personalize learning; and (d) focusing on adapting skills to accommodate changes in work rather than learning fixed skill sets.
- Trends in the future of work and skills include changes such as (a) gig work versus long-term careers, (b) continued adaptability, (c) hiring at low- and high-skill end with less at the middle-skill level, (d) global work teams while living locally, (e) increasing service work, and (f) standardization versus bespoke work (see jagged profiles as mentioned by Ms. Cator).
- Promising technologies in education are adaptability, including a wider variety of students, specialized job/task-specific reading, and web-based learning.
- The following may contribute to disruptions in teaching and learning: (a) students having more agency over their learning, (b) basic skills taught in context using simulations or serious games such as used in the military and medical training, (c) self-directed learning will require resources for teachers to help students who have trouble directing their own work, and (d) emphasis on career preparation with certifications and badges over liberal arts education.
- The three most concerning trends are (a) equity in education, (b) equity in defining preparedness, and (c) increasing the pace of disruptive economic change.

Alana Dunagan offered the following insights:

- The future of learning and work includes the following trends:
  - increased online learning in higher education and K-12
  - learning not requiring a terminal degree (e.g., a certification)
  - workforce alignment of education
- Higher education institutions are seeing falling enrollment, while training in specific skills matters more. She described the parallels between disruptive innovations in education and in business. She explained that corporate bankruptcy following implementation of disruptive technology occurs when companies do not adapt by using technology to expand the reach of their services (i.e., they continue serving the same set of customers rather than expanding their customer base); Blockbuster is an example of this situation.
- Jobs requiring higher education are growing twice as fast as jobs that do not, because of disruption by the education technology market. Innovators in the education technology space are developing partnerships with employers and creating new ways of offering higher education providing the needed training.
- The biggest concern in education and work is the prestige-based model of signaling competence (i.e., a degree from an elite university is highly valued over a degree from a lower tier school without regard to a student's actual knowledge and skill). This model ignores the skills a student has and does not include employers in identifying the skills that students should learn. A better model would engage businesses in identifying skill needs, offer education aligned to workforce needs, and provide students with evidence of skill attainment and a means for submitting that information to employers.

Devin Fidler provided a historical perspective to inform the following trends:

- The history of change in organization strategies evolved from guilds to industrialization to manufacturing/assembly to digital. The advent of the World Wide Web facilitated communication and has expanded to commerce and coordination.
- Examples of using technology to speed up work include peer to peer applications such as TaskRabbit, Gigwalk, and Upwork. These platforms have millions of people enrolled to offer their services with qualifications based on past performance. Employers can use these applications to identify well-qualified candidates with the appropriate skills mix and a history of positive reviews; employees can use these applications to find jobs and to see what skills are in demand.
- The most promising technologies are using organization technologies in education technology with artificial intelligence.
- Disruption will come from small innovative organizations who are more nimble than large businesses.
- The biggest concern is the stereotype that organization is dehumanizing; however, organization can expand human capability.

Nancy Lue identified the following education megatrends:

- Return on education (i.e., value of education) is similar to an internal rate of return (IRR), a term very popular in Silicon Valley to evaluate whether to invest in something. In 2015, 50% of college graduates were working in fields they did not study in school, and more than a third indicated they would study different subjects if they had the opportunity to do it all over again. In a 2013 survey, nearly 40% of college graduates indicated university did not prepare them for employment. Meanwhile, companies and non-profit organizations (e.g., Coursera, EdX, Khan Academy) offer courses for free or with a credential for $100. General Assembly boasts a 98% success rate in securing jobs or promotions within six months for their graduates.
- Continuous learning (e.g., Kaizen education) offers an opportunity for adults to keep up with education. Millennials are projected to have 15 careers in their lifetimes so this ongoing education is important. Coursera's MOOC "Learning How to Learn" has been highly successful, with over half a million "alumni."
- Technology provides opportunities for ongoing learning. Video games are one venue for learning. One way to get people interested in education is to make the best (aka, "rock star") teachers available through technology.
- Knowledge increasingly can be seen as currency (e.g., micro-credentials, badges). The degree-driven, prestige-driven education system isn't meeting the needs of modern society. "What you know" is becoming more important than "where did you go." Individuals can curate a portfolio of skills evidenced by micro-credentials, etc.
- Big data and smart data provide an opportunity to use data to personalize learning (Dreambox, Knewton, etc.).
- Mobile technology learning applications are widely available. Today, 90% of high school and college students own a smart phone, and time spent on smart phones is increasing. Smart phones are providing opportunities to learn in small bits of time as well as in dedicated sessions.
- Mind, body, and soul: Breakthroughs in brain research and cognitive science are being incorporated into learning. Evidence is mounting that physical fitness, happiness, diet,

overall wellness, and mindfulness (e.g., Goldie Hawn's MindUp program) are associated with successful learning.

- Equity is the greatest concern and pervades all of the trends. For example, education technology has costs which limit access. While mobile technology is available to many, ten percent of students do not have smartphones.

Discussion

Thanos Patelis (HumRRO) facilitated a deeper discussion among panelists about common themes and the discussion questions.

Personalized learning. Content can be tailored to student preparation, interest, and ability. Learning will feel more purposeful, connected, and relevant. Fewer students will be seated in rows in classrooms on a rigid schedule. In high school, students may enroll in work training programs or participate in micro-internships. Teachers will serve as mentors. There is a need to change the traditional school organization/culture and provide teachers with the knowledge and skills to educate students in a new environment.

Contextual data. Is a student goal-focused or not? Using data about students' goals can improve instruction. Contextual data (e.g., goals, interests, self-confidence) may provide clues as to why a student might be struggling and may also provide insights to inform how to individualize instruction.

Equity. Opportunity to learn pervades multiple areas. Cost and availability can be barriers to access educational technology and higher education.

Big data. Educational technology generates a lot of data. Educators need to learn how to analyze and use the data, taking a data systems point of view. Also, there is a need to teach teachers how to capture and document performance data on what students are doing in the classroom and how to use those data to improve classroom instruction and activities.

Data dashboards. Data dashboards can connect data from different sources, interpret multiple data points, and provide evidence of what students can do (versus cannot do).

Micro-credentials. Micro-credentials can be used by students and teachers. Students could earn a micro-credential when mastering a concept. Teachers can use their students' micro-credentials to identify the skills acquired and those that need to be taught or re-taught.

Competency assessments. Students would benefit from measures of job-related skills to show their potential and demonstrate performance capabilities, particularly if the measures do not correlate to student background. Employers benefit because they have evidence of a job candidate's skills. Educators can use competency data to mentor students on achieving goals.

Panelist Recommendations

As a wrap-up exercise, Thanos Patelis asked each panelist to make one recommendation for the Governing Board to consider.

Randy Bennett – Use NAEP's national probability sample to describe what instruction is like at different levels for different types of students (e.g., students with disabilities, socioeconomic status) across time.

Karen Cator – Work toward a more coherent assessment system across NAEP and states.

David Conley – Endorse the work of the *Ad Hoc* Committee with a longer-term vision for NAEP to be bold in creating better items and measuring traditional content with greater precision.

Alana Dunagan – Develop innovative methods to measure flexibility, problem solving, and non-traditional skills that people will need in the future.

Devin Fidler – Look at partnering with prestigious organizations within the learning space that function outside of formal assessment, such as skunk works and incubators.

Nancy Lue – Use NAEP to assess the technology gap and equity issue in technology use outside of the classroom.

Reflections

Terry Mazany expressed his appreciation for the panelists' insights. He noted that each expert presented similar ideas through a different lens; while this might have seemed repetitive, it actually reinforced the conclusions. The panelists convinced him that traditional education enterprise is collapsing in slow motion. Innovation outside of education is occurring at an accelerating pace. Learning might occur in smaller units such as micro-credentials.

Mr. Mazany discussed the high cost of traditional higher education and the trillion-dollar impact of student debt on the economy. He acknowledged the existence of prestige-based signaling that maintains inequity in the system. These are complex and challenging social issues. NAEP may be able to be a market signal by Governing Board priorities regarding what to measure and report on. He opined that perhaps NAEP can reinforce that prestige alone is not the gold standard.

Appendix A: Meeting Agenda, Attendees, and Panelist Biographies

Futurist Expert Panel

Thursday, June 21, 2018 1:00 pm – 4:00 pm PT

Room: Cypress A * Hyatt Regency San Francisco Airport
1333 Bayshore Highway * Burlingame, California, USA, 94010

Agenda

1:00 – 1:15 pm	Welcome, Introductions, and Overview of the Ad Hoc Committee *Terry Mazany, Chair of the Ad Hoc Committee on Measures of Postsecondary Preparedness* Overview of the Agenda and Goals for the Meeting *Thanos Patelis, HumRRO*
1:15 – 2:45 pm	Panelist Perspectives and Initial Thoughts Regarding the Discussion Questions *A series of ten-minute presentations, each followed by a five-minute Q&A.* 1:15 – 1:30 Randy Bennett *(Educational Testing Service)* 1:30 – 1:45 Karen Cator *(Digital Promise)* 1:45 – 2:00 David Conley *(EdImagine)* 2:00 – 2:15 Alana Dunagan *(Clayton Christensen Institute)* 2:15 – 2:30 Devin Fidler *(Rethinkery Labs)* 2:30 – 2:45 Nancy Lue *(Advanced Education Research & Development Fund)* *Questions for Discussion:* 1. What are the trends you see that will define the future of learning and schooling? 2. What are the trends you see that will define the future of work and the skills that will be most valued by employers of the future? 3. What are the most promising technologies that will redefine education? 4. What things are most likely to disrupt how we think about teaching and learning? 5. What are the trends that most concern you, and why?
2:45 – 3:45 pm	Panel Discussion *Facilitated by Thanos Patelis*
3:45 – 4:00 pm	Final Reflections *Terry Mazany*

Conducted in Support of the National Assessment Governing Board's
Ad Hoc Committee on Measures of Postsecondary Preparedness

Attendees

Expert Panelists:

- Randy Bennett, Norman G. Frederickson Chair in Assessment Innovation in the Research & Development Divisions, Educational Testing Service
- Karen Cator, President and CEO of Digital Promise
- David Conley, President, EdImagine
- Alana Dunagan, Researcher for Higher Education, Clayton Christensen Institute
- Devin Fidler, Founder, Rethinkery Labs
- Nancy Lue, Co-Lead, Advanced Education Research & Development Fund

Governing Board Members:

- James Geringer, former Governor of Wyoming
- Carol Jago, Associate Director, California Reading and Literature Project at UCLA
- Terry Mazany, Chair, *Ad Hoc* Committee on Measures of Postsecondary Preparedness
- Dale Nowlin, Teacher and Mathematics Department Chair, Bartholomew Consolidated School Corporation, Columbus, Indiana
- Linda Rosen, former Chief Executive Officer, Change the Equation, Washington, DC
- Chasidy White, Director of Strategic Initiatives, Office of the Superintendent, Montgomery, Alabama

Governing Board Staff Members:

- Michelle Blair, Assistant Director for Assessment Development
- Bill Bushaw, Executive Director
- Lisa Stooksberry, Deputy Executive Director
- Lily Clark, Assistant Director for Policy & Research

HumRRO Staff Members:

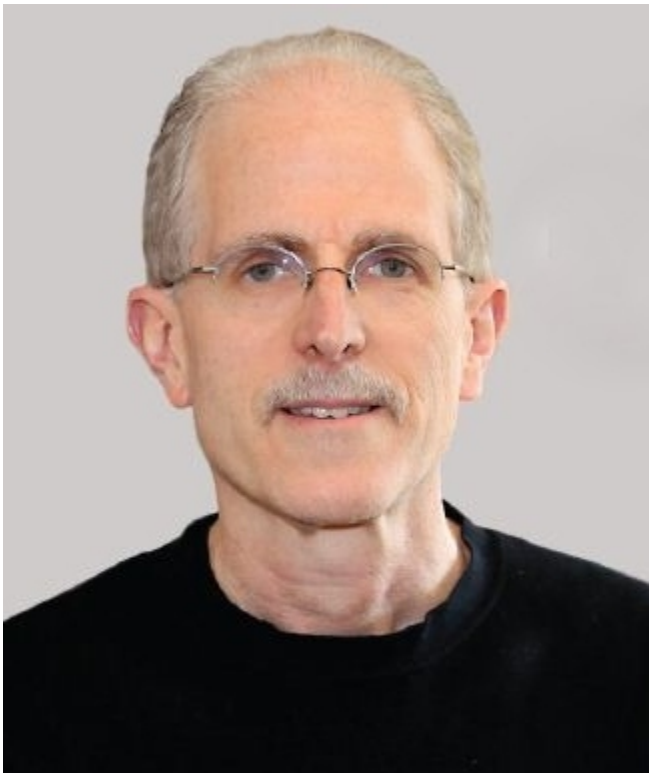
- Monica Gribben, Senior Staff Scientist
- Sunny Becker, Principal Staff Scientist
- Thanos Patelis, Principal Scientist

Ad Hoc Committee Meeting on Postsecondary Preparedness

Panelist Biographies

Randy E. Bennett Ph.D.

Norman O. Frederiksen Chair in Assessment Innovation in the Research & Development Division Educational Testing Service



Randy E. Bennett is Norman O. Frederiksen Chair in Assessment Innovation in the Research & Development Division at Educational Testing Service in Princeton, New Jersey. Bennett's work has focused on integrating advances in cognitive science, technology, and educational measurement to create approaches to assessment that have positive impact on teaching and learning. From 1999 through 2005, he directed the NAEP Technology Based Assessment project, which included the first administration of computer-based performance assessments with nationally representative samples of school students, and the first use of "clickstream," or logfile, data in such samples to measure the processes used in problem solving. From 2007 to 2016, he directed an integrated research initiative titled, *Cognitively-Based Assessment of, for, and as Learning* (CBAL), which focused on creating theory-based summative and formative assessment intended to model good teaching and learning practice. Randy Bennett is president of the International Association for Educational Assessment (IAEA) (2016-), an organization primarily constituted of governmental and non-governmental nonprofit measurement organizations throughout the world, and immediate past president of the National Council on Measurement in Education (NCME) (2017-2018), whose members are individuals employed primarily in universities, testing organizations, state education departments, and school districts. He is a Fellow of the American Educational Research Association.

Karen Cator

President and CEO of Digital Promise

Karen Cator is President and CEO of Digital Promise and a leading voice for transforming American education through technology, innovation and research. From 2009-2013, Karen was Director of the Office of Educational Technology at the U.S. Department of Education, where she led the development of the 2010 National Education Technology Plan and focused the Office's efforts on teacher and leader support. Prior to joining the department, Cator directed Apple's leadership and advocacy efforts in education. In this role, she focused on the intersection of education policy and research, emerging technologies, and the reality faced by teachers, students and administrators. She began her education career in Alaska as a teacher, ultimately leading technology planning and implementation. She also served as Special Assistant for Telecommunications for the Governor of Alaska. Cator holds a master's in school administration from the University of Oregon and received the 2014 College of Education Distinguished Alumni award. The American Association of Publishers has awarded Cator with the 2014 Visionary Award. She received her bachelor's in early childhood education from Springfield College and received the 2015 Distinguished Alumna award. She is an Aspen Pahara Fellow, the past chair for the Partnership for 21st Century Skills and has served on boards including the Software & Information Industry Association-Education.

David Conley, Ph.D.

President, EdImagine
Professor of Educational Policy and Leadership in the College of Education at the University of Oregon
Director, Center for Educational Policy Research

David Conley is Professor of Educational Policy and Leadership in the College of Education at the University of Oregon where he directs the Center for Educational Policy Research. He is the founder and president of EdImagine, an educational strategy consulting company. Additionally, he founded and served for 12 years as CEO of the Educational Policy Improvement Center, EPIC (now Inflexion). He recently completed an appointment as Senior Fellow for Deeper Learning under the sponsorship of the Hewlett Foundation.

Dr. Conley is a national thought leader in the areas of college and career readiness, student ownership of learning, systems of assessment, educational accountability, and the future of education and the economy. He has published multiple articles and policy briefs as well as three books in these areas. His most current book, published by Harvard Education Press, is entitled *The Promise and Practice of Next Generation Assessment.*

He serves on numerous boards and advisory committees including as a member of the technical advisory committee of the Smarter Balanced Assessment Consortium (SBAC) and the Illinois State Board of Education Accountability Technical Advisory Committee, and as a founding board member of New Meridian, which now manages the PARCC assessments. Additionally, he chairs the New Meridian Steering Committee. Previously, he co-chaired the Validation Committee for the Common Core State Standards.

