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STEM-Centric Career Development for a Competitive Workplace

Rich Feller & Jackie Peila-Shuster, Guest Editors

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CAREER PLANNING and ADULT DEVELOPMENT

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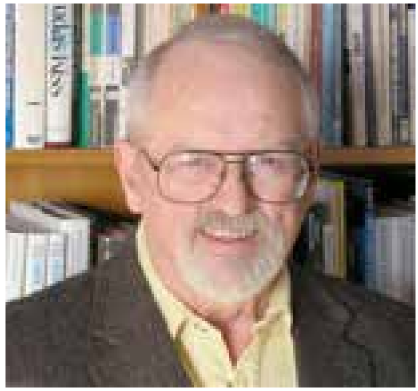
STEM-Centric Career Development for a Competitive Workplace

NCDA Honors Dick Knowdell

At its 100th Anniversary Conference in July 2013 President Rich Feller of the National Career Development Association honored Richard Knowdell. Text of the citation is presented below.

Rich Feller, PhD, President National Career Development Association



Richard Knowdell, President Career Research and Testing

Richard Knowdell. is President of Career Research & Testing. One of the most popular product developers, presenters, and supporters of NCDA as an exhibitor, Richard's guidance and support has been critical to NCDA's conferences and professional development success. Richard has trained and certified over 6,000 Job and Career Transition Coaches around the world. His card sorts, Career Development Network, and Career Planning and Adult Development Journal have influenced the way millions of practitioners do their work. His attention to the needs of corporate career development, coaching, and veterans was frequently ahead of its time. Worldwide, Richard has advocated for NCDA membership and supported our growth in ways that cannot be quantified.

Foreword

Looking Ahead With the Journal

This issue of the ***Career Planning and Adult Development Journal*** is devoted to **STEM-Centric Career Development for a Competitive Workplace,** with Guest Editors **Rich Feller, PhD,** and **Jackie Peila-Shuster, PhD,** of Colorado State University. Our sincere appreciation goes out to our guest editors and the excellent contributors of articles for creating this issue of the Journal.

Here is what we have planned for future issues of the Journal:

Social Media and Career Development, Guest Editor **Melissa Venable,** PhD, an instructional designer/project manager in Beaufort, South Carolina.

Student Articles Special Issue of the Journal, with Guest Editors **Jackie Peila-Shuster, PhD,** of Colorado State University and **Debra Osborn, PhD,** of Florida State University.

Book Reviews 2013-2014, with our new Book Reviews Editor **Maggi Payment Kirkbride,** career counselor in San Diego, California.

Special Veterans Journal issue! How about a little help in putting together this issue? We need articles on employment, job search, career development, and transition to civilian careers for our returning veterans. Guest editor TBD.
Thank you!

Steven E. Beasley, Managing Editor
Career Planning and Adult Development Journal
e-mail: stevenbeasley@verizon.net

INTRODUCTION TO THIS ISSUE

Recognition of the National Career Development Association's (NCDA) 100th anniversary is noted on the cover of this Volume 29 Number 2. For one hundred years NCDA has inspired and empowered the achievement of career and life goals by providing professional development, resources, standards, scientific research, and advocacy. As President of NCDA I (Rich Feller) and co-editor Jackie Peila-Shuster are honored to reflect on NCDA's history, impact and potential as it enters its second century. Inviting authors for sixteen articles with a deep respect for career development is a challenge considering the many Career Planning and Adult Development Network and NCDA members who have shaped NCDA's legacy. Connecting the STEM workplace, the needs of a highly competitive workplace, and the mission of NCDA requires a remarkable group of authors. Their roles within career development include corporate leaders, career center advisors, counselor educators, and futurists. Conducting research, providing direct service, designing career interventions and programs for unique audiences, this volume's authors help youth and adults design careers, find jobs and re-invent themselves.

NCDA's early commitments to equality and access to education, confronting oppression, and supporting human rights were pivotal to an industrial society. NCDA's pioneering efforts were carried forward within career and technical education, the National Defense Education Act (which advanced STEM under a different name), the National Occupational Information Committee, the creation of the Career Development Facilitator program, and other transformative initiatives propelled career development forward.

With a powerful and shorter history, the Career Planning and Adult Development JOURNAL's legacy of (1) quality writing about the interests of a broad range of human resource and career practitioners (2) focusing on specific and well-focused cutting edge career planning and adult development topics and (3) providing timely turnaround and agility in its review and access process helped career development concepts transcend academic and organizational borders. Such a significant contribution parallels NCDA's efforts to advance the field beyond traditional walls, income levels, or geography. As a result STEM issues and their role in creating a competitive workplace is a reminder of NCDA's roots and the opportunity to highlight the importance of developing interventions which help clients become more flexible, competent and agile within an ever-changing competitive and global workplace.

In **STEM Careers in the National and International Economy, Charles Lehman** provides data on current trends and future projections regarding STEM employment in the United States, as well as how this country compares with others in an increasingly competitive global economy. He goes provides information regarding proposed federal and local solutions to address the current and future STEM worker shortage.

Jim Brodie Brazell, a very popular futurist and consultant addresses the problems in the theoretical framework of education and workforce definitions of STEM while addressing the larger issue adopting and diffusing technology while instilling innovation within our systems. Within **STEM 2.0: Transformational Thinking About STEM for Education and Career Practitioners**, he argues for education, workforce, and economic development innovation strategies that require a transdisciplinary approach strategy.

Jobs within the new world of work require substantive changes in the skills needed to succeed in highly technical work environments. **New Jobs and New Skills for a Changing Workplace: STEM Enabled Technicians and Professionals** by **Joyce Malyn-Smith** and **David M. Smith** help us understand how expert thinking, complex communication, computational thinking, intergenerational communication, navigating organizational cultures, collaborating face to face and in virtual environments, working in geographically distributed teams, and using social media to build business are only some of the new skills needed for success in today's highly dynamic competitive workplace.

In **Connecting the Disconnects: Considerations for Advancing Racial/Ethnic and Gender Diversity in STEM, Angela Byars-Winston** reminds readers of the disconnects that exist between the American ideal of equal opportunity and access and the lived experiences of racial/ethnic minority women and men, and White women. She goes on to provide highly useful suggestions as to how career development professionals can engage intentionally in efforts to provide bridges across these schisms and broaden the participation of underrepresented minorities in, and their access to, STEM fields.

In **NASA Exploring Now and in the Future: With a Prepared STEM Workforce, Joyce Leavitt Winterton** illustrates how education is a fundamental part of NASA's purpose and vision as it supports those seeking and promoting STEM careers. NASA's commitment to inspiring the next generation of explorers and inventors is unprecedented. From that has come a generation of competitive workers in fields far beyond space travel.

Debra Kaye Holman reminds us that career development needs to include post-degree success for college students in a global community in **Supporting STEM Student Success, Competitive Advantages, and Engagement in Career Development.** She discusses the competitive advantages for students in STEM fields, as well as the support needed from career counselors, faculty, and professional advisors to facilitate their ability to manage the career challenges and embrace the opportunities they will meet post-degree. Also important, she reports, is ongoing STEM-Centric development for those professionals supporting these students.

Hardhats, Boots, and Goggles Revisited – STEM Career Development for the 21st Century
by **Abigail Holland Conley, Sylvia Nassar-McMillan,** and **Lynn Zagzebski Tovar** notes stereotype threat in regards to individuals that are underrepresented in STEM, and how it can influence internalized self-concept and self-efficacy with resultant effects on academic and career beliefs and performance. The authors utilize social cognitive career theory to provide ways to conceptualize these issues and create culturally competent interventions that can challenge stereotypes and abate the damaging consequences of stereotype threat.

Sheron Mark, Dennis DeBay, Lin Zhang, James Haley, Amie Patchen, Catherine Wong, and **Michael Barnett** introduce the constructs of science interest development, learning science for social justice, and out-of-school learning environments in **Coupling Social Justice and Out-of-School Time Learning to Provide Opportunities to Motivate, Engage and Interest Under-Represented Populations in STEM Fields.** They also present the integration of these constructs in building transformative learning environments to support ethnic minority youth in pursuing STEM careers. Their model for urban science education is called Social Justice for Talented Emerging Minds (SjTEM) program and they illustrate it with a case study of a youth participant in the program.

STEM Related Career Development for Experienced Workers by **Sally J. Power,** illustrates how career specialists can work with clients well into their careers on ways to learn how to integrate their work experience with technological advancements to further develop their career competitiveness. She also explores the challenges that these experienced workers may face with this type of learning and ways in which career counselors and coaches can support them. Additionally, she identifies how human resource professionals can utilize this information to identify organizational training and development needs.

Laurie Carlson and **Bernadine Knittel,** speak to the role of school counselors in helping students consider and prepare for the competitive workplace within STEM work. Their **Using the Career Decision Making System (CDM) to Enhance STEM Opportunities for Secondary Students** offers hope and a case study about offering STEM-Centric academic and post-secondary planning.

STEMcareer.com - Resources for Students, Educators, Counselors, and Parents by **Bradley T. Graham** reviews the elements and potential of a non-commercial practitioner's website designed for counselors, parents, students and educators as a tool to help those seeking and promoting STEM careers. His lens as a university career counselor offers useful insights about application.

In **Applying Lessons Learned from Women/Minority STEM Retention to Build the Next Generation of "STEM Innovators," Marie Zimenoff** explores various reasons why the United States falls behind other nations in awarding STEM degrees and retaining professionals, including the economic cost. She then proposes practical interventions, from building individual self-efficacy to increasing corporate partnerships, that career professionals can use with students and professionals in the STEM fields to help increase persistence and retention.

In **Career Advising Workshop Exercise for Software Engineers, Todd Sedano** and **Mikelynn Romero** discuss the difficulty STEM students face connecting the new skills obtained in their education to open jobs in the workforce. To meet this challenge they devised a workshop based on the Holland Party Game by Bolles (2012) and adapted it to the software industry. They share the initial results of the workshop in which they matched software industry skills with the Holland code descriptions, and they provide ideas for future research and activities.

As Director of Global Talent Management at General Motors, **Bill Huffaker** offers an inside look at the shared responsibility among employees, managers and organizations for career development within a competitive workplace. Within **Creating a Culture of Career Development in Corporations** he advocates for a shared leadership mindset to drive a development culture within the corporation.

HIRE Education: STEM and the Transportation Industry by **Janice M. Tkaczyk,** a retired school counselor and now staff member of Universal Technical Institute, highlights the importance of career technical education and helping students stay in rigorous high schools to build strong companies able to drive the transportation infrastructure in a highly competitive environment.

And to complete this volume **Jenn Long** and **Rich Feller** offer **An International View of Career Development: Interventions Addressing Global Competition in the STEM Marketplace.** Examining a competitive workplace requires looking beyond and across borders to understand the full picture of where and how STEM-Centric careers influence career development efforts internationally.

As one reflects on NCDA's history and mission and its relationship to the Career Planning and Adult Development Journal, it is a great pleasure to see the public, organizations and countries attend to career planning and adult development. As work and one's career identity can define one's experience and contribute to a sense of purpose and fulfillment, connecting career interventions to factors shaping a competitive workplace is expected. With much gratitude we are pleased to advance that connection within this commemorative volume. And as NCDA members we offer sincere appreciation to Dick Knowdell, the Publisher and Steven Beasley, Managing Editor for this rich opportunity.

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Rich Feller and **Jackie Peila-Shuster,** Guest Editors

Chapter 1

STEM CAREERS IN THE NATIONAL AND INTERNATIONAL ECONOMY

by Charles Lehman

Introduction

As the world becomes ever more interconnected in a high technology knowledge based economy, the STEM (science, technology, engineering, and mathematics) occupations have become increasingly important. Composing only 5 per cent of worker employment, they account for an estimated 50 per cent of economic growth (Adkins, 2012). They are proving to be essential for national economic development, international competition, and individual employment success. During most of the last century the United States has been a world wide leader in invention, innovation, and scientific research, major factors contributing to the substantial increase in living standards in the country. Employment and training for STEM occupations provided the basis for this, resulting in good employment opportunities at remunerative salaries. This trend is expected to continue as shown by current and projected workforce data.

More recently, increasing emphasis has been put on the importance of these jobs in competing internationally as the global economy becomes more technologically advanced and high skill education initiatives are developed in other counties. In 2009, for the first time, over half of U.S. patents were granted to non U.S. companies (National Math + Science Intiative, n.d.). Furthermore, with outsourcing of lower skilled jobs to other countries the United States is becoming more dependent on high skilled jobs to provide employment opportunities and offset losses in lesser skilled occupations and traditional industries.

However, the evidence shows that the United States is falling behind other countries in STEM education and workforce by not adequately enrolling and preparing students for higher education in these high technology fields. As the respected Business Roundtable's Tapping America's Potential Coalition (TAP, n.d.) stated "… the United States is facing a critical talent gap in STEM and is not keeping pace with foreign competition." Failure to adequately educate and employ a high technology labor force will result in a diminished U.S. economy with possible international security issues.

This article highlights data on the current and future employment situation for STEM graduates in the United States and how this country compares with others in the increasingly competitive international economy. It concludes with proposed federal and local solutions to address the issue.

Definition

While there is no single standard definition of STEM occupations, the most comprehensive and official one has been developed by the U.S. Bureau of Labor Statistics. They have identified 97 occupations in computer and mathematics, architecture and engineering, and life and physical sciences along with their associated managerial, teaching, and sales jobs. In total, these number about 8 million jobs in the United States, which is 1 in 18 or 6% of total national employment (Langdon, McKittrick, Beede, Khan, & Doms, 2011). Nearly half of these STEM jobs are in computer occupations such as systems analysts and programmers, network administrators, software engineers, and support specialists. Other occupations include the engineering disciplines, physicists, chemists and biologists. There are occupations that do not require a university degree, such as engineering and science technicians and drafters, with 8.8% of those employed in STEM fields attaining a high school education or less (Langdon et al., 2011).

Recent Employment Trends

Employment opportunities in STEM fields have been very good in recent years during both growth and recessionary periods. STEM occupational employment in total has grown three times as fast as non STEM occupations in the first decade of the 21st century (Langdon et al., 2011). Even during the recession beginning in 2007, unemployment among STEM occupations has been less severe, peaking at a rate of 5.5% in 2009 compared to 10% for non STEM which occurred in 2011 (Chairman's Staff, U.S. Congress Joint Economic Committee, 2012). For computer and mathematics jobs, the comparison has been even more favorable with an unemployment rate of only 4.1% in 2012 compared to the overall 8.9% unemployment rate. In addition to employment opportunities, wages for these worker groups are well above the national average. The top ten bachelor degree programs with the highest annual wages are all STEM occupations.

Anecdotal evidence points to a continuing unmet demand for engineering, computer, and certain science workers. Many manufacturing and other industry managers express concerns about a shortage of available engineering and science graduates to hire. In contrast to this, a few analysts have been pointing out the worker glut in such fields as chemistry and claiming that certain high technology employers are overstating the job need to ensure a readily available labor supply from an increased graduation cohort and easing of regulatory restrictions on hiring foreign scientists and engineers (Downey, 2012). However the predominance of evidence in the employment data supports the current analysis of a STEM worker shortage with favorable employment opportunities.

STEM Skills in Other Occupations

According to a brief by Langdon et al. (2011), about two thirds of the 9.3 million workers with STEM degrees work in a non STEM occupation. This additional demand for STEM trained workers comes from the increasing need for computer applications and technical knowledge skills in other industrial and occupational areas and provides another competitive advantage for STEM trained workers. In particular, fields such as health and education employ a large proportion of such workers. Furthermore, STEM degree holders earn higher wages whether they work in STEM occupations or not.

National Job Projections

The most recent official job projections are those by the Bureau of Labor Statistics in 2012. They forecast job growth in STEM related occupations to increase at 17% over the 2010-2020 decade compared to 14% for non STEM jobs (Chairman's Staff, 2012). Certain occupations will increase substantially more rapidly; most computer and related jobs which comprise nearly half of the STEM jobs are projected to increase much faster than average with systems analysts at 22% and both data base and network administrators and network over 27% (Cover, Jones, & Watson, 2011).

International Graduate Comparisons

There are 350,000 bachelors degrees in STEM majors awarded annually in the United States (Chairman's Staff, 2012). Graduate enrollments in mathematics and science fields increased by 35% in the last decade (Gonzalez & Kuenzi, 2012). While the number has been growing, it is primarily due to the increase in overall graduate school enrollment. Masters degrees in STEM fields have actually decreased from 18% as a percentage of all degrees to 11% over the same period. Proportionately the percentage of bachelors degrees that are STEM majors has also decreased, from 24% in 1985 to 18% in 2009 (they are projected to decline further to 16% by 2020) (Chairman's Staff, 2012). Furthermore many of these degree recipients are foreign students who do not plan to or cannot stay in the United States.

A useful international comparison is with the countries in the Organization for Economic Co-Operation and Development (OECD), 34 nations in North and South America, Europe, and Asia which have comparable educational and economic systems and data. While the total number of STEM degrees granted each year in the United States is the most of any OECD country, the share that are STEM graduates in the United States ranks 27th, considerably below the OECD average (Chairman's Staff, 2012). The top countries for this measure are France, Germany, and South Korea; even less developed countries like Mexico and Turkey rank higher than the United States. Using another measure of competitiveness--the number of STEM graduates employed as a proportion of all employed younger workers (25-34 year-olds)--the United States ranks 23rd, well below the average, and trailing such countries as South Korea, England, Australia, Canada, and Germany (Chairman's Staff, 2012).

