National Assessment Governing Board

Ad Hoc Committee on Measures of Postsecondary Preparedness

Thursday, May 17, 2018

3:00 – 5:00 pm

Research Question #3: Measures of Preparedness—Measures for What?

AGENDA

3:00 – 3:15 pm	Welcome and Overview of Committee's Charge *Terry Mazany, Committee Chair* *Bill Bushaw, Executive Director*	Attachment A
3:15 – 3:45 pm	Reflections on the Higher Education Innovators Expert Panel Meeting *Terry Mazany*	Attachment B
3:45 – 4:30 pm	Discussion of the Measures of Preparedness *Terry Mazany*	Attachment C
4:30 – 5:00 pm	Discussion of Next Steps *Terry Mazany*	Attachment D
Informational Items: *Literature Review on Question 1: Work of the Future* *Final Report of Industry Expert Panel Meeting Notes*		*Attachment E*

At the March 2018 meeting of the Ad Hoc Committee on Measures of Postsecondary Preparedness, the Governing Board staff were asked to research what actions were taken by states as a result of NAEP's academic preparedness reporting. Executive Director Bill Bushaw agreed to explore this and noted that he expected limited findings on state behavior given the preparedness metric was reported at the national level only. He directed the Board's communications contractor, Hatcher Group, to conduct a media scan to answer this question. What follows is the summary of their results.

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The Hatcher Group conducted a media scan using Google News and Vocus, and a general Google search, to determine whether there is evidence that states are making decisions about students' readiness for college and careers based on NAEP's academic preparedness measure.

Media Results

We searched using Google News from 2013 to the present and Vocus from 2016 to the present. The search terms all included "state" or "states" and the following:

- NAEP and academic preparedness measure (one result)
- NAEP and Grade 12 and college ready
- NAEP and Grade 12 and college preparedness
- NAEP and Grade 12 and college and careers
- NAEP and Grade 12 and proficient and college

The one article found under "NAEP and academic preparedness measure" was a June 24, 2014, Commentary in *Education Week* by David Driscoll, then-chair of the Governing Board discussing the 2013 released of the NAEP measure of academic preparedness.

"In early May, NAEP released new information on academic preparedness as well as the 12th grade NAEP results on reading and mathematics. The numbers show that 2013 performance in both of these critical subjects was unchanged from the last assessment year of 2009—in other words, there was academic stagnation."

The other search terms, combined, turned up more than 1,000 articles. But we found no references to states using NAEP's academic preparedness measure to make decisions about their own policies.

The Grade 12 NAEP scores received significant general media coverage, particularly after the release of the 2015 results.

We found a general National Public Radio blog post, "Most High School Seniors Aren't College or Career Ready, Says 'Nation's Report Card' " from April 2016 on the 2015 NAEP results,

directly linking Grade 12 *Proficient* and college readiness. It quotes Governing Board member Andrew Ho. However, it doesn't address whether states are using this measure.

We found an *Atlanta Journal-Constitution* article, "Disappointing 12th grade scores on Nation's Report Card: Why aren't reforms working?" from April 2016 that links the Grade 12 scores and college readiness to the effectiveness of past reform policies in Georgia. The article quotes Terry Mazany, then chair of the Governing Board. However, it does not address whether Georgia has used the measure to enact any new policies.

This article from the website FiveThirtyEight, "What We're Missing In Measuring Who's Ready For College," questions the link between NAEP Grade 12 scores and college readiness. It presents different viewpoints about the best measures of college preparedness. The article does not address whether states are using this measure; it just discusses the validity of NAEP as a college preparedness measure.

One of the best overviews of the topic of how states are determining college preparedness was an Oct. 2, 2017, piece from *Education Week,* "A Guide to State ESSA Plans." The guide makes no mention of NAEP Grade 12 results. This section is a quick overview of the types of "readiness measures" in various state plans:

"At least 35 states are incorporating some kind of postsecondary-readiness measure, whether that's ACT scores, SAT scores, dual enrollment, Advanced Placement, career and technical education pathways, a mix of those factors, or something else. For instance, New York is looking at whether students enroll and pass advanced courses or earn college credit through dual enrollment. And Georgia is considering whether students earn credit through AP or International Baccalaureate courses, or a CTE certification."