He has conducted multiple major research studies for the Association of American Universities, the College Board and its Advanced Placement program, the International Baccalaureate, and the National Assessment of Governing Board. He has most recently studied next generation systems of assessment, new indicators of college readiness, and new methods to determine career readiness.

Before entering higher education at the University of Oregon in 1989, Dr. Conley spent 20 years in the public-school system in a variety of roles including teacher and co-director of two alternative schools, a site and central-office administrator, and an executive in a state education agency. He is a first-generation college attendee who received his AA from Cabrillo College, his BA from the University of California, Berkeley, and his MA and PhD from the University of Colorado, Boulder. He grew up on the central coast of California, where he spent a great deal of time at the beach.

Alana Dunagan

Researcher, Higher Education, Clayton Christensen Institute

Alana leads the Institute's higher education research and works to find solutions for a more affordable system that better serves both students and employers. In this role, Alana analyzes disruptive forces changing the higher education landscape. Her research includes studying business model innovations, public policies, and investment strategies that can give rise to new and sustainable postsecondary models.

Prior to joining the Christensen Institute, Alana spent ten years in institutional investment management working on behalf of nonprofits, particularly colleges and universities. She worked as an investment consultant for Slocum, and spent five years with Macalester College managing their $700 million endowment. She holds a BA in Economics and Political Science from Macalester College and an MBA from the Harvard Business School.

Devin Fidler

Founder, Rethinkery Labs

Devin has worked with senior leaders at dozens of Fortune 1000 companies to systematically explore emerging issues and technologies, and to analyze their potential impacts. His ongoing work at Rethinkery Labs, including developing tools for "self-driving" management, has been covered by HBR, the New York Times, Wired and a number of other publications. He argues that today, companies themselves are a technology on the verge of disruption. Prior to founding Rethinkery, Devin founded and led the Future of Work and Future of Learning programs at the Palo Alto-based Institute for the Future.

Devin is a frequent speaker at gatherings of business leaders and others interested in the transformation of work and organizations. He approaches projects from a strongly international perspective, having lived and worked in several countries throughout his career.

Nancy Lue

Co-Lead, Advanced Education Research & Development Fund

Nancy Poon Lue is currently co-leading the exploration of a national Advanced Education Research & Development Fund on behalf of the Chan Zuckerberg Initiative and the Bill & Melinda Gates Foundation. She is also a Partner and Secretary of the Board of Directors of the venture philanthropy organization Silicon Valley Social Venture Fund (SV2). Previously, she served as Executive Director at the venture capital firm Global Silicon Valley (GSV) and was the inaugural General Manager of the EdTech Lab at GSVlabs. During the Obama Administration, Nancy was a Senior Advisor at the U.S. Department of Education where she led the development of the agency's five-year strategic plan. Nancy is a Senior Fellow with the American Leadership Forum-Silicon Valley and sits on the Advisory Board of the AT&T Aspire Accelerator and the GreenLight Fund-Bay Area. She earned her B.A. and Ed.M. from Harvard College and Harvard Graduate School of Education

Appendix B: Panelist Presentations

Note: These slides are the intellectual property of the presenters and should not be used or distributed for purposes beyond this Committee without permission.

Bennett Presentation

Trends in the Future of Learning

- Be technology based, making greater use of complex tasks, games, simulations
- Based on more modern underlying models of cognition and learning
- Be personalized in terms of:
  - Accessibility
  - Competency level
  - Background and interest
  - Learning goal
- Include (or give greater emphasis to) "new" competencies, e.g.:
  - Socio-emotional learning
  - Citizenship, civic engagement
  - Cross-cultural competence
  - Using technology tools for problem solving
- Include traditional competencies
  - Knowledge acquisition and construction
  - Made more (not less) important by technology
- Include focus on cross-cutting skills within the disciplines
  - Communication, critical thinking
- Embed assessment within instruction, including automated analysis and feedback

3

Thoughts on the Future of Education and Work

Randy Bennett
Educational Testing Service
Princeton, NJ 08541
rbennett@ets.org

Presentation as a member of the Futurist Expert Panel at the meeting of the National Assessment Governing Board's Ad Hoc Committee on Measures of Postsecondary Preparedness, San Francisco, CA, June 2018.

Trends in the Future of Work

- Continued automation of many types of manual, cognitive, and social-interactional work
- Pervasiveness of technological tools for problem solving as:
  - Aids requiring constant proximal human interaction (Excel)
  - Extensions allowing for remote reach (drones)
  - Assistants: Carry out this subtask (Siri)
  - "Intelligent" implementers: Work independently with human QC

4

Overview

1. What are the trends you see that will define the future of learning and schooling?
2. What are the trends you see that will define the future of work and the skills that will be most valued by employers of the future?
3. What are the most promising technologies that will redefine education?
4. What things are most likely to disrupt how we think about teaching and learning?
5. What are the trends that most concern you, and why?

2

Most Likely Challenges to Disruptions for Teaching and Learning

- In K-12, the challenges are still greater than the disrupters
  - Level of, and extent of variation in, quality of teaching
  - Level of, and extent of variation in, school technology
  - Variation in funding for education by locale
  - Grade-based organization of schooling
  - Local control
    - Little coherence, massive inefficiency due to no chance for economy of scale
  - Size (3rd largest country in the world)
  - Concerns for privacy of student data
  - Concerns over the corporatization of education
  - Public indifference, even antipathy, toward rigorous expectations and toward addressing inequality

7

Skills Most Valued by Employers

- Using technology tools for problem solving—i.e., to create value by being able to use:
  - Aids requiring constant proximal human interaction (Excel)
  - Extensions allowing for remote reach (drones)
  - Assistants: Carry out this subtask (Siri)
  - "Intelligent" implementers: Work independently with human QC
- Being able to, individually and in collaboration with others, locate, evaluate, integrate, synthesize, apply, and construct knowledge (i.e., to learn)
- Being able to communicate, educate, and help others make effective decisions

5

Most Likely Disruptors

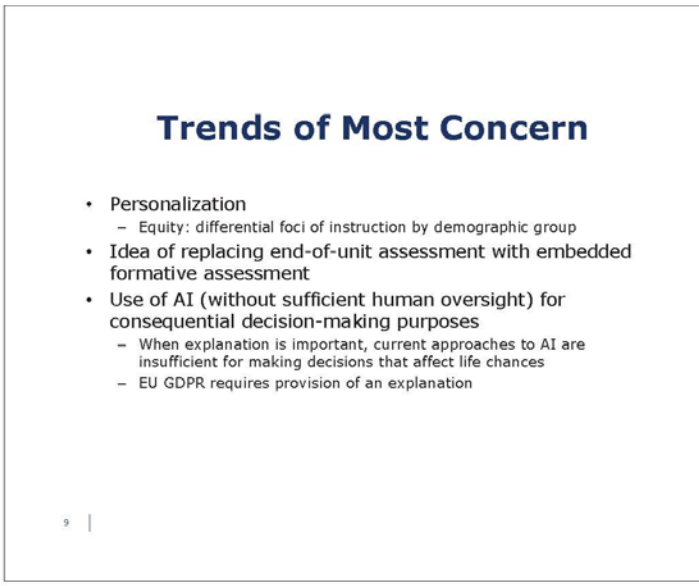
- People
  - What factors will make educators, policy makers, parents, students, and public advocate for, and accept, change?

8

Most Promising Technologies for Education

- Technologies that increase opportunities for remote social interaction
  - Learning is a social activity
- Adaptive learning (intelligent tutoring) combined with human instruction
- Simulations, games, virtual reality that pose tasks and situations similar to the ones students must learn to negotiate as proficient practitioners in a domain
- Analytics to help adapt instruction, guide students in managing their learning, help teachers improve instruction and its management

6


Trends of Most Concern
• Personalization
– Equity: differential foci of instruction by demographic group
• Idea of replacing end-of-unit assessment with embedded formative assessment
• Use of AI (without sufficient human oversight) for consequential decision-making purposes
– When explanation is important, current approaches to AI are insufficient for making decisions that affect life chances
– EU GDPR requires provision of an explanation
9

Cator Presentation


"Futurist" Panel
Karen Cator
@kcator
Digital Promise


1. What are the trends you see that will define the future of learning and schooling?
2. What are the trends you see that will define the future of work and the skills that will be most valued by employers of the future?
3. What are the most promising technologies that will redefine education?
4. What things are most likely to disrupt how we think about teaching and learning?
5. What are the trends that most concern you, and why?


1. What are the trends you see that will define the future of learning and schooling.
• Personalization
• Learner Variability (advancements in learning sciences)
• Competency based learning (+performance assessment)
• World Challenges (e.g., UN SDGs)
• Workforce Changes


Global Goals
THE GLOBAL GOALS

What are the trends you see that will define the future of work and the skills that will be most valued by employers of the future?

Artificial Intelligence

- Ability to learn
- Work with others
- Flexibility and comfort with complexity
- Creativity and solution development
- Computational Thinking

What is uniquely human?

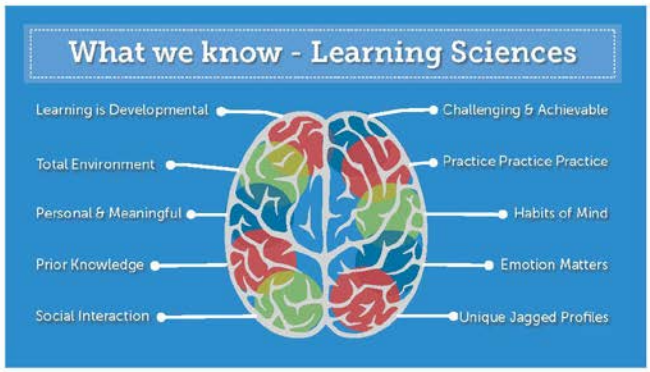
What are the most promising technologies that will redefine education?

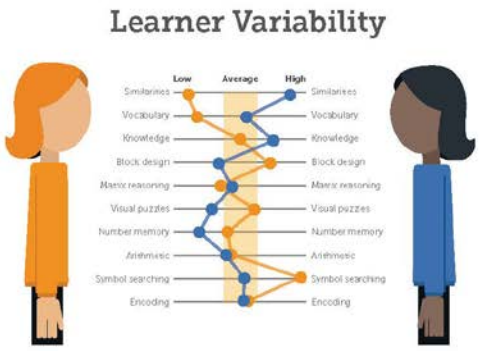
Augment Human Performance

- Data and instrumentation (like location & weather) - Adaptive
- Improved diagnostics and embedded assessment
- Moving from (average and comparison) to precision and accuracy
- Virtual and augmented reality
- Open Education Resources - organized, findable and contextualized

What things are most likely to disrupt how we think about teaching and learning?

- Learning Sciences
- Improvement Science
- Research and Evidence
- Advanced R&D - Pasteur's Quadrant



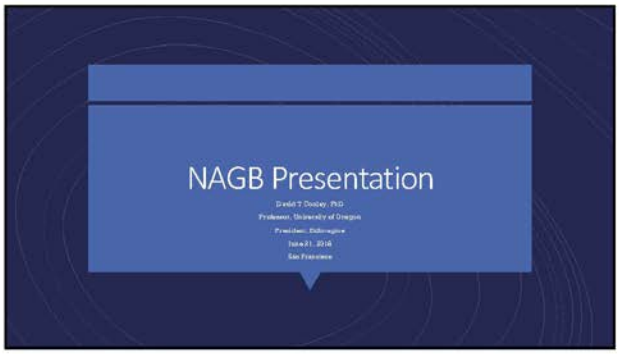


What are the trends that most concern you, and why?

- Lack of respect for and disenfranchised teachers
- Under-resourced schools
- Cost of higher education
- Assessments that fall far short of the full picture
- Issues of inequity
- Digital Learning Gap (Access - Participation - Powerful Use)


Digital Promise
Accelerating Innovation in Education

Conley Presentation


NAGB Presentation
David T Conley, PhD
Professor, University of Oregon
President, EdImagine
June 21, 2016
San Francisco


the questions
1. what are the trends you see that will define the future of learning and schooling?
2. what are the trends you see that will define the future of work and the skills that will be most valued by employers of the future?
3. what are the most promising technologies that will redefine education?
4. what things are most likely to disrupt how we think about teaching and learning?
5. what are the trends that most concern you, and why?


trends that will define the future of learning and schooling?
democratization of access to knowledge
unbundling of the learning process
removal of instructor as bottleneck or gatekeeper
just-in-time learning
social learning
complex profiles of learners
importance of adaptability over fixed skill set
need to have all workers be competent thinkers, adaptable learners


trends that will define the future of work
gig vs. career
low skill vs. high skill
on-site vs. off-site
startup vs. legacy business
globalism vs. localism
service vs. product
automation/standardization vs. customization/bespoke

6/24/2

skills that will be most valued by employers of the future

- adaptability
- data analysis and interpretation
  - ability to collect and analyze information, determine validity of source, reach conclusions
- entrepreneurship
  - be one's own employer
- problem formulation
  - not problem solving
- ability to work with wide variety of people
  - different cultures/backgrounds/gender/social class
- ability to read technical manuals, interpret graphics
  - charts, graphs, diagrams)
- all types of computer skill including web-based skills

the most promising technologies that will redefine education

- neuroscience
  - understanding the physiology of learning
- 5g cellular networks
  - 3 gigabit/sec to well over 10Gbps
- gamification including simulations
  - learner ability to manipulate the learning environment and move through it at their own pace and on their own path
- AI in its various manifestations
- matrix learning

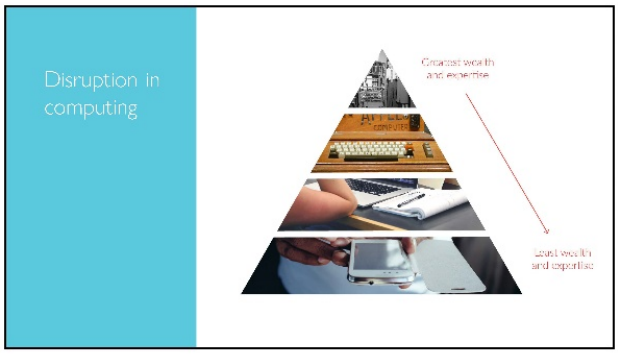
things are most likely to disrupt how we think about teaching and learning

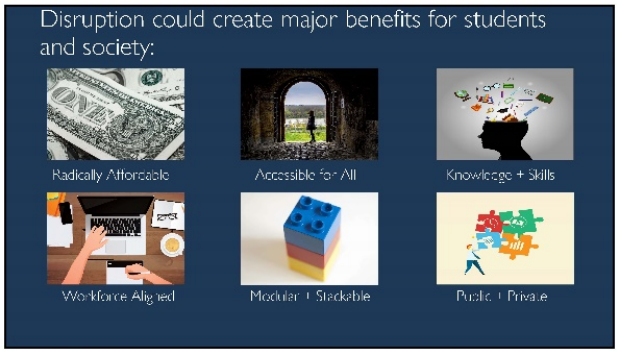
- self-directed learning
- de-emphasis of basic skill mastery out of context
  - basics learned via application of knowledge
- simulations, serious games
- self-directed learning
- decline of liberal education
- modularization of learning
  - certificates, badges, competencies

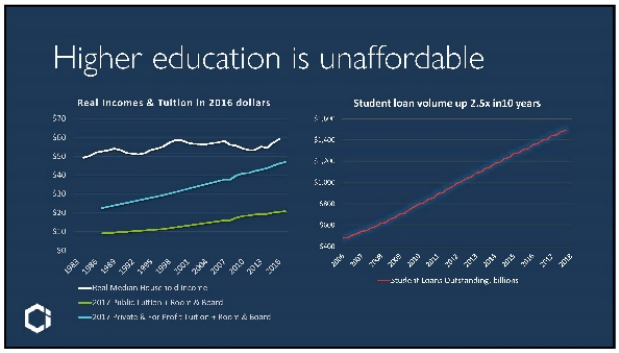

trends that most concern me, and why
equity issues
increasing economic and educational polarisation
growing gap in access to "privileged knowledge" in all its forms
vastly different definitions of what "prepared" means among different economic and social groups
ever-increasing pace of disruptive economic change
lag between changing economic and social structures and education's ability to adapt
what will the role of formal schooling be beyond socialization functions and social sorting?