Realizing the critical importance of highly trained workers in a technologically advanced world, many foreign countries are rapidly expanding their university engineering and science infrastructure and enrollments. Examples of these include Saudi Arabia building a $10B science and technology center, Russia's innovation university, and Singapore's scientific investment of over a billion dollars in medical science education. China is funding tens of new technology universities and now graduates over 400,000 engineers per year compared to 60,000 in the United States (down from 70,000 ten years ago) (Langdon et al., 2011). In Asia, 24% of graduates are engineers compared to 5% in the United States (Langdon et al., 2011).

International Education Comparisons

The United States does not rank well in STEM education measures compared to other countries. The World Economic Forum ranks the United States 48th in quality of mathematics and science education (National Math + Science Initiative, n.d.). A prime indicator of international competitiveness is mathematics and science proficiency among high school students which is closely tied to the ability to satisfactorily complete postsecondary education in a STEM postsecondary educational major. Alarms have been raised about how poorly the United States performance ranks in this measure of its educational system. By this measure, the United States is sorely lacking with one respected test showing them lower than average among OECD countries and with only 5 countries measurably lower. The United States is behind 31 other countries in mathematical proficiency. Less than a third of U.S. students perform at the proficiency level, well below such countries as Japan, Germany, Canada, and China (Peterson, Woessmann, Hanushek, & Lastra-Anadon, 2011).

Improving student proficiency could result in dramatic economic growth. One estimate is that if U.S. students could attain the proficiency level of Canada and South Korea, it would greatly increase the growth rate by 30-50 per cent over the next ten years which would result in national economic output increase of $1 trillion/year (Peterson et al., 2011). Some analysts attribute the poor levels in part to shortages of well qualified science and mathematics teachers. Attracting the best is more difficult in this country than in many others where teacher pay and prestige well exceed the United States.

Federal Solutions

Both local and national proposals have been offered to address the current and future STEM worker shortage. At the federal level these are primarily legislation to offer financial and other incentives to school districts and to increase the supply of foreign educated workers. At the state and local level these are aimed at increasing the quality and quantity of mathematics and science education and attracting students to these fields. Federal educational initiatives have been limited primarily due to federal budget restraints. A national STEM education strategy is under development concentrating on teacher undergraduate education and outreach to underrepresented minority and female groups. They are focusing on encouraging minority populations (Gonzalez & Kuenzi, 2012). There are also several bills currently in Congress relating to educational and employment barriers (Chairman's Staff, 2012).

However, most federal initiatives are addressing the problem by increasing the number of available foreign high technology workers that can be employed by U.S. companies. One prominent current legislative proposal would offer green card visa status to advanced degree graduates to stay in the United States. The employers of these immigrants would pay a fee to support science education. This is a part of the whole immigration legislation debate which is expected to result in increased foreign high skilled workers. Regardless of outcome, the limited number of such foreign workers should not reduce the need for domestic worker training and needs.

Local Solutions

At the state and local levels, the main emphasis for success will need to come from local educators, counselors, and educational administrators. A number of recommendations have been made, primarily at the k-12 pipeline that should increase the number of qualified STEM students. These include:

For administrators

- Strong mathematics and science programs in k-12 schools (Half of Americans say their local public schools do not put enough emphasis on mathematics and science education [Langdon et al., 2011].)
- More and better mathematics and science teachers (Only one in five STEM college students felt that their education from k-12 education

provided excellent preparation for STEM college courses [STEM Education Coalition, 2011].)

For teachers and counselors (Wentzel, 2012)

- A strong emphasis on the importance of students taking mathematics courses
- Advising students on the opportunities and advantages of STEM careers (Eighty percent of college STEM students made that decision before leaving high school [Microsoft, n.d.].)
- Using career information assessment and informational systems to help students understand all aspects of STEM occupational training and work, and how their abilities and interests align them with those opportunities
- Providing mentors and role models
- Promoting STEM careers to underrepresented female and minority students

Conclusion

Workers in the high technology STEM occupations are critical for continuing economic advances in the United States. These jobs have and will continue to offer favorable employment opportunities. However, the proportionate number of new college graduates has been declining in the United States as those in other countries rapidly increase. Furthermore, national high school mathematics and science programs and student abilities are rapidly falling behind many other nations. While some governmental policies are being proposed to address the issues, they do not match the efforts and successes in many other countries. Without a major increase in educational efforts resulting in more STEM professionals, the United States risks losing its international economic leadership.

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About the author

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Chapter 2

STEM 2.0: TRANSFORMATIONAL THINKING ABOUT STEM FOR EDUCATION AND CAREER PRACTITIONERS

by **Jim Brodie Brazell**

Introduction

STEM (science, technology, engineering, and mathematics) is a key concern for all those interested in the advancement of education and workforce competitiveness, and now provides the impetus for promoting economic growth, wealth creation, and national security in the United States and most industrialized nations. Although STEM is now at the forefront of policy and education practice, the current approaches are driven by the perception that there is a shortage of STEM talent.

Labor market data do not indicate a rise in STEM wages attributed to labor market shortages. In other words, the laws of supply and demand indicate, on the whole, there is no shortage of STEM workers today relative to demand. There are, however, a few pockets of STEM jobs where there are shortages including engineering disciplines, multi-skill technicians, and the Federal cyber security workforce. While data do not indicate an overwhelming demand for STEM workers, many job forecasts show increasing demand for STEM workers over the next decade.

This paper points to problems in the theoretical underpinnings of dominant U.S. education and workforce definitions of STEM, while presenting a broader conceptual framework for practitioners to understand STEM in terms of innovation. Today, exigent labor market requirements are for STEM-based skills across many jobs not typically classified as STEM. The net effect of the adoption and diffusion of technology is transformation of social institutions—including family, work, school, law, the economy, and national defense. It is therefore important to define STEM in a way that elucidates how these institutions are changing as well as what skills give rise to economic innovation and sustainability of democratic ideals.

The Wisdom of Crowds

"By a show of hands, what percentages of jobs in the United States in 2010 are classified as STEM jobs by the United States Department of Commerce? How many people think it's 60 per cent or more? How

about 25 to 49 per cent? 6 to 24 per cent? Less than 6 per cent?" The answer is 5.5 per cent. (Langdon, et al, 2011) per cent

Above is an informal audience survey the author has delivered during approximately 50 public U.S. STEM workshops and speeches for industry, education, workforce, economic development, and military career and education practitioners between 2011 and 2013. The result of this informal survey has been virtually the same: 50 per cent of audiences believe that 60 per cent of U.S. jobs are classified as STEM. The overwhelming majority of audiences believe that 25 per cent or more are classified as STEM jobs. And, approximately one per cent of audiences get the answer, 6 per cent or less, correct.

The proclivity of education and workforce practitioners to overestimate the number of jobs classified as STEM by a factor of 5 to 10 indicates that audiences view STEM as greater than the sum of its specialized education and career parts. Today, however, the dominant practice in education focuses on STEM as math and science while positioning technology as instructional technology.

For example, Educate Texas states: "The Texas Science, Technology, Engineering and Mathematics (T-STEM) Initiative offers a fundamental approach to empower teachers, inspire students, and advance the studies in these four fields. The public-private initiative of academies, professional development centers and networks is designed to improve instruction and academic performance in science and mathematics-related subjects at secondary schools." (Educate Texas, 2013)

When audiences are asked to define STEM, however, approximately one-third defines STEM as a process of change enabled by technology artifacts (computers, networks, robots, cell phones, software, etc.). In other words, many education and workforce practitioners view STEM as innovation: The tools, knowledge, and processes necessary to transform existing situations into preferred situations.

While many career and education practitioners generally understand STEM as a transformational system of technologies and a process of innovation, the dominant workforce and education definitions of STEM are functionally specialized, missing the systemic and transformative nature of STEM and the wisdom of practitioners (crowds).

U.S. Department of Commerce Definition of STEM Jobs

The U.S. Department of Commerce, Economics and Statistics Administration July 2011 Issue Brief, ***STEM: Good Jobs Now and For the Future***, lists fifty specific occupation codes totaling 7.6 million STEM workers, or 5.5 per cent of the workforce in 2010. The occupational codes are divided into four categories: computer and math, engineering and surveying, physical and life sciences, and STEM managerial occupations. The Department of Commerce offers the following definition of STEM along with the rationale for discounting other science- and technology-based disciplines: The acronym STEM is fairly specific in nature—referring to science, technology, engineering, and math—however, there is no standard definition for what constitutes a STEM job. Science, technology, engineering, and math positions consistently make the lists of STEM occupations, but there is less consensus about whether to include other positions such as educators, managers, technicians, health-care professionals or social scientists. In this report, we define STEM jobs to include professional and technical support occupations in the fields of computer science and mathematics, engineering, and life and physical sciences. Three management occupations are also included because of their clear ties to STEM. Because of data limitations, education jobs are not included. Further, we elected not to include social scientists. (Langdon, et al, 2011)

The largest group of STEM jobs lies within the computer and math fields, accounting for 46 per cent of all STEM employment. Second are engineering and surveying occupations with one-third of STEM employment. Thirteen percent of STEM jobs are in the physical and life sciences, and 9% of STEM jobs are management occupations. The Brief defines STEM employment to include not just scientists and engineers, but also science and engineering technicians and drafters, while computer occupations range from computer support specialists to computer software engineers. (Langdon, et al, 2011)

There is a lack of granularity in labor market data, making meaningful understanding of STEM jobs very difficult. Traditional approaches to specialized labor market classification functionally obfuscate the increasingly integrated nature of STEM knowledge and skills required of many jobs not typically classified as STEM. This specialized and functional definition of STEM seems to be aimed at defining STEM in terms of the perceived value of disciplines and jobs necessary for technological advancement of society without regard for the contributions of other disciplines to technological invention and innovation. Indeed, the advancement of technology through innovation is proven to arise from the plurality, debate, discourse, veracity, and synthesis of knowledge, rather than specialized notions of jobs or disciplines.

In order to understand STEM jobs, one must look beyond traditional STEM labor market definitions (and codes) to the transformational system of technologies, work processes, and competencies ushering in job innovation. And, in order to understand what conditions give rise to invention and innovation, one must look to the intersection of disciplines and perspectives.

Knowledge and Skill Innovation: Toward a Method of Defining What's Next in Jobs

According to Richard Froeschle, a Labor Market Economist with the Texas Workforce Commission: There are thousands of job openings, regardless of the occupational title, for which employers are looking for folks with strong, core scientific, statistical, and technology competence. The true secret behind the curtain is more than the handful of real occupational shortages we have in several engineering and IT disciplines (including cyber security) but the absence of scientific thought processes and application of mathematical precepts across many different occupations—most of which transcend traditional STEM definitions. (R. C. Froeschle, personal email communication, March 19, 2013)

To illustrate Froeschle's point, consider the case for STEM+ARTS jobs. Arts-based jobs in copyright industries contribute significantly to U.S. gross domestic product (WIPO, 2012). Arts-based jobs are key to U.S. innovation and wealth creation and many are functionally dependent on mastery of core science, technology, engineering, and mathematics principles and processes (Brazell, 2011). Examples include architects, video game designers, special effects artists, video postproduction editors, sound engineers, and even 2-D and 3-D artists.

Froeschle has made significant strides in understanding the labor market impact of STEM-oriented work activities and related underlying competencies. His work yields a broader definition of STEM jobs and a more granular understanding of the ubiquitous nature of STEM across many occupations and industry clusters. One may understand this systemic approach to jobs analysis as ***knowledge and skill innovation.*** Knowledge and skill innovation is the practice of identifying how social institutions such as employment are changing procedurally, and what competencies support institutional growth and sustainability through both analysis and synthesis. Understanding how jobs are changing relative to emerging technology and labor market need is important to the transformation of workforce competitiveness. Analysis and synthesis of knowledge and skill innovation are also integral to understanding how education, medicine, law, mass media, civil society, the economy, and national security are changing.

The STEM Effect: Understanding How and Why Work is Changing

In STEM, research processes and disciplines are being redefined by the functional integration of disciplinary knowledge and processes. This effect was labeled convergence at the turn of the century by the National

Science Foundation and other scientific, engineering, and computer science institutions (NSF/DOC, 2003). This consilience—jumping together—of knowledge and disciplines distinctively marks the birth of a new era: Convergence means a broad rethinking of how all scientific research can be conducted, so that we capitalize on a range of knowledge bases from microbiology to computer science to engineering design. In other words, the convergence revolution does not rest on a particular advance, but on a new integrated approach for achieving advances. (MIT, 2011)

The functional integration of disciplinary knowledge and processes is not only part of emerging science and technology research and development; it is also an overwhelming characteristic of work in the 21st Century. This trend is driven by the convergence of technology, data, and work processes. While computers deliver efficiencies often resulting in less people required to perform work tasks, the activities left to humans often require integration of knowledge and skill for individual workers, as well as a requirement for small multi-disciplinary teams to effect work outcomes.

Whether one works at a fast food restaurant, an automotive repair shop, a school, a farm, a manufacturing plant, a nuclear power plant, a bank, a government office, a forest preserve, or a science and technology research and development laboratory, computers have become an integral part of work processes and there is a general trend toward knowledge and skill synthesis. For example, nurses are now required to be patient advocates, caregivers, technicians, computer operators, researchers, first responders, and supply chain managers.

Modern work is characterized by increasing abstraction demanding cognitive and interpersonal skills effective at solving complex problems. It is often dependent on collaboration of multi-disciplinary teams to achieve innovation through design processes. General requirements for work include computing skills, multi-disciplinary (or systems) knowledge, inter-personal communication skills, collaboration and negotiation skills, design process skills, and innovation-based problem solving.

While the industrial era was fueled by worker specialization, the emerging economy is characterized by an integration of knowledge, and a requirement for workers who transcend traditional functional and disciplinary boundaries. One should understand the cause of this change in the context of work as increasing automation and computer-driven work processes, while the effect is a general requirement for transdisciplinary actors.

National Academies of Science Definition of STEM for K-12 Education

In September 2010, the President's Council of Advisors on Science and Technology (PCAST) presented their definition of STEM education in the context of K-12 education in the report, ***Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America's Future.*** According to PCAST: *STEM education,* as used in this report, includes the subjects of mathematics, biology, chemistry, and physics, which have traditionally formed the core requirements of many state curricula at the K-12 level. In addition, the report includes other critical subjects, such as computer science, engineering, environmental science, and geology, with whose fundamental concepts K-12 students should be familiar. The report does not include the social and behavioral sciences, such as economics, anthropology, and sociology; while appropriately considered STEM fields at the undergraduate and graduate levels, they involve very different issues at the K-12 level. (PCAST, 2010)

For career and workforce education practitioners, it is imperative to note that the words *Career and Technical Education, Career Pathways, Programs of Study,* or *Vocational Education* do not appear once in the 118-page tome that forms the platform upon which working groups were formed and ultimately upon which policy decisions have been made for K-12 STEM education. It would seem that PCAST's narrow and specialized definition of STEM lends itself to the cultivation of the vocations of science, technology, engineering, and math practice, however, the analysis, recommendations, and funds flowing from these recent efforts have effectively disenfranchised Career and Technical Education (CTE) from STEM practice.

Education, workforce, economic development, and national defense are all being transformed by convergence and the STEM Effect. What is required now, more than ever, is a systemic approach to understanding change such as knowledge and skill innovation.

In order to bring about desired outcomes relative to innovation, an integration of knowledge- and skill-based instructional techniques is required to align incumbent and dislocated workers, as well as the next generation (children in school), with changing technology, labor market requirements, and the demands of civil society. In the context of primary school education, even PCAST suggests this approach backed by research:
…a growing body of research has illuminated how children learn about STEM, making it possible to devise more effective instructional materials and teaching strategies. The National Research Council and other organizations have summarized this research in a number of influential reports and have drawn on it to make recommendations concerning

the teaching of mathematics and science. These reports transcend tired debates about conceptual understanding versus factual recall versus procedural fluency. They emphasize that students learning science and mathematics need to acquire all of these capabilities, because they support each other. (PCAST 2010)

It is time for education practitioners and policy makers to move beyond the progressive and conservative political ideologies that effectively divide the worlds of science and art, classical education and practical arts, and academics and Career and Technical Education. We are now witnessing the era of convergence, consilience, and transdiscipline.

The unification of classical knowledge, practical arts, artistic expression, and contemporary technologies is the key to finally achieving real and meaningful change in schools. The goals of increasing student retention, performance, graduation, and matriculation can be realized by opening schools more fully to include STEM, the arts and Career and Technical Education as part of mainstream education practice for all students. A movement toward this unification in education is demonstrated in pockets of innovation today.

The Arts Effect on STEM: Understanding TEAMS Education as the Basis for Education Transformation

The PCAST report and the Department of Commerce Issue Brief cited above define STEM similarly. Most notably, both include (1) computer science and computer technician disciplines along with (2) engineering and engineering technician disciplines with near equal weight to scientific disciplines. This represents progress in policy circles while broad educational adoption is still pending.

