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Investing In Early Education in Science, Technology, Engineering, and Mathematics to Prepare Future Workforce

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ABSTRACT:A serious need is emerging for power, energy, and construction industries to replace retiring engineers and technicians so that the critical expertise is maintained. Yet skilled workers are not easily available to replace them at the rate of the demand. Training new workforce for entry level positions requires investment by the industry for their education. While companies are not willing to involve themselves in the classroom trainings, they are happily helping with on-the-job training. On the other hand, community colleges and four year institutions are facing nationwide budget cutting exacerbating special training for the future workforce. Therefore, the industry has been focusing on building a strong relationship with the educational institutions to train this workforce with cooperative and general education. Today there are several cooperative programs with two or more agencies involved to achieve the goal of preparation of technical workforce for future--such as STEM program. Our goal is to evaluate these programs, identify their shortcomings, and finally suggest an alternative method to training beginning with early childhood.

KEYWORDS:ENERGY, TRAINING, WORKFORCE, TECHNOLOGY, STEM PROGRAM,

I. INTRODUCTION

Industry in general and the energy sector in particular are experiencing a sharp decline in skilled and experienced workers at every level. The oil and gas industry in spite of global expansion in this area, are struggling to hire qualified staff to respond to the volume of demand for these commodities. Even smaller power plants—like the ones located at hospitals and universities—face the similar problems. In fact attracting and retaining qualified workforce is one of the biggest challenges and risks for the industry for future success. This issue is not caused by a lack of assets, but rather is an issue of knowledge and significant level of expertise that the upstream and midstream businesses are facing (Orr and McVerry 2007).

The workforce worry in energy is particularly acute, and because energy is fundamental to practically every other economic sector it could have an impact far beyond the traditional energy industry fields of electricity, oil and gas exploration and development and refining. Due to the anticipated industrialization of China and India, the global demand for energy is projected to increase 35% by the year 2035 (Handley 2013). Although, some energy productions such as coal and nuclear are staggering, a recent study by Krishnan and Associates (2005) found that the average age of the workforce of the US coal-fired power plants is 48. This survey also concluded that the average coal-fired plant will likely lose half its current plant workers in the next decade due to retirement and attrition. The specialized labour to replace this loss will likely be difficult (Krishnan Associates 2005).

In recent years, a number of different organizations; educators, industry, and political leaders have pushed for greater emphasis on STEM disciplines integrations in schools. The committee on Science, Technology, Engineering, and Mathematics (CoSTEM), a national educational organization of engineers, scientists, and technicians—wrote to president-elect Obama urging him “to not lose sight of the critical role that STEM education plays in enabling the United States to remain the economic and technological leader of the 20th century global market place” (Man-Energy-

WP 2014). Today, the relationship between science, engineering, technology, and mathematics disciplines are becoming increasingly stronger, affecting the workforce for solving skilled worker's problems.

The construction industryis facing the same problem—a lack of skilled workers. Since 2007, the US construction industry has lost about 2 million jobs. Much of this deficiency occurred as former construction workers secured their employment with other economic segments, including manufacturing, distribution and retail. Now the construction industry is booming again particularly in infrastructure and retrofitting while the industry struggling to recruit skilled workers in the technology and engineering field. The Maryland Center for Construction Education and Innovation (MCCEI) in conjunction with the Sage Policy Group, Inc. and the Regional Economic Studies Institute (RESI), of Towson University developed a report to provide stakeholders with an understanding of how Maryland 's educational institutions can help bridge the gap between construction skills and supply and demand for the 21st Century (MCCEI report 2013).