Dunagan Presentation

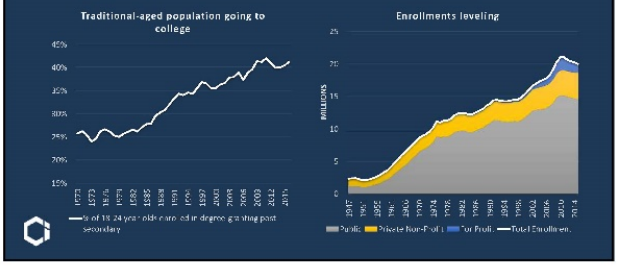

CHRISTENSEN INSTITUTE
The Future of Teaching and Learning
Alana Dunagan
@AlanaDunaganED


Disruption in computing
Greatest wealth and expertise
Least wealth and expertise


Disruption could create major benefits for students and society:
Radically Affordable
Accessible for All
Knowledge + Skills
Workforce Aligned
Modular + Stackable
Public + Private


Higher education is unaffordable
Real Incomes & Tuition in 2016 dollars
Student loan volume up 2.5x in10 years

Today's Landscape: Enrollment



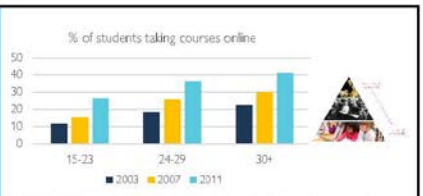
But our economy is more dependent on skilled workers than ever before

Skills matter more than ever

- Employers can't hire because they can't find skilled workers
- Jobs requiring higher education are growing twice as fast as those that don't

Lots of new, innovative players emerging

1) Online learning is quickly becoming ubiquitous in higher education



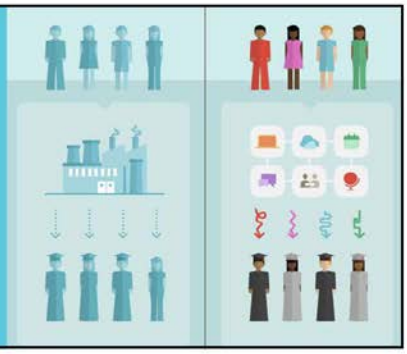
Fall 2016: 30.8% of undergrads and 36.8% of graduate students are learning online

Online learning is especially prevalent among those who otherwise wouldn't be able to access higher education

*About half of **parents** enrolled in school were learning online*

Access and equity, affordability

Personalization, competency based education, student supports & mentoring, experiential learning



College is still the currency of the labor market…

…But, as Ryan Craig says, it's a currency system with $10,000 bills *and no smaller denominations.*

Automation and technology are changing the nature of work—and that change will be continuous.

Learning won't end with college graduation.

…This creates big opportunities

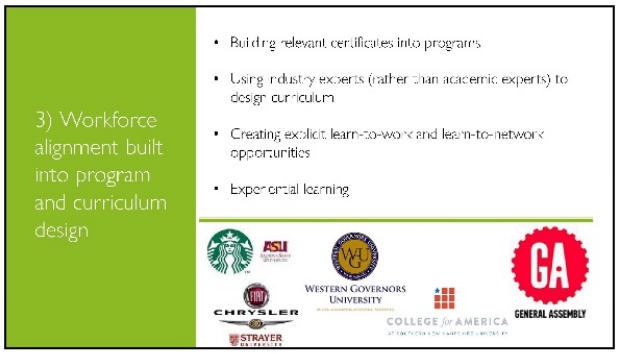
Udemy

coursera

UDACITY

degreed.

2) Learning in smaller denominations than the degree


3) Workforce alignment built into program and curriculum design
• Building relevant certificates into programs
• Using industry experts (rather than academic experts) to design curriculum
• Creating explicit learn-to-work and learn-to-network opportunities
• Experiential learning
ASU
WESTERN GOVERNORS UNIVERSITY
CHRYSLER
STRAYER
COLLEGE for AMERICA
GA
GENERAL ASSEMBLY


Keep the conversation going.
#disruptiveinnovation
@AlanaDunaganED
@ChristensenInst
adunagan@christenseninstitute.org
www.christenseninstitute.org

Fidler Presentation

6/24/2

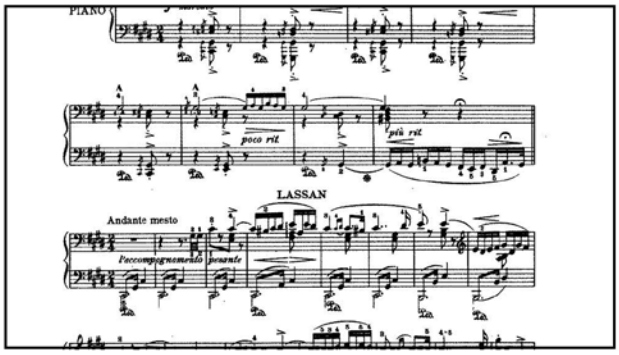
- Biotech
- Nanotech
- Greentech

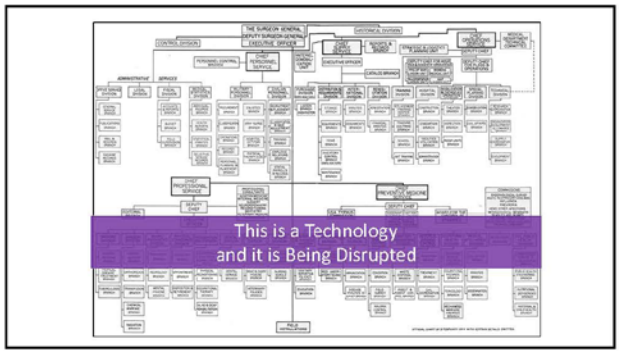
Much Bigger: Organizational Technologies

Preparing for Next Generation Organizational Technologies

Devin Fidler | Devin@RethinkeryLabs.com

6/24/2





There Are Many Ways to Organize

- 4000 years ago- **First** legal **structures for companies**
- 900 years ago- Trade guilds encode industry across Europe
- 250 years ago- industrialization and modern companies emerge
- 130 years ago- Assembly lines, globalization etc.

RETHINKERY LABS

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Digital Organization is Special

RETHINKERY LABS

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Communi cation - Commer ce - Coordinat ion

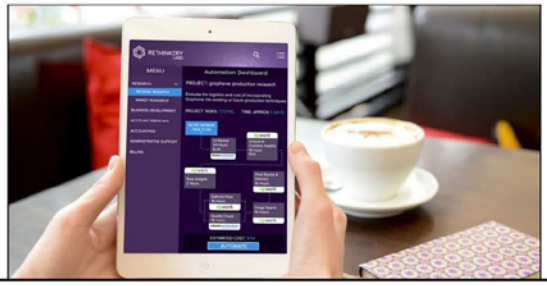
6/24/2

Human Task Routing

toptal
taskrabbit
intel
upwork
UBER
Microsoft
Gigwalk
CATALANT
airbnb
P&G
amazonmechanical turk
heal

Use emerging technologies to:
activate, deactivate & reconfigure resources
where they are needed &
when they are needed

The Frontiers of "OrgTech"



A Collective Intelligence Engine

- Work that looks for people, instead of people looking for work
- Using platforms to find the best matches available
- Collective Intelligence Surfacing Insights

Gigwalk
upwork
taskrabbit

Training, National Interest, and the New OS

- Orchestration becomes a more powerful skill
- Many more established industries can expect competitors built along these lines- Transition and national interest

RETHINKERY LABS

Thank You!

Devin Fidler | Devin@RethinkeryLabs.com

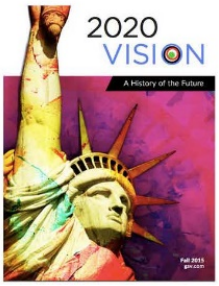
RETHINKERY LABS

Lue Presentation

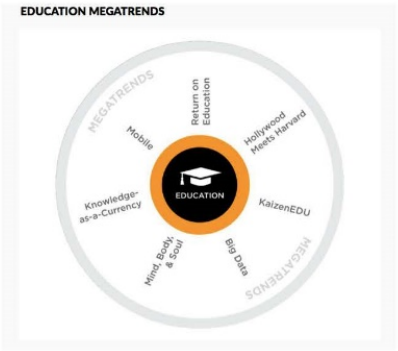
National Assessment Governing Board Futurist Panel

June 21, 2018

Nancy Poon Lue



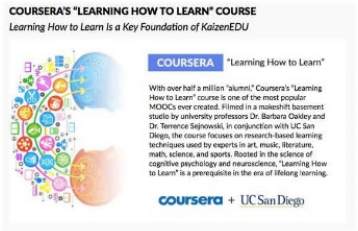
gsv.com/2020-vision



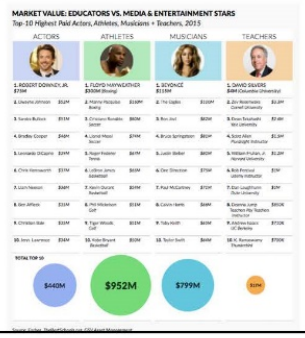
1. Return on Education (ROE)

1

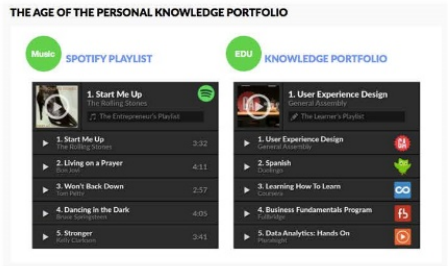
2. Kaizen Edu



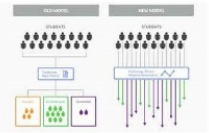
3. Hollywood Meets Harvard

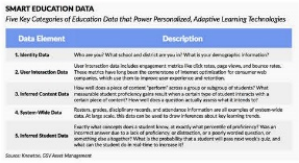


4. Knowledge As a Currency

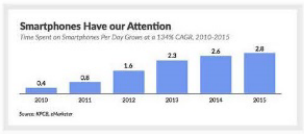


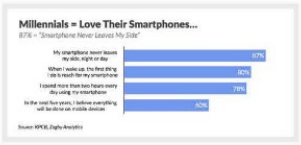
5. Big Data = Smart Data





6. Mobile





7. Mind, Body, Soul

Appendix G. Expert Panel: State Assessment Directors

Summary of the Expert Panel Meeting with State Education Officials June 28, 2018

National Assessment Governing Board Ad Hoc Committee on Measures of Postsecondary Preparedness

To support the charge of the Ad Hoc Committee on Measures of Postsecondary Preparedness, the Human Resources Research Organization (HumRRO) convened a small volunteer panel of education officials responsible for their state's assessment and/or accountability. The meeting was conducted in partnership with the National Assessment Governing Board (Governing Board) and the Council of Chief State School Officers (CCSSO). The focus group was conducted on June 28, 2018, in San Diego, California during the CCSSO-sponsored National Conference on Student Assessment. The purpose of the focus group was to gather information about states' definitions of postsecondary preparedness/readiness and their efforts to develop and use indicators of postsecondary preparedness/readiness.

The focus group participants included **Chris Janzer,** Michigan; **Russell Keglovits,** Nevada; **Shelley Loving-Ryder,** Virginia; **Vaughn Rhudy,** West Virginia; **Michael Sibley,** Alabama; **Jenny Singh,** California; **Allison Timberlake,** Georgia; and **Vince Verges,** Florida. Ms. Loving-Ryder and Mr. Sibley participated in the panel as both state experts and members of the State Policy Task Force, which is jointly convened by the Governing Board and CCSSO.

In attendance were Governing Board members **Tyler Cramer** and **Joseph Willhoft**; Governing Board staff members **Michelle Blair**, **Lily Clark**, **Sharyn Rosenberg**, and **Lisa Stooksberry**; CCSSO staff members **Fen Chou** and **Scott Norton**; and HumRRO staff members **Sunny Becker**, **Monica Gribben**, **Thanos Patelis**, **Sheila Schultz**, and **Arthur Thacker**.

An overview of the Governing Board and the charge of the Ad Hoc Committee on Measures of Postsecondary Preparedness, along with the agenda and the logistical information for the meeting, were sent to the participants as read-ahead materials. The meeting agenda is at Appendix A.

Thanos Patelis, HumRRO Principal Scientist, started the meeting by reviewing the agenda and goals. Lily Clark, Governing Board Assistant Director for Policy and Research, welcomed everyone and provided an overview of the Governing Board's Strategic Vision initiative to "develop new approaches to measure the complex skills required for transition to postsecondary education and career," which led to the creation of the Ad Hoc Committee on Measures of Postsecondary Preparedness and the impetus for this focus group meeting.

Mr. Patelis facilitated a discussion among the participants that highlighted the following guiding questions:

- How does your state define college and career readiness?
- Did your state consult with industry groups to define career readiness?
- What measure(s) does your state use to assess career readiness?
- Is military service a component of postsecondary readiness in your state?
- How does your state use noncognitive measures?

- Are there innovative or nontraditional indicators that your state might use to measure or report on students' college and/or career readiness (e.g., student interest, micro-credentials earned, work-based learning)?
- What NAEP reporting on postsecondary readiness would be useful to states?

Following is a general summary of the information provided by this group of state assessment and accountability experts on definitions, activities, and indicators of postsecondary preparedness/readiness.

Definitions

The state officials offered examples of definitions of college and career preparedness/readiness used in their respective states. It was evident from the examples that states have a variety of definitions for college and career readiness. The definitions and indicators for college readiness were separate from those of career readiness. Most of the definitions for career readiness explicitly included "soft skills," such as communication, collaboration, problem solving, and business practices. The state officials acknowledged the importance of soft skills to college and career readiness while also noting the challenge they pose in developing and measuring indicators related to these skills.

The definitions of college and career preparedness/readiness represented by the participating state officials varied in certain aspects and included the following:

- Two states defined *college readiness* as students who enroll and succeed in college courses without remediation.
- The use of benchmarks on college entrance and placement tests serve as a default definition of *college readiness*.
- *Career readiness* can be defined as obtaining a job that pays a living wade, which varies by location.
- *Career readiness* in several states was defined by a set of credentials from a career and technical education (CTE) program that did not include inter- and intra-personal skills. However, some other states included soft skills, such as inter- and intra-personal skills and business skills, in their definitions.
    - In one state, the inclusion of service learning was part of the secondary school experience that contributed to a career ready diploma seal.
    - In another state, career readiness was defined as acquiring specific skills from CTE programs as well as successful performance on assessments that represented specific skills (e.g., National Occupational Competency Testing Institute) and experience in a simulated workplace program.
- One state described the development of *college and career readiness* standards that defined specifically what is meant by college attendance and students' understanding of the available career fields.
- *Military readiness* was offered as a postsecondary option that involves a set of cognitive and physical requirements, which is seen as an indicator of readiness in some state accountability plans.

A couple of state officials commented how they would welcome a definition of college and career readiness from the Governing Board.

Learning Opportunities and Interventions

Several state officials described the following efforts for students to acquire college and career readiness skills:

- States work with schools and industry to develop diplomas to certify technical career skills.
    - The diploma is earned through CTE programs, work-based learning, industry/credential exams, or portfolios.
    - One state developed career ready diploma seals that reflect cooperation between CTE programs and industry to introduce service learning and experiences for students to acquire industry-specific technical and broad inter- and intra-personal skills (e.g., leadership, collaboration, communication skills).
- Programs to prepare students for career readiness are designed to take advantage of local industry and involve the cooperation and input of businesses likely to hire postsecondary students.
- Schools encourage or adopt dual enrollment initiatives to increase student access to college-level courses and experiences.
- Soft skills, such as communication and leadership skills, are taught through service learning, student organizations, work-based learning, and simulated work environments.
- One state's goal is to prepare students for college or a career by ensuring they are agile in facing an environment where the requirements are not always known.
- One state official indicated that the state department of education is (and should be) flexible in facilitating local education agencies to develop pathways for students that are relevant for local conditions and situations.
    - As an example, one school district described a multi-national company that moved into the municipality with plans to add an international business pathway for students. Students who complete designated international business courses and activities earn a career ready seal on their diplomas.

Data and Indicators

The state officials identified sets of skills important for college and career readiness. Some commented on the difficulty in measuring certain skills from both practical/logistical and technical/measurement perspectives. One state official opined that it is easier to measure college readiness than career readiness. Many state officials noted the difficulty with career readiness data is twofold: (a) the skills to be assessed are multi-faceted in nature and (b) there are practical limitations in identifying measurable indicators for all facets.

The skills explicitly mentioned, especially for career readiness, include business practices, collaboration, leadership, communication, creative problem solving, argument and reasoning, designing solutions, time management, and intellectual curiosity.

Several state officials indicated the Governing Board could contribute to the measurement of the soft skills important for indicating career readiness, particularly if provided at the state level. One official, however, encouraged the measurement of both college and career skills, but also cautioned that one consequence of reporting these skills by state is how industry may use them to target or avoid certain states for opening corporate and business locations.