Ultimately, the lack of parity for science and engineering, or science and computer science, can be attributed to prejudice that alienates both as *crafts* focused on *applied arts* in contradiction to *pure science* or *serious academic inquiry*. Though recent efforts related to STEM have given engineering and computer science some lift relative to *academic* subjects, in K-12 schools, community colleges, and universities, these subjects are largely relegated to non-essential and non-core subjects for general education students. This prejudice against applied arts prohibits fully realizing the potential benefits of unifying academic studies and applied learning techniques as a method of achieving goals related to increasing performance outcomes for communities, schools, teachers, and students. The two reports are also parallel in negating the following disciplines and related jobs as integral to STEM: (1) social science, (2) behavioral science, (3) medical and allied health, (4) business, marketing, entrepreneurship, and accounting, (5) architecture and technical arts (such as 3-D digital media design or copyright-based jobs), and (6) law and international studies—not to mention the arts. The idea that these disciplines are separate and not core to STEM is a form of intellectual isolationism that will cost proponents the benefits of real progress and ultimately equity in educational outcomes.

While the aforementioned disciplines are typically not included in current STEM policies and educational practices, there are movements in the U.S. and abroad to couple STEM and non-STEM subjects to promote innovation in educational practice. For example, STEM and arts, STEM and Career and Technical Education, STEM and liberal arts, STEM and entrepreneurship, STEM and research, and STEM and medical (health care) initiatives have appeared in the literature and in practice since 2005. The most promising of these initiatives intellectually is, ***Innovations in the Formal Education of Future STEM Innovators***, the work of Bob Root-Bernstein Department of Physiology, Michigan State University. (B. Root Bernstein, n.d.)

In these model initiatives the common denominator is usually (1) integration of subjects and knowledge, (2) application of knowledge through practice, (3) use of contemporary technologies, processes, and tools, and (4) fundamental and balanced inclusion of the arts, computational thinking, and engineering design. The true distinguishing feature of what is next in education, however, is (5) the pursuit of transformation of some aspect of society led by students. Schools that unify these five features are what the author calls classical contemporary education, or TEAMS. TEAMS is an acronym for *technology, engineering, arts, mathematics, and science*.

Opening the Door to the Real World: The Catalytic Role of Transdiscipline

The key ingredient of classical contemporary education is the intersection of classical and contemporary knowledge with the goal of enabling student-driven transformation of society and the natural world through innovation: the creation of new discourse, knowledge, processes, systems, tools, and/or languages. At the heart of TEAMS-based schools is the belief that students can and will make contributions to advancing society through creativity and innovation if we simply facilitate, teach, support, and enable students to integrate school learning with transformational initiatives in the world at large. Rather than closing the door and saying, *The real world is out there but the classroom is the only world that matters now,* the TEAMS approach to human development throws the doors of education open and asks students to make a difference in the world by making a unique and compelling contribution through public projects. This practice can be understood as transdiscipline.

The responsibility and method of transdiscipline in education is to get students to be involved in the transformation (design, execution, and sustainability) of their particular circumstance as well as the transformation of society and the world. The role of transdisciplinary research and learning is ultimately to promote process and design supported by rational thought while allowing room for the idea that all knowledge is provisional and subject to change in time.

According to Murat Tanik of the Society for Design and Process Science: The scientific world-view simply says *we know very little and the little we know is subject to change and not fully reliable*. This little sentence above took thousands of years of human efforts to develop. However, in current education even with *robots and what not* we cannot relate this notion to young people. Learning only mathematics, science, and engineering does not teach this. And does not develop mature rational and ethical human beings.

Transformative thinking or thinking for understanding (or scientific thought process) are identical and necessary conditions for any early education for all human beings. This is different from teaching science. It is teaching a type of thinking which has its roots in curiosity, skepticism, and rationality. (M. Tanik, personal e-mail communication, March 23, 2013)

Like a model or simulation, the math is never perfect but it is simultaneously exact in a given run-time, yet it is perpetually open to change, including complete reconceptualization. In this way, transdiscipline moves beyond the dichotomy between subjective and objective notions of science and art without which scientific revolution (Kuhns, 1970) would not be possible. This reflexivity between art and science is necessary for human advancement, understanding, and innovation. Without this oscillation, we would be perpetually stuck in a given moment of time, and a given understanding of the world, and a given understanding of the self, and a given understanding of our relationship to one another and the world. Like stories that are both fact and fiction, scientific and artistic reflexivity opens the human species to the possibilities of evolution, creativity, and ultimately free will.

A Critical Intersection: Unifying Theory and Action

The intersection of school-based learning and public engagement is essential to educational innovation and transformation today. Seymour Papert's adaptation of Jean Piaget's constructivism offers a theoretical platform for the importance of public engagement—connection theory and action in the public sphere. Piaget proposed the theory of *constructivism* in human development. According to Papert:

Constructionism-the N word as opposed to the V word-shares contructivism's view of learning as *building knowledge structures* through progressive internalization of actions... It then adds the idea that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it's a sand castle on the beach or a theory of the universe. (Papert, 1991, in Ackermann, n.d.)

Without an intersection between schools and the public sphere, learning is a closed garden. By opening the garden to public performance, engagement, and discourse, we open students to the very real and consequential notion of self-efficacy through social constructivism while promoting cultural innovation. In other words, unification of theory and action in learning closes the feedback loop among human development, human motivation, human experience, and the purpose of learning: to cultivate human understanding, empathy, and sustainability.

Lev Vygotsky's cultural-historical psychology also offers a theory of development that is useful in this context: Vygotsky (1978) argued that learning is not a matter of autonomous development but, instead, a kind of *cultural apprenticeship* in which, by taking part in activities with others, the learner encounters and appropriates the tools and practices of the community and, in the process, transforms them into personal resources for individual thinking, feeling and acting. (Wells and Ball, n.d.)

Like some of the author's audiences who see STEM as the tools, knowledge, and processes necessary to transform existing situations into preferred situations, classical contemporary education transcends STEM to unify knowledge and the arts with an eye toward students leading the way to the future through public engagement. Examples of classical contemporary education in the U.S. include: (1) Philadelphia Performing Arts Charter School (K-8), ppacs.net, Philadelphia, PA, (2) Clark Magnet School, clarkmagnet.net, La Crescenta, CA, (3) Indian River State College, irsc.edu, Fort Pierce, FL, (4) University of Maryland Baltimore County, umbc.edu, Baltimore, MD, (5) Olin College, olin.edu, Needham, MA.

Conclusion: Toward a Transformational Definition of STEM

When our predecessors stood at the edge of the world and gazed at Sputnik orbiting, they did not respond to the Russians' apparent lead in science and technology with a narrow focus on cultivating science- and technology-based leaders. Brigadier Gen. Robert F. McDermott, the founding dean of the U.S. Air Force Academy, redefined military training and set a precedent for the transformation of military academies and universities to connect art and science, classical learning and applied arts. Rather than focusing exclusively on military life and science and technology, General McDermott, created the Air Force Academy by converging military leadership training, classical education studies, and STEM (Brazell, 2008). In effect, he advocated and created a model of classical contemporary education based on his experience at the first American public school and his alma mater: Boston Latin. The object lesson for STEM proponents in General McDermott's approach is that a world characterized by increasing science- and technology-based complexity requires expanding human development to include a broader range of disciplines, subjects, knowledge, perspectives, and processes to enable creativity and ultimately cultural sustainability. Similarly, today our strategy for education, workforce, and economic development innovation requires a transdisciplinary approach.

Therefore, when we set out to analyze jobs and make recommendations relative to education, we should move past the STEM 1.0 idea of specialized disciplines. STEM 2.0 defines STEM as the transformational system of technologies, knowledge, and skills necessary for X. The ***X*** in the equation can be educational innovation, workforce competitiveness, economic growth, or what ever one's end goal.

In the end, what is required in our understanding is to see technology not as an artifact such as a computer or a robot, rather, as the unification of art and science to transform society through the process of design. We are the technology. Technology is not an external force, beyond our control, acting on society. Technology is a mirror of the human condition, our will, and our effort.

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Jim Brodie Brazell is a public speaker and jobs and technology forecaster based in Texas. He is a member of the Society for Design and Process Science (SDPSNET.org) STEM committee. SDPS' goal is to be a catalyst for change, enabling the discovery of new approaches that lead to alternative solutions for the increasingly complex problems that face civilization. In 2012, Brodie was recognized by the Society for his contributions to STEM including being a voice for transdisciplinary theory and practice. During 2012, he contributed to ***Building a More Secure and Prosperous Texas, A Report from the Texas Cybersecurity, Education, and Economic Development Council*** catalyzing a SEMATECH-like movement for industry R&D collaboration and information-sharing across industries. During 2012 he authored: ***How Children's Toys Reflect What's Next in Technology and in Education*** and ***Internet 2.0: What's Next in Computing - How Cyber Physical Systems are Changing Business, Commerce, and the Economy.*** Forthcoming publications in 2013 include: The Need for a Transdisciplinary Approach to Security of Cyber Physical Infrastructure and The STEM Effect: Innovation through Transformational Thinking and Practice. During the past decade, his work includes: supporting the formation of the Austin-San Antonio Corridor, accelerating one dozen start-ups; catalyzing regional and international high technology initiatives; performing technology forecasts for the State of Texas; designing video games for major military commands and civilian workforce initiatives; and advocating for TEAMS and classical contemporary education in school reform. In 2008, his essay, ***The Bellwether Sounds***, was one of the first public voices proclaiming the need for the people to recognize the importance of science and technology to U.S. global competitiveness and security. For the past six years, he has been a featured speaker at national education, workforce, defense, and economic development conferences. A collegiate national champion in public speaking from Bradley University, a few of his audiences include: The World Book Fair, 11th and 12th International Conference on Technology Policy and Innovation, The World Congress on Information Technology, National School Boards Association, International Society for Technology in Education, Reliance 21 - Defense Science and Technology, National Security Agency, Armed Forces Communications Electronics Association, Society for Design and Process Science, and the Chautauqua Institute. He is a STEM advocate for the IDEAS Orlando creative team, and a member of the Thornburg Center for Teacher Professional Development. He is an active volunteer to the Society for Design and Process Science, the Software Engineering Society, the Greater San Antonio Chamber of Commerce IT Committee, Cybercityusa.org, and a supporter of SolarHigh.org (Space Based Solar Power). He is a 1994 George Gilder Fellow in High Technology, Entrepreneurship, and Public

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Chapter 3

NEW JOBS AND NEW SKILLS FOR A CHANGING WORKPLACE:

STEM-Enabled Technicians and Professionals

by **Joyce Malyn-Smith** and **David M. Smith**

Introduction

Worldwide rapid technological advances of the last quarter century have produced a global innovation economy driven by technology. New technologies and their work applications have profoundly affected all industry sectors from medical imaging to large-scale databases used in financial services and research to construction of energy efficient and healthy buildings to the arts. At the same time connectivity brought about by the internet has created a new global workplace providing new ways of working online and in geographically distributed teams.

While familiar reports cite the need for more scientists and engineers (Business Round Table, 2005; National Academies of Sciences, 2005), the Thrive Report (Council on Competitiveness, 2008) speaks to our nation's need to retain a leadership position in technology in order to "outcompute" and thereby outcompete in the global innovation economy. Thrive cites the need for "more computational scientists and engineers to leverage America's IT advantage" (Council on Competitiveness, 2008, p. 6) as one of the four areas policymakers need to focus on to ensure that Americans can maintain our innovative advantage. The NSF set a bold Cyberinfrastructure Vision for 21st Century Discovery (NSF, 2007) and laid the groundwork for increased attention on STEM education to prepare a future work force with the skills and knowledge needed to design, deploy, adopt, and apply cyber-based systems, tools, and services (NSF, 2009). Sharing similar concerns, computer scientists and educators have approached this issue by exploring and advocating for the integration of computational thinking (CT) into the K–20 curricula in order to ensure that all learners leave school with the ability to think like computer scientists using cyberinfrastructure resources to carry out routine tasks and solve problems at schools and at work. These changes have created new jobs in America's workplaces and a demand for new skills needed for workplace success.

At the same time we are mindful of a new generation of digital natives developing a different skill set through their long-term intensive interactions with traditional and new technologies. In addition to changing social, communication and problem solving routines, many believe that these technology experiences are changing the way youth think and process information (Are digital natives wired differently?). If so, then while we are in the midst of rapid technological change we are also in the midst of profound cultural and social change. Combined, these two shifts – the shift towards using technology tools and processes for living, learning and working; and the shift in ways of thinking and problem solving associated with human/computer interaction – are reshaping the world of work. It also presents a significant challenge to career development professionals seeking to assist youth and adults in moving towards productive and rewarding careers.

Though this sea change is taking place, the number of STEM empowered workers in the United States is not able to meet our nation's needs despite a broad base of support from policy makers, practitioners and researchers concerned with developing our nation's next generation of STEM talent. Some of the factors leading to this skills shortage include: (1) The retirement of baby boomers with bachelor degrees. STEM workers are the fourth largest group of that population (Carnevale et al, 2011). (2) The decline in the number of post-secondary students in the U.S. seeking STEM degrees to about 18 percent, half of which are foreign students. Though producing the most degreed stem workers, the US ranks 27th in the percentage of STEM graduates in industrialized nations (STEM, 2012). And (3) The need for a *homegrown* STEM pipeline to fill positions in our secure national laboratories and defense agencies is of great national concern. Add to that the changing nature of STEM jobs needed for a changing workplace and the problem is heightened.

New Skills for New Jobs

As we explore the new world of work we can see many new jobs developing in large and small companies as well as substantive changes in the skills people need to succeed in these highly technological work environments. What does the research tell us about the new skills needed for new jobs in technology, science, engineering, and math? Below are examples of two new jobs whose creation was driven by technological change. They are followed by examples of research on skills that are needed to succeed in the new workplace, and suggested activities to help career professionals better understand the skill requirements of the new STEM workforce.

New Jobs for the New Workplace – Mecomtronics Technicians

The term **mecomtronics** is defined as *The combined disciplines of mechanics, computers, telecommunications and electronics; robotics* (ATE, 2004, p. 15). As technologies are driven deeper into the world of work, new occupations are emerging that require workers to be cross trained in more than one traditional career field. One of the first, and now commonly known mecomtronics occupations, is the Mecomtronics Technician who maintains, troubleshoots and repairs mechanical equipment driven by electronic components. As the need for such workers grew, so did the technical training programs that prepare these technicians for work. Program developers integrated the most relevant components in the curricula of mechanics, computers, telecommunications and electronics programs to train Mecomtronics Technicians to perform the routine tasks and solve problems related to this new career field. A Mecomtronics Technician might troubleshoot and repair equipment in a computer driven robotic manufacturing assembly line, or green building HVAC (heating, ventilation and air conditioning) system.

New Jobs for the New Workplace – Health IT Specialists

More recently the computerization of health records created new jobs in a field now called Health IT (Information Technology). Health IT specialists maintain health records, facilitate information sharing across healthcare providers and public health authorities, and help redesign the flow of work within health and hospital settings. Their responsibility is to maximize the quality and efficiency benefits of electronic health records while maintaining privacy and records security. Through funding from the Department of Health and Human Services, community colleges nationwide are redesigning courses and establishing new programs to prepare workers for this new field. New Health IT occupations include (a) practice workflow and information management redesign specialists, (b) clinical practitioner consultants, (c) implementation support specialists, (d) implementation managers, (e) technical/software support staff, and (f) trainers.

New Skills for the New Workplace – Expert Thinking and Complex Communication

The changes we are experiencing today were discussed in 2004 in ***The New Division of Labor – How Computers Are Creating the Next Job Market*** by Harvard Graduate School of Education Professor Richard Murnane and MIT Economics Professor Frank Levy. Their premise was that many of the routine cognitive and manual work tasks performed by humans would be taken over by computers. The authors identified two general skills that are increasingly needed and which computers cannot replicate: expert thinking and complex communication. They predicted that routine cognitive tasks and routine manual tasks that can be described by deductive or inductive rules would be subject to computerization; consequently, jobs focused on those routine tasks would also be subject to elimination. On the other hand, non-routine manual tasks such as truck driving will remain unaffected, and expert thinking and complex communication will rise. *"Expert thinking, addresses the ability to solve new problems that cannot be solved by rules. New problems range from conducting research to fixing a new problem in a car (not covered in the manual), to creating a new dish in a restaurant. Complex communication, addresses the ability not only to transmit information, but to convey a particular interpretation of information to others in jobs like teaching, selling, and negotiation. If a student gets a calculus lesson from the web, the student will literally have the information. But there is no guarantee that the student will understand the information she is receiving. It takes a good teacher to present the information in a way that allows the student to translate the information into knowledge she can apply"* (HGSE, 2004).

New Skills for the New Workplace - Computational Thinking
Since the publication of Jeanette Wing's article **Computational Thinking** in 2006 -- in which she challenged us to believe that thinking like a computer scientist should be a core skill for all who live, learn, and work in the digital age -- the conversation on computational thinking has expanded into the discourse of the national community of computer science professionals as well as educators who are developing the next generation of STEM talent. Nonetheless, various groups concerned with evolving technological fluency have been struggling to define *computational thinking* operationally or to generate examples that clarify the concept for educators attempting to build pathways to STEM careers (Allan et al., 2010; Cuny, Snyder, & Wing, 2009; National Research Council, 2010; Wing, 2009).