Policy-Related Reports

We also did a general Google search (non-media) of various key terms linking Grade 12 NAEP Proficiency and college readiness. This search turned up several academic papers that mention NAEP in this context, but no discussion of state-level activity to connect college preparedness and Grade 12 NAEP scores.

An additional Google search using "NAEP academic preparedness measure and states" primarily returned links from NCES and the Governing Board itself.

The closest discussion of this issue was in a February 2017 report, "The College and Career Readiness of U.S. High School Graduates," from Achieve, a Washington-based organization concerned with students' academic preparation. Achieve does incorporate NAEP scores into its index for college and career readiness, but only state-level NAEP scores for students in grades 4 and 8.

We also looked for material from the Council of Chief School Officers, but a March 2017 report, "Destination Known: Valuing College AND Career Readiness in State Accountability Systems," makes no mention of NAEP.

Another report, Science & Engineering Indicators 2018 from the National Science Board, incorporates a discussion of Grade 12 NAEP scores in relation to the ACT:

"Other measures of college readiness support the ACT findings. National Association of Educational Progress (NAEP) college-ready indicators provide readiness estimates based on a nationally representative sample of students. The National Assessment Governing Board (NAGB), which sets policy for NAEP, began using NAEP in 2013 to estimate the percentage of grade 12 students who possess the knowledge and skills in reading and mathematics that would make them academically prepared for first-year college coursework. NAGB conducted a decade of research to determine the NAEP scores students need to earn to demonstrate college readiness. According to results from the 2015 NAEP, an estimated 37% of twelfth graders were prepared for college-level coursework in mathematics (Kena et al. 2016), a finding similar to that of ACT and one that is echoed in Achieve Inc.'s 50-state analysis of student performance on college readiness indicators. Achieve found that, even in the highest performing state, only 42% of students were ready for college-level work in mathematics (Achieve Inc. 2016)."

Finally, the Thomas B. Fordham Institute's *Flypaper* blog ran a post recently (Feb. 6, 2018) advocating for NAEP to begin regularly reporting state-by-state results at the twelfth-grade level. The post was authored by Chester E. Finn, Jr., Distinguished Senior Fellow and President Emeritus of the Thomas B. Fordham Institute. Finn writes:

"Now is the perfect time to resume reporting results for twelfth graders on a state-by-state basis and to do so on a regular cycle. … Reading, writing, and math are the obvious subjects to do this with, but how great it would be also to report twelfth grade state results in other core subjects, particularly science and history!"

At this point, it seems that NAEP is part of the discussion of college readiness, but only to the degree that it's linked to ACT scores or other more direct measures of readiness.

*****DISCUSSION DRAFT*****

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 part of meeting the charge of the *Ad Hoc* Committee on Measures of Postsecondary Preparedness, HumRRO organized and facilitated a meeting with a small number 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.

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.

*****DISCUSSION DRAFT*****

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.

- 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[1] 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 the services and support structure 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. Other students may start and stop their education multiple times and attend several different institutions before graduating.
- 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.
- Postsecondary institutions need to create pathways to develop agile employees who are open to lifelong learning.
- 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 information technology (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 qualifications for instructors and low standards for their graduates. Both of these factors could be a barrier to continued education.

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

- 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.
- 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. IT workers already face this with certifications in different technology and applications. Highly-regulated occupations will likely be the last ones to make changes.
- 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 the value of the program as students work toward their bachelor's degree.
    - Give students the ability to curate their work and educational experiences.
- 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.
- 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.

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.[2]
- 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.

