Mitigating Future Workforce Risk through the Education of Young Children - 11551

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ABSTRACT

Global challenges in nuclear materials management include the potential risk that an adequately skilled and educated workforce will not be available to support the technical requirements of the nuclear industry in the future. An inadequate workforce can adversely impact schedule, performance and ultimately corporate and government financial liabilities. This paper explores the corporate mitigation of future engineering and technical workforce risk through support for and investment in early childhood and elementary school education.

The entry level workforce for the years 2025 through 2035 is currently less than 10 years of age. Educational outreach initiatives at many organizations reflect a “top down” approach by focusing on partnerships with universities, technical schools, high schools, and even middle schools. While important, these efforts alone may be insufficient to fulfill the large number of technical workers potentially needed in the future.

Early childhood and elementary education are integral components of the engineering education pipeline. Workforce planning at companies that depend on the availability of mathematically and scientifically literate talent should extend beyond recruiting from top university engineering programs. Long-term workforce planning strategy should include the early stages of the educational pipeline in order to ensure an adequate number of qualified students are eligible to enter and successfully complete engineering and technical programs in the years 2025 and beyond.

Industry has a vested interest in joining government, communities, and civil society partners in early childhood education initiatives. Potential future technical workforce challenges can be mitigated by corporate initiatives that partner with and/or supplement government and community efforts to sustain and improve U.S. student performance in Science Technology Engineering and Math (STEM) education in support of a sustainable engineering workforce.

INTRODUCTION

Challenges in nuclear materials management include the potential risk that an adequately skilled and educated workforce will not be available to support the technical requirements of the nuclear industry in the future. With the majority of existing U.S. nuclear reactors scheduled to be retired after 60 years of operation (the initial 40-year license plus one 20-year license renewal, consistent with the U.S. Energy Information Administration Annual Energy Outlook 2010), nuclear projects underway and in the pipeline will require a substantial technical workforce for decades into the future. As nuclear projects have long-term horizons, it is important that workforce planning reflect a similar long-term perspective to mitigate the potential consequences of an insufficient workforce.

The proactive management of critical and strategic resource availability is important to any business. Like other technology-rich industries, the nuclear materials management supply chain depends on a steady and rising supply of, among other things, industrial, mechanical, electrical, civil and nuclear engineers as well as other technically skilled workers. While often there is great energy expended in selecting/recruiting the best available inputs at a competitive price, it is also important to ensure such a procurement/recruitment strategy does not neglect the sustainability of long-term supply.

Current educational outreach initiatives at many companies focus predominantly on relationships and partnerships with universities, technical schools, high schools, and middle schools. While important, these efforts alone do not ensure that the ultimate workforce yield from universities and technical schools will be sufficient.

The entry level workforce for the years 2025 through 2035 is currently less than 10 years of age. Organizations that depend on technically skilled workers can help prepare for future workforce challenges by understanding the importance of investing in early childhood education today. A direct investment in elementary school education is a complementary approach to supporting the full educational spectrum which fuels the engineering and technical workforce pool.

By investing in initiatives that partner with and/or supplement current educational efforts to sustain and improve U.S. student performance in Science Technology Engineering and Math (STEM) education, it is possible for companies to mitigate potential future workforce challenges. Industry can make intentional educational investments in locations and activities that are aligned with corporate objectives and long-term strategies and that reflect the broader trend toward investment in engineering education throughout the pre-kindergarten through 12th grade (P-12) educational spectrum.

FUTURE WORKFORCE PLANNING

The need to ensure robust workforce planning is highlighted by the current and future demand for engineering and technical talent juxtaposed against growing expectations for support of an increasingly technology intense economy as well as the anticipated retirement eligibility of a significant percentage of technical workers in many sectors such as the electric utility industry. Therefore, effective workforce planning requires the examination of the entire educational pipeline which supports the downstream “production” of engineers and other technical workers.

Many companies have expanded their understanding of long-term workforce risk and the importance of ensuring adequate yields from engineering and technical universities. However, there still remains a need for companies to recognize the importance of supporting educational pipeline segments farther upstream, including high school, middle school, elementary school, and pre-kindergarten.

A comprehensive approach to corporate educational investments is critical to ensuring adequate long-term supply of qualified engineering talent. Investments in early childhood and elementary school education can be integrated into existing engagement with middle schools, high schools, and universities in support of a robust workforce planning strategy.

ENGINEERING SUPPLY AND DEMAND

Mitigating future engineering workforce risk requires an assessment of both the demand for engineers and the supply of qualified engineering professionals. The future demand for engineers, which will be strongly influenced by the technological trajectory of the U.S., may exceed the influence of a single company or industry. However, the future supply of qualified engineering professionals can be impacted by individual organizations and industries. Analyzing the long-term supply of qualified engineers requires examination of the educational pipeline and student performance as well as an exploration of why students may not be drawn to engineering as a profession.