Examples of computational thinking (CT) that could be integrated into K–12 learning were proposed by participants at the April 2010 **Thought Leadership for Computational Thinking Conference,** co-hosted by the Computer Science Teachers Association and the International Society for Technology in Education. The recently proposed images of a *computationalist* as a person who does computing and a *contextualized computationalist* as a person who engages in CT while working in domain-specific disciplines/jobs (Isabel et al., 2009) are helping us to imagine what CT might look like when used to solve workplace problems. "Building expressive and descriptive models of physical, human, or abstract systems" in medicine, engineering, environmental sciences, and other STEM fields is one example of how contextualized computationalists might do this (Isabel et al., 2009).

EDC Research: Computational Thinking in America's Workplace
In the National Science Foundation funded Advanced Technological Education project titled "Computational Thinking in America's Work-

place", Education Development Center, Inc. (EDC) worked with a technical committee of scientists and engineers from the SANDIA and Los Alamos national laboratories and CT thought leaders from the University of Washington, Massachusetts Institute of Technology, Williams College, Santa Fe Institute, and Raytheon Corporation to identify and validate a common core of CT skill sets used by scientists, technicians/ technologists, engineers and mathematicians in America's STEM workplaces. This work resulted in a profile of the Computational Thinking-Enabled STEM Professional. A CT-Enabled STEM Professional "uses skills, habits and approaches integral to solving problems using a computer (e.g. abstraction, automation and analysis) as he/she engages in a creative process to solve problems, design products, automate systems, or improve understanding by defining, modeling, qualifying and refining systems, processes or mechanism generally through the use of computers. Computational thinking often occurs in collaboration with others." (EDC, 2011).

The expert panel identified three job functions which cross cut all of the work of a CT-enabled STEM Professional: engages in a creative process; collaborates; and documents. They also identified eight major job functions: identifies the problem; specifies constraints; designs the model/system; builds the model; develops experimental design; verifies the model; optimizes the user interface and model; and facilitates knowledge/discovery. For each job function the expert team identifies constituent tasks. Sixty-eight tasks, in all, were identified. In addition to the identification of essential job functions and work tasks, the importance of computer modeling in the life of the Computational Thinking-Enabled STEM Professional is worth noting **[Figure 1]** (EDC, 2011).

New Skills for the New Workplace – Social Media

The social media phenomenon made possible by internet technologies began as an outlet for personal expression and creating social groups. However, its value in building identity and in reaching target markets was quickly realized by business. We see social media used today to build business-to-business and business-to-consumer networks, market products and services, engage customers and build a strong business base. The use of social media by business is growing as is the need for Social Media Enabled Technicians.

The FedEx Office **Signs of the Times Small Business Survey** polled 500 small business owners across the country in 2011. In responses to the question about how they plan to grow their businesses in 2011, social media was one of the few methods that gained when compared to the 2009 and 2010 surveys. The study shows that 45 per cent of small-business respondents listed social media in their plans for business growth in 2011, compared to 36 per cent in 2010 and 24 per cent in 2009 (FedEx Office, 2011). This finding is further supported by a study by the University of Maryland's Smith School of Business that looked at the relationship between social media and small businesses. The study found that the "technology adoption rates in the U.S. have doubled in the past year from 12 to 24 per cent. Facebook and LinkedIn have become the predominant platforms for small business owners while it is expected more small businesses will use Twitter as a customer service channel in the year ahead" (Mashable.com, 2010).

EDC Research: Social Media Enabled Professional
Using the same modified DACUM approach (expert panel, development of the occupational profile) employed in the Computational Thinking research, EDC in partnership with the Advanced Technological Education (ATE) National Center for Information and Communications Technologies (ICT) at Springfield Technical Community College identified and validated social media skills needed by technicians to develop their business brand and social network. In addition, after the profile was developed the project team worked with the expert panel to develop examples of how technicians use social media tools in routine work, to solve problems, and manage a business enterprise. Armed with these examples, staff with technical and community college faculty developed rubrics to guide assessment of these new media skills. Future work in this continuing project will include developing problem-based learning scenarios to integrate social media business skills into community college technical program curricula.

The expert panel defined the Social Technology Enabled Professional as one who: builds, maintains, manages and leverages online social networks to engage with customers, business partners, employees and key influencers with the goal of building organizational success (EDC, 2012). The profile identified 59 related tasks and six major duties associated with that new job: conduct research; create a social networking strategy; establish an online presence; create content to engage community; manage online presence; and engage in professional development/ongoing learning.

The value of using social media to build a business brand and network is not limited to building a small business. Its value was clearly shown to this article's co-author, Dr. Malyn-Smith, as the Principal Investigator of the ITEST (Innovative Technology Experiences for Students and Teachers) Learning Resource Center. The ITEST team used social media to improve its service to the ITEST community. The team studied the Social

Media profile and information contained in its associated rubrics, then integrated some of the strategies into its dissemination plan. An editorial calendar was established (Social Technology Enabled Professional task 4A); content appropriate to the specific goal of building participation in an upcoming webinar was crafted (4C); content meaningful to the ITEST audience and consistent with organizational brand and voice was created (4D); compelling content using relevant media (text, audio, video, etc.) was produced (4F) and strategically, syndicated across social platforms and existing markets (4H). The result of this social media approach was a 500 per cent increase in attendance in the targeted webinar over previous webinar attendance with the same participant group.

Today the foundational skills required for this work – use of social media tools and a level of comfort using social technologies as communication devices – are learned in and out of school beginning in childhood. The new workplace skill requires individuals to build on their technology interests and capacities and learn to apply those to specific workplace functions. In this case that function was to use social media to build a business brand and network.

New Skills for the New Workplace - Arizona's New Workplace Employability Skills

In the preceding sections, we focused on the changing STEM employment environment nationally. We also see regional needs driving region-specific approaches to address industry, education and workforce needs. For example, Arizona's New Workplace Employability Skills initiative mirrors the call for new skills identified in the research discussed above. The workplace is an "increasingly dynamic space with a number of key drivers: rapid technological change, the interaction of multiple generations working side by side, and the pace of innovation, all of which place an increased demand for creativity and innovation on the workplace." (Arizona State University, 2011, p. 3). Regardless of the business or industry, no matter how proficient in the technical skills of a job, an employee who lacks the ability to communicate, collaborate, think, and demonstrate a work ethic that supports the goals and culture of the organization is not likely to get or keep, let alone advance in, a job (Arizona State University, 2011, p. 14). Over a two-year period, in a process facilitated by the University of Arizona's Workforce Education Development Office (WEDO), Arizona's employers, met, discussed, and vetted the basic workplace skills they expect their employees to possess in order to ensure productivity and success of their companies and to sustain a strong state economy.

As one Arizona employer noted during a skills standards development session *We hire for the hard skills, we fire for the soft skills* (Anonymous employer, 2012). Arizona's New Workplace Skills model builds upon, expands and deepens our traditional view of the *soft skills* needed for workplace success and reflects the complex and the integrated nature of work in the 21st century. As cited below, this model recognizes three types of skill sets needed for workplace success: Core Human Interaction Skills for the New Workplace, skills related to Developing the New Worker and skills needed for success in the Redefined New Workplace. It also deepens our understanding of the complexities of today's workplace by drawing focus to new skills such as intergenerational competence as well as cross-cultural competence, organizational culture, self-direction, ethical practices, and the nuances of the newly defined core skills of complex communication and expert thinking.

As we dig deeper into this model the Arizona report more precisely defines these skills as follows:

- Skills for Core Human Interaction in the New Workplace include:
- Complex Communication (worker employs complex communication skills in a manner that adds to organizational productivity);
- Collaboration (worker collaborates, in person and virtually, to complete tasks aimed at organizational goals); and
- Expert Thinking (worker integrates a mastery of technical knowledge and skills with thinking strategies to create, to innovate, and to devise solutions).

Skills for Developing the New Worker include:

- Professionalism (worker conducts oneself in a professional manner appropriate to organizational expectations),
- Initiative and Self-Direction (worker exercises initiative and self-direction in the workplace), and
- Intergenerational and Cross-Cultural Competence (worker interacts effectively with different cultures and generations to achieve organizational mission, goals, and objectives); and
- Skills for Success in the Redefined, New Workplace include:
- Organizational Culture (worker functions effectively within an organizational culture),
- Legal and Ethical Practices (worker observes laws, rules, and ethical practices in the workplace), and
- Financial Practices (worker applies knowledge of finances for the profitability and viability of the organization).

The work in Arizona adds to our understanding of the importance of employability within the context of developing STEM-Enabled Technicians and Professionals.

A Continuum Model for STEM

A continuum model for the application of STEM skills and knowledge to life and career roles was developed in 2010, at the Education Development Center, Inc. (EDC, 2010). The **STEM for Learning, Living, and Working** model works outward from (1) STEM skills needed for living and learning to (2) use of STEM skills in all work. These are surrounded by (3) intensive skills and competencies needed for STEM application throughout all industry sectors. The outside band (4) includes technical skills and competencies specific to STEM industry workers and researchers. As one moves along a continuum from the level one inner circle to the level four outside band the depth, breadth, and complexity of needed STEM skills and knowledge increases. Many educators have used this model as a reference point as they have explored ways to address STEM within their school programs and curricula.

Application of Fundamental STEM Skills for Living and Learning.

The center circle contains the core skills of a STEM-Enabled literate society. This level represents foundation knowledge gathered and skills practiced from informal and discipline specific learning within K-12 education. Included in this circle is the application of Science Technology, Engineering, and Math concepts to daily life. Some application examples: balancing a checkbook (Math); online research and purchasing (Math and Technology); waste recycling (Science and Engineering).

Application of Core STEM Skills for Work

Core STEM Skills undergird our world of work. The following examples reflect only a few of the existing applications. The use of technology tools provide a foundation for most business practices and operations from email to data and information management, HR systems, decision modeling and asset tracking. Science and Engineering concept application ranges from selection of ergonomically designed furniture, space allocation, construction planning, material selection, product design and manufacturing, etc. Math concepts underlie development of accounting, payroll, sales, and inventory systems.

Application of STEM Intensive Skills/Competencies to the STEM-Enabled Workforce

The third ring of the model reflects skills and knowledge needed by STEM-Enabled workers. Employment opportunities for these workers exist in sixteen career clusters identified by the U.S. Education Department. As knowledge and innovation economies grow and progress, this STEM-enabled workforce will require a deeper understanding of science, technology, engineering, and mathematics concepts, and more skills in the sophisticated use of technology tools and systems applied to specific industry and business environments. Today's STEM enabled workers are found in every industry sector, for example, educators using e-textbooks, smart whiteboards and websites to teach subject matter; engineers using Computer Aided Design (CAD) and collaboration software to design new products online in geographically distributed teams; and neurointerventionalists who use minimally invasive therapy in to perform angioplasties of blood vessels in the brain to increase blood flow of victims of intracranial aneurisms.

Industry-Specific Technical Skills/Competencies for STEM Professionals.

The outer two circles represent the technical skills and competencies specific to the STEM industry. Scientists, engineers, and technologists who use STEM systems to do their work are part of the innermost of these two circles. Use of computer modeling, technology tools, and cyber infrastructure characterize the work lives of today's scientists and engineers. The outermost circle represents researchers, creators, and developers of science, technology, and engineering products and services. Technology researchers and product designers—those scientists, engineers, technologists, and mathematicians who design and create the STEM products and services—provide the resources that are used by people who populate the other circles.

Including New STEM Skill Areas in Career Development Activities

The *Making Sense of STEM for Living, Learning and Working model* provides a useful tool for career counselors and other career development professionals to visualize the STEM skills progression needed to live, learn and work in today's innovation economy driven by technology; and to differentiate between STEM-enabled careers and careers as STEM professionals. Career development is a process that begins early in life at home, is nurtured in and out of school during childhood, adolescence and adulthood, and is translated into a productive and rewarding career. Even when the career development process is nurtured and supported and a long term vision is cast for a future career, individuals may have difficulty understanding the marketability of their skills/knowledge and how to translate that into a paying job. We offer the following real life example of a high school student who worked for several summers helping his father install computer labs at a local college. When it was time for him to find summer work on his own, his first thought was to try to get a job folding pizza boxes. He was unable to make the connection between the value of the networking technology skills developed in his summer work and the value of his skills to an employer he did not know. In today's world -- where youth and adults develop technology skills in informal, community-based environments, as well as school-based learning environments-- it falls upon those supporting career development to help individuals understand the marketability of their skills and knowledge and translate those into job opportunities. To help career development professionals better understand the skill requirements of STEM technical and professional workers , we suggest the following activities.

- Learn about the new jobs and new skill requirements inherent in a global innovation economy driven by technology by spending time in the workplace.
- Create externships for self and others to learn about the changes taking place in industries in communities from which your clients are drawn.
- Develop partnerships with local businesses to facilitate internships for students and externships for teachers.
- Join business associations to develop relationships with potential employers. Seek a mentor from the business community. Develop partnerships with local businesses to facilitate internships for students and externships for faculty.
- Bring the new workplace into your space. Host in-person and online learning exchanges between employers seeking workers for new jobs and/or with new skills and people seeking employment. Video tape/archive these exchanges to share with others. Repurpose the videos/webinars inviting industry guests to participate in follow-up Q&A.

As few assessments take into account the new workplace skills, listen carefully to what individuals say about their work and leisure interests and prior experience. Probe with questions to determine their talents in relation to new workplace skill requirements. Help them understand the marketability of their capacities and connect them to employment opportunities. Millennials, for example, may need help connecting their technology talents to workplace needs. More mature clients may need assistance understanding and valuing their prior experiences navigating organizational cultures.

Seek out clearly articulated language that describes new jobs and new skills, particularly what workers need to know and do to succeed at work. Use the duties and tasks found in new worker profiles, such as those included in this article, to develop career activities/assessment for your clients. For example, have clients circle the tasks they can perform and use that language in resumes. Help individuals to prepare for job interviews by reviewing tasks listed on the profiles and discussing examples of their work successes and challenges they have overcome in relation to these tasks.

New jobs integrating the previously separate industry and education/training sectors challenge us all to rethink the world of work. Expert thinking, complex communication, computational thinking, intergenerational communication, navigating organizational cultures, collaborating face to face and in virtual environments, working in geographically distributed teams, and using social media to build business are only some of the new skills needed for success in today's highly dynamic world of work. The emergence of new jobs and new skills requires leaving our comfort zones, making new connections outside the box and developing new relationships with others. As we consider how to prepare others for success in this new world of work – we must ask: How ready are we?

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Joyce Malyn-Smith's body of work focuses on developing strategic initiatives in workforce and human development. She is principal investigator of workforce education projects in EDC's Division of Learning and Teaching where she leads various national projects funded by the National Science Foundation (NSF), Education Department (ED), state and local agencies. A seasoned project leader, she is principal investigator of the Computational Thinking (CT) in America's Workplaces (NSF) project working with scientists and engineers from national laboratories and industry to create a framework that details the work of U.S. STEM professionals empowered with computational thinking. This project is informing and advancing ongoing national efforts to define CT and to integrate CT into K–20 education programs aimed at building the next generation of STEM innovators. She also leads the New Media Technician project funded by NSF to define how technician entrepreneurs use social media tools/resources to build a business brand and network; and to integrate social media tools into technician education programs in community colleges nationally. As principal investigator of the ITEST (Innovative Technology Experiences for Students and Teachers) Learning Resource Center (NSF, 2003-2013.) serving more than 195 NSF projects, and partnering with national organizations, she provided overall conceptual leadership guiding the LRCs philosophy, goals, activities and services; develops partnerships and is responsible for raising the public visibility of ITEST nationally. For nine years she led NSF's Information Technology Across Careers initiative that integrated core IT skills into career programs in community colleges using a problem-based learning approach. She served as Project Director for the U.S. Education Department's initial IT Career Cluster Initiative project (Building Linkages in IT) leading education leaders from 13 states in developing and piloting a skills framework for pathways to IT careers; and for the National School-to-Work Office led EDC's Techforce Initiative highlighting and expanding IT employer activities in School-to-Work nationally. She was the skill standards developer for 3 National Skill Standards Board projects (Bioscience, Chemical Process, Human Services) and the leader of EDC's Power Users of Technology Initiative. Prior to joining EDC, she served Boston Public Schools as a teacher and citywide administrator for more than 20 years. As Program Director Occupational Instructional Design she directed the competency-based curriculum development and production process for 29 vocational skills programs and managed business education for the city's 15 high schools (4,000 students). She led three significant reform efforts in BPS: 1) the move from traditional teacher-centered lecture/demonstration-based teaching and learning programs to a student-centered competency-based curriculum and assessment model for Boston's vocational/technical programs; 2) the reform and program evaluation process for Boston's Business Education programs; 3) with the Director of Education and Employment led the merger of Madison

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APPENDIX ON THE FOLLOWING PAGES:

Figure 1: Profile of a CT Enabled STEM Professional Research Scientist.

Figure 2: Profile of a Social Technology Enabled Professional.

Figure 3: Arizona's New Workplace Skills.