II. EXISTING STUDIES OF WORKFOCE DEVELOPMENT

All sections of the US industry face a skilled workforce shortage. When this shortage translated to the energy industry,it became acute and urgent. The energy industry has been trying to organize different expert groups such as educators, industry executives, engineers, and human resources agencies who are somehow involved in training, preparing and certifying and locating workforce. In doing so, among others, Manpower conducted a series of one-on-one interviews with human resource executives, training and education experts and workforce development advocates, in 2013 to develop a questionnaire. This survey was then distributed via email to over 6,000 energy company executives (Centre for Energy Workforce Development 2014). The results, were presented in four reports; report one-The energy Workforce Crisis, report two-What's working in Energy Workforce Development, report three-Rebranding Energy Jobs, and report four-A Call for Collaboration

Report one focuses on labour availability for current and near future due to retirement of older workforce and the lack of new skilled workers to replace them, as was described earlier. Report two examines the activities of all stakeholders in building the supply of skilled workers and increasing access to talent, and mitigating the demand for new talent. Report three looks at understanding problem: the need to rebrand the energy jobs and make it more appealing to younger workers, their parents, and career counsellors. Report four proposes a path forward to all stakeholders and outlines what policy makers and educators can do to ensure a brighter workforce future. Based on the above survey, some strategies were made to effectively tackle the problem areas; Strategy #1 build the talent supply, Strategy #2 find new access to talent supply, Strategy # 3 mitigate the demand for new talent, and Strategy # 4 develop new workforce capabilities. The following sample case studies based on the above strategies were shown to advance the talent supply for the industry.

Case study for Strategy #2, PNM's San Juan Generating Station, for instance, combines cooperative education and general education. Each apprentice must complete 2000 hours of on-the-job training and a minimum of 144 hours of classroom training. To ensure the continued relevancy, San Juan College teaches courses on-site at PNM and uses former PNM employees as instructors. This training is open only for PNM employees offering three different tracks: General Plant Operator, Environmental Process Operator and Industrial Mechanics. This program has been successful and has about an 80% graduation rate.

Case study for strategy #4, SheleNet spans four states: Pennsylvania, Ohio, West Virginia and New York, in 2010 the US Department of Labour, Employment and Training Administration funded this $5 million community-job-based training grant program to ready entry-level workers for natural gas jobs.

III. EXISTING STUDIES IN STEM PROGRAM IMPROVEMENT

STEM is a curriculum based on the idea of educating students in four specific disciplines — science, technology, engineering and mathematics — in an interdisciplinary and applied approach. Rather than teach the four disciplines as separate and discrete subjects, STEM integrates them into a cohesive learning paradigm based on the real-world.

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Though the United States has historically been a leader in these fields, fewer students have been focusing on these topics recently. According to the U.S. Department of Education, only 16 percent of high school students are interested in a STEM career and have proven a proficiency in mathematics. Currently, nearly 28 percent of high school freshmen declare an interest in a STEM-related field, but 57 percent of these students will lose interest by the time they graduate from high school (US Department of Education web site)

There have been many scholarly attempts to improve STEM education program within the last decade. In this sectionwe review the existing research studies in the areas of STEM education programs. Kuenzi et.al 2006, evaluated the program based ongrowing concern that the United States was not preparing a sufficientnumber of students, teachers, and practitioners in the areas of science, technology,engineering, and mathematics (STEM). They then proposed an improvement plan to the US Congress in which many bills have been influenced by leading academic, scientific, and business organization reports.These recommendations to improve STEM policy concern every aspect ofthe educational pipeline.The focus of the report was on five areas: improving elementary and secondarypreparation in math and science, recruiting new elementary and secondary math andscience teachers, retooling current math and science teachers, increasing the numberof undergraduate STEM degrees awarded, and supporting graduate and early-careerresearch. Asundastudied STEM programs in a sense to offer a conceptual framework for integrating its subjects in a universal curriculum as well as preparing them for the future career. He then provided a premise foreducators who were interested in delivery of STEM content in CTE (curriculum and technology education) may reflect upon as they prepare students for the 21st century workforce. This framework includes four theoretical constructs—including system thinking, situated learning theory, constructivism, and goal orientation theory—that blend together to accentuate how students may learn STEM concepts in CTE (Asunda 2014).

“Bridging STEM with Mathematical Practices” is the title for another research in this area by Bennet and Ruchti. They argue that even though each STEM field has their own distinct way of thinking, they are common practices that can link learning to increase student readiness. Integrated content represents an ideal situation for learning environment in practice therefore it should be linked in learning experiencesas well (Bennet and Ruchti 2014).