State officials offered various comments and suggestions about data related to college and career readiness:

- Geographic differences reported in relevant career skills were based on the types of local industry and available jobs. States want data at a regional level.
- Some soft skills are not easily defined or measured (e.g., time management, intellectual curiosity).
- Student level data on absences, credits, and required course attainment can serve as proxies for some soft skills.
- A portfolio of artifacts (in the form of certificates, work-based learning, etc.) or experiences (advanced courses, dual credit) can be used as an indicator of college and career readiness.
- A concern about equity in terms of (a) opportunities to learn and (b) distribution of funds to offer college and career readiness opportunities (test fees) was expressed.
- Student service learning could be used as a relevant data point.
- One suggestion was for states to support and incorporate local accountability plans and metrics that involve school-specific indicators of important constructs such school culture, climate, and other environmental measures.
    - Examples of using school climate and school culture surveys were reported.
- Indicators used in state accountability plans included attendance, course participation, college entrance and placement test scores, and certification test results.

Various comments were offered about the measurement of college and career readiness:

- College readiness is easier to measure than career readiness.
- Soft skills typically are not included in state standards, so what to measure becomes a challenge.
- Measures should be general (versus specific) to remain relevant over time.
- Soft skills should be measured early (e.g., age appropriate elementary and middle school skills) to allow time for students to close gaps and attain common school and workplace skills. Early measurement would provide schools with data to monitor student learning and acquisition of these important life skills.
- States would like to see best practices in providing, documenting, and measuring college and career readiness skills.
    - For example, is there evidence that students who earn certificates are successful?
- A couple of state officials commented that the Governing Board is in a unique position to develop a measure(s) of soft skills at the state/national level.
- It would be a tremendous contribution if the Governing Board created a single definition inclusive of both college and career readiness as well as developed indicators to measure those skills.

Appendix A: Meeting Agenda and Attendees

Discussion of State Efforts on College and Career Readiness

Thursday, June 28, 2018, 7:30 − 8:50 AM PST
Room: Cobalt 520 (Level 5)
Hilton San Diego Bayfront
San Diego, California

Agenda

Purpose: Identify and discuss states' current and innovative practices regarding college and career readiness to inform the National Assessment Governing Board's effort to *"Develop new approaches to measure the complex skills required for transition to postsecondary education and career."*

7:30 – 7:45 AM **Breakfast & Introductions**

7:45 – 8:00 AM **Overview of the National Assessment Governing Board's Initiative on Postsecondary Preparedness**
Lily Clark, Assistant Director for Policy and Research
National Assessment Governing Board

8:00 – 8:50 AM **Discussion of State Efforts on College and Career Readiness**
Thanos Patelis, Facilitator, HumRRO

Guiding Questions:

- How does your state define college and career readiness?
- Did your state consult with industry groups to define career readiness?
- What measures does your state use to assess career readiness?
- Is military service a component of postsecondary readiness in your state?
- How does your state use non-cognitive measures?
- Are there innovative or non-traditional indicators that your state might use to measure or report on students' college and/or career readiness (e.g., student interest, micro-credentials earned, work-based learning)?
- What NAEP reporting on postsecondary readiness would be useful to states?

8:50 AM **Thank you and Adjourn**

Attendees

State Officials (Department of Education)
Chris Janzer, Michigan
Russell Keglovits, Nevada
Shelley Loving-Ryder, Virginia
Vaughn Rhudy, West Virginia
Michael Sibley, Alabama
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Appendix H. Expert Panel: Youth

The summary of the Young Adult Expert Panel meeting is forthcoming.

Appendix I. Literature Review: Work of the Future

Work of the Future – 2030

Overview of Jobs of the Future

History shows major changes in the occupational landscape and pace of life with each of the four industrial revolutions (Vale, 2016). The first industrial revolution, characterized by the steam engine, led to greater dispersal of jobs as those requiring machine power were not restricted to locations with wind or flowing water to power mills. Electricity and mass production brought about the second industrial revolution, leading to a surge in manufacturing jobs and supporting industries such as transportation, sales, and business. The advent of the digital age, the third industrial revolution, gave us the ability to collect and process massive amounts of data quickly and opened up new jobs related to computers and technology innovation. Now, we are entering the fourth industrial revolution, highlighted by the internet of things and artificial intelligence (Choi, 2017; Vale, 2016).

Throughout history, the introduction of new technologies has led to changes in jobs, from replacing workers with machines to changing how people perform their job to creating new occupations. According to futurists, this trend will continue. Policy analysts predict up to 47 percent of jobs in the United States could be automated between 2017–2037 (Bakhshi, Downing, Osborne, & Schneider, 2017; Houser, 2017). Opportunities will become limited in many industries, mostly in low- or medium-skill jobs, as automation reduces the number of humans needed to perform routine tasks. Further, business leaders and strategists predict that 50 percent of the occupations of 2014 will no longer exist in 2025 (Andrew, Ip, & Worthington, 2014). Technology, automation, artificial intelligence, and other innovations that have yet to be developed will lead to new occupations and jobs.

Atkinson and Wu (2017) take a different perspective of technological disruption, suggesting that others have based their doomsday predictions of rampant job loss on “faulty logic and erroneous empirical analysis.” Instead, they calculate, from 2010 to 2015, approximately six technology-related jobs were created for every 10 lost, the lowest share of jobs lost to technology of any period since 1950 to 1960.

While there will likely be changes in jobs and occupations of the future, what those changes will be, the extent and pace of changes, and the impact on employees entering or currently in the workforce are equivocal. In this report, we review the research related to potential changes in the workplace and highlight forecasts of jobs of the future.

Projections of Shifts in Jobs

Prediction of widespread unemployment due to technological advances is nothing new. For example, in the 1930’s, John Maynard Keynes predicted large-scale job loss associated with new technologies (as cited in Frey & Osborne, 2013). Recently in the United States, automation has been replacing jobs faster than it can create them (Atkinson & Wu, 2017; Brynjolfsson & McAfee, 2011), although perhaps not as quickly as some suggest. Autor, Levy, and Murnane (2003) found that as industries use automated technology to reduce the cost of performing routine cognitive and manual tasks, they hire more people to perform nonroutine cognitive tasks.

The occupations in which people are or will be employed are expected to shift, but this does not necessarily mean current jobs will be totally eliminated. As Manyika (2017a) reports, at least 30 percent of activities for most occupations could be automated using current technology. Assuming in many current occupations certain activities or tasks will be automated, current jobs

will change and more people will need to work with technology. Although some employees may lose their jobs because automation will drastically eliminate the need for human skills, integration of technology will help other workers perform their job better or enable them to be more efficient or productive. For still other workers, the demand for their skills may increase or the nature of what they do and how they accomplish tasks at work will change.

*O*NET Projections*

O*NET OnLine (National Center for O*NET Development, 2018) is a rich source of "detailed descriptions of the world of work." There is a wealth of data available to those looking for work or interested in changing careers, as well as support for workforce development and human resources professionals, researchers, and policy analysts.

Using 2016–2026 employment projections from the Bureau of Labor Statistics, O*NET includes a set of Bright Outlook occupations. Twelve of the Bright Outlook occupation categories (including 20 distinct occupations) are expected to grow rapidly with an employment increase of 10% or more and are forecasted to have 100,000 or more job openings between 2016 and 2026 (see Table 1). O*NET identifies occupations linked to the green economy, focused on reducing environmental risks and initiating sustainable development without degrading the environment. Green jobs identified in O*NET are those where changes are expected in job demand, including work requirements such as tasks performed or worker qualifications such as knowledge, skills, and credentials needed for employment in these positions.

Table 1. O*NET Bright Outlook Occupations with Rapid Growth and Numerous Job Openings

Major Occupation Group	Occupation Category	Green Economy Sector
Business and Financial Operations	Accountants and Auditors	
Education, Training, and Library	Teachers and Instructors, All Other (includes Tutors)	
Healthcare Practitioners	Registered Nurses (includes Acute Care Nurses, Advanced Practice Psychiatric Nurses, Critical Care Nurses, and Clinical Nurse Specialists)	
Healthcare Support	Home Health Aides	
	Nursing Assistants	
Personal Care and Service	Personal Care Aides	
Food Preparation and Serving	Cooks, Restaurant	
	Combined Food Preparation and Servicing Workers, Including Fast Food	
Building and Grounds Cleaning and Maintenance	Janitors and Cleaners, Except Maids and Housekeeping Cleaners	
	Landscaping and Groundskeeping Workers	
Sales	Sales Representatives, Services, All Other (includes Energy Brokers)	X
Construction and Extraction	Construction Laborers	X

Source: O*NET OnLine

Several researchers have mined the O*NET data to make predictions about the future of jobs, identifying ones expected to increase and ones to decrease in the future. Bakhshi et al. (2017) used O*NET's importance ratings in foresight exercises to generate input for a machine learning model, with the goal of mapping O*NET knowledge, skills, and abilities variables to future occupational demands. In the United States, the model predicts increased demand for teachers from pre-school through high school and post-secondary. Animal care workers, legal professionals, and engineers round out the top five occupations with expected increased demand.

Jobs Expected to be Lost or to Decrease

Job loss and decrease due to technology is evident all around us. Grocery stores offer multiple lanes where customers scan their own purchases, monitored by a single cashier. Only a few years ago there were multiple cashiers serving the customers. Financial institutions offer more and more automated functions such that their customers need to interface with a person less often than ever before. For example, customers can now use a mobile application to deposit a physical check without leaving home. Andrew, Ip, and Worthington (2014) predict customer work will disappear and many middle management positions will no longer exist in 2025. Frey and Osborne (2013) describe greater use of data and algorithms to computerize cognitive tasks such as fraud detection, health care diagnostics, legal document review, and financial advice. With automation expanding into more cognitively-advanced occupations, demand for individuals with certain professional skills, such as financial analysts and law clerks, are predicted to decline.

Frey and Osborne (2013) used O*NET data to study how susceptible jobs are to computerization. Using data for 702 occupations, they modeled the potential for jobs to be automated within 10–20 years. Their model predicted workers are most likely to be replaced with technology in occupations that involve transportation and logistics, office and administrative support, manufacturing, and service.

Bakhshi et al. (2017) did not use their model to predict decreased demand, but rather to predict low probability of increased demand. Those in skilled and semi-skilled trades, such as woodworkers, printing workers, metal and plastic workers, and other production occupations, were at the top of the future low demand list. Financial clerks received low ratings comparable to those in the trades.

Jobs Expected to Increase

Bakhshi et al. (2017) expect growth in professional occupations that require creative, digital, design, and engineering expertise. In addition to creativity, Osborne and Frey (n.d.) suggest growth in jobs that require social intelligence and manipulation, such as iOS and Android developers, social media interns, big data architects, data scientists, user interface/user experience (UI/UX) designers, Zumba instructors, and beachbody coaches. Further, strong interest in environmental sustainability is expected to benefit individuals employed in architectural and green occupations (Bakhshi et al.). Also, they foresee increased roles for people specializing in work reorganization, such as management analysts and training specialists.

New Jobs to be Created

Jobs requiring creative intelligence and social and emotional intelligence are predicted to be added to the economy, as are positions requiring the ability to leverage artificial intelligence (AI; Andrew, Ip, & Worthington, 2014). New jobs using creative or social and emotional intelligence or AI are expected to be more fulfilling than current jobs.

Generally, specific details about future jobs are scarce. Wagner (2011) discusses 70 jobs likely to exist in 2030. These jobs will be created through (a) retrofitting or adding new skills to existing jobs, (b) blending or combining functions from different jobs or industries, and (c) problem solving or creating new jobs to solve a problem. Types of jobs that might be added through retrofitting could support commercial space travel, such as space construction, space suit repair, space junk recyclers, astro-teachers, and exozoologists. By blending careers, the future might include environmental health nursing to treat patients exposed to toxins. To provide authoritative news in an era when anyone can publish online may lead to authority-journalists who specialize in an occupation and are cross-trained to report about their field. To solve future problems, we may hire digital footprint managers or digital archaeologists or future-guides. Wagner mentions occupations in the sustainability and green energy industries may be added, such as green career coach, autonomous vehicle operator, energy harvester, drone dispatcher, smart car interior designer, smart road designer/engineer, and smart road sensor control monitor/analyst. Gordon (2011) predicts there will be new careers inspired by nanotechnology, such as bio-botic physicians and bio-botist assistants to integrate biological functionalities and implanted nano-robotics to extend life.

Drivers of Change

The literature discusses three major drivers of projected shifts in jobs of the future—technology (Frey & Osborne, 2013), artificial intelligence (Manyika, 2017b), and social changes (Bakhshi et al., 2017; Manyika, 2017a). With changes in jobs come adjustments in the workplace. Experts predict that workplace culture and processes will shift as well as career paths and how people learn the necessary job skills needed to perform jobs of the future.

Impact of Technology

Literature is replete with observations of the accelerating impacts of technology in recent decades, including predictions this acceleration will continue. Baby boomers remember a world when communication required a phone call that was timed when both parties were available to speak or a letter that took days to be delivered; researching a topic involved going to the library or referencing a home copy of encyclopedia volumes; and getting a flat tire meant a hike to find a pay phone. Today's young people are digital natives. They cannot imagine a world before e-mail allowed asynchronous communication; the internet offered a wealth of instantaneous information at one's fingertips; and cell phones connected individuals to worlds beyond measure. The explosion of technology is expanding in multiple directions—and quickly.

Bakhshi et al. (2017) employed an innovative approach to predicting job trends by first paneling experts in "foresight workshops" and then inputting their expert judgments into a machine learning system. Their analysis of the experts' judgments identified three key trends in technological change. First, fears about the impact of automation on employment are enduring. Second, estimates of the impact of future automation range from 9–47 percent of U.S. employment. Third, technology can amplify human performance and bring about new occupations and sectors.

For its 21st annual survey of CEOs worldwide, PwC interviewed 1,293 CEOs in 85 countries, including 104 from the United States, in October and November 2017 (Ryan, Sapin, Rao, & Ampil, 2018).

Based on these interviews, U.S. CEOs were hiring for broadly relevant digital skills and collaborative, creative, and efficient work styles. About two-thirds (63%) of those who were hiring found it more difficult to identify qualified workers than before. Responses to this same

survey indicated that artificial intelligence (AI) will be the innovation of the next two decades. CEOs predict that many workers will need AI literacy.

One of the challenges of a rapidly changing work environment is the ability of workers to keep pace. While new entrants into the workforce will grow up and attend school immersed in state-of-the-art technology, continued innovation ensures even these digital natives—those who have an advantage over older, digital immigrants who completed school before digital technology became omnipresent—will require ongoing training to stay current on technological knowledge, awareness, and skills. Employees who joined the job market prior to many of the current technological advances are already challenged with staying up to date. Two approaches to keeping tenured employees abreast of the latest technological developments are upskilling and reskilling.

Upskilling

When an employee upskills, that individual learns new skills to improve performance on the job or to adapt to new requirements of the job. Upskilling has the advantage of retaining experienced employees, a positive outcome as these employees are a known commodity to the employer, absent the risks of employing a new hire who may not be a good fit. Knowledge of corporate procedures, norms, and expectations eliminate the need for orientation and start-up time, and reduce the probability of missteps. Retaining seasoned employees also supports the maintenance of institutional memory, which can be crucial as an organization evolves and grows.

Training to upskill employees may be sought by the employee, imposed by the employer, or both. The PwC's Workplace of the Future study found three-quarters of respondents expressed willingness to update their own skills. At the same time, most responding CEOs acknowledged an ongoing responsibility to upskill their employees (Ryan et al., 2018).

PwC's Annual Global CEO Survey specifically investigated the employer's perspective on upskilling. Nearly two-fifths (39%) of respondents reported initiating or using continuous learning initiatives to provide development paths for employees to gain skills.

Reskilling

When an occupation becomes obsolete or the changing nature of the position no longer suits an employee, reskilling may be in order. More disruptive than upskilling, reskilling is training an employee to perform an entirely different job.

Results from PwC's annual survey of CEOs indicate companies that "reinvent their own talent" by reskilling their employees will have an edge by creating pathways for employees to better contribute to data-driven initiatives, which may lower costs and improve the customer experience among other impacts (Ryan et al., 2018). However, the U.S. lags other large economies (e.g., Germany, China, Japan) in assuming responsibility for retraining after automation (i.e., robots and AI) has been introduced into a job. The authors conclude that, while automation will result in job losses, over time those will be generally offset by new jobs. They note that "retraining workers to work with the support of AI will be important to future economic success" (Ryan et al., 2018, p. 15)

Working with Data

Alec Ross, author of Industries of the Future, provides an historical perspective of the workplace. He describes land as the raw materials of the agricultural age, followed by iron in the industrial age, and data in the information age. He posits that whoever owns, controls, and/or

can harvest meaning from data will define the future workplace. Ross (2016) emphasizes the sheer quantity of data being produced in recent history and the opportunity for data analytics to mine those data. For example, he notes that "90 percent of the world's digital data has been generated over the last two years" (page 154). He opines that the sum of "all data from paintings on cave walls through 2003, we now produce every two days" (Ross, 2017).