Figure 4: STEM Concentric Circle Model

Figure 1: Profile of a CT Enabled STEM Professional Research Scientist

A Profile of a Computational Thinking Enabled STEM Professional in America's Workplaces - Research Scientists/Engineers

A computational thinking enabled STEM professional uses skills, habits and approaches integral to solving problems using a computer (e.g. abstraction, automation and analysis) as he/she engages in a creative process to solve problems, design products, automates systems, or improve understanding by defining, modeling, qualifying and refining systems, processes or mechanism generally through the use of computers. Computational thinking often occurs in collaboration.

Engages in a creative process | Collaborates | Documents

CATEGORY	JOB FUNCTIONS	ACTVITY 1	ACTVITY 2	ACTVITY 3	ACTVITY 4	ACTVITY 5	ACTVITY 6	ACTVITY 7	ACTVITY 8	ACTVITY 9	ACTVITY 10	ACTVITY 11	ACTVITY 12	ACTVITY 13
Defines	A. Identifies problem.	A1. Identifies the scope of the problem.	A2. Selects relevant aspects of the problem.	A3. Identifies data sources.	A4. Identifies risks of failure.	A5. Defines assumptions and limitations.	A6. Identifies existing tools and solutions.	A7. Researches existing knowledge.	A8. Determines if problem is already solved.	A9. Identifies the need for a computational approach.				
	B. Specifies constraints.	B1. Determines if stakeholder has articulated the correct problem.	B2. Identifies stakeholder.	B3. Conducts needs analysis.	B4. Resolves conflicting requirements.	B5. Specifies requirements of the solution.	B6. Specifices resource requirements.	B7. Specifies accuracy to be achieved.						
Models	C. Designs the model / system.	C1. Proposes solution(s) / outcome(s) related to the problem.	C2. Identifies why the proposed solution is better than existing solutions.	C3. Strategizes computational approach.	C4. Identifies what modeling technique / solution / approach to employ. (Defines accuracy to be achieved)	C5. Defines relationships among data (1:1, isomorphism).	C6. Reverse engineers processes and/or products.	C7. Applies systematic techniques to isolate cause & effect.	C8. Selects common features / properties from specific examples of the model / scenario / process.	C9. Decomposes problem / objects / processes / data.	C10. Abstracts the real world scenario /object into an analog.	C11. Abstracts physical behavior of the problem.	C12. Selects salient features to be included in the model.	C13. Designs the User interface.
	D. Builds the model.	D1. Defines variables.	D2. Defines interactions among variables, objects or elements.	D3. Chooses an appropriate representation (e.g. data structures to represent the world).	D4. Uses applicable existing code / technology.	D5. Leverages existing solutions, algorithms.	D6. Writes programs.	D7. Modularizes the model.	D8. Identifies sources of error.	D9. Debugs / troubleshoots.	D10. Conducts fuzz testing (permutation testing).	D11. Builds the User interface.		
	E. Develops experimental design.	E1. Defines parameter space of the experimental test bed.	E2. Defines initial conditions under which the model operates.	E3. Develops testing equipment.	E4. Executes model / experiments using model.	E5. Tests limits and sweeps parameter space.								
Qualifies	F. Verifies the model.	F1. Assures model correctness.	F2. Generates potential solutions / possibilities.	F3. Compares the behavior of the model/ work product to a known solution or analytic solutions).	F4. Compares model with manufactured solutions.	F5. Tests the User interface.	F6. Validates the model.	F7. Assesses the degree to which the solution meets the product specifications or intended results.	F8. Analyzes the sensitivity of the solution with respect to model parameters.					
Refines	G. Optimizes the user interface and model.	G1. Improves input / Interface.	G2. Creates visual representation of output data.	G3. Optimizes the model.	G4. Uses iterative refinement to focus on the problem.	G5. Proposes strategies to improve solution.	G6. Identifies risks (e.g. sub-optimal solution).	G7. Executes improved strategies.	G8. Selects improved solution.					
	H. Facilitates knowledge/ discovery.	H1. Generates new hypotheses that feedback to experimental design.	H2. Observes phenomena to determine relationships (emergent behavior).	H3. Explains observed phenomena.	H4. Discovers new relationships.	H5. Refines experimental design.	H6. Assesses the degree to which the solution produces new findings / knowledge.	H7. Analyzes experimental data.						

Figure 2: Profile of a Social Technology Enabled Professional

Learning Occupation: The Social Technology Enabled Professional builds, maintains, manages and leverages online social networks to engage with customers, business partners, employees and key influencers with the goal of building organizational success.

DUTIES	TASKS											
1. CONDUCT RESEARCH	1A. Consults with communications or marketing colleagues.	1B. Identifies target market.	1C. Determines value of social media to organization.	1D. Evaluates social network platforms.	1E. Evaluates new methods, tools and devices (technologies).	1F. Determines required skill set and resources to implement strategy.	1G. Analyzes social networking activities of competitors/ influencers.	1H. Identifies applicable legal and regulatory policies.	1I. Adapts best practices in social media deployment.	1J. Assesses hard costs for implementing social networking strategy.	1K.	1L.
2. CREATE A SOCIAL NETWORKING STRATEGY	2A. Defines goals and objectives of social media strategy.	2B. Creates strategies to support the organizational goals and objectives (e.g. business plan).	2C. Defines success metrics aligned to organizational objectives.	2D. Determines content tactics to achieve social network strategy objectives.	2E. Aligns social networking strategy to business/ marketing strategy.	2F. Defines social media policy, guidelines and procedures.	2G. Incorporates key messages to promote business.	2H. Creates budget to support strategy.	2I. Allocates resources, staff, etc.	2J.	2K.	2L.
3. ESTABLISH AN ONLINE PRESENCE	3A. Ensures professional persona supports organizational objectives.	3B. Sets up accounts on selected social network platforms.	3C. Ensures consistent visual and key message branding across platforms (style guide)	3D. Enables users to share content across platforms.	3E. Links accounts to each other, to the website, and email signatures.	3F. Establishes initial voice (i.e. subject matter expertise).	3G. Promotes social accounts across all media and platforms.	3H. Posts relevant content to social networks.	3I. Invites others to engage with online presence.	3J.	3K.	3L.
4. CREATE CONTENT TO ENGAGE COMMUNITY	4A. Establishes editorial calendar.	4B. Monitors industry news for topical content.	4C. Crafts content that supports organizational functions.	4D. Solicits content from internal/ external sources.	4E. Creates content meaningful to audience and consistent with organizational brand and voice.	4F. Produces compelling content using relevant media (text, audio, video, ...)	4G. Assigns tags and key words to content to optimize discoverability.	4H. Syndicates content across social platforms and existing markets.	4I. Requests content contributions from online community.	4J.	4K.	4L.
5. MANAGE ONLINE PRESENCE	5A. Collects social analytic data.	5B. Analyzes social analytic data.	5C. Refines social strategy based on established metrics.	5D. Refines the profile based on experience.	5E. Monitors personal and professional brand mentions.	5F. Engages in online reputation management.	5G. Optimizes size and quality of online community to achieve organizational goals.	5H. Manages online community (don't feed the trolls)	5I. Responds (to both positive and negative comments) to community in a timely fashion and constructive manner.	5J. Creates new communities in response to needs.	5K. Utilizes new and emerging technologies and platforms.	5L. Integrates social networking into core organizational processes (e.g. sales, customer support, HR, fund raising)
6. ENGAGE IN PROFESSIONAL DEVELOPMENT/ON-GOING LEARNING	6A. Seeks out mentors.	6B. Stays current on emerging technologies.	6C. Attends relevant conferences.	6D. Maintains professional online C.V.	6E. Maintains professional library.	6F. Participates in professional organizations.	6G. Mentors others.	6H. Engages in cross discipline training.	6I. Articulates value of social networking activities to other departments/ functions of the organization.	6J. Articulates a changing role in supporting organizational goals.	6K.	6L.

Figure 3: Arizona's New Workplace Skills

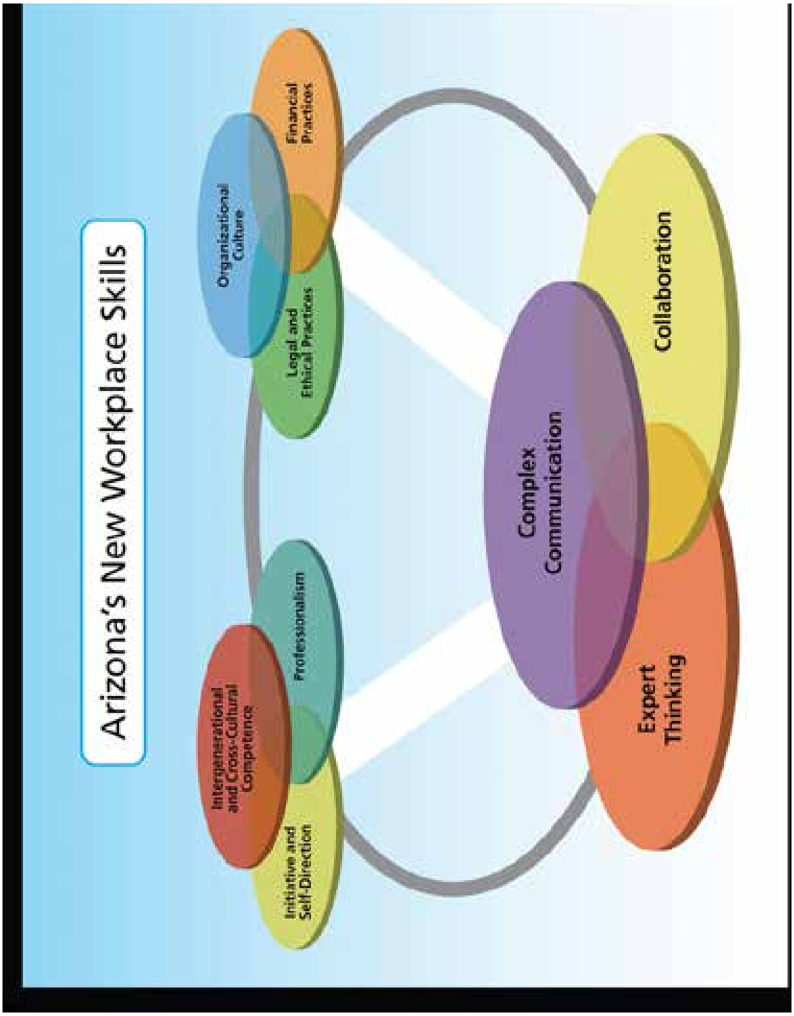
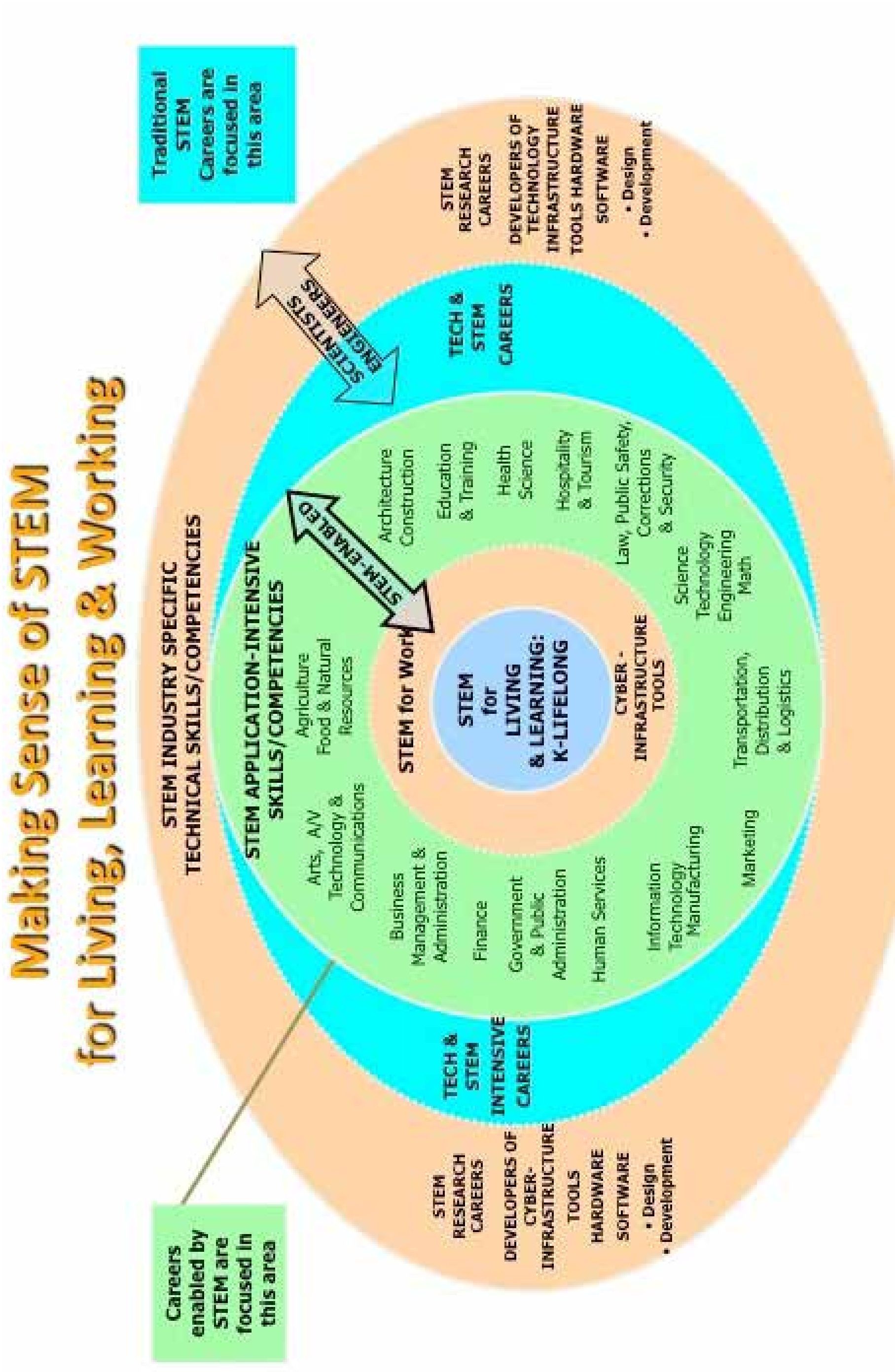


Figure 4: STEM Concentric Circle Model



Chapter 4

CONNECTING THE DISCONNECTS

Considerations for Advancing Racial/Ethnic and Gender Diversity in STEM

by **Angela Byars-Winston**

Introduction

Why should you care about careers in science, technology, engineering, and mathematics, referred to collectively as STEM careers? After all, there are over 20,000 occupations catalogued by the U.S. Department of Labor and STEM workers only make up 5.5 per cent of the total workforce. So what is all the fuss about STEM?

First, job growth in STEM fields is expected to be high for the next several years, at 17 per cent compared to 10 per cent for total job growth in the labor market (2008-2018).

Second and following this job growth pattern, STEM workers have lower unemployment rates than do non-STEM workers.

Third, STEM careers offer some of the best salaries and smaller pay gaps by race and gender compared to non-STEM fields (Carnevale, Smith, & Melton, 2011; Langdon, McKittrick, Beede, Kahn & Doms, 2011). Clearly, STEM occupations offer bright economic prospects to both individuals and to the nation, with over 2 million job openings forecasted between the years 2008 and 2018. But who is being prepared to fill them? For practitioners who are interested in promoting work options for a wide range of clients, here is the point where you might start caring about STEM careers.

Women make up 51 per cent of the workforce but hold less than 25 per cent of college-educated STEM jobs (Beede, et al., 2011). Racial/ethnic minorities including African Americans, Latino/as, and Native Americans hold only 9 per cent of these jobs (National Research Council, 2011). Ironically, White women and racial/ethnic minority women and men have higher labor force participation rates than White men; and this trend is expected to continue (Toossi, 2004). Given the increasing STEM employment demand and the growing numbers of women and racial/ethnic minorities in the labor force, gender and racial/ethnic disparities in STEM participation is a significant national concern.

Considering Some STEM Disconnects

We know that interest in science is genderless and colorless. Consider that at both the high school and college level, women and racial/ethnic minorities report similar, and in some cases, higher interests in STEM subjects and higher intentions to pursue STEM majors than their male and White counterparts (Hanson, 2009; National Science Board, 2012). But as previously noted, these groups are just not as present in STEM fields as their interests and intentions suggest they would be. In other words, despite initial connections to STEM, some groups become systematically disconnected from these fields.

A general consensus now exists that ability is not a primary factor in explaining underrepresentation or attrition in STEM; highly capable students leave the sciences, a disproportionate number of which are racial/ethnic minority women and men and White women (American Association of University Women [AAUW], 2010; Hyde, 2007; Seymour & Hewitt, 1997).

There are several reasons that contribute to STEM underrepresentation that highlight disconnects between an American ideology of equal opportunity and access and the actual experiences that various groups encounter in STEM. These disconnects reveal the schisms that exist between the prevailing myth of meritocracy and the persistent reality of educational and occupational inequity. I suggest that we counter these disconnects with intentional efforts to broaden STEM participation and connect more diverse groups to STEM opportunities.

The wide range of root causes for STEM underrepresentation cannot be reviewed here. Readers are referred to the National Alliance for Partnerships in Equity website (see **Table 1**) and the AAUW (2010) report ***Why So Few?*** for fuller discussions. Instead, I offer three disconnects that I have found in my research and practice on increasing STEM participation to be especially common influences on STEM experiences for women and racial/ethnic minorities.