Potential engineers need to possess critical math and science competencies, but must also ultimately choose to become engineers. In 2008, the National Academy of Engineering published the book, *Changing the Conversation: Messages for Improving Public Understanding of Engineering*, which explored how to better encourage young people to consider the engineering profession and the importance of effectively doing so in support of the U.S. as a continued leader of innovation. From a marketing communications and outreach perspective, it is noted that, "most outreach initiatives target high school students with an eye toward priming the engineering education pipeline…less attention has been paid to elementary and middle schools…"[1]

The future demand for engineers is projected to increase while there appears to be a current decline in the number of students pursuing engineering degrees.[2] According to the U.S. Department of Labor, engineering employment in the U.S. during the 2008-2018 decade will increase by 11 percent.[3] Commenting on the downstream end of the future engineering workforce pipeline, Thomas Peterson, Directorate for Engineering, National Science Foundation testified on October 29, 2009 before the U.S. House of Representatives Committee on Science and Technology that there has been a decline in the percentage of SAT and ACT college entrance exam takers indicating their intent to pursue engineering. Peterson remarked that, "I personally believe that the absence of introducing basic engineering concepts in pre-college curricula, even down to the elementary and middle school levels, is a dominant factor in this situation."[4]

While there have been differing assessments regarding if and when the U.S. might face an engineering shortage, from a business risk perspective it is logical for companies to consider whether adequate programs and curricula are in place to support the development of engineers from pre-kindergarten all the way to the university level. A 2008 paper, *Advancing Engineering Education in P-12 Classrooms*, highlights that, "research from engineering education and the learning sciences suggests that students need to develop a deep understanding of fundamental science, mathematics and technology principles across P-12 if they want to pursue a wide range of

[1] National Academy of Engineering. (2008). *Changing the Conversation: Messages for Improving Public Understanding of Engineering*.
[2] Brophy, S., Klein, S., Portsmore, M., & Rogers, C. (2008). *Advancing engineering education in P-12 classrooms*. Journal of Engineering Education, 97(3), 369.
[3] http://www.bls.gov/oco/ocos027.htm
[4] http://gop.science.house.gov/Media/hearings/research09/oct22/Peterson.pdf

engineering and technical career opportunities."[5] Additionally, in her National Science Foundation supported paper, *Lost Talent, The Underparticipation of Women, Minorities, and Disabled Persons in Science*, Jeannie Oakes examines the pathway to a scientific career. While there are a number of different variables and influential drivers regarding the ultimate decision to pursue a scientific career, Oakes notes that middle school and high school experience with math and science seems to influence whether some students "leave the scientific pipeline" even before college. Similarly, she observes that "persistence in a scientific major" is underpinned by high school achievement.[6]

In 2009, the U.S. Power and Energy Engineering Workforce Collaborative published a report suggesting that, "Over the next five years, approximately 45 percent of engineers in electric utilities will be eligible for retirement or could leave engineering for other reasons."[7] Furthermore, the report recognizes that K-12 education plays an important role in supporting a strong pipeline of students entering engineering.

Current indicators point toward a continuous need for trained engineers to support the long-term growth of the U.S. economy and the sustainability of existing technology-dependent industries. Students must be adequately trained and encouraged to explore potential career avenues in engineering fields throughout pre-kindergarten, elementary school, middle school, high school, and university.

U.S. MATH AND SCIENCE PERFORMANCE

According to the U.S. Department of Labor, "engineers apply the principles of science and mathematics to develop economical solutions to technical problems. Their work is the link between scientific discoveries and the commercial applications that meet societal and consumer needs."[8] Based on this definition of engineering as applied math and science, the link between mathematical and scientific literacy, and discovery and innovation, is driving renewed commitment to improved Science Technology Engineering and Math (STEM) education in the U.S. Furthermore, the concern that Americans are not performing on par with their peers around the world provides additional impetus for increased support for math and science education at an early age.

The Program for International Student Assessment (PISA) is an international test administered every three years to 15-year-olds in 30 countries participating in the Organisation for Economic Co-operation and Development (OECD) and 27 non-OECD jurisdictions. PISA assesses performance in reading, mathematics, and science. According to scores from the 2009 PISA regarding scientific literacy, American 15-year-olds performed at the average OECD score, ranking 13th out of OECD countries. Regarding mathematic literacy, Americans performed below the OECD average score, ranking 19th out of OECD countries.[9] Another international assessment, the Trends in International

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[5] Brophy, S., Klein, S., Portsmore, M., & Rogers, C. (2008). *Advancing engineering education in P-12 classrooms*. Journal of Engineering Education, 97(3), 370.

[6] Oakes, J. (1990). *Lost talent: The under participation of women, minorities, and disabled persons in science.* Santa Monica, CA: The Rand Corporation.