[2] 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

- Four-year institutions look for grit or persistence as a necessary skill for student success. Students with a solid foundation and grit should be able to succeed, whereas students with a strong foundation and no grit may not be able to handle the rigor of college.
- Schools can provide learning and workplace skills.
    - 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 on subsequent courses increased and retention went up. 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.
- 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).
- Employers are looking for people who can work across left and right brains and are able to work with technology.
- Consider where or why skills are needed to build awareness of how skills fit into work.
- Students need to learn how to get "unstuck" when in a challenging situation.

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[3] to document achievements and portfolio.
- Need new types of student assessment.
    - Current ones focus too much on knowledge and not enough on skills, character, and meta learning.
    - Most current assessments are unassisted, working alone. Need assisted assessments or hands-on performance assessments.
- Create dashboards for parents and students to see skill attainment, including credentials.
- Leading-edge assessments use simulation and are more applied, with problem solving scenarios that assess whether you can use knowledge.
- 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.

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

    - 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.
    - 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 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. Several paradigm shifts: (a) knowledge/skill flip, (b) everything has a developmental progression except technology, (c) the nontraditional student of today is the traditional student of tomorrow, (d) students as 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. Role of NAEP: alignment of NAEP with Every Student Succeeds Act (ESSA) and its requirements, such as conditions of learning---we need to back-map this.

*****DISCUSSION DRAFT*****

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

*****DISCUSSION DRAFT*****

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

*****DISCUSSION DRAFT*****

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.

*****DISCUSSION DRAFT*****

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

*****DISCUSSION DRAFT*****

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.

*****DISCUSSION DRAFT*****

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.

*****DISCUSSION DRAFT*****

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.

May 17, 2018 — Discussion of Measures of Preparedness

To explore the Strategic Vision priority to "Develop new approaches to measure the complex skills required for transition to postsecondary education and career," (SV #10), the Ad Hoc Committee on Measures of Postsecondary Preparedness identified the following three research questions to guide its review of existing research and collection of expert testimony:

1. *Work of the Future – Readiness for what?*
2. *Requisite Skills for Future Work – Skills for what?*
3. *Measures of Preparedness – Measures for what?*

At their March 2018 meeting, the ad hoc committee expressed the view that students graduating in 2030 will continue to need content knowledge in addition to the interpersonal and intrapersonal skills that are now considered critical for any postsecondary path. At the May meeting, the committee will continue to discuss what cognitive and non-cognitive skills students need, which will provide the foundation for addressing the third research question.

Following the committee's discussion of the below topics, the Governing Board's contractor HumRRO will prepare a report for the committee that identifies metrics from NCES, NAEP, and other sources which tap the skills the committee recommends capturing. This research may also help identify where there are no existing metrics for skills that the committee considers essential.

1. *What subjects of knowledge are the most critical for postsecondary preparedness?*
   - Reading
   - Mathematics
   - Science
   - Writing
   - US History
   - Civics
   - Geography
   - Economics
   - Technology and Engineering Literacy
   - Arts
   - Foreign Language
   - Financial Literacy
   - Other?

2. *What interpersonal and intrapersonal skills are the most critical for postsecondary preparedness?*
   - Collaboration
   - Creativity
   - Communication
   - Problem-solving
   - Adaptability
   - Perseverance
   - Critical thinking
   - Intellectual openness
   - Conflict Resolution
   - Inquiry
   - Self-efficacy
   - Leadership
   - Social and Emotional
   - Other?

3. *Are there specific external data sources (beyond NAEP and NCES) that the Committee wants to include in its measure of postsecondary readiness (e.g. apprenticeships, workplace learning experiences, and industry recognized credentials)?*

Preparedness Strategy: Working Draft for the Ad Hoc Committee's Discussion on Next Steps

In August 2017 the National Assessment Governing Board commissioned the Ad Hoc Committee on Measures for Post-Secondary Preparedness to review existing research, collect expert testimony, and prepare recommendations for the Governing Board's consideration to achieve Strategic Vision priority #10, which is to "Develop new approaches to measure the complex skills required for transition to postsecondary education and career."