PwC issued a report on the workforce of the future, using findings from a survey of 10,000 people in China, India, Germany, the United Kingdom, and the United States on how they think the workplace will evolve. From the survey findings, the authors developed four "Worlds of Work" for 2030 to describe hypothetical future scenarios defined along two continuums: collectivism and fragmentation. Authors concluded the increasing use of digital platforms and AI mean data are key. With augmented intelligence, humans and machines collaborate to make decisions. Uniquely human traits of emotional intelligence, creativity, persuasion, and innovation become more valuable. Adaptability will become increasingly important as work changes (PwC, 2017).

Human-Technology Interactions

Not only are data produced and stored at astounding rates, but individual access to such data through technology is expanding. Ross (2017) asserted that 20 billion networked devices were in circulation in 2017. He projected this number will reach 45 billion in 2020. This growth will likely not produce a steady expansion across all markets, but rather result in bursts of growth in traditional areas that have not been as impacted by the digital economy, such as transportation or mining.

PwC's Annual Global CEO Survey predicts that businesses will initiate upskilling initiatives to teach employees the skills they need to augment their own work with the support of technology. The authors contend that companies will infuse AI into all aspects of their business, not just technology-related areas (Ryan et al., 2018).

New Technology Jobs

Technology jobs such as software engineers are on the rise, but two other trends may result in new technology jobs. First, the blending of AI technology with a human component, or augmented intelligence, may open opportunities for technology-enhanced versions of jobs that are available today (PwC, 2017).

Second, Ross (2016) points out an increasingly popular conviction that the opportunities of the future will no longer rigidly distinguish technical fields from liberal arts or humanities. He suggests hybrid studies will become more prevalent, such as a combination historian/electrical engineer or political scientist/computer scientist. He describes the thinking of Toomas Ives, President of Estonia: "…domains previously occupied only by people with backgrounds in the liberal arts, like government, will become increasingly occupied by people with more background knowledge in science and technology" (page 246).

Impact of Artificial Intelligence

Types of Artificial Intelligence

Although people may mean different things when they refer to artificial intelligence (AI), they generally mean the use of computers to perform tasks that require cognition and learning without programming the steps of the task. Often, AI is used to refer to machine learning, "where computers are taught or self learn how to recognize things" (Shaw, 2017). Bughin et al. (2017) describe other types of AI, including computer vision, autonomous vehicles, natural language, smart robotics, and virtual agents.

Machine learning is intensive, for the humans who must provide the "training data" and for the computer to process the information. Shaw notes that machine learning has many applications, such as predicting nefarious behavior or mechanical breakdown and identifying possible disease in 3D radiology images. Research is underway to explore the use of AI to make machine learning more efficient and accurate.

Shaw expects computer vision, using cameras to infer what they are seeing, to become the most prevalent type of sensor. Computer vision will be integral for self-driving cars and other autonomous vehicles such as self-driving trucks, buses, trains, and ships. Autonomous flying drones, which may be used for package delivery or to aid in aerial search and rescue, also will benefit from computer vision.

Natural language processors are familiar to many as they ask Siri for directions or to settle a debate. Smart home devices such as Google Home or Alexa are natural language processors. Once these devices understand what a person has said or written, Shaw states that a virtual agent is the next step. The virtual agent can help the human, provide financial advice, perform basic health diagnosis, or guide an individual through steps of an activity or job. Smart robotics are in use today, especially in manufacturing. Shaw expects robotics to become more prevalent in medicine, cleaning, stocking, agriculture, and food service in the future.

Machine learning is but one way of many to categorize AI. Hintze (2016) defines AI using a hierarchy from type I-reactive machines (e.g., Deep Blue, IBM's chess supercomputer) to type II-limited memory (e.g., self-driving cars monitor information over time) to type III-theory of mind (e.g., understanding that thoughts and emotions affect behavior) to type IV-self-awareness (e.g., being aware of oneself).

New Artificial Intelligence Jobs

Research continues to advance AI (Bughin et al., 2017; Hintze, 2016; Shaw, 2017), with the implication that jobs developing and studying AI will continue to grow as the technology is incorporated into more daily life routines. Research firm Gartner, as cited in Singh (2017), predicts by 2020 more jobs will be created by the expansion of AI than will be lost. They estimate, that although AI will be responsible for the loss of 1.8 million jobs between 2018 and 2020, AI will create 2.3 million jobs. Healthcare, the public sector, and education will lead the way in incorporating AI into their sectors.

Increasing use of digital platforms and AI mean data will be key to creating new AI jobs (PwC, 2017). With augmented intelligence, humans and machines must collaborate to make decisions. Singh (2017) expects one in five workers will rely on AI to assist them in their jobs by 2022. It will be important for people to learn to work with and alongside AI machines.

Impact of Social Changes

Globalization

Globalization refers to the increasing interconnectedness of the world, both economically and politically. Along with automation, globalization is viewed as one of the main factors shaping the future workforce (Bernstein, 2016; Simon, 2016).

Companies operating on an international scale may have financial incentive to move jobs from the U.S. to other countries. This has been demonstrated historically through the loss of low-skilled manufacturing jobs due to offshoring (Hatzichronoglou, 2005). Today, higher skilled jobs also run the risk of offshoring, including computer-oriented science, technology, engineering, and mathematics (STEM) jobs (Lim, 2016).

Technological advances are closely linked with globalization's impacts on the workforce. "Labor-linking" technology allows geographically dispersed people to vie for the same job, creating a competitive environment that could potentially drive wages down (Basu, 2016). However, there remain numerous higher-skilled jobs that are less subject to this threat, particularly those in healthcare and service industries that require face-to-face interactions (Blinder, 2007).

The potential for interaction with clients, customers, and coworkers from across the globe has implications for the skills that are valuable as well as valued. For example, employees may find it easier to negotiate the workplace when they have the skills needed to communicate effectively with geographically dispersed people from a range of sociocultural backgrounds. 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.

Environmental Sustainability

Environmental policies have long been linked to the reduction of jobs in specific industries (e.g., coal), though a causal link is up for debate (Morgenstern, Pizer, and Shih, 2001). The availability of jobs in such industries in the U.S. may in fact be limited by a decreased demand for fossil fuels that has resulted from advances in energy efficiency technology (Magill, 2017). Regardless of the mechanism at work, there is reason to believe the jobs of the future will continue to be shaped by both policy and consumer behavior related to environmental sustainability.

Beyond contributing to the obsolescence of some jobs, the focus on environmental sustainability continues to create new jobs and to change jobs that currently exist. Job opportunities for innovation related to environmental sustainability may increase as individuals and corporations alike seek to reduce energy consumption and waste (Bakhshi, Downing, Osborne, & Schneider, 2017). Companies that are changing practices to reduce their environmental footprint may create jobs for "sustainability professionals" who will take on the role of managing company resources (Hamilton, 2012). The National Center for O*NET Development has identified green economic sectors, green increased demand occupations, green enhanced skills occupations, and green new and emerging (N&E) occupations, many of which will likely boast increased job opportunities in coming years. Green enhanced skill jobs are those in the existing occupation that require significant changes due to the impact of the increased focus on environmental sustainability (O*NET, 2018).

Demographic and Population Patterns

As of 2016, foreign-born workers constituted nearly 17% of the U.S. labor force (Bureau of Labor Statistics, 2017). By 2060, approximately 20% of the total national population is expected to be foreign-born (Colby & Ortman, 2015). Some raise concerns about the potential loss of jobs by American-born workers to immigrants (Hoban, 2017). Others argue the rising immigrant population will increase opportunities for U.S.-born workers, as immigrants frequently perform low-skilled jobs that are complementary to, and increase the productivity of, work performed by other Americans (Greenstone & Looney, 2012). However, many immigrants also hold advanced degrees, particularly in STEM fields (Solis, 2011), and could therefore play a crucial role in meeting the demand for highly skilled workers.

As working Baby Boomers draw closer to retirement age, there is concern over the loss of the knowledge and skills of the overall labor pool (Burke & Ng, 2006). Globally, the ratio of non-working age people to working age people appears to be on the rise (Bakhshi, Downing, Osborne, & Schneider, 2017). This trend may be counterbalanced by policy changes that raise

retirement ages or provide incentives for older workers to remain on the job (Lerman & Schmidt, 1999).

The overall aging of the population has implications for available jobs. Jobs in healthcare and the production of goods and services targeting the needs of older citizens are on the rise (Singh, 2015). However, the influx of highly-educated Millennials into the workforce has its own implications. These workers are anticipated to bring a new set of expectations of their employers, including demands for improved working conditions and human resources policies (National Academies of Sciences, Engineering, and Medicine, 2017). At the same time, there is rising concern regarding this full subpopulation's preparedness with the skills required in the ever-changing world of work (KRC Research, 2014).

Education and Training

It has been estimated that most children entering primary schools today will work in job types and roles that don't yet exist and that will be characterized by the need for not only technological, but also social and analytical skills (World Economic Forum, 2016). It is anticipated workers of the future will hold an increasing number of jobs over their lifetime (Pompa, 2015). These factors, coupled with increasingly rapid technological change, will necessitate a continuous process of education and training throughout these future workers' careers (Karoly & Panis, 2004). This suggests the need for consideration of both the education and training offered to students prior to their entry into the paid labor force, as well as how systems for continued education and training will be implemented and sustained.

Numerous innovative approaches to preparing students with the in-demand middle level skills needed to perform jobs of the future are expanding in their implementation. Career and technical education (CTE) programs, apprenticeships, early college high schools, and career academies are among the approaches that seek to bolster the skill levels of Americans entering the workforce for the first time (Joint Economic Committee Democrats, 2018). On-the-job training (OJT) models are another innovative approach that provides incentives to employers to hire lower-skilled workers and offer them targeted training while they engage in paid labor, as well as offer continued training to allow for career advancement (Kobes, 2013).

Equity Issues

Many anticipate the trends of globalization and automation will lead to increasing inequality, as wages for highly skilled workers rise while low- and unskilled workers will compete with both automation and workers located in other countries (The Foundation for Young Australians, 2017). Other areas of concern regarding equity in the workplace relate to gender and age. Women who seek to both parent and work continue to face potential wage reductions and loss of skill development when they take time off for family leave (O'Marah, 2018). Some anticipate women will be disproportionately impacted by job losses due to automation (Hayasaki, 2017). Aging workers may face threats to their continued employment over issues related to healthcare costs and age-related disabilities (National Bureau of Economic Research, 2018).

New Social-Oriented Jobs

Futurists envision new positions will be created to do work that has never been done before. Most of these jobs will develop in response to shifts in the marketplace or they will be created because of advancing technologies. Envisioned jobs include those that harness the power of social media to create tailored experiences for customers or clients (Wagner, 2010). With more companies using social media to connect with customers and to expand their presence in the market, employees' experience with and understanding of social media will be increasingly valued by employers (Kumar, Bezawada, Rishika, Janakiraman, & Kannan, 2016). Companies

and organizations will need to monitor, maintain, and improve their online presence, and new positions will likely be created for that purpose (University of Kent, 2018).

Workplace of the Future

When examining the workplace of the future, Frey and Osborne (2013) convened human experts in machine learning to classify a subset of jobs according to the likelihood of their "automatability." Through analysis of O*NET variables as proxies for three irreplaceable attributes (i.e., perception and manipulation, creative intelligence, and social intelligence) they developed a model to predict the automatability of the full set of O*NET occupations. Results indicated that 47 percent of U.S. employment can be classified as high risk for automation within the next decade or so.

The Guardian's Workplace Benefits Study (2017) defines four top trends impacting the workforce in 2018 and beyond. Each of these trends is related to technology:

- Technology is enabling an on-demand workforce;
- Automation is requiring an enhancement of workforce skillsets;
- Employers are reinventing talent recruitment; and
- Varying workplace demographics require different strategies for adoption.

Workplace Culture

Agile Workforce

As organizations are required to respond quickly to changes in an increasingly globalized and technologically advanced world, they seek an agile workforce that is similarly capable of responding to unanticipated change with speed and flexibility (Breu, Hemingway, Strathern & Bridger, 2001). Workers of the future may be expected to rotate among a variety of roles and tasks, as employers seek to find the skills needed for a specific task at a particular time (Wadors, 2018). As companies leverage a variety of work models (e.g., ad hoc teams, crowdsourcing, independent contractors) to meet their needs, workers may find themselves entering into many different types of nontraditional work arrangements (Green, 2014). Andrew, Ip, and Worthington (2014) expect an increase in distributed work places. Continual reskilling will be a key element in sustaining high levels of agility (Lyons, Blitz, & Whittall, 2017).

Less Structure and Predictability

Careers have been traditionally viewed as a progression of jobs, often upward through a predictable, hierarchical structure (Lyons, Schweitzer, & Ng, 2014). Careers of the future will likely unfold in less hierarchically structured environments, where there will be increased interconnectedness among departments and where individuals may assume different job roles depending on the context of the work at hand (Heerwagen, 2016). Job tasks themselves are expected to be less structured and predictable as new technologies replace once rote and predictable duties with ones that require abstract thinking and flexibility (National Academies of Sciences, Engineering, and Medicine, 2017).

Sharing Economy

More and more, modern day consumers and workers engage in short-term economic transactions around services that involve sharing some material good (e.g., car, living space) or skill for monetary compensation (Sundararajan, 2016). Also referred to as the gig economy, platform economy, access economy, or collaborative consumption, this sharing economy is

anticipated to increase exponentially over the coming decades (Yaraghi & Ravi, 2016). Such work arrangements have both potential positive and negative consequences for workers of the future. It can be argued that individuals will be empowered by the sharing economy to go into business for themselves and gain returns on their assets. On the other hand, the sharing economy removes protections that workers have enjoyed under more traditional work arrangements (Lamberton & Rose, 2012).

Continuous Learning

McKinsey & Company (2017) recommend that workers of the future be prepared to be lifelong learners. McKinsey Global Institute (MGI) partner Susan Lund explained, "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."

Guardian (2017) recommends that employers address the need for continuous learning through experiential, retraining, and cross-training programs, as well as mentoring, e-learning opportunities, and tuition assistance.

Ross (2016) opines the U.S. adoption of free education until the age of 18 was appropriate as long as a high school graduate could get a job in a "port, factory, mine or mill—a middle class job." However, in the information age, he suggests we know the pace of change demands that we be lifelong learners.

Flexible and Non-Traditional Career Paths

Predictions regarding future career paths are wide ranging. Popular "wisdom" has long asserted that younger generations no longer expect to join an employer after high school or college and stay with that same employer until retirement. Lyons, Schweitzer & Ng (2015) analyzed the career mobility patterns of four generations and found that job mobility increased with each successive generation. Specifically, "The magnitude of the differences was large, as Millennials [born 1980 or later] had almost twice as many job and organizational moves per year as the generation Xers [1965-1979], almost three times as many as the Boomers [1946-1964], and 4.5 times as many as the Matures [born prior to 1946]" (page 16). However, this change in job mobility does not reflect an increase in employee turnover from one employer to another, but rather increased movement through various positions within a company. They postulate that technology, among other factors, may make some positions obsolete. The authors conclude the traditional career model is still strong and the "oft-cited truisms about the 'new' or 'modern' careers may be exaggerated" (page 18).

Intuit & Emergent Research (2017) predict that by 2021, 9.2 million American workers will derive at least some of their income as independent contractors operating within a "gig economy"—situations in which organizations establish short-term contracts on an as-needed basis. This is a substantial growth projection relative to the 3.9 million in 2016. McKinsey Global Institute (2016) estimates that 20–30 percent of individuals of working age in the U.S. and the European Union conduct independent work.

This trend is facilitated by technology that allows a job incumbent to be geographically distant from the employer; the advantages to an organization of selecting the best candidates for a given project, without a long-term commitment; and the ability to increase and decrease staff

levels as demand warrants. This is further enabled by current and planned features in job-employee matching software such as Monster.com, Aftercollege.com, and Taskrabbit and networking sites such as LinkedIn (Brynjolfsson & McAfee, 2016).