Following each disconnect described, I offer strategies and considerations that may help career professionals connect individuals, particularly underrepresented minority groups (URMs) to STEM fields.
Table 1 summarizes the strategies and considerations listed below for career professionals along with web resources for more information. Additionally in **Table 1,** I include some considerations and web resources for individuals interested in pursuing STEM.

Table 1: Recommendations and Resources for Increasing Connections to STEM

Stakeholder: Career Professionals

Recommendations:

- Broaden knowledge of what STEM careers are
- Encourage more career training in higher education, especially at community college level
- Gain insider knowledge about local STEM trends and opportunities
- Encourage all clients' or students' passion for science
- Support clients' self-efficacy (confidence) in STEM
- Connect clients with culturally-competent STEM mentors—including peers
- Support Growth Mindset—"mind as muscle" attitude

Resources

National Alliance for Partnerships in Equity, "Root Causes and Strategies": www.napequity.org/root/

STEM Equity Pipeline, www.stemequitypipeline.org/

See video of panel discussion in May 2010 from the US Dept of Labor on youth entering STEM careers:
www.dol.gov/dol/media/webcast/20100505-stem/

See website for ideas and resources by Dr. Rich Feller:
www.stemcareer.com

Connect a Million Minds Initiative by Time Warner Cable
www.connectamillionminds.com/.

www.mindsetonline.com

Table 1: Recommendations and Resources for Increasing Connections to STEM

Stakeholder: Individuals

Recommendations

- Get information about diverse career pathways in STEM (see Feller's website)
- Accept struggle and failure as part of the road to STEM success —develop "bounce back" plans in advance
- Build social networks that can help in accessing STEM opportunities and navigating STEM environments
- Cultivate mentor relationships that can support and guide STEM goals

Resources

MentorNet; Virtual Mentoring Network in STEM, www.mentornet.net

See evidence-based strategies for reducing and resisting bias at www.reducingstereotypethreat.org

Connecting the Disconnects

Disconnect #1: Stereotypes about White women and racial/ethnic minority men and women in STEM. A recent study by Moss-Racusin, Dovidio, Graham, and Handelsman (2012) found that science faculty (biology, chemistry, and physics) rated a male applicant as more competent than the identical female applicant, offering males $4,000 more in annual salary and more career mentoring than the females. Interesting in this study is that female faculty were just as biased against female applicants as were male faculty. These findings and others show that the *science = White male* norm persists such that URMs are less easily fit into STEM culture than White males.

Not surprisingly, women and racial/ethnic minority individuals regularly report encountering negative stereotypes about their (mis-)fit and (in-) ability in STEM. The stereotypes are generally that 1) males are better than females or White individuals are better than racial/ethnic minorities in mathematics, spatial skills, and scientific thinking and, therefore, 2) STEM work is better suited for males and White individuals (AAUW, 2010). These stereotypes elicit implicit biases that can contribute to unaffirming and even hostile climates in STEM for URM individuals (Carnes et al., 2012), and result in social isolation for these groups. Some women and racial/ethnic minorities in STEM feel "visibly invisible" as a consequence of being highly *visible* for their racial and gender status while at the same time having their potential in STEM be highly *invisible* (Bowen, 2012; Ong, 2001). Consequently, many URM individuals feel that they have to prove their intellectual competence in STEM and debunk stereotypes about women and racial/ethnic minorities in STEM. Navigating the experience of being the "other" in STEM may also mean working to be seen as an individual and not as a representative of one's racial or gender group.

Connects: Career development professionals may do well to:

- Address implicit bias about prevailing cultural attitudes about who belongs in STEM; this includes the biases that some women and racial/ethnic minorities may have internalized as well as biases from majority groups about underrepresented individuals.
- Challenge stereotypes and misinformation about STEM occupations and workers.
- Use counterstereotypic images and examples of STEM workers and professionals in career interventions to offer broader views of "who does STEM" (e.g., images of STEM individuals across racial/ethnic groups, ability statuses, gender).
- Build cultural competence (comfort interacting with individuals outside of one's own ethnic group) to be able to interact and work in

diverse society for both URMs and majority White and male individuals. Encourage self-affirmations. Spending 15 minutes in self-affirmations (of one's skills, values) increased African Americans' academic performance over a semester (Cohen, Garcia, Apfel, & Master, 2006). Self-affirmations may be especially useful for URMs vulnerable to concerns about confirming stereotypes about their cultural groups in STEM.

- Help individuals build networks that include social contacts (e.g., peers) and community resources that can provide them with instrumental and emotional support in their STEM pursuits.

Disconnect #2: Women and racial/ethnic minorities are often not thought of to receive STEM career information. Because of the historically low participation of URMs in STEM, assumptions persist that URMs are simply not interested in STEM. Further, STEM industries do not communicate the message that women and racial/ethnic minorities are wanted and needed in the field (Bayer Corporation, 2010). As a result, these groups may not be targeted to receive information about STEM educational and career opportunities. Career development professionals need to familiarize themselves with the broad range of STEM pathways and employment opportunities. Jobs in STEM fields range from the most complex research and development and leadership positions to production, repair, marketing, sales and other jobs that require competencies built upon STEM knowledge. In fact, about 35% of STEM jobs will be available to those with less than a bachelor's degree by the year 2018 (Carnevale et al., 2011). Career counselors and related professionals are in the position to expose, inform, and motivate clients to pursue STEM fields and, thus, can play an important role in broadening STEM participation in multiple career pathways to more culturally diverse groups.

Obviously, too few White women and racial/ethnic minority women and men are identified, nurtured, and encouraged to enter STEM fields. In a 2010 survey of chemists and chemical engineers, 77% said that they were not identified or encouraged to enter STEM studies early on; more African American men (91%) and women (88%) believed this to be the case than White women (76%) and Asian women (63%) (Bayer Corporation, 2010). Regardless of some differences in survey responses across racial and gender groups, what is noteworthy is that at least two-thirds or more of all respondents reported not being fostered into STEM. This is particularly troubling because STEM interests generally begin in early childhood. According to astronaut, medical doctor, and chemical engineer Dr. Mae Jemison, this means that for some individuals, their "interests hit roadblocks along an academic system that is still not blind to gender or color" (as cited in Bayer Corporation, 2010). Many individuals are highly motivated to pursue, and intrinsically interested in, STEM fields but are either overlooked to enter STEM or have limited knowledge about the diverse career pathways and jobs available in STEM fields (Byars-Winston, 2012). Facilitating career exploration, career planning, and career commitment is likely to help nurture and sustain STEM career interests and eventual goals.

Connects: Career development professionals may do well to:

- Attend to equity in offering STEM career information to a range of clients, not to just those who may appear enthusiastic and "fit" for these fields.
- Increase the visibility and broaden individuals' knowledge of what STEM careers are.
- Present a variety of STEM career pathway options, across educational levels and not just for college-educated/degreed individuals.
- Inform clients of the many opportunities for preparation and training in STEM fields in addition to higher education degrees, including vocational training, apprenticeships, and industry-based certifications.
- Cultivate networks with culturally-relatable models in STEM to connect clients with career information.
- Become involved in your local community to advance the next generation in STEM. For ideas, visit the website http://www.connectamillionminds.com/. Enter your zip code and be immediately connected with local STEM activities, efforts, and collaborations.

Disconnect #3: Individuals' compromised beliefs about their STEM abilities. My research with racial/ethnic minority women and men in science and engineering indicates that self-efficacy beliefs (or confidence) to complete a STEM degree and positive outcome expectations (anticipated consequences from reaching a goal) are significantly associated with STEM interests and goals that lead to academic persistence and eventual career choice (Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010). People with strong efficacy beliefs are likely to persist toward their goals despite challenges because they view struggles or failures, like not passing an organic chemistry course the first time, as a natural part of learning and grow from them. They are also likely to view ability as acquirable through effort and dedication and they hold on to realistic judgments of their skills and abilities, even when faced with others' presumptions about their incompetence. The opposite is also true. People with moderate or weak efficacy beliefs are more likely to consider setbacks as confirmation of their innate deficits for STEM, conforming to a view of ability as inherent—you either have it or you don't. Carol Dweck's concept of growth mindset shows that viewing one's "mind as a muscle" can create motivation to reach a goal (see **Table 1** for Dweck's website). To be sure, the path to realizing success is partially paved with obstacles, which is particularly true for many women and racial/ethnic minority individuals in STEM. Encountering social challenges, like stereotypes about URMs in STEM or lack of faculty encouragement in STEM courses, can leave some individuals to question whether they have what it takes to succeed in STEM and to wonder whether or not pursuing STEM is worthwhile. Suffice it to say, the confidence and initial attraction that many URMs have in STEM can be eroded away by the STEM culture and environment and contribute to the further loss of these groups from STEM. But, finding ways to buffer potentially discounting experiences can sustain individuals' high self-efficacy, keep them focused on what drew them to STEM to begin with (positive outcome expectations), and help them to stay on the STEM path.

Connects: Career development professionals may do well to:

- Cultivate individuals' self-efficacy beliefs to support their STEM pursuits, especially through verbal encouragement from respected others (e.g., faculty, role models in STEM) and through owning and internalizing their successes and achievements.
- Facilitate accurate self-appraisals about STEM competencies and accurate threat appraisals about potential STEM barriers.
- Develop strategies to build academic and career resilience for URMs in STEM. This may include anticipating potential challenges and generating bounce-back plans ahead of time to manage the challenges.
- Encourage a growth mindset that emphasizes STEM ability as acquirable (as opposed to being fixed) that can be increased by effort—STEM talent can be developed!

Conclusion

In 2009, President Obama's *Educate to Innovate* campaign was launched to improve the nation's participation in STEM. Among the three pillars of this campaign is the commitment to "expand STEM education and career opportunities for underrepresented groups, including women and girls." Despite a host of challenges that can disconnect URM individuals from STEM, career development professionals can work to intentionally connect more diverse groups to STEM opportunities and, thereby, advance racial/ethnic and gender diversity in these fields.

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About the author

Angela Byars-Winston, PhD, is a counseling psychologist and Associate Professor of Medicine in the University of Wisconsin School of Medicine and Public Health. Her research focuses on understanding how culture relates to academic and career development in STEM, for which she was recognized by the White House and President Obama in 2011. She is currently Principal Investigator for a multi-year grant from the National Institutes of Health to investigate and measure the effect of training interventions for research mentors of ethnically diverse undergraduates in biological science. She is a nationally recognized expert in career development interventions to promote and diversify STEM, and multicultural competence, and regularly consults in educational, private business, and non-profit settings including Boeing Aircraft, MD Anderson Cancer Center in Houston, TX, and Southern University in Baton Rouge, LA. Her publications have appeared in numerous career journals including the Journal of Counseling Psychology, Career Development Quarterly, Journal of Vocational Behavior, Journal of Career Assessment, and Journal of Career Development—for which she serves on the editorial board, and in several edited volumes such as Career Counseling for African Americans and the Handbook of Multicultural Counseling (2nd Edition). She has served the American Psychological Association through various positions in the Society for Counseling Psychology (Division

17) and the Society for the Psychology of Women (Division 35). She is past Co-Chair (2006-2008) of the Professional Standards Committee for the National Career Development Association. She is currently a member of the STEM Equity Pipeline National Advisory Board, the Wisconsin Career Development Association Executive Committee, and the National Career Development Association Diversity Committee. She earned the PhD in counseling psychology at Arizona State University in 1997 specializing in vocational psychology, and completed a pre-doctoral clinical internship at the University of Maryland, College Park in 1996. She earned bachelor's degrees in psychology and Spanish literature [1991] and a master's degree in counseling at San Diego State University [1992]. Contact her as follows:

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Chapter 5

NASA EXPLORING NOW AND IN THE FUTURE:
With a Prepared STEM Workforce
by **Joyce Leavitt Winterton**

"Why do I need to know this? What difference will it make in my life?" NASA and its education programs help students answer these inevitable questions regarding subjects like mathematics and science and skills such as writing, critical thinking and question answering. Students engaging with NASA educational programs might well use all of these subjects and skills, simultaneously, while working with a cross-discipline team – just like in the real word. These experiences show students the relevance of science, technology, engineering and mathematics (STEM) education and illustrate their direct impact on students' future career options.

NASA is uniquely able to contribute to practical STEM education, thanks to its history and vision for the future. For over 50 years, NASA's journeys into air and space have developed humankind's understanding of the universe, expanded the frontiers of scientific research, advanced technology breakthroughs, and enhanced air travel safety and security. These accomplishments and NASA's unique missions, resources (content, people, and facilities) and education initiatives provide a robust foundation for educational opportunities for students of all ages. Through partnerships with the various NASA centers and mission directorates, other federal agencies, private industry and scientific research, education and academic organizations, NASA is helping to spark student interest and guide them toward STEM majors and careers. Education is a fundamental part of NASA's purpose and vision: to reach for new heights and reveal the unknown for the benefit of all humankind. During Astronaut Neil Armstrong's speech to celebrate NASA's 50th anniversary he stated, "I submit that one of the most important roles of government is to motivate its citizens, and particularly its young citizens, to love to learn, and to strive to participate in—and contribute to—societal progress." NASA's educational initiatives and investments are designed to do just that. Specifically, NASA's education goals are to:

- Strengthen NASA and the Nation's future workforce.
- Attract and retain students in science, technology, engineering and mathematics, or STEM disciplines.

- Engage Americans in NASA's missions.

NASA seeks to inspire the next generation of explorers, innovators, and leaders. By fueling an increased interest in STEM among America's youth, NASA is contributing to societal progress, the United States' global competitiveness and a strong national economy.

NASA STEM Educational Internships and Programs
NASA's STEM education efforts are based on the breadth of NASA missions, research and technology development. This variety and depth gives students of all ages and backgrounds the opportunity to engage in real-world STEM applications. NASA also provides a variety of STEM professional development and curriculum support for K-12 teachers and college faculty. Here are some examples of NASA education initiatives available to students and teachers.

Internships
NASA offers internships at each of its nine centers and the Jet Propulsion Laboratory to provide real-world paid experiences for high school, undergraduate and graduate students across the United States. All opportunities and applications are available through one website http://intern.nasa.gov. Students complete an online profile including a transcript of credits and letters of recommendations. When that process is completed students can review and apply for opportunities which have been developed and described by a NASA mentor. Student interns become an important part of the NASA team and learn from experts in their chosen field. What may be surprising to some is that NASA's internship opportunities are as broad as its current workforce. This obviously includes engineers and scientists, but also other disciplines such as safety, contracting, business, communications, education, medical, environmental and computer simulations.

Student Flight Opportunities
The NASA Science Mission Directorate (SMD) manages the Suborbital Program which provides core platforms, such as piloted and remotely piloted aircraft, sounding rockets and balloons to conduct frequent flight opportunities for NASA scientific and technology development investigations. NASA's suborbital activities date from the earliest days of the Agency, with thousands of aircraft, sounding rocket and balloon missions conducted since the early 1960s. It has provided fundamental discoveries of our earth, the sun, the solar system, and the universe. Suborbital platforms have also played an important role in developing and validating space technologies. In fiscal year 2012, SMD launched 30 sounding rocket and balloon missions and flew 3,300 airborne science hours. Over 900 undergraduate and graduate students participated in earth and space

science and technology investigations as part of these missions through the Suborbital Research Program. These student suborbital opportunities help address a looming crisis in training the next generation of aerospace scientists and engineers. They also help students acquire practical skills, develop experience with a project life-cycle and participate in the exciting launch and flight operation of their payload. Here are some examples of the student suborbital opportunities:

RockOn!

The Wallops Flight Facility (WFF), part of NASA's Goddard Space Flight Center (http://www.nasa.gov/wallops), provides many authentic engineering and science experiences to students and faculty utilizing its suborbital launch platforms. WFF's Sounding Rocket Program Office conducts RockOn! with the Colorado and Virginia Space Grant Consortia. RockOn! provides participants an introductory session in building small experiments that are launched on sounding rockets. Since 2008, over 150 participants have built standardized experiments that fly on a NASA Terrier-Improved Orion suborbital sounding rocket. The 35-foot-tall rocket flies to an altitude of 75 miles. After launch and payload recovery, the participants conduct data analysis and discuss their results. Fifty-four higher education institutions from 33 states have benefited from RockOn!. Following RockOn!, universities return to WFF to fly their own custom-built, self-contained experiments as part of the RockSat-C Program. Building on their first two successes, the RockSat-X is the next level of complexity and provides university experiments full access to a space environment by ejecting the skin of the sounding rocket, which allows for ejectables and deployables. Since 2008, 30 higher education institutions from 15 states have participated. These opportunities provide a great basis for capstone projects or extracurricular programs. Additional information, including on-line registration can be found at http://spacegrant.colorado.edu/rockon/2013/index_2013.html.