Although, engineering by design and other engineering-related curriculum initiatives have assisted the profession in maintaining some presences in the secondary schools,school administration has struggled to maintain a foothold for technology and engineering education. It seems that since technology education became scarce in secondary schools, integrated STEM education is attracting educators, politicians and the media nationwide (Daugherty et.al.2014). While secondary schools are hardly maintaining STEM curriculum through new initiatives, elementary schools seem to be pleading for help in implementing new integrated STEM education program. Elementary educational leaders are increasingly recognizing that integrated STEM curricula may have the greatest impact at the early education level. Research suggest that children’s aspiration in science and technology, technology careers is largely formed by the time children reach upper elementary school and has very little after that (Archer et.al., 2012; Murphy and Beggs 2005; Tai, Qi Liu, Maltese, Fan 2006). Our focus in this study is the integration of the science, engineering and mathematics in early childhood education where the human brain has the most potential to grasp and create.

IV. DISCUSSION ON OPTIONS FOR TECHNICAL EDUCATION

We cannot deny the importance of science, technology, engineering and mathematics for student success at all levels of education and later in career. The future workforce will most probably be based on skills which require at least some knowledge of mathematics and science. These issues are so crucial that our president have identified an overarching goal to improve STEM education and in that he identified three priorities to ensure more students develop math and science skills; improving the quality of teachers, improving undergraduate teaching practices, and finally expanding STEM education and career opportunities for underrepresented groups including minorities and women (US Department of Education 2013). With these programs, more studentswill have opportunities for high-quality STEM learning environment which motivate them to pursue degrees and careers in technical fields.

Despite an annual federal investment of almost $ 3 billion, too many students are unprepared in STEM areas particularly those in underrepresented groups. The Administration is then proposing a comprehensive reform and

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reorganization of STEM education programs to increase the impact of investments in four areas; K-12 instruction, undergraduate education, graduate fellowships and activities that take place outside the classroom (US Department of Education 2013).

There are currently a lot of different options for technical education. In grades pre-kindergarten through 8th grade, students have the opportunity to participate in science or technical education programs as part of the required curriculum for all students. The programs may be special programs that are offered occasionally, such as all Kindergartners will have the opportunity to handle materials that teach physics at the mobile science museum as the museum travels from one school to another (Lower Shore Child Care Resource and Referral Centre), or the science and technology activities may be included in the classroom activities, or it could be a room where the students visit on a weekly basis. In mathematics and English, there are common core standards for grades K through 12th grade.

In most states, there are more standards of learning for all subject areas. In some high schools, beginning with 9th grade, there are some special programs that allow students to complete coursework in the technical fields, whether it is computer science, construction management or nursing, child development or other topics of interest in a particular region or school. The students may also have the option to complete college level course work, either as an Advanced Placement option, or as a co-enrolled college course. The school districts determine availability of courses. President Obama just signed the Workforce Innovation and Opportunity Act of 2014 on July 22. This act was designed to make technical education available to all students, but with a focus on children and adults who may be underprepared. The act provides an opportunity to be career ready and to have a clear career pathway so that the students are prepared for work after attending the community colleges.

Not everyone had an equal chance to be successful during the formal school years due to reasons ranging from long term social injustice, varying financial stratification, stability of family structures, earlier education opportunities, and different learning styles. Therefore, not everyone starts at the same place when entering college. Reaching the variety of people entering college may be an interesting adventure, and it is possible. The question is how. The circle of education needs to be changed to provide more people with more opportunities to maximize our future opportunities. The question might also be when would be the best time to intervene to make the most changes over a long period of time. This paper is suggesting that early education with the family supported in that endeavour might be a possibility.