Interdisciplinary Teams

Based on research by Burkus (2016), some organizations encourage employees to engage in more face-to-face communication in an effort to increase problem solving and decision making efficiency (as cited in Colbert, Yee, & George, 2016). As a result, workplaces evolve to provide more flexible space for collaborating and working in teams (Giang, 2015). Experts from Unum Limited's Futures100 network (2014) foresee more conversation and debate, either face-to-face or on conversation-based platforms. Employees will need to blend skills and disciplines when working with others. They will collaborate with each other rather than compete. Workers will need listening skills and to display empathy, and build relationships to enable collaborative and interdisciplinary ventures.

Summary of Themes of Work and Workplace of the Future

When it comes to work of the future, change is the only certainty. However, this review of relevant literature points to some overarching themes that provide a solid base for making predictions about the world of work that today's kindergartners will need in 2030 when they graduate from high school. This world will likely look very different from the world of work their parents were prepared for, both in terms of the available jobs and the work environment in which those jobs are carried out.

Jobs of the future will undoubtedly involve technology. From searching job openings, to performing job tasks, to receiving professional development, interacting with new and emerging technologies will be a distinctive feature of future jobs. Fields that had previously been quite separate may be blended in new ways, and existing jobs may be blended with new technologies to create positions we've never seen (think: space junk recyclers!).

The high school graduates of 2030 will set out on a career pathway 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 find themselves part of an increasingly diverse and dispersed workforce. Jobs will be continually evolving to meet changing demands and to incorporate the latest innovations. Ongoing training will be a necessary component of future jobs. Employees will need to adapt and embrace life-long learning to be successful in the workplace.

With some sense of what the future holds for work and the workplace, it becomes clear expected changes in jobs and job environments will correspond to changes in associated skills. A key next step to ensuring that students graduate high school in 2030 prepared for the next step on their postsecondary pathway is to identify the skills and abilities needed to successfully perform the jobs of the future.

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Appendix J. Literature Review: Skills of the Future

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[41] 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.

[41] 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[42]) 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*

[42] 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[43] 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 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.

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

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 loT, 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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Appendix K. Literature Review: State Indicators of College and Career Preparedness

A Review of State Indicators of College and Career Preparedness

Introduction

The purpose of this memorandum is to review states' practices for measuring college and career readiness. The memorandum begins by exploring how states have defined the constructs of "college and career readiness." Next, common and well-established measures such as college entrance exams and statewide assessments in English Language Arts (ELA) and mathematics are described. Then, some less-established academic indicators are discussed. Finally, the memorandum discusses other career or work readiness indicators, including non-academic and other innovative indicators, that states may be including in their suite of exams to tap into career or workplace skills.

The information included in this memorandum was obtained from (a) states' federal peer review submissions, (b) publicly available information on websites (e.g., state websites, research organization websites, test vendor websites, governmental organization websites), and (c) a review of current articles and scientific literature (e.g., EdWeek articles). Each listed indicator/assessment includes its own research base and documentation; it is beyond the scope of this memorandum to include all of that information. However, enough detail is provided to allow interested parties to discover more information about assessments of interest.

As this memorandum will illustrate, assessments specifically designed to address "career readiness," including non-cognitive, social-emotional learning, and career exploration, are not widely used by states. Some of the indicators described in herein may be used by a single state or may not be administered to all students or even to all schools/districts within a state. However, many states are in the midst of procuring new statewide assessment contracts and the landscape of assessment is ever-changing. Thus, there are likely additional indicators of preparedness for college and career that are not included in this memorandum. As such, this memorandum represents a preliminary effort to catalog some of the innovative ways that states are beginning to approach college and career preparedness.

Framing the Need to Address Readiness for College and Career

Preparing students for post-graduation opportunities has long been a priority for states, districts, schools, teachers, and parents. The current expansion of the global economy and ongoing labor market shifts has refocused attention on the readiness requirements for student success in an ever-changing post-secondary landscape. The current workforce demands employees who can fill jobs that require a combination of technical and academic skills (Carnevale, Smith, & Strohl, 2010). However, employers struggle to find such qualified workers (Organization for Economic Co-operation and Development, 2013). Educational institutions struggle with defining and measuring the knowledge, skills, abilities, and dispositions necessary for success in the current post-secondary world. These efforts are key to guiding educators' efforts to identify which students are on track to succeed as they graduate from high school.

Porter (2018) provided an overview of the current landscape of occupations in the United States and their requirements during a talk at the National Conference on Student Assessment (NCSA). He described ways that states have attempted to upgrade their tests to prioritize the most relevant knowledge and skills for students. The summary figure is reproduced below.

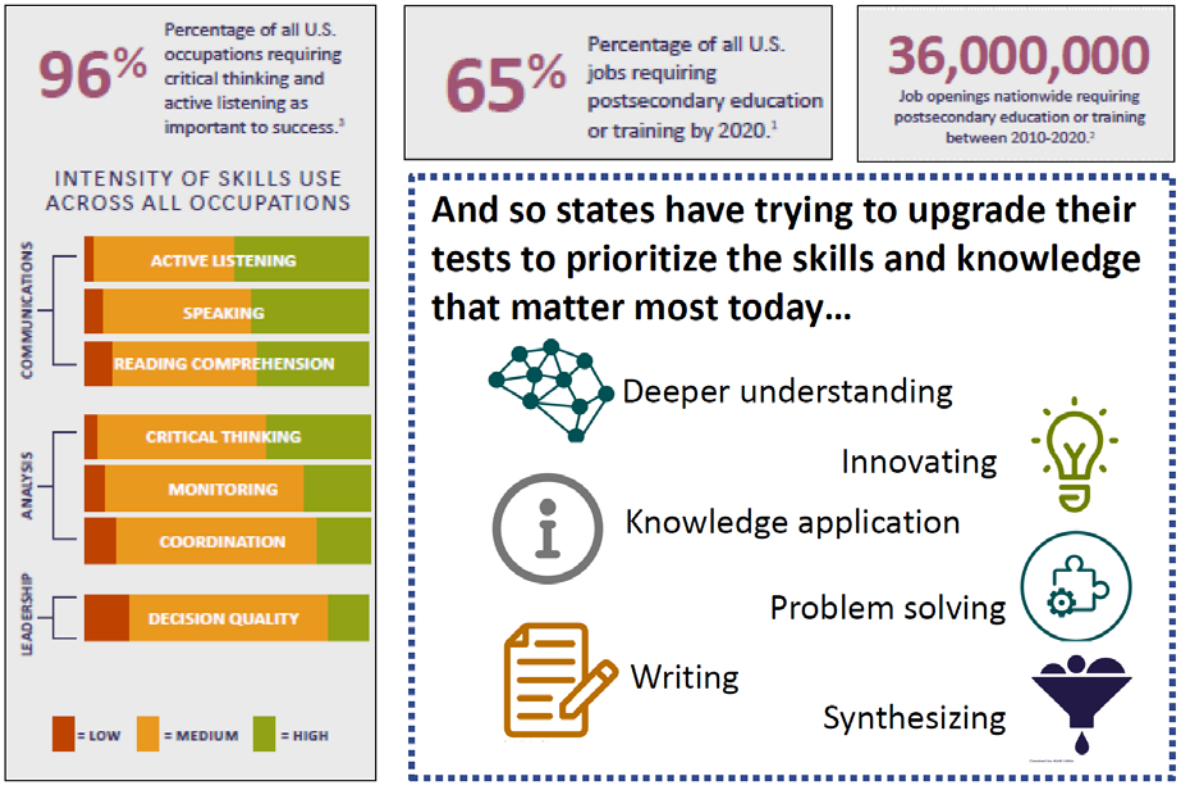


Figure 1. Occupational overview for the United States.

According to Mishkind (2014), 37 states defined college and career readiness as of 2014. For 33 of those, a single definition was used to describe both college and career readiness. The rationales for using a single definition tend to include views on the interconnectedness and similarities between visions of preparedness for college and preparedness for career. For example, the Oregon Investment Education Board[44] indicates that, "the overarching skills and strategies required for students of all ages entering colleges and careers are consistent." New Hampshire, in their ESEA flexibility request[45], stated, "Evidence and experience indicate the knowledge and skills needed to succeed in college and career are greatly similar, and that all graduates will need some form of postsecondary education or training to succeed during their careers."

The U.S. Department of Education (ED) currently indicates that "Nearly every state now has adopted college- and career-ready standards." This quote refers to college and career readiness specifically in the subjects of mathematics and ELA. ED also describes the requirements for approval of state assessment and accountability systems under ESSA related to standards, indicating that "All states approved for ESSA flexibility have engaged in one of the following endeavors to raise expectations for students' academic performance:

- Upgraded their existing standards to make them more rigorous by working with their four-year public universities to certify that mastery of standards ensures that students

[44] See http://stand.org/oregon/OEIB.
[45] See https://www.education.nh.gov/accountability-system/documents/flexibility-waiver-request-renewal.pdf.

will not need to take remedial coursework upon admission to a postsecondary institution in the system; or

- Adopted and implemented common standards developed by a consortium of states that build toward college and career readiness.[46]

According to ED, as of May 31, 2018, 33 states (plus the District of Columbia) included a measure of college and/or career readiness in their ESSA plans.[47]

In states where there are separate definitions, there is a tendency for considerable overlap in the definitions. For example, the Nebraska Department of Education defines a career ready person as follows, "A career ready person capitalizes on personal strengths, talents, education and experiences to bring value to the workplace and the community through his/her performance, skill, diligence, ethics, and responsible behavior.[48] The Nebraska Career Readiness Standards indicate that when students are career ready, they are prepared for the next steps in their lives—whether that means getting their first job or beginning their college 'career' (which eventually leads to the workplace as well). Being career ready also means being ready for life." Nebraska is one of an increasing number of states to also include career and technical education as part of their statewide accountability system. They provide programs outside of the regular school day for students to connect with resources to develop interests and skills for future success.

Mishkind (2014) identifies specific components of the states' definitions of college and career ready and places them into the following six categories:

- Academic knowledge (e.g., English, mathematics, core subjects, preparation to take credit-bearing courses in related subjects)
- Critical thinking and/or problem solving (e.g., reasoning, problem solving, analysis, evaluation, presentation of ideas and information)
- Social and emotional learning, collaboration, and/or communication
- Grit/resilience/perseverance
- Citizenship and/or community involvement
- Other additional activities

Distribution of these components among the 37 states identified by Mishkind (2014) is presented in Figure 2. Similar reports reflecting the state definitions under ESSA have not yet been published.

This memorandum treats "readiness" and "preparedness" synonymously, although states may make distinctions between them. Treatment of the terms is not consistent from state to state, with some referencing "readiness" only as a link to college placement tests' established readiness benchmarks, while others treat readiness more generally. This memorandum is concerned with documenting the ways that states address readiness, so both terms were used in its preparation and no distinctions were made between them.

[46] See https://www.ed.gov/k-12reforms/standards.
[47] See https://www.ecs.org/50-state-comparison-states-school-accountability-systems/.
[48] Definition adopted in 2010, see https://www.education.ne.gov/nce/careerreadinessstandards/.

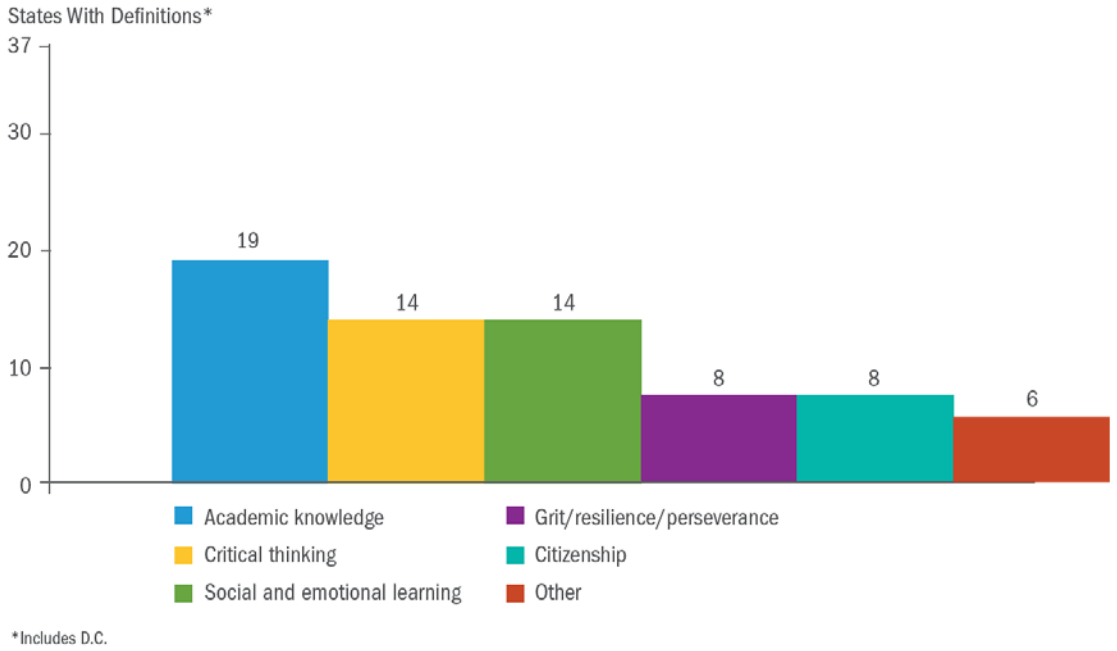


Figure 2. Components of state definitions of "College and Career Ready"

Typical Measures of Readiness

While states are exploring expanded definitions of readiness, their federal peer review submissions indicate that, for the most part, academic or college readiness is the aspect that is measured. Academic readiness is typically measured by traditional assessments, and work or career readiness is considered either synonymous or is described as a set of traits or characteristics that extends beyond academic readiness. States assume academic readiness is a necessary component of preparation for both college and career. Most states do not include measures of non-academic readiness in their accountability systems.[49]

1. State Accountability Tests

State are required under ESSA to test students in grades 3-8 and high school in ELA and mathematics. Some statewide assessments are administered on computers while others are administered via paper and pencil. These assessments are typically a mix of multiple-choice and short constructed response (students provide a brief written response) items. Some state tests also include multiple-select items (which are selected response items with potentially more than one correct answer), essay or extended constructed response items (longer writing pieces), or technology enhanced items (TEIs). TEIs must be computer administered and may include matching, drag-and-drop, ordering, or other tasks that are more readily performed in the computer administered environment.

[49] See https://www2.ed.gov/admins/lead/account/stateplan17/statesubmission.html, for a full description of states' peer review submissions.

Most statewide summative assessments are based on the Common Core State Standards for (CCSS) ELA and mathematics. The figure below, from the Association for Supervision and Curriculum Development (ASCD),[50] shows the state level adoption of the CCSS as of 2018. States highlighted in green are adopters, Minnesota, (highlighted in blue) adopted the ELA but not mathematics standards. States highlighted in gray did not adopt the CCSS. This graphic shows there is more agreement among states than not regarding what academic content students should learn in school, at least for ELA and mathematics.

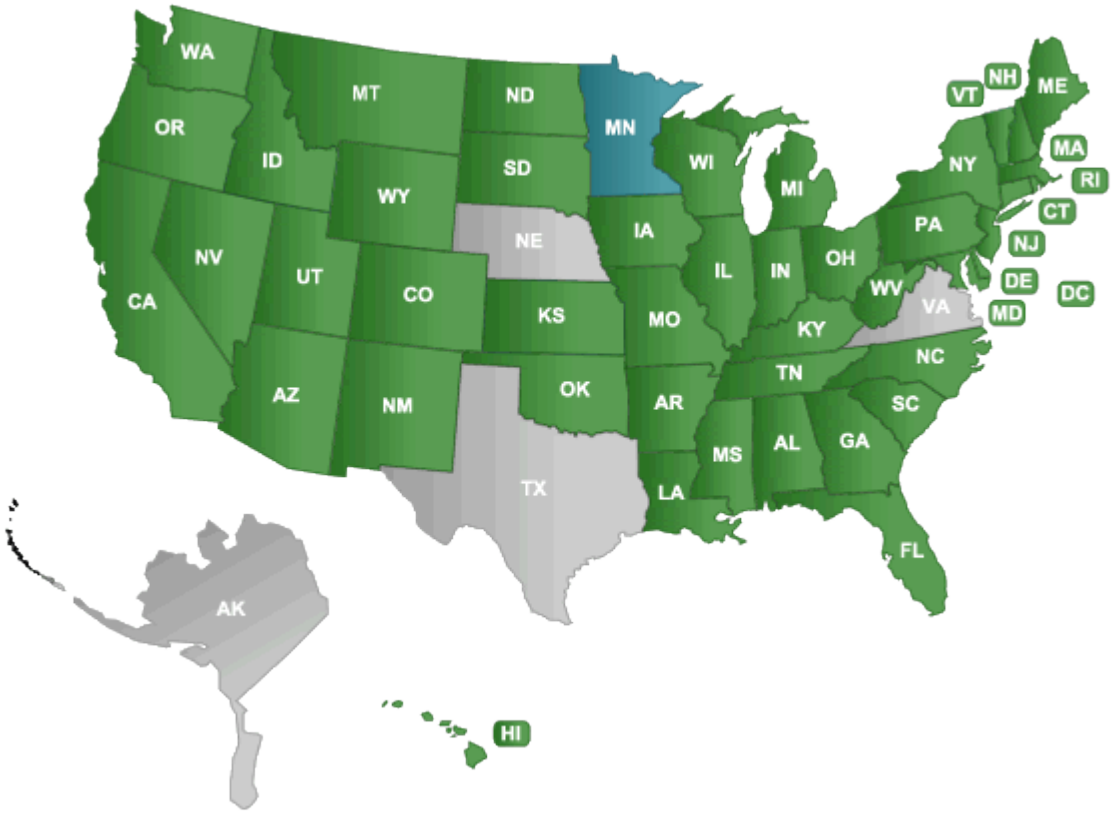


Figure 3. CCSS adoption, by state.