High Altitude Student Platform (HASP)

WFF Balloon Program Office and the Louisiana Space Consortium provide students the opportunity to send experiments to the edge of space on a scientific balloon. Since 2006, this annual project provides near space access for 12 undergraduate and graduate student experiments carried by a NASA research balloon. The High Altitude Student Platform (HASP) is a balloon-born instrument stack that is launched from the Columbia Scientific Balloon Facility's site in Fort Sumner, New Mexico. The flights last 15 to 20 hours and reach an altitude of 23 miles. HASP provides a space test platform for student research and the development of satellite payloads and space-engineering products. The project includes a standard mechanical, power and communication interface for the payload. This simplifies integration, allows the student payloads to be fully exercised, and minimizes development/operation costs. HASP is lightweight with simple mission requirements, thus providing maximum flexibility in the launch schedule.

HASP fosters student excitement in an aerospace career path, involves students with every aspect of the program and enhances their technical skills and research abilities. There have been 50 student-built payloads flown, engaging over 400 students from 27 universities, colleges and minority-serving institutions located across 14 states, Puerto Rico and Canada. Additional information and application materials for HASP can be found at http://laspace.lsu.edu/hasp.

Reduced Gravity Flight

The Johnson Space Center manages the Reduced Gravity Student Flight Opportunities Project which provides a unique academic experience for undergraduate students. Over the course of six months, students propose, design, fabricate, fly and evaluate a reduced-gravity experiment of their choice. The project introduces young scholars to careers with NASA and the space program. It also encourages research and testing of serious scientific and engineering ideas and educates both the general public and school aged children about educational and professional opportunities available with NASA. Additional information about the Reduced Gravity opportunity and how to become involved can be found at http://microgravityuniversity.jsc.nasa.gov/. Please note that this NASA experience is intentionally not referred to by its nick name ("The Vomit Comet") due to the fact that only a very small portion of participants experience such discomfort. It is an amazing and rewarding opportunity based on the author's experience.

The Student Airborne Research Program (SARP)

The Student Airborne Research Program (SARP) is an annual eight-week summer program for college juniors and seniors and early graduate students to provide hands-on research experience in all aspects of a scientific campaign using NASA's Airborne Science aircraft. Students receive classroom lectures and experiment design mentoring by leading earth science community members. ***The students integrate their experiments onboard an aircraft,*** participate in mission planning, conduct ground-truth field experiments and flight operations. Once flights are completed, students analyze and interpret flight data and results from their experiments. Additional information on SARP can be found at http://airborne-science.nasa.gov/.

Professional Development for Educators

K-12 educators are important gatekeepers to a quality and relevant education for students. NASA provides hands-on workshops for teachers that support curriculum and academic standards needed to train NASA's future workforce as well as our nation's workforce. Here are some examples of NASA professional development opportunities for teachers, geared towards building the competencies and skills required to plan and implement NASA's scientific and technology missions and launches.

Wallops Rocket Academy for Teachers and Students (WRATS)

The Sounding Rocket Program Office and the Wallops Flight Facility (WFF) Education Team developed the Wallops Rocket Academy for Teachers and Students (WRATS), providing high school and middle school participants with an authentic experience to reinforce STEM concepts. The WRATS workshop is held in June with 20 teachers from 12 to 15 states. The participants learn about the dynamics of a launch, safe flight operations and view the university and community college RockOn! NASA Terrier-Orion sounding rocket launch. Participants build and test model rockets with parachutes and then launch them from the Wallops Range, NASA's only owned and operated launch range. The WRATS workshop provides practical physics and engineering lessons.

The Wallops Balloon Experience for Educators (WBEE)

The Wallops Balloon Experience for Educators (WBEE) is a workshop for middle school and high school educators with a focus on NASA's Suborbital Carriers Research Programs, scientific balloons, and the study of Earth's atmosphere. WBEE is conducted by the Balloon Program Office and the WFF Education Team in collaboration with the Louisiana Space Consortium at NASA's Columbia Scientific Balloon Facility (CSBF) in Palestine, Texas during July. The week-long workshop includes presentations along with hands-on fabrication of balloon payload instruments that measure air temperature, pressure, and humidity during flights on two neoprene hand-launched balloons, BalloonSats. The two balloons and up to ten instruments are launched and flown by CSBF WBEE team members. Participating WBEE educators subsequently retrieve data from their balloon instruments following flights that achieve altitudes of over 90,000 feet. Workshop educators then analyze their data and present their results.

Hurricane and Severe Storm Sentinel (HS3)

The Hurricane and Severe Storm Sentinel (HS3) investigation is a multi-year airborne field campaign funded under NASA's Earth Venture program. The goals of HS3 are to improve understanding of the atmospheric processes that play a critical role in the formation and intensification of hurricanes in the Atlantic Ocean basin. HS3 uses two of NASA's unmanned high-altitude, long-endurance Global Hawk aircraft. One aircraft samples the environment of storms while the other measures inner-core (eyewall and rainband) winds and precipitation. Middle school teachers on the eastern shore of Virginia, Maryland and Delaware participate in a workshop at WFF which provides information on how to include NASA's HS3 mission in their curricula about hurricanes and storms.

Lunar Atmosphere and Dust Environment Explorer (LADEE)
NASA's Lunar Atmosphere and Dust Environment Explorer (LADEE) is a robotic mission that will orbit the moon to gather detailed information about the lunar atmosphere, conditions near the surface, and environmental influences on lunar dust. LADEE is scheduled to launch from WFF in August 2013. A workshop for pre-service teachers about the LADEE mission will be held at WFF and focus on using the LADEE mission to improve students' performance and interest in STEM subjects.

LADEE is also partnering with the Lewis Center for Educational Research and NASA's Jet Propulsion Laboratory, Pasadena, Calif., to provide students across the country and around the world the opportunity to help track and monitor the status of the LADEE spacecraft in flight. The Goldstone Apple Valley Radio Telescope (GAVRT) program allows students in their classrooms to remotely control giant 34-meter deep space communication dishes at NASA's Goldstone Deep Space Communications Network in Goldstone, Calif. These dishes are ideal for conducting a wide range of radio astronomy research projects. During the LADEE mission, students will monitor the carrier signal from the LADEE spacecraft, perform Doppler measurements around the firing of the spacecraft's main thruster and listen for changes that might indicate a change in spacecraft status. K-12 teachers interested in more information and learning how to receive GAVRT training can visit the GAVRT website: http://www.lewiscenter.org/gavrt/.

NASA Explorer Schools (NES)
NASA Explorer Schools (NES) is an opportunity for any secondary education school across the United States to engage with NASA's educational resources and experts. NES uses a Virtual Campus website (http://explorerschools.nasa.gov) to provide professional development and support for educators and allows students to participate in the NASA's missions of discovery and exploration. NES offers free cross-cutting NASA STEM content for middle school and high school teachers to apply in their classrooms. Once a school registers online they will be a NES participant and have access to lessons, professional development, ***NASA Now*** classroom videos, monthly video chats and recognition opportunities. Through partnerships with national educational organizations and use of best educational practices, the NES project is designed to inspire students to participate in NASA missions and develop their aptitudes in STEM.

The International Space Station (ISS)

The International Space Station (ISS) is an amazing engineering accomplishment and the most complex structure ever built in space. The ISS is an internationally-developed research facility located in Earth's lower orbit. It serves as a research laboratory where astronauts from around the world conduct experiments in human health and exploration, technology testing for enabling future exploration, research in basic life and physical sciences as well as earth and space science. NASA has developed a website where educators can find lessons for advanced high school math and science classrooms at http://spacestationlive.nasa.gov/educators/index.html. These resources are designed to enhance existing classroom concepts. Educator guides are available for download to assist in bring the excitement of the ISS to classrooms.

Learning About New NASA STEM Opportunities

NASA regularly offers new STEM education opportunities for students, educators and institutions. The best way to learn how to take advantage of them is through NASA's website pages for educators (http://www.nasa.gov/audience/foreducators/index.html) and students (http://www.nasa.gov/audience/forstudents/index.html). From the educators' homepage you can also subscribe to ***Express***, NASA's e-mail newsletter with updates on NASA's education efforts and how you can become involved. You can also visit ***STEM Careers*** (http://stemcareer.com/), a website developed by Dr. Rich Feller for career counselors, parents and students that highlights relevant STEM content from NASA.

Conclusion

It may depend on your age which NASA accomplishment is most significant to you. For some it is astronaut Neil Armstrong's first steps on the moon. For others it is the Mars Rovers, Spirit and Opportunity, that explored years beyond their expected timeframe, or the launch of the Space Shuttle to the International Space Station. Or perhaps it's the Hubble Telescope's images of solar systems we did not even know existed. No matter which is your favorite, the one consistent factor is the competent civil servants, contractors, university researchers and private companies that pushed the envelope to explore, make dreams reality and ask the question ***what if?*** Exploring and better understanding our world, our solar system and the universe is part of the motivation for students to excel in STEM subjects and pursue related college majors and careers. NASA's ability to explore now and in the future will significantly depend on its workforce having the vision, courage and competencies to dream new dreams and make them a reality.

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Chapter 6

SUPPORTING STEM STUDENT SUCCESS, COMPETITIVE ADVANTAGES, and ENGAGEMENT in CAREER DEVELOPMENT

by **Debra Kaye Holman**

21st Century Student Success and Career Development

Success in higher education can be defined in a variety of ways ranging from academic achievement to degree completion and management of post-degree transitions (Kuh, Kinzie, Buckley, Bridges, & Hayak, 2007). Those within the academy as well as those from outside college and university settings have often focused on success in terms of student retention and graduation with a baccalaureate degree (Kuh, Kinzie, Schuh, Whitt & Associates, 2010; National Leadership Council for Liberal Education and America's Promise, 2009; Pascarella & Terenzini, 2005; Tinto, 1993). This perspective has been reinforced at the highest national levels. For example, in the United States during his first term, President Obama (2009) set a goal for American higher education to produce the largest number of college graduates globally by 2020.

Beyond degree attainment, others have emphasized student success in the transition from earning a degree to earning a living and thriving in the world at-large. Such transitions can be supported through career development coordinated with career counselors and others in the academy, such as faculty and professional advisors, committed to honoring students' life stages *partly by facilitating the process of maturation of abilities and interests and partly by aiding in reality testing and in the development of the self concept* (Super, 1953, pp. 189-190). Over four decades ago, Harrison (1968) described career development as a primary imperative of higher education. He held that the academy has a responsibility to students and society to prepare individuals to successfully contribute in *the world of work* as well as successfully *cope with the revolutionary characteristics of modern times* (Harrison, 1968, p. 671).

Emphasis on 21st century career development reinforces the position that student success post-degree must be associated with more than promoting *career awareness and job placement* while students are in school (Cook & Schamp, 2012, p. 378). The National Research Council (2012) has emphasized providing students developmental experiences that promote *deeper learning and . . . skills to success in education, work, and other areas of adult responsibility* (p. 37) capable of sustaining them over a lifetime. The New Leadership Alliance for Student Learning and Accountability (2012) has charged that *those granting educational credentials must ensure that students have developed the requisite knowledge, skills, values, and attitudes that prepare them for work, life, and responsible citizenship* (p. 3). Recently Carnevale (2013) has suggested that career development must do even more by helping students develop the knowledge, skills, and abilities that allow them to be competitive over the course of their careers in a complex, global environment.

STEM-Centric Competitive Advantages in Career Development- STEM (science, technology, engineering, and mathematics) students have been shown to perceive a competitive advantage in selecting their majors and having a career path that provides professional opportunity upon completion of their degrees. In the 2012 administration of the National Survey of Student Engagement (NSSE), a subset of 21,000 undergraduates were asked a series of questions related to their choice of major. More than other students surveyed, STEM students, regardless of race or ethnicity, were shown to have selected their majors based on the availability of future employment (NSSE, 2012, p. 16). STEM students' perceptions of a competitive workplace advantage can be borne out through their professional experiences shortly after graduating. In a longitudinal study of 2001 Gates Millennium Scholars (GMS, 2013), a program which financially supports minority students with academic and leadership potential, and GMS applicants not accepted to the program, students were surveyed at two year intervals from 2002 through 2006 (Hu & Wolniak, 2010, pp. 754-755). Study findings demonstrated that for those who had graduated and entered the workforce, *STEM students had higher earnings than their non-STEM counterparts* regardless of participation in GMS (Hu & Wolniak, 2010, p. 758). Rosenberg (2013) highlights another competitive advantage for students in STEM majors: the potential availability of funding during their degree programs and in research and development positions upon degree completion. The America COMPETES Acts (2007, 2011) have funneled billions of dollars into innovation in science and technology and have bolstered provisions for STEM education in the United States.

STEM-Centric Success and Engagement in Career Development- While STEM students may have competitive advantages in obtaining employment following degree completion, to have a successful, engaging journey of personal and professional development over the course of their lives, they can benefit from supportive interactions with career counselors, faculty members, and professional advisors during their education.

Writing for the National Institute for Learning Outcomes Assessment, Makela and Rooney (2012) held that: *Well-trained, experienced career services professionals are educators, well-positioned to bridge the gap between the academic learning and personal development outcomes and help students learn [emphasis retained] how to explore career options, make career decisions, and develop career management skills that students will use throughout their lifetime*. (p. 2)

As educators, those working in the field of career counseling know that college students are typically attempting to successfully define both career and personal directions while undertaking their degrees (Cook & Schamp, 2012, pp. 380-384). The very nature of students' multiple paths of exploration gives counselors the opportunity to help students learn techniques for managing life's stresses as well as designing life paths that are meaningful and fulfilling (Cook & Schamp, 2012, pp. 388-390). In the potential for engaging in special programs and funding opportunities, however, STEM students may face unique developmental challenges in balancing personal and professional goals. Rosenberg (2013, p. 23) cautions career counselors to remain attuned to students' values and interests in addition to their skills, so they retain congruence between who they are and who they aspire to be. He also recommends observing standard practices in career counseling, such as connecting students to reputable sources of information and modeling good decision-making techniques, in order to ensure students' developmental needs are met and ethical practices in counseling are maintained (Rosenberg, 2013, p. 23). Assisting students with creating career development plans can further allow them to "assess and act on the interplay between their career decisions and identity" (Feller & Peila-Shuster, 2012, p. 223).

Faculty and professional advisors working with STEM students can further advance successful career development by encouraging their students to take part in curricular and cocurricular learning experiences and opportunities connected with student engagement and success (Astin, 1984; Bonwell & Eison, 1991; Chickering & Gamson, 1987, 1991; Dewey, 1938; Feldman & Newcomb, 1970; Kuh, 2008; Kuh et al., 2010; Pace, 1980; Pascarella & Terenzini, 1991, 2005). For example, in a 2011 study of over 400,000 undergraduates in the United States, student engagement in high-impact practices (Kuh, 2008), such as undergraduate research with a faculty member, internships, and service learning, was associated with almost 80% of seniors reporting "perceived gains in job- or work-related knowledge and skills" (NSSE, 2011, p. 14). However, when looking more closely at students' participation in such experiences, a similar NSSE-based study conducted with 362,000 undergraduates in the United States (NSSE, 2010, p. 9) found that not all STEM majors took part in high-impact practices at the same rates. Roughly only 60% of STEM students in biochemistry, biophysics, chemistry, or physics reported having had the opportunity to take part in research with a faculty member by their senior year (NSSE, 2010, p. 10). The percentages were even lower for all other STEM majors surveyed, including biology; botany; engineering (chemical, civil, electrical, and industrial); applied health sciences (nursing, pharmacy, physical therapy, and technology); and mathematics. Additionally, while at least 50% of most STEM majors in the study reported having had the chance to do an internship or practicum by the senior year, results were mixed for participation in service learning, with approximately 60% of STEM majors in the applied health sciences and only 40-50% of all other STEM majors engaging in service (NSSE, 2010, p. 10).

Faculties are uniquely situated to encourage STEM students to engage in high-impact practices and also provide entry points for their participation in research and other hands-on experiences in their disciplines. Professional advisors can promote students' placements in internships, practicums, and service learning experiences by actively seeking to connect them to campus and community organizations providing such opportunities. The combined efforts of faculty and professional advisors support STEM students' successful and engaged career development by helping them acquire additional knowledge and skills. They also provide pathways for students to road test their abilities and develop or strengthen a work ethic while still in college.

STEM-Centric Support for Counselors, Faculty, and Advisors

Whether working with STEM students as a career counselor, faculty member, or professional advisor, those in the academy seeking to advance STEM-centric career development should themselves seek opportunities for ongoing development and professional connections with others focused on serving in STEM education. By seeking supportive interactions on campus, opportunities can arise to advance student engagement and experiential learning in one's own institution (Holman, Smith, & Welch, 2009). Novel collaborations may also develop between academic and student affairs units which further enhance student career development campus-wide (Frost, Strom, Downey, Schultz, & Holland, 2010). Support can additionally be found by engaging with other STEM-oriented professionals at regional and national levels. While the following list is in no way inclusive of all educational organizations supporting STEM student career development, it provides connections to additional resources and individuals advancing STEM student success:

Resources
ACPA College Student Educators International
http://www2.myacpa.org/

American Association for the Advancement of Science (AAAS)
http://www.aaas.org/

Council on Undergraduate Research (CUR)
http://www.cur.org/

NASPA Student Affairs Administrators in Higher Education
http://www.naspa.org/

National Academic Advising Association (NACADA)
http://www.nacada.ksu.edu/

North American Association for Environmental Education (NAAEE)
http://www.naaee.net/

National Career Development Association (NCDA)
http://ncda.org/

National Society for Experiential Education (NSEE)
http://www.nsee.org/

Interacting with others professionally provides avenues for the exchange of ideas, best practices, and research in STEM education. It can also aid in professional renewal, allowing those who serve STEM students to recharge, reinvigorate, and retain their spirit of service in higher education.