Judging from the grants that appear to be offered to increase STEM education (http://stemgrants.com/) it appears that the majority of the grants are offered to those who work with children between Kindergarten and the end of undergraduate work in college. There are few exceptions. However, the early childhood education believes that education begins at birth (Canada, n.d.), Regenstein, E. (n.d.). Therefore, providing developmentally appropriate education at a time when the families can access education, and are interested in getting their children on the track to be successful, may be an option to getting more families interested in science, technology, engineering, and mathematics (STEM) related fields.

V. PROPOSAL FOR LONG-TERM PROGRAM

The early childhood years include the years that the brain undergoes the fastest growth and include the years where children develop interests for life. Attending preschool programs may help children get a better start in the school system, but may not get children into the middle class, according to Karl Alexander (2014), a sociology professor at Johns Hopkins University, unless there are supports in place that will help the children in the long term. Gregory Canada, who is working on the Harlem Children's Zone project (hcz.org) is hoping that working with the community and the family along with education will break the cycle of poverty. Combining early childhood education, adding the lifelong support of the family through education, using a nature based family education program in the early years may do just that. In early education, we need to begin the process of observing, thinking, questioning, seeking relationships between what is observed. Teaching children to love science, using experiential education to help children learn how to learn, along with teaching the families how to support the children, may create just the right mix for increasing interest in science, technical, engineering and mathematics.

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The opportunity to be outside, together, creates attachment between the family members, and when the family explores outside with other families, social connections develop, creating a community of learners that can provide support for each other and their children (Satterlee, Commons, 2008)). According to Satterlee, (2010) who did a longitudinal study on the SPARK (Shore People Advancing Readiness for Knowledge) the children who participated in this program over the course of one to two preschool years stayed on grade level for at least their first ten years of school. Satterlee has continued to follow the children to high school, with the first children in this study graduating from high school in the next 2 to 3 years. The children in the study lived on the Eastern Shore of Virginia, a rural area, rivalling Appalachia for the depth of poverty.

Some of the children began their program when their parents were attending a GED or an ESL program. A few of the children had parents who were professional lawyers and teachers. Nearly all of the children have excelled in school, and their parents have maintained an interest in the child's schooling, and some of the parents have managed to go to college themselves, and/or obtain better jobs as their English improved. Nearly 50% of the adult program attendees are male. Many of the families who had children in the program as pre-schoolers have continued to come to the program that has evolved to follow the families' interests.

The children, who are now in middle school and high school, are participating in a research project supported by the Chincoteague Bay Field Station to build oyster castles to encourage oyster growth to clean the Chincoteague Bay and decrease erosion of the land surrounding the bay. The families with children in middle school are doing water quality testing of the creeks on the bay side of the Eastern Shore of Virginia's peninsula. The families with pre-schoolers who have just joined the program continue to explore the bay, the ocean, the farms, the woods, the islands and the marshes in the area. A surprise from this study was an observation from one of the teachers at an elementary school where this program is in place was that the parents of the children involved as pre-schoolers were attending the PTO meetings in unexpected numbers and have continued to be involved in their child's educational process.

Since higher education is the largest discretionary items in state budgets, states funding for higher education tends to rise when the economy is sound and to drop during recession. Even during good economic times, the rise in educational funding does not seem adequate because of the rise of enrolment and inflation.When the nations' top science educators were asked: What are the challenges facing STEM Education today? " and on the follow up question "Select 3 of the most important challenges facing STEM Education today" the majority identified the following (STEMRepots 2010):

- Funding in K-12 specifically designate for STEM is insufficient (64.2%)
- Professional development for STEM teachers is insufficient (59.7%)
- STEM education in K-8 is lacking or inadequate (55.0%)
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VI. CONCLUSION

In the short term, elevating the early childhood from a field to a profession (Goffin, 2013) and encouraging the profession to require the teachers in early childhood education to obtain coursework for deeper understanding of how to teach the very basic levels of science, technology, engineering and mathematics to the families with very young children would be a beginning step. Writing to the political leaders encouraging funding for grants for STEM research for families with very young children would encourage more research to determine the possibilities that might be there for interests to develop in the STEM fields. Further studies are needed on the efficacy of increasing the amount of science, technology, art and engineering that are offered in early childhood.

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