At the broadest level of policy, NAEP provides the platform to change the nation's valuation of what is important in student learning and create a paradigm shift in what matters and gets measured. The National Assessment Governing Board has the opportunity to determine whether or not there is a compelling national interest that warrants changes in NAEP to signal such a shift. To effect such a change below are five proposed options that the committee can consider recommending, either singularly, or in combination (note that prior to finalizing any recommendation the committee will need to consult with NCES and gather information to determine feasibility):

1. **Career Preparedness Assessment**: Develop a new state and TUDA-level framework and assessment for career preparedness knowledge and skills that could be offered at 8th and/or 12th grade (possibly replacing the current NAEP grade 12 assessments with a single assessment to report a postsecondary preparedness measure at the state level).

2. **Assessment Alignment with Career Preparedness Indicators**: Restructure existing cognitive assessments to report results more aligned with a preparedness construct that considers economic demands and the numerous postsecondary pathways for students in the assessments of what 12th graders should know and be able to do.

3. **Contextual Variables**: Within the context of existing assessments, develop and include contextual questions that better capture dimensions of preparedness and contribute to changing the national narrative on what is important in student achievement by increasing the focus on contextual variables in reporting NAEP results.

4. **Special Studies of Career Preparedness Systems**: Much like NAEP's transcript studies, conduct a special study of the provision of key policies and practices for career preparedness from a sample of schools, districts, and states (for example, partnering with New Skills for Youth to study the practices of the ten participating states).

5. **Other Data:** Serve as a vehicle to collect and report industry recognized credentials, workplace learning experiences, apprenticeships, etc. and broker data from various sources beyond NAEP to capture a wider range of achievement measures that are more reflective of, and customizable to, students' learning ecosystems and pathways.

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Work of the Future – 2030

Literature Review

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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		
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.

References

Andrew, P., Ip, J., & Worthington, J. (2014). *Fast forward 2030: The future of work and the workplace*. Los Angeles: CBRE.

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

Autor, D. H., Levy, F., & Murnane, R. J. (2003, November). The skill content of recent technological changes: An empirical exploration. *The Quarterly Journal of Economics*, *118*(4), 1279-1333. Retrieved from: economics.mit.edu/files/581

Bakhshi, H., Downing, J., Osborne, M., & Schneider, P. (2017). *The future of skills: Employment in 2030.* London: Pearson and Nesta. Retrieved from: https://www.nesta.uk/sites/default/files/the_future_of_skills_employment_in_2030_0.pdf

Basu, K. (2016) *Globalization of labor markets and the growth prospects of nations* (Policy Research Working Paper 7590). Washington, DC: World Bank.

Bernstein, A. (2016, October). Globalization, robots, and the future of work: An interview with Jeffrey Joerres. *Harvard Business Review*, 74-79.

Blinder, A. S. (2007). *How many US jobs might be offshorable?* (CEPS Working Paper No. 142). Princeton, NJ: Princeton University.

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.

Brynjolfsson, E., & McAfee, A. (2011). *Race against the machine*. Lexington, MA: Digital Frontier Press.

Brynjolfsson, E., & McAfee, A. (2016). *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*. New York, NY: W.W. Norton & Company, Inc.

Bughin, J., Hazan, E., Ramaswamy, S., Chui, M., Allas, T., Dahlstrom, P.,…Trench, M. (2017, June). *Artificial intelligence: The next digital frontier?* Discussion Paper. McKinsey Global Institute. Retrieved from: https://www.mckinsey.com/~/media/McKinsey/Industries/Advanced%20Electronics/Our%20Insights/How%20artificial%20intelligence%20can%20deliver%20real%20value%20to%20companies/MGI-Artificial-Intelligence-Discussion-paper.ashx

Bureau of Labor Statistics. (2017, May 18). *Foreign-born workers: Labor force characteristics – 2016* [News release]. Retrieved from: https://www.bls.gov/news.release/forbrn.nr0.htm/Labor-Force-Characteristics-of-Foreign-Born-Workers-Summary

Burke, R. J., & Ng, E. (2006). The changing nature of work and organizations: Implications for human resource management. *Human Resource Management Review*, *16*, 86–94.