[7] U.S. Power and Energy Engineering Workforce. (2009). *CollaborativePreparing the U.S. Foundation for Future Electric Energy Systems: A Strong Power and Energy Engineering Workforce*

[8] http://www.bls.gov/oco/ocos027.htm

[9] U.S. Department of Education. (2010). *Highlights From PISA 2009: Performance of U.S. 15-Year-Old Students in Science and Mathematics Literacy in an International Context*

Mathematics and Science Study (2007), reflected an improvement in American fourth and eighth graders' performance in mathematics, but not science.[10]

Building on this examination of American performance regarding mathematic and science literacy, Greg Pearson and A. Thomas Young define technology as the process by which humans modify nature to meet their needs and wants, and technological literacy in terms of three interdependent dimensions—knowledge, ways of thinking and acting, and capabilities. In their book, *Technically Speaking: Why All Americans Need to Know More About Technology,* they extrapolate from American math and science literacy and posit that while not yet concretely measured, "it seems logical to assume that American students are not as technologically literate as their international counterparts."[11]

EARLY CHILDHOOD DEVELOPMENT AND SCIENTIFIC LITERACY

The exploration of the impact of early childhood education (birth to eight years of age[12]) on subsequent learning and development is rooted in an understanding of the major development theories that shaped the 20th century understanding of child development and learning. Dr. Karen Lind's work in education draws on decades of research regarding cognitive development, early childhood programs, and science education. The U.S. Department of Education Office of Education Research and Improvement published her paper, "Science in Early Childhood: Developing and Acquiring Fundamental Concepts and Skills," in which she reinforced the important link between scientific literacy and the integration of science inquiry and exploration into early childhood education.[13]

The Early Childhood Longitudinal Study (ECLS-K), Kindergarten Class of 1998-99, examined the mathematics and science performance of a group of approximately 8,000 American kindergarten students over nine school years (from fall of 1998 to spring of 2007). As noted in Science and Engineering Indicators: 2010, "Students' relative achievement when starting school had an influence on growth and eventual grade 8 scores, shown by the trajectories of those scoring in the lowest, middle two, and highest quartiles in kindergarten."[14] In this regard, the study reflects the *continuity-discontinuity* issue, namely that early development is related to later development, but not perfectly.

Drawing on cognitive, behavioral, and social learning theories, a group of researchers from the Tufts Psychology of Abilities, Competencies, and Expertise Center and the Boston College Lynch School of Education initiated a research study to explore an innovative approach to addressing the challenge of improving American students' scientific achievement and technological literacy through design-based instruction for young children. *Transforming Elementary Science Through Lego Engineering Design* hypothesizes that, "when children engage in design activities whose successful completion requires understanding of specific science content, the children will make

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[10] National Science Board. (2010). *Science and Engineering Indicators: 2010*
[11] Pearson, G and Young (2002), A. *Technically Speaking: Why All Americans need to Know More About Technology*. Washington, DC: National Academy Press.
[12] http://www.unesco.org/new/en/education/themes/strengthening-education-systems/early-childhood/
[13] Lind, Karen ( ). *Science in Early Childhood: Developing and Acquiring Fundamental Concepts and Skills*.
[14] National Science Board. (2010). *Science and Engineering Indicators: 2010*, 1-8.

progress toward two major educational objectives simultaneously. On the one hand, the young students will develop knowledge of and skills in engineering design, which are fundamental components of technological literacy. On the other hand, the children will develop deeper understanding of science content because they are using it in the service of design completion.[15] Based on an initial study consisting of 14 experimental and 6 control classrooms, the researchers found that there was a statistically significant improvement in science content learning as a result of the teacher-training supported engineering-based curriculum.[16]

EDUCATIONAL OUTREACH AND THE ELECTRIC POWER SECTOR

According to an examination of publicly available information regarding AREVA's U.S. electric utility customers' primary and secondary educational outreach programs, a number of electric utilities engage children through initiatives that target elementary, middle, and high school students. Some of the elementary school focused initiatives include:

Table I. Early Childhood Education Outreach at Select U.S. Electric Utilities.

Company	Early Childhood Education Outreach
Arizona Public Service	Benjamin FranKlown - a 20 minute interactive experience for students in grades PreK-4. In an assembly format, students are invited to visit with Benjamin FranKlown as he talks about energy conversation.[17]
Ameren	Louie the Lightning Bug - an Ameren Illinois safety mascot, ready to share his important messages about electrical safety anywhere kids may be. Students can learn more about Louie by visiting his Electric Universe, a website that features fun games and fantastic facts about electric safety for kids.[18]
Florida Power & Light	Captain Conservation - a free school assembly program that teaches children to be heroes by conserving energy through fun, original and interactive songs.[19]
Pennsylvania Power & Light	Bright Kids with E-Power - in school interactive presentation with take home energy efficiency kits for students and teachers targeting grades 2-3.[20]
The Southern Company	Kilo-What? - for elementary school students. Online and downloadable lessons about the principles and definitions of electricity. [21]
South Carolina Electric & Gas	Homework Centers - provide secure, supervised environments where children in grades two through five can spend time after school working on homework assignments and developing study skills.[22]

[15] http://www.ceeo.tufts.edu/Research-Projects/reese.html referencing Pearson, G and Young (2002), A. *Technically Speaking: Why All Americans need to Know More About Technology*. Washington, DC: National Academy Press.