In addition to largely agreeing on tested content, states have been steadily moving toward asking students to perform more complex and challenging tasks on summative tests. The testing consortia, Smarter Balanced Assessment Consortium and the Partnership for Assessment of Readiness for College and Career (PARCC), require a great deal of strategic thinking (critical thinking, reasoning, and developing a plan) and even extended thinking (thinking to investigate a problem and synthesize information) in a substantial portion of their assessment items. Figure 4 compiles information on the level of complexity among several summative state tests (Porter, 2018). This research was compiled from studies conducted by HumRRO (Schultz, Wiley, Michaels, & Dvorak, 2016), the Thomas B. Fordham Institute (Doorey & Polikoff, 2016) and Rand (Faxon-Mills, Hamilton, Rudnick, & Stecher, 2014).

[50] See http://www.ascd.org/common-core-state-standards/common-core-state-standards-adoption-map.aspx

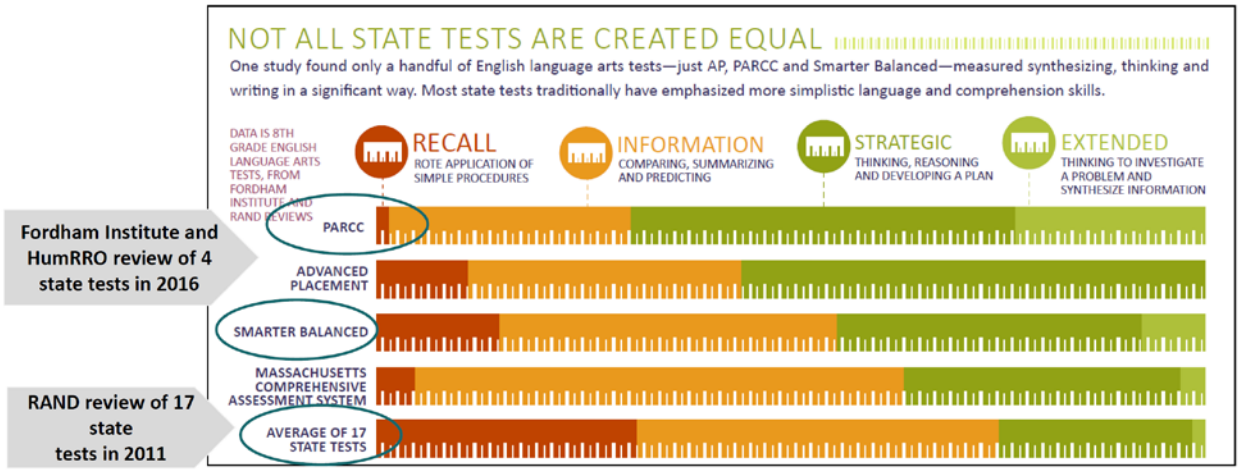


Figure 4. Cognitive complexity of state assessments.

States have adopted challenging content standards and state assessments have become increasingly more complex. However, comparability of students' scores across states remains challenging. Unless states use a common assessment with common proficiency definitions (such as those states in consortia), students' proficiency may depend on the state where they were tested. To address comparability, states participate in reading and mathematics testing on the National Assessment of Educational progress (NAEP).[51] NAEP is a complex suite of assessments based on rigorous academic frameworks documents. NAEP tests do not report individual student scores, but report at the state level based on samples of students. The National Center for Education Statistics (NCES) produces maps between state and NAEP proficiency standards, allowing states to compare the rigor of their standards using a common assessment.[52] States often reference the NAEP Mathematics and Reading Frameworks and the NAEP proficiency standards when they design their own assessments.

2. High School GPA

Student academic performance is also tracked by grade point average (GPA), a simple transformation of the letter grades they receive for their courses. GPA is not typically tracked at the state level as part of accountability, but grades are commonly used as an indicator of college readiness and GPA is a required component on most college applications. Some states, notably Kentucky, use grades to determine supplemental funding provided to help students pay for college. The Kentucky Educational Excellence Scholarship (KEES) program rewards students who graduate with at least a 2.5 GPA, and the amount of money provided to students goes up if their GPA is higher.[53]

The measure of GPA includes more than academic knowledge (Farrington, Roderick, Allensworth, Nagaoka, Keyes, Johnson, & Beechum, 2012). The requirements for achieving strong grades in classes also incorporates perseverance, compliance, and time management. Depending on the nature of their classes, students may also need to demonstrate their ability to

[51] See https://nces.ed.gov/nationsreportcard/.
[52] See https://nces.ed.gov/nationsreportcard/studies/statemapping/#.
[53] See https://www.kheaa.com/website/kheaa/kees?main=1. Students can increase their KEES scholarships with high test scores as well (e.g. ACT, Advanced Placement, International Baccalaureate, Cambridge Advanced International).

collaborate with others, communicate their ideas, and even to construct products. Grades are more far-reaching than summative tests. However, grades are not standardized from teacher to teacher, school to school, or district to district, and they are not typically used by states in their accountability computations.

3. Course Requirements/Completion

States require that all students complete a certain number of courses in specific subjects prior to graduation. These required courses include ELA, mathematics, science, and social studies; however, they may also include arts, health, physical education, foreign language, or others. The Education Commission of the States (ECS) maintains a website that details all states course requirements for graduation.[54] In addition to state requirements, districts may add their own requirements for earning a high school diploma.

4. End-of-Course Assessments

States may use either summative tests for high school students administered in particular grades, or they may tie testing to the completion of courses, or both. When states choose to use end-of-course (EOC) exams, they are most often tied to English 10 or 11, and to either Algebra 1 or Algebra 2 courses. For example, PARCC created assessments for multiple English and mathematics courses for states, including subject-specific mathematics courses like Algebra and Geometry, as well as Integrated Mathematics. These types of tests limit the amount of content to be assessed to that addressed by a single course (as opposed to the full range of high school standards), but they assume all courses with a common name cover essentially the same content. States may require or encourage schools to use the assessment scores as part of student's grades, or as a course completion requirement. EOC assessments may be used for state accountability computations.

Even states who use EOC exams vary greatly on the number of EOC exams offered, the courses for which they are offered, and whether EOC exams are used for accountability. For example, a state may use an Algebra 2 EOC exam for high school accountability, but offer an Algebra 1 EOC exam that is not used. For states with science accountability in place for high school, this is further complicated by course taking patterns (science courses do not follow a particular sequence and students may not take certain science courses). Some states provide EOC exams for Biology for accountability, and require that all students take a biology course, while others require a more general science exam administered at a particular grade level. Others require the Biology EOC exam, but supplement it with other science content to address physical and earth/space sciences.

5. Graduation Exit Exams

The following thirteen states used high school graduation (or exit) exams as of 2017; Florida, Indiana, Louisiana, Maryland, Massachusetts, Mississippi, New Jersey, New Mexico, New York, Ohio, Texas, Virginia, and Washington[55]. Exit exams require that students demonstrate some minimum level of academic competency, typically in ELA and mathematics, as a condition of graduating. Students who do not pass the exams do not receive a high school diploma. While not specifically designed to indicate college or career readiness, high school exit exams help certify to employers that graduates can be expected to have a minimum level of competency in

[54] See www.ecs.org
[55] See https://www.fairtest.org/graduation-test-update-states-recently-eliminated

the tested subjects. These types of exams are controversial for several reasons, including the argument that they may reduce graduation rates and increase dropout rates, and they may test content that is commonly found in middle school standards rather than in high school. Exit exams tend to focus on literacy and numeracy, rather than the more complex high school standards. The literature is mixed on these topics and too extensive to adequately review here. Arkansas, Arizona, Georgia, Idaho, Minnesota, Oklahoma, Rhode Island, and South Carolina had graduation exams, but they recently terminated the requirement for high school graduation. California, Nevada, and Pennsylvania currently have a moratorium on graduation tests.

6. College Entrance Exams

College entrance exams are another commonly used type of assessment of readiness for specific courses in colleges or universities. Common examples of entrance exams include College Board's Accuplacer[56] assessments, ACT's Engage[57] assessments (ACT previously promoted a placement test called Compass), and a multitude of college- and university-created placement tests. While not typically used statewide, these assessments provide indications for higher education of the likelihood that students will successfully complete specific courses. Results from these assessments may be used to place students into non-credit remedial courses at a college or university.

In the early years of its reporting as part of state accountability systems, college entrance exams were frequently used as an indicator of college and career readiness. For example, the Southern Regional Education Board (SREB) presented changes in average SAT composite scores as an indication of trends in college and career readiness (SREB, 2012). As the concept of readiness for college and career has become better articulated, it is clear college entrance exams may not be the most appropriate tool for measuring career readiness.

The ACT and SAT programs are very clear about their intended purposes. The ACT is designed to measure "academic readiness for college."[58] Similarly, the SAT measures what students "need to succeed in college."[59]

Approximately half of states' accountability systems incorporate college entrance exams as an indicator of college and career readiness. Typically, student performance (e.g., meeting established benchmarks) is measured, but in a small number of states only rates of participation in these exams is reported. In no states are college entrance exams the sole indicator of college and career preparedness. Typically, these scores are reported along with several other indicators, such as performance in advanced coursework (e.g., AP or IB classes), as well as performance on WorkKeys®,[60] earning credentials or certifications, and/or performance in career and technical education classes (American Institutes for Research, 2018).

College entrance exams have the benefit of large, well-established bodies of validity evidence, and as such may be viewed as a cost-effective resource for measuring postsecondary preparedness. However, one potential concern is the extent to which the content knowledge and skills measured by these exams aligns with the content standards adopted in accordance with state law. Most states have adopted standards that are closely related to the CCSS. ACT

[56] See https://accuplacer.collegeboard.org/
[57] See http://www.act.org/content/act/en/products-and-services/act-engage-college.html
[58] See https://www.act.org/content/act/en/products-and-services/the-act.html.
[59] See https://collegereadiness.collegeboard.org/sat/inside-the-test.
[60] See http://www.act.org/content/act/en/products-and-services/workkeys-for-educators.html.

(2010) conducted an evaluation of the alignment between its College Readiness Standards and the CCSS and found substantial levels of alignment in terms of reading and mathematics, with weaker alignment in writing. Similarly, the College Board found strong alignment between the SAT and common core anchor standards in reading, writing, language, and mathematics (Vasavada, Carman, Hart, & Luisier, 2010). However, a recent study by Assessment Solutions Group found it would not be appropriate to allow school districts in Florida to opt to use the ACT or SAT in lieu of its state assessment (Roeber, Olson, & Topol, 2018). Currently, 25 states require all high school students to take the ACT or SAT, and 12 states use the ACT or SAT for accountability.[61]

College entrance exams such as ACT and SAT identify cut scores, or benchmarks, to assist in defining and evaluating student progress toward, and achievement of, adequate levels of college preparedness. States may be required by law to identify benchmarks specific to their own state. For example, the Wisconsin Department of Public Instruction convened panels of educators and other stakeholders to evaluate ACT benchmarks and determine the appropriateness of identifying state-specific benchmarks (Wisconsin Department of Public Instruction, 2015).

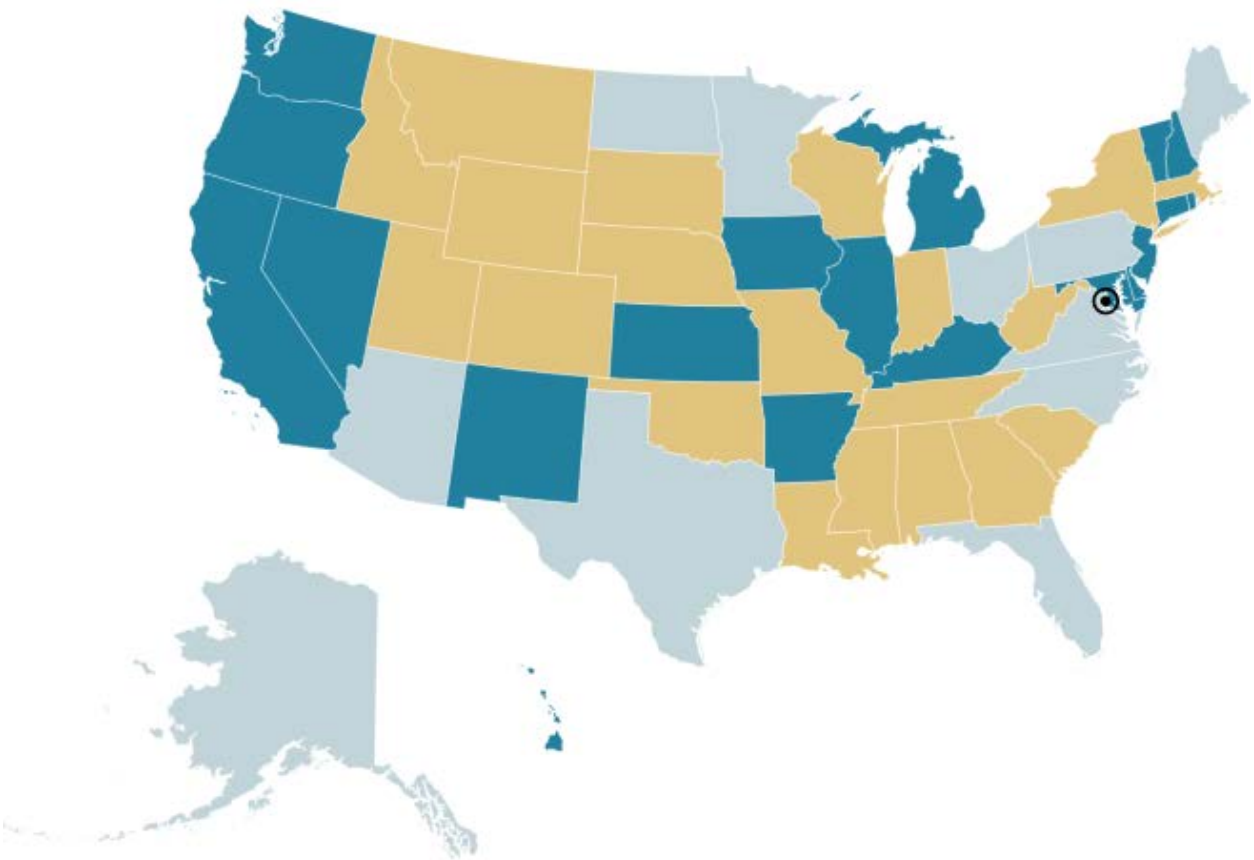
Academic Readiness Measures Beyond ELA and Mathematics Achievement

Academic preparation for college and career involves more than preparation in ELA and mathematics. High school students take at least 20 courses in grades 9–12, and only eight of those courses are typically required to be English or mathematics courses.[62] Students also take courses in science and social studies. They may take classes in the arts, technical courses, foreign language courses, and others. The NCLB and ESSA helped create a focus on English and mathematics, but now states have largely adopted the Next Generation Science Standards (or similar state-specific, three-dimensional science standards) and many have also adopted social studies standards . Many states have begun to test these subjects as part of their accountability systems.

1. Science Assessments

Nearly two-thirds of U.S. students live in states that have education standards influenced by the *Framework for K–12 Science Education*[63] and/or the *Next Generation Science Standards (NGSS)*[64]*.* Figure 5 shows these states in blue and yellow (blue states have adopted NGSS, yellow adopted their own standards based on National Research Council [NRC] frameworks). Both documents promote a more complex phenomenon-based view of science and stress students' capacity to use their science knowledge in unfamiliar contexts. They address science and engineering principles, cross-cutting concepts, and content knowledge and expect those ideas to intersect for students through rich science instruction.