Choi, J. (2017, July 17). *The future of jobs and the fourth industrial revolution: Business as usual for unusual business*. Retrieved from: https://blogs.worldbank.org/psd/future-jobs-and-fourth-industrial-revolution-business-usual-unusual-business

Colbert, A., Yee, N., & George, G. (2016, June). The digital workforce and the workplace of the future. *Academy of Management Journal*, *59*(3), 731-739. doi: 10.5465/amj.2016.4003

Colby, S. L., & Ortman, J. M. (2015). *Projections of the size and composition of the U.S. population: 2014 to 2060*. United States Census Bureau. Retrieved from https://census.gov/content/dam/Census/library/publications/2015/demo/p25-1143.pdf

Frey, C. B., & Osborne, M. A. (2013, September 17). *The future of employment: How susceptible are jobs to computerisation*? Oxford, England: University of Oxford. Retrieved from: https://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

Giang, V. (2015, January 12). What will work look like in 2030? *Fast Company*. Retrieved from: https://www.fastcompany.com/3040701/2hat-will-work-look-like-in-2030

Gordon, A. (2011, January-February). Careers inspired by nanotech trends. *The Futurist*, 30-33.

Green, S. (2014). Building the agile workforce. *Harvard Business Review*. Retrieved from https://hbr.org/2014/01/building-the-agile-workforce

Greenstone, M., & Looney, A. (2013, August 2). *What new immigrants could mean for American wages*. Brookings. Retrieved from https://www.brookings.edu/blog/jobs/2013/08/02/what-new-immigrants-could-mean-for-american-wages/

Guardian. (2017). *Top 4 trends impacting the workforce in 2018 and beyond*. Retrieved from: https://www.guardiananytime.com/gafd/wps/wcm/connect/08172300-0fde-4add-a200-d6507e8f3670/4-Trends-Impacting-the-Workforce-in-2018.pdf?MOD=AJPERES&CVID=lZPOL44

Hamilton, J. (2012). I*s a sustainability career on your green horizon?* U.S. Bureau of Labor Statistics. Retrieved from https://www.bls.gov/green/sustainability/sustainability.pdf

Hatzichronoglou, T. (2005). *The impact of offshoring on employment: measurement issues and implications*. Paris, Washington, DC: OECD.

Hayasaki, E. (2017). Is AI sexist? *Foreign Policy.* Retrieved from http://foreignpolicy.com/2017/01/16/women-vs-the-machine/

Heerwagen, J. (2016, October 5). The changing nature of organizations, work, and the workplace. *Whole Building Design Guide.* Retrieved from https://www.wbdg.org/resources/changing-nature-organizations-work-and-workplace

Hintze, A. (2016, November 13). Understanding the four types of AI, from reactive robots to self-aware beings. *The Conversation.* Retrieved from: https://theconversation.com/understanding-the-four-types-of-ai-from-reactive-robots-to-self-aware-beings-67616

Hoban, B. (2017, August 24). *Do immigrants "steal" jobs from American workers?* Brookings. Retrieved from https://www.brookings.edu/blog/brookings-now/2017/08/24/do-immigrants-steal-jobs-from-american-workers/

Houser, K. (October 19, 2017). Is technology really going to destroy more jobs than ever before? *Futurism.*

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

Joint Economic Committee Democrats. (2018, January 11). *Expanding opportunities through middle skills education.* Retrieved from https://www.jec.senate.gov/public/_cache/files/25915db9-709b-4b09-87f5-768cc6fe8206/middle-skills-pathways.pdf

Karoly, L. A., & Panis, C. W. A. (2004). *The 21st century at work: Forces shaping the future workforce and workplace in the United States*. CA: Rand Corporation. Retrieved from https://www.rand.org/pubs/monographs/MG164.html