[16] http://www.ceeo.tufts.edu/Research-Projects/reese.html

[17] https://aps.com/my_community/EducationTools/EducationTools_4.html
[18] http://www.ameren.com/sites/aiu/Community/Pages/Schools.aspx
[19] http://www.fpl.com/community/learning/captainconservation.shtml
[20] http://www.pplelectric.com/e-power/Features/thinkenergy/brightkids.htm
[21] http://www.southerncompany.com/learningpower/whats_electricity.aspx
[22] http://www.sceg.com/en/my-community/education?WT.mc_id=education-sponsor

While these examples highlight what is currently being done in terms of outreach to children who fall within the "early childhood education" age-span, only 36% of AREVA's electric utility customers have one or more programs that specifically target and serve primary and elementary schools. The majority of programs focus either on middle and high schools, or include a broad program (often a web site) intended to improve K-12 students' awareness and understanding of energy and electricity safety issues.

In terms of energy education, several of AREVA's electric utility customers (as well as AREVA) support the 30-year-old National Energy Education Development (NEED) project, whose mission is *to promote an energy conscious and educated society by creating effective networks of students, educators, business, government and community leaders to design and deliver objective, multi-sided energy education programs*.[23] NEED pairs K-12 energy curriculum with teacher training and development in recognition of the importance of engaging both students and teachers in support of developing tomorrow's energy leaders.

Although there is activity on the part of U.S. electric utilities in reaching out to and supporting student interest in STEM subjects and energy topics, there is room for additional investment in early childhood and elementary school-focused programs, from not only a community investment perspective but also in support of mitigating potential business risk through long-term workforce planning.

AREVA's EDUCATION OUTREACH

AREVA believes in energizing future engineers and scientists and engaging students at a young age. The company is involved in educational outreach throughout the U.S. and internationally. Locally, AREVA reaches out to elementary school students through Lego League and robotic teams as well as through Engineering Week activities and class visit presentations. However, similar to its utility customers, in aggregate, AREVA's educational outreach initiatives skew more toward middle school and high school students, focusing on introducing them to and supporting their interest in engineering.

AREVA recognizes the strategic importance of engaging young children in methods of scientific inquiry and the development of basic math and science literacy which will underpin any future career in engineering. In support of both local community involvement and long-term workforce planning, AREVA is currently exploring a number of potential initiatives that target support for elementary school math and science programs such as:

- Pre-kindergarten and elementary school class visits by trained AREVA employees focused on supporting existing science curriculum through interactive, experiential learning exercises and experiments
- Support for elementary education grant writers utilizing AREVA proposal and DOE grant process experience and techniques to increase grant win rates
- Extension of existing programs to additional AREVA U.S. sites
- Collaboration with stakeholders through NEED as well as through other programs

[23] www.need.org

CONCLUSION

Sustaining and improving U.S. student performance in STEM subjects in support of an engineering and technical workforce requires a longer-term, life-cycle approach that includes early childhood development and learning. Policy makers and industry, including the nuclear materials management sector, have a common vested interest in ensuring a strong pipeline of mathematically and scientifically literate professionals. Whether in support of a U.S. economy rooted in technological innovation or to sustain the capacity for companies to support growth with appropriately trained talent, STEM subjects must continue to be important staples of the American educational diet.

For companies who depend on the availability of mathematically and scientifically literate talent, workforce planning cannot focus solely on support for and recruiting from top university engineering programs. Effective workforce planning should also consider the early stages of the educational pipeline in order to ensure an adequate number of qualified students can continue to supply “downstream” engineering and technical programs. Corporate investment should similarly extend across the entire educational spectrum to mitigate potential future workforce challenges.

Future workforce success is linked to the educational achievements of today’s young children. As the emphasis on integrating STEM education throughout the full spectrum of P-12 education continues, from a long-term workforce planning perspective, companies in related and affected industries need to be aware of and supportive of these efforts. Industry can benefit from recognizing the importance of integrating early childhood education into its broader workforce planning strategy. As the pace and pressures of technological innovation is ever quickening, now is the time for industry to partner with government and civil society partners in developing a robust foundation for mathematic and scientific literacy that supports future generations of engineers and technical workers.