[61] For a complete list of states requiring ACT or SAT see https://www.edweek.org/ew/section/multimedia/what-tests-does-each-state-require.html.
[62] See www.ecs.org
[63] See https://www.nap.edu/read/13165/chapter/1.
[64] See https://www.nextgenscience.org/.



Nineteen states and the District of Columbia (representing over 36% of U.S. students) have adopted the Next Generation Science Standards (NGSS). *The 19 states are Arkansas, California, Connecticut, Delaware, Hawaii, Illinois, Iowa, Kansas, Kentucky, Maryland, Michigan, Nevada, New Hampshire, New Jersey, New Mexico, Oregon, Rhode Island, Vermont and Washington.*

Twenty states (representing 29% of U.S. students) have developed their own standards based on recommendations in the NRC Framework for K-12 Science Education. *The 20 states are Alabama, Colorado, Georgia, Idaho, Indiana, Louisiana, Massachusetts, Mississippi, Missouri, Montana, Nebraska, New York, Oklahoma, South Carolina, South Dakota, Tennessee, Utah, West Virginia, Wisconsin, and Wyoming.*

Figure 5. State science standards summary.

Most states test science once in elementary school (usually at grade 4 or 5), once in middle school (usually in grade 7 or 8), and once in high school (usually in grade 11 or as an end-of-course biology assessment). Science assessments are only now catching up to the adopted science standards. Some states (e.g., Kentucky) have implemented highly complex phenomenon-based assessments for science (similar to scenario-based tasks used in NAEP). These assessments are similar to passage-based ELA assessments, where students are given a passage to read and then answer questions requiring them to interpret or interact with the passage. In science, students would be given a thorough description of some scientific phenomenon, which may include experimental results, data tables, graphs or charts, or other information referencing the problem the students are expected to help solve. Students demonstrate their understanding of science content by interacting with the phenomenon. Phenomenon-based assessments can take longer to develop, may be more expensive than more traditional tests, and may take longer for students to complete. States are struggling with

the structure of science assessments, how to ensure alignment to complex three-dimensional standards, and how best to report science scores for students, as well as for schools.

2. Social Studies Assessments

Historically, states have not adopted common social studies standards or tests of social studies. While there is a growing trend for states to adopt social studies standards (see above), assessments of social studies remain less common than ELA, mathematics, or science. Social studies assessments, when administered, are typically given at the same grade levels as science. The content of state-wide social studies tests is based on standards that vary considerably from state to state. Some states use EOC assessments of US History in high school, while others test social studies more broadly at specific grade levels.

The National Council for Social Studies (NCSS) has published social studies standards, but they have not been widely adopted by states or included as the basis for assessments in state accountability systems. The NCSS has identified five disciplines of social studies: history, geography, civics and government, economics, and psychology. Those disciplines address ten themes of social studies, including:

- Culture
- Time, continuity, and change
- People, places, and environments
- Individual development and identity
- Individuals, groups, and institutions
- Power, authority, and governance
- Production, distribution, and consumption
- Science, technology, and society
- Global connections
- Civic ideals and practices

Career or Work Readiness

There is growing acceptance of the notion that readiness for college and readiness for career are distinct but overlapping constructs. Patelis (2018) notes there are sets of skills at the intersection of career and college preparedness. Similarly, ACT has developed an integrated framework that defines the core academic skills for readiness from kindergarten through one's career.[65] The common thread here is that there are key academic components that are common to postsecondary readiness in general, whether a student opts to continue learning in a postsecondary educational setting or in a more applied, workplace-based setting.

[65] See http://www.act.org/content/act/en/college-and-career-readiness.html.

Career preparedness includes three major skills needed to perform work: (a) core academic skills; (b) employability skills; and (c) technical, job-specific skills (ACTE, 2010). *Academic skills* include foundational academic knowledge in mathematics, ELA, and science or technology, including the application of these skills, which were described in the prior section of this memo. *Employability skills* are skills that are critical to workplace success and include critical thinking, adaptability, problem solving, oral and written communication, collaboration and teamwork, creativity, responsibility, professionalism, ethics, and technology use. *Technical skills* represent job-specific knowledge and skills needed to enter a career.

Next, some indicators of career readiness that are being used or being considered by states and districts are presented. Because many states are currently exploring career readiness indicators, due at least in part to expanded flexibility in ESSA for using such measures, there is not clear documentation currently available on which districts within which states are using these indicators.

1. Assessments of Career or Work Readiness

The Center on Education Policy (2013) found via survey that 36 of 46 participating states assessed students on academic skills related to career readiness. Smaller numbers reported assessing students on technical skills (33 states) and employability skills (28 states). They found the tests most commonly used to assess employability skills and/or applied academic skills were the Armed Services Vocational Aptitude Battery (ASVAB) and WorkKeys® assessments. The ASVAB tests are designed to measure verbal, mathematics, science and technical, and spatial domains. WorkKeys® "measure foundational skills required for success in the workplace" via several assessments including applied mathematics, graphic literacy, workplace documents, applied technology, and business writing, among others.[66]

A smaller number of states reported administering the National Occupational Competency Testing Institute (NOCTI) assessments. NOCTI offers a Workplace Readiness assessment to assess employability skills at the high school level, as well as tests of employability skills that are targeted toward middle school students.[67] Currently, 11 states use NOCTI in some capacity, but their use of the assessments is varied. Some require full census testing in high school, while others make the NOCTI assessments available for school or district use.

In fall 2017, the Center for Educational Testing and Evaluation (CETE) conducted its first operational administration of the Career Pathways Assessment System (cPass® assessments), which are designed to measure "both the knowledge and skills needed for specific career pathways."[68] In addition to a general Career and Technical Education (CTE) assessment, cPass® offers assessments of Comprehensive Agriculture; Power, Structural, and Technical Systems; Animal Systems; Plant Systems; Horticulture; Manufacturing Production; Comprehensive Business; Finance; Accounting; and Drafting. Currently, Kansas and Colorado are members of the collaborative that oversees administration of the cPass®.

Still other states have developed their own career readiness assessments. For example, Kentucky developed the Kentucky Occupational Skills Standards Assessment (KOSSA), which

[66] See https://www.act.org/content/act/en/products-and-services/workkeys-for-employers/assessments.html.
[67] See http://nocti.org/BlueprintCategoryLinks.cfm?category=Employability%20Skills.
[68] See https://careerpathways.us/.

assesses a combination of academic, employability, and occupational skills specific to each of more than 30 career pathways.[69]

2. Industry Certifications

Achieve, Inc. found substantial variability of states' approaches to incorporating industry certification into educational policy and processes (Muller & Beatty, 2009). Some states guide students along a CTE pathway, ensuring they complete the course requirements that will best prepare them for achieving certification within their preferred industry. Other states allow districts to develop approaches that meet their specific needs. Among the more innovative programs are the tiered diploma system developed in Florida that offers a credential-based graduation option and the "Core 40 with technical honors" diploma offered in Indiana.

3. Descriptors of Traits or Characteristics

While not written into statute or as part of the accountability computations, some states have published traits or characteristics of college and career ready students that go beyond academic expectations. These traits or characteristics may include citizenship, financial responsibility, goal setting, problem solving, and reasoning, among others. For example, in 2013, Michigan produced a list of *Characteristics of Career and College Ready Students*. Michigan's source documents include the Michigan Literary Standards, National Research Council (NRC) Science and Engineering Practices, Michigan Social Studies Grade Level Content Expectations (GLCE) and High School Content Expectations (HSCE), Michigan Mathematics Practices, Michigan Visual, Performing and Applied Arts (VAPAA) Guidelines, and Career and Technical Education (CTE) Career Ready Practices. Under each source document, Michigan then lists the specific characteristics gathered from each source, grouped into four main headings (a) Technology and Tools, (b) Argument and Reasoning, (c) Communication and Collaboration, and (d) Problem Solving.[70] Other states have addressed attributes of readiness in similar ways (e.g., Kentucky, Nebraska). According to ED, six states plan to use an art access/participation, or well-rounded education measure, in their accountability systems.[71] States' plans tend to focus on the school level, measuring access or participation rates, rather than on individual student's preparedness.

4. Social and Emotional Skills Assessment

Social and emotional skills assessment is a relatively new field for estimating students' academic preparedness. The ACT Tessera[72] is focused on the holistic growth of the "whole child." It measures students' social and emotional learning skills and provides data to help schools support goal setting and promote continuous improvement. ACT Tessera includes indicators of grit, teamwork, resilience, curiosity, leadership, and school climate. It uses a combination of self-report and forced choice and situational judgment test items to ensure accurate reporting and minimize student "faking." Reports are provided at the student and school levels, and both students and schools receive recommended resources and strategies to address areas requiring increased focus.

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[69] See https://education.ky.gov/CTE/kossa/Pages/default.aspx

[70] Downloaded July 3, 2018 from https://www.michigan.gov/documents/mde/Characteristics_of_Career__College_Ready_Students_v4.11.13_417952_7.pdf

[71] See https://www.ecs.org/50-state-comparison-states-school-accountability-systems/

[72] See https://pages2.act.org/Tessera-Brochure-Learn-More.html#_ga=2.261599630.22546774.1532353457-1600368859.1524168013

5. Service Learning/Applied Experience

Service learning, for which students engage in projects or activities to improve their communities or address social problems where they can apply their learning, is increasingly reported as a requirement for high school graduation. To date, only Maryland and Washington D.C. have statewide service learning requirements; however, 19 other states allow districts to require service learning as a graduation requirement. A full description of service learning requirements for graduation by state can be found at the Education Commission for the States website (http://ecs.force.com/mbdata/mbquest3RTE?Rep=SL1301).

6. Interest or Suitability Inventories (Career Exploration)

Although they do not require interest or suitability inventories for career exploration, many states indicate these tools are available and they may provide links to them for interested students. Their use may also be promoted at the district or school levels. Some of these tools provide information at the classroom or school level, but the information provided varies greatly from one tool to the next. In addition, many colleges and universities encourage students to complete interest inventories or surveys prior to applying for admission or choosing a major. They may promote this activity through interaction with high school guidance officers or others with access to high school students nearing graduation.

When available, survey results are used to help students explore the fit between their interests or traits and potential future jobs or college major fields of study. These types of surveys have been used for a long time and there are a wide variety currently available to students. Some of the oldest are based on personality traits, with the personality traits matched to specific careers or job categories. Examples include the Myers-Briggs Type Indicator (MBTI) (Myers & McCaulley, 1985), Keirsey Temperament Sorter (1998), and Strong Interest Inventory (Donnay, 1997). These indicators of traits and their relation to jobs have been used for more than 50 years, with the Strong Interest Inventory used since 1927. The Five Factor Model (FFM) of personality traits is more commonly used today in business and industry, and it has been linked to academic performance indicated by grade-point-average (GPA) in high school and college (Poropat, 2009). These types of inventories assume the traits or interests are not (or are very minimally) mutable. They focus on using information about the students to match them with careers or job families that are best suited to their specific characteristics.

Below are some specific interest inventories/platforms that are currently in use.

6a. ASVAB Career Exploration Program (CEP)

A comprehensive career planning program, the ASVAB Career Exploration Program (CEP) is the only career planning resource available to high schools nationwide that offers high school students the opportunity to explore all paths to career satisfaction—education, work, training, military, and/or certification—because the ASVAB CEP assesses academic ability and career interests.[73] The ASVAB CEP first helps students identify skill strengths based on their ASVAB multiple-aptitude skills test results and then links those skill strengths with an interest inventory that highlights work-related interest areas where students are most likely to succeed. ASVAB's *Find Your Interests Inventory* is based on Holland's occupational codes: Realistic, Investigative, Artistic, Social, Enterprising, and Conventional (RIASEC).[74] The Holland Codes refer to a theory of career choice based on personality type. Finally, students access a catalog of careers with

[73] See https://www.asvabprogram.com/
[74] See https://www.hollandcodes.com/

relevant occupational data and a full suite of future-oriented planning tools that help them develop an action plan to share with parents and educators.

Equipped with an understanding of their skills and interests, students can explore careers that coincide with their skill-interest profile and their aptitudes. Participation is voluntary. Students in grades 10–12 and college are encouraged to use the ASVAB CEP to identify their skill strengths and explore potential careers that require those skills.

Students gain access to career exploration tools after they receive their scores. Then, they can independently explore any careers that interest them, including those found in the military. The Department of Defense (DoD) sponsors ASVAB CEP with a two-part mission: to provide a career exploration service to U.S. youth and to provide qualified leads to military recruiters. Participants have no obligation to military service, but 11th–12th grade students who choose can use their scores to explore enlistment. ASVAB CEP is provided to students at no cost. Currently, 12 states use military testing or enlistment as an indicator for accountability in their ESSA plans. Kentucky, for example, provides students multiple options for demonstrating postsecondary readiness, including a military readiness route that includes ASVAB and military enlistment.

6b. Career Cruising

Career Cruising's (https://public.careercruising.com/en/) online interface engages students in exploring their interests and aspirations through interactive games starting in K–2, followed by career activities and assessments in later grades. Career Cruising connects the real world to the classroom with current career and labor market information, salaries, and educational pathways. With this resource, students can explore skills like financial literacy and goal-setting through video interviews, role-playing activities, and more. Using Career Cruising for K–12, students discover how their strengths and interests align with careers that inspire them, and build the academic plan to get them there. Career Cruising helps students understand how the schoolwork they do today impacts the life they live beyond graduation.

Career Cruising for K–12 starts by engaging elementary-aged students through a light-hearted yet informative career education program. There are two interactive game experiences, one for grades K–2 and one for grades 3–5. Students are introduced to many careers through animated characters and solve career-related mysteries as they progress through a fictional town, learning as they go. The experience results in students being more informed about different careers and gaining a basic understanding of academic and career planning, which sets the stage for them to transition to the full Career Cruising program as they move to middle and high school.

Students begin with comprehensive assessments to reveal their own strengths and interests. Then, from the database of hundreds of careers, a select list of careers is presented to the student matching his/her strengths and interests based on his/her answers. Students explore those career possibilities through multiple pathways, including interviews, job descriptions, salary expectations by region, and more. A data library gives students access to college and technical school details, including applications, tuition, enrollment, and more. Students can see which courses will best prepare them for their desired path. Customized for specific graduation requirements, course planning means that students pick their classes in alignment with their career and postsecondary goals. Students can record their goals, save preferred jobs, and track college applications in a digital portfolio. Students make their choices by test-driving career options to see how choices they make might impact their future. Financial literacy lessons help them understand the importance of financial planning and role-playing activities help pull together everything they learn.

6c. Additional Career Interest Inventories and Planning Tools

There are several other career interest inventories and career planning tools on the market that can and are being used by schools. A few examples include Kuder,[75] Naviance,[76] World of Work Inventory,[77] and ACT Engage.[78] Increasingly, career interest exploration begins as early as kindergarten and is typically provided in an online environment (see World of Work and Career Cruising).

Conclusions

Most states have adopted a definition of college and career readiness and require schools to test students using measures of readiness as part of their statewide testing programs. Definitions of readiness are typically encompassing and do not differentiate between college and career, although there is commonly a focus on academic preparation for college. Typically, states measure ELA and mathematics achievement and use those scores as the main indicators of readiness.

When states do address career paths specifically, they typically rely on WorkKeys® or narrowly defined industry credentials. Other aspects of career or work readiness, when they are addressed at all, are measured using participation rates or information about access at the school level. There is very little information generated at the student level specific to career readiness in most states.

States are increasingly demonstrating that they value social and emotional learning, but there are no widely used large-scale measures of non-cognitive skills. According to a panel of state education leaders who met at the Council of Chief State School Officers' National Conference on Student Assessment in 2018, these skills are viewed as essential for both college and career. Skills in communicating, collaborating, creative problem solving (individually or on teams), among others, were listed as essential tools for success in a multitude of careers. The panel also indicated that these skills are very difficult to define and measure.

States are making progress towards addressing college and career readiness, but to date, their efforts have been narrow and focused on academic preparation for college, and primarily on ELA and mathematics. States tend to treat career readiness as synonymous with college readiness. When states include career readiness in their accountability systems, they tend to use narrow indicators, or they only address non-cognitive skills at the school level. The construct of readiness encompasses more than academics, and despite some progress by the states, none have fully addressed college and career readiness in their assessments and accountability systems, and information about students' readiness remains incomplete.

[75] See https://www.kuder.com/
[76] See https://www.naviance.com/
[77] See http://www.wowi.com/
[78] See http://www.act.org/content/act/en/products-and-services/act-engage-students-parents.html

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