Kobes, D. (2013, November). Making on-the-job training work: Lessons from the Boeing Manufacturing On-the-Job Training Project. *Jobs for the Future.* Retrieved from http://www.jff.org/publications/making-job-training-work-lessons-boeing-manufacturing-job-training-project

KRC Research. (2014). *The Prepared U Project: An in-depth look at millennial preparedness for today's workforce.* Retrieved from https://www.bentley.edu/files/prepared/1.29.2013_BentleyU_Whitepaper_Shareable.pdf

Kumar, A., Bezawada, R., Rishika, R., Janakiraman, R., & Kannan, P. K. (2016). From social to sale: The effects of firm-generated content in social media on customer behavior. *Journal of Marketing, 80*, 7–25.

Lamberton, C. P., & Rose, R. L. (2012). When is ours better than mine? A framework for understanding and altering participation in commercial sharing systems. *Journal of Marketing, 76*, 109–125.

Lerman, R. I., & Schmidt, S. R. (1999). *An overview of economic, social, and demographic trends affecting the U.S. labor market.* Retrieved from https://www.dol.gov/dol/aboutdol/history/herman/reports/futurework/conference/trends/trends.pdf

Lim, D. (2016) *The work that can't be offshored or automated.* Committee for Economic Development. Retrieved from: https://www.ced.org/blog/entry/the-work-that-cant-be-offshored-or-automated

Lyons, M., Blitz, M., & Whittall, N. (2017). *Shaping the agile workforce. Accenture Strategy Report*. Retrieved from https://www.accenture.com/us-en/insight-shaping-agile-workforce

Lyons, S. T., Schweitzer, L., & Ng, E. S. W. (2015). How have careers changed? An investigation of changing career patterns across four generations. *Journal of Managerial Psychology, 30*(1), 8-21. Retrieved from: https://doi.org/10.1108/JMP-07-2014-0210

Magill, B. (2017, April 8). Americans used a lot less coal in 2016. *Scientific American.* Retrieved from https://www.scientificamerican.com/article/americans-used-a-lot-less-coal-in-2016/

Manyika, J. (2017a, May). *Technology, jobs, and the future of work* (Executive Briefing). McKinsey Global Institute. Retrieved from: https://www.mckinsey.com/global-themes/employment-and-growth/technology-jobs-and-the-future-of-work

Manyika, J. (2017b, December). *What is the Future of Work?* (Podcast). McKinsey Global Institute. Retrieved from: https://www.mckinsey.com/global-themes/future-of-organizations-and-work/what-is-the-future-of-work

McKinsey & Company. (2017). *The digital future of work: What skills will be needed?* Retrieved from: https://www.mckinsey.com/global-themes/future-of-organizations-and-work/the-digital-future-of-work-what-skills-will-be-needed

McKinsey Global Institute. (2016, October). *Independent work: Choice, necessity, and the gig economy.* Retrieved from: https://www.mckinsey.com/~/media/McKinsey/Global%20Themes/Employment%20and%20Growth/Independent%20work%20Choice%20necessity%20and%20the%20gig%20economy/Independent-Work-Choice-necessity-and-the-gig-economy-Executive-Summary.ashx

Morgenstern, R. D., Pizer, W. A., & Shih, J. S. (2001). Jobs versus the environment: An industry-level perspective. *Journal of Environmental Economics and Management, 43*, 412-436.

National Academies of Sciences, Engineering, and Medicine. (2017). *Information technology and the U.S. workforce: Where are we and where do we go from here?* Washington DC: National Academies Press.

National Center for O*NET Development. *The Green Economy.* O*NET Resource Center. Retrieved April 8, 2018, from https://www.onetcenter.org/green.html

National Center for O*NET Development. *O*NET Online*. Retrieved from https://www.onetonline.org

O'Marah, K. (2018). Gender equity: Redesigning work for tomorrow. *Forbes.* Retrieved from https://www.forbes.com/sites/kevinomarah/2018/01/12/gender-equity-redesigning-work-for-tomorrow/#444f8b9f482e

Osborne, M. A., & Frey, C. B. (n.d.) *The Future of Employment.* Oxford, England: University of Oxford. Retrieved from: https://futureoflife.org/data/PDF/michael_osborne.pdf

Pompa, C. (2015). *Jobs for the Future.* London: Overseas Development Institute. Retrieved from https://youtheconomicopportunities.org/sites/default/files/uploads/resource/ODI-JobsfortheFuture.pdf

PwC. (2017). *Workforce of the future: The competing forces shaping 2030*. Retrieved from: https://www.pwc.com/gx/en/service/people-organisation/workforce-of-the-future/workforce-of-the-future-the-competing-forces-shaping-2030-pwc.pdf

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

Ross, A. (2017). *The industries of the future.* Presentation at Politics and Prose, Washington, DC.

Ryan, T., Sapin, D., Rao, A, & Ampil, C. (2018, January). *US Business Leadership in the World in 2018: US Supplement to the 21st Annual Global CEO Survey.* PwC. Retrieved from: https://www.pwc.com/us/en/library/ceo-agenda/ceo-survey.html

Shaw, M. (2017, September 11). *The 6 types of artificial intelligence.* Hewlett Packard Enterprise. Retrieved from: https://community.hpe.com/t5/Digital-Transormation/The-6-types-of-artificial-intelligence/ba-p/6976199#.WsgQGi7wbcs

Simon, S. (Host). (2016, December 10). *Economist says manufacturing job loss driven by technology, not globalization* [Radio broadcast episode]. https://www.npr.org/2016/12/10/505079140/economist-says-manufacturing-job-loss-driven-by-advancing-technology-not-globali

Singh, S. (2015, October 7). Future of United States to 2025. *Forbes*. Retrieved from https://www.forbes.com/sites/sarwantsingh/2015/10/07/future-of-united-states-to-2025/#79b99c5445a2

Singh, S. (2017, December 13). By 2020, artificial intelligence will create more jobs than it eliminates: Gartner. *The Economic Times.* Retrieved from: https://economictimes.indiatimes.com/jobs/by-202-artificial-intelligence-will-create-more-jobs-than-it-eliminates-gartner/articleshow/62053363.cms

Solis, H. L. (2011). Immigrants and America's future. America's Quarterly. Retrieved from http://www.americasquarterly.org/node/2419

Sundararajan, A. (2016). *The sharing economy: The end of employment and the rise of crowd-based capitalism.* Cambridge, MA: MIT Press.

The Foundation for Young Australians. (2017). *The new work order: Ensuring young Australians have skills and experience for the jobs of the future, not the past.* Retrieved from http://www.voced.edu.au/content/ngv%3A69383

University of Kent. (2018). *Future Jobs.* Retrieved from https://www.kent.ac.uk/careers/Choosing/future-jobs.htm

Unum Limited. (2014). *The future workplace: Key trends that will affect employee wellbeing and how to prepare for them today.* Surrey, England: Author.

Vale, R. (2016, August 12). *The four industrial revolutions in a glimpse.* Retrieved from: richmondvale.org/industrial-revolutions

Vozza, S. (2016). Eight career skills you need to be competitive in 2016. *Fast Company.* Retrieved from: https://www.fastcompany.com/3055352/eight-career-skills-you-need-to-be-competitive-in-2016

Wadors, P. (2016, February 9). *Bet big on agility... The agile workforce.* Retrieved from https://www.huffingtonpost.com/pat-wadors/bet-big-on-agility-the-ag_b_9175648.html

Wagner, C. G. (2011, January-February). 70 jobs for 2030: Emerging careers and how to create them. *The Futurist*, 30-33.

World Economic Forum. (2016). *The future of jobs: Employment, skills and workforce strategy for the fourth industrial revolution.* In Global Challenge Insight Report. Retrieved from http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf

Yaraghi, N., & Ravi, S. (2017). *The current and future state of the sharing economy.* Brookings. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3041207

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.