Concluding Remarks
Supporting STEM student success, competitive advantages, and engagement in career development helps prepare students to manage career challenges and opportunities upon completion of their degrees. Such efforts benefit not only students but also society through the development of STEM professionals ready to engage and succeed in a 21st century competitive workplace.

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Chapter 7

HARDHATS, BOOTS and GOGGLES REVISITED:

STEM Career Development for the 21st Century

by **Abigail Holland Conley, Sylvia Nassar-McMillan**, and **Lynn Zagzebski Tovar**

Abstract

Science, technology, engineering, and mathematics (STEM) careers of the 21st century have replaced the *nontraditional* and higher wage yielding careers of earlier decades. For women and other groups still underrepresented in these high tech careers, effective career counseling interventions need to take into account the support structures these individuals may have along with combating the barriers that may still exist, such as stereotype threat and others that serve to hinder career entry or career success in the STEM fields. Social cognitive career theory offers a framework for developing and delivering such interventions. We review contemporary labor market statistics in these careers, overview current stereotype threat literature, introduce social cognitive career theory and its corresponding interventions, and provide a case study to illustrate effective and culturally competent career intervention strategies. Finally, we provide a list of internet-based resources as helpful tools relevant to STEM career counseling interventions.

In decades of the late 1900s, women were often encouraged to explore *careers that pay* or careers such as construction or skilled trades (e.g., electrician, plumber) and others that were heavily dominated by men, typically yielding higher average salaries and wages (Monty, 2012; Western Michigan University, 1986). In today's job market, science, technology, engineering and mathematics (STEM) continue to represent fundamental areas for both growth and opportunity in a more contemporary high-tech context (Ruffino, 2010). For example, STEM occupations are projected to increase by 17 per cent from 2008-2018, while non-STEM occupations are only projected to grow 9.8 per cent. In addition, people in STEM fields earn 26 percent more money than people in non-STEM fields (Langdon, McKittrick, Beede, Khan, & Doms, 2011). And yet, according to the National Science and Technology Council (NSTC, 2011) the United States does not produce enough STEM workers to meet the rising demand of the industry. Sixty per cent of the new jobs that will be created in the 21st century require STEM skills that only 20 per cent of the current workforce possesses (NSTC, 2011).

Persons with disabilities, women, African Americans, Hispanics, and Native Americans are considered underrepresented in STEM fields because they represent a smaller percentage of STEM degree recipients and employed engineers and scientists than they do in the United States population (U.S. Commission on Civil Rights, 2010). While women constitute just over half of the U.S. population, they make up only 27 per cent of the science and engineering workforce. Indeed, only 8 per cent of the science and engineering occupations are held by African-Americans, only 4 per cent by Hispanics, and only 3 percent by American Indians/Native Alaskans, Native Hawaiians/Other Pacific Islanders, or multi-racial individuals (NSF, 2009). With these challenges in mind, many programs have developed to support and increase the number of underrepresented workers in STEM fields. For example, one of the key goals of President Obama's Educate to Innovate initiative is to develop and support STEM education and career opportunities for underrepresented groups (White House, 2010).

Individuals' internalized ideas about their capabilities and identities start to form at a very early age. This development of self-concept and self-efficacy, potentially influenced by a psychological concept called stereotype threat (Steele, 1992; 1997), interacts with a developing belief system of what type of people do what type of work. Therefore, to diversify the STEM workforce, it is essential to examine the underlying stereotypes that individuals hold starting at a very young age. Research has shown that children as young as three to four years old demonstrate ethnic and racial awareness (Aboud, 1988). In addition, children in elementary school as early as second grade hold the stereotype that math is a male domain (Cvencek, Meltzoff, & Greenwald, 2011) and, moreover, racial minority elementary school children may hold negative stereotypes of their own group's academic competence (Alameda, 1998; McKown & Weinsteni, 2003).

Stereotype Threat and Diversity in the Workforce

Stereotype threat (Steele, 1992; 1997) is a psychosocial predicament in which members of stigmatized groups must contend not only with the anxiety already associated with performance of the task, but also the fear that failure will reinforce some negative stereotype about the group or, in turn, about themselves. Two decades' worth of literature on stereotype threat indicates that members of academically stigmatized groups experience heightened anxiety in academically related situations. This anxiety impedes performance on academic tasks, making schooling and other task oriented situations aversive and helps explain persistent achievement gaps (Spencer, Steel, & Quinn, 1999). Research has shown underperformance due to stereotype threat in individuals at every level of education: elementary and middle school students (Good, Aronson, & Inzlicht, 2003; Huguet & Regner, 2007; McKown & Weinstein, 2003; McKown & Strambler, 2009), high school students (Keller, 2007; Osborne & Walker, 2006), college students (Beasley & Fischer, 2012; Steele & Aronson, 1995; Spencer, Steele, & Quinn, 1999) and elderly adults (Hess, Auman, Colcombe, & Rahhal, 2003; Scholl & Sabat, 2008). While stereotypes and the impacts of stereotype threat are pervasive, it is important to note that retraining stereotypic attitudes has been found to reduce stereotype threat in women (Boucher, Rydell, van Loo, & Rydell, 2012; Forbes & Schmader, 2010) and people of color (Adams, 2005; Aronson, Fried, & Good, 2002). Therefore, examining individuals' stereotypes as they relate to career beliefs are important to help create meaningful interventions to challenge stereotypes and combat the deleterious effects of stereotype threat.

In addition, as previously mentioned, STEM careers have, on average, lower unemployment rates and higher salaries than non-STEM occupations. The underrepresentation of advanced degree attainment and workforce composition within these professions underscore the urgency of promoting educational and employment equity in our counseling work. Some of the contextual factors impacting these statistics include stereotypic career messages in the media, overt and covert discouragement of STEM aspirations for diverse learners, and a lack of diverse, positive role models within STEM professions. Our professional and ethical codes underscore the criticality to address potential barriers and obstacles that people may face in their career development (e.g., ACA, 2005). Thus, we will explore social cognitive career theory as it relates to working with underrepresented individuals interested in STEM fields and generate specific ideas that can be integrated into career counseling interventions with diverse populations.

Social Cognitive Career Theory

Social cognitive career theory (SCCT; Lent, Brown & Hackett, 1994) is an integrative theory of academic and career-related interests, choice, performance, and satisfaction. SCCT creates a useful foundation for conceptualizing and designing career development interventions, including efforts to engage and support underrepresented individuals in the STEM workforce. SCCT is particularly relevant when working with diverse populations because it explicitly takes into account contextual factors and societal barriers. SCCT explores the relationships between an individual's self-efficacy, outcome expectations, goals, and contextual supports and barriers. Self-efficacy refers to individuals' beliefs about their ability to perform or accomplish specific behaviors. Outcome expectations, on the other hand, represent individuals' beliefs about the consequences of their actions. When exploring goals, it is useful to examine how determined an individual is to engage in a particular activity or to produce a particular outcome. And finally, SCCT focuses on exploring the contextual supports and barriers that accompany the identified goal pursuit. SCCT career counseling interventions that are particularly salient to STEM fields include (a) expanding vocational interests, (b) clarifying career goals, (c) strengthening self-efficacy beliefs, (d) instilling realistic outcome expectations, (e) exploring and managing environmental barriers (i.e. racism, sexism, etc.), and (f) building environmental support systems (Lent, Brown, & Hackett, 1994). Each intervention and its application to STEM fields will be explored in more detail below.

Expanding vocational interests. A common strategy in career counseling is to help expand clients' vocational interests by exploring specific career trajectories and introducing them to careers of which they may previously have been unaware. When working with underrepresented populations, it is also important to explore areas of high aptitude, as clients may have disregarded their skills if they have received covert or overt messages that they do not belong in particular fields irrespective of their talents. For example, when using a card sort activity, it is useful to go beyond the traditional questions of what careers our clients would or would not choose and examine them through a SCCT lens. In other words, within the SSCT framework one might ask a client which career they might choose *if they thought they could succeed* or *if they perceived that career as being more desirable*. By asking these types of questions, the career counselor can explore the client's self-efficacy and outcome expectations relative to STEM fields for which they might truly possess an aptitude.

Clarifying career goals. To effectively facilitate clients' career decision making, it is important to help the client explore goal selection, gather occupational information, solve problems, plan for their future career trajectory, and appraise themselves accurately. Various scales and assessments may help to tease out the client's career goals and career commitments. Specifically related to STEM fields, the Careers in Science Inventory (Nassar-McMillan & Conley, 2013) is a useful tool to collaboratively evaluate with clients whether their education and career plans match their career goals. It also useful for counselors to examine their own beliefs and biases as they relate to stereotypes about careers, in addition to educating themselves about specific STEM careers and career paths.

Strengthening self-efficacy beliefs. An essential step to combatting stereotype threat is strengthening self-efficacy beliefs. This can be done by identifying clients' strengths, along with their corresponding personal and performance accomplishments. In particular, it is important to reframe anxiety producing situations as steps toward progress, as opposed to perfection. In addition, it is helpful to provide clients with opportunities for vicarious learning experiences, particularly including role models with whom clients might identify in terms of gender, race, ethnicity, age, and the like. Finally, in order to increase clients' self-efficacy it is important to create small, successful experiences related to academic and professional domains. This involves setting specific and attainable goals that are challenging enough to foster a sense of accomplishment. In addition, the career counselor can examine the client's attributions and challenge those that attribute positive accomplishments to external forces such as luck (e.g., "I got a good grade in math because the teacher felt sorry for me") and attribute negative accomplishments to internal forces such as personal intelligence (e.g., "I got a bad grade in science because I am just not smart enough").

Instilling realistic outcome expectations. In addition to building client self-efficacy, it is essential to help instill realistic outcome expectations with the client. Accurate occupational information is essential in and of itself, and also is a necessary tool to challenge stereotypical roles often portrayed in the media and throughout society. This includes accessing accurate information and knowledge about STEM careers and STEM career trajectories. One way to address this challenge is to identify and connect clients with individuals they can meet for an informational interview or to job shadow. It is also helpful for career counselors to help clients manage information gathered for effective decision making, through tools such as a decisional balance sheet or a formal pro/con listing process.

Exploring and managing environmental barriers. While exploring the client's interests and goals, it is crucial to also attend to contextual challenges such as environmental barriers of racism, sexism, ablism, and other profiling and discrimination. Through this process, counselors are wise to reflect upon their own beliefs and biases as they become intertwined with clients' social contexts through the myriad of ways in which they inherently, and perhaps subconsciously, encourage or discourage particular careers for particular clients. Moreover, it is important to help clients consider their environmental, familial, and personal barriers relative to their career goals and expectations. It is also important to be mindful of cultural considerations for the client. For example, in collectivistic cultures it is not uncommon for family desires, more so than personal interests, to influence individual career choice. Therefore, it is important for counselors to help clients negotiate their family systems and list and evaluate gains and losses for possible career decisions. Particularly relevant to STEM fields are awareness and acknowledgement that underrepresented group members may experience more barriers to career attainment. Therefore, activities that are projective in nature such as the Draw a Scientist Test (DAST; Chambers, 1983) may help foster discussions and exploration of equality perceptions and expectations.

Building environmental support systems. Finally, it is essential that career counselors help their clients build comprehensive support systems that consider environmental, familial, and personal relationships such as family, friends, teachers, and mentors. It is particularly important to consider supports that might correspond or counteract specific barriers clients may identify. Of particular salience to underrepresented populations is attaining mentors in STEM fields with whom clients identify at some level. If it is difficult to find a STEM mentor that could relate to an underrepresented client, there are many great resources available on the internet. For example, the White House recently released a toolkit for community-based organizations entitled "Becoming a Science, Technology, Engineering, and Math (STEM) Mentor" (Corporation for National and Community Service, 2013). An important caveat, however, is that in utilizing multimedia sources with diverse learners is it critical to consider access issues and create a time and space for clients to explore resources if they do not have home access to a computer. To further explore the interventions described above, we will now consider a case study.

Case Study: "I just forgot"

Matthew, a 27 year old African American male, is the academic coordinator for a pre-college program run in conjunction with a local university. He is passionate about his job, which includes providing youth at area high schools with mentoring, programming, and counseling regarding advanced educational opportunities. Lately, he has become concerned that Renata, a 17 year old Mexican American female, has missed several of the deadlines for turning in parent permission slips and college application materials. In addition to the ramifications of the missed activities on Renata's career trajectory, Matthew is worried he will have to terminate Renata from the program. Renata has strong scores on her PSAT, and an A/B average on college prep coursework, however, she describes herself as "not testing well". The results from a career interest inventory showed a pattern of interests in the investigative professions including engineering. When asked what she wants to do, she often hesitates before naming engineering or nursing. She is the oldest of three. Her father owns a small landscaping company and her mother is a traditional homemaker. Renata attends the required meetings for the program, as do her parents. Most recently, Renata missed the scheduled field trip for an outreach program in the School of Engineering at the university.

Analysis. It is telling that Renata thinks that she does not "test well", despite having done very well on her SAT prep work and practice tests. It is not uncommon for underrepresented students with strong academic aptitude to underperform in the high stakes testing environments due to stereotype threat. The pressure of either confirming societal stereotypes about the groups with whom she identifies or simply the pressure of having to "represent" her gender and ethnicity positively may make school related tasks aversive. By not attending the field trip, she avoids the pressure, *even though she is interested in, and identifies with, becoming an engineer.*

In addition, Matthew should examine his own knowledge about different careers and whether he is providing enough specific information about careers with which he may be less familiar, such as engineering. He believes Renata would make an excellent nurse given her demeanor and strong math and science skills. And he realizes that, despite his commitment to opening up the widest range of career possibilities for his students, he does not know that much about what an engineer really does in order to talk in detail with Renata and her parents about engineering as a potential career path, and how it differs from a medical career. Therefore, Matthew's plan should include: (a) learning more about engineering and math careers, (b) in addition to providing information about financial aid, admissions, and college access, he should incorporate web sites that highlight successful individuals in engineering and other professions, (c) show Renata the Society of Hispanic Professional Engineers to introduce contrasting messages to those that serve to reinforce stereotype threat, and (d) involve Renata's parents by having them complete the Draw a Scientist test and talk about how to support their children in the different professions.

Summary

From a SCCT lens, counseling goals for underrepresented clients interested in STEM fields should include increasing self-efficacy through small stakes tasks and environments; challenging cultural stereotypes by connecting clients to mentors and role models in STEM fields; expanding vocational interests to learn more about specifically what engineers and scientists could do and what their respective career trajectories include; examining the realistic barriers of sexism, racism, etc.; and building personal strengths to help confront and break down those barriers. In closing, we have compiled a list of online resources that provide accurate career information and diverse role models in various salient 21st century STEM professions. Through many of these resources, career counselors can offer their clients positive vicarious learning experiences, opportunities for personal accomplishment, and engaging and fun learning experiences related to the STEM professions.

Online Career Development Resources

O*NET Online: http://www.onetcenter.org

Parent and Counselor page of Engineer Your Life: http://www.engineeryourlife.org/cms/Counselors_Parents.aspx

Sloan Career Cornerstone for Counselors: http://www.careercornerstone.org/forcoun.htm

STEMcareer: http://www.STEMCareer.com

WAMC Women in Science, Technology, Engineering, and Mathematics On The Air: http://womeninscience.org/index.php

Occupational Outlook Handbook: http://www.bls.gov/oco

Sloan Career Cornerstone Center: www.careercornerstone.org

NASA eClips: http://www.nasa.gov/audience/foreducators/nasaeclips/

EngineerGirl: http://www.engineergirl.org/

Engineer Your Life: http://www.engineeryourlife.org

What are Scientists and Engineers Like (a NASA resource): http://www.jpl.nasa.gov/education/index.cfm?page=141

Society of Hispanic Professional Engineers: http://www.shpe.org/

National Society of Black Engineers: http://www.nsbe.org

American Indian Science and Engineering Society: http://www.aises.org

Association for Women in Science: http://www.awis.org/

Toolkit: Becoming a Science, Technology, Engineering, and Math (STEM) Mentor: http://www.serve.gov/toolkits/pdf/STEM_mentoring_toolkit.pdf

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Chapter 8

COUPLING SOCIAL JUSTICE and OUT OF SCHOOLTIME LEARNING to PROVIDE OPPORTUNITIES to MOTIVATE, ENGAGE, and INTEREST UNDERREPRESENTED POPULATIONS in STEM FIELDS

by **Sheron Mark, Dennis DeBay, Lin Zhang, James Haley, Amie Patchen, Catherine Wong, Michael Barnett**

Introduction: Current Status of Ethnic Minorities in STEM Fields

Ten years into a new century and we continue to face significant social changes that are impacting the economy and workforce. To meet these challenges, there has been an increasing emphasis placed on preparing the next generation to be scientifically literate citizens and to be proficient in the skills required to work in Science, Technology, Engineering, and Mathematics (STEM) career fields. For example, the National Science Board's Science and Engineering Indicators (2010) showed that the science and engineering workforce grew 3.2 per cent on average from 2004 to 2007, a growth rate twice as high as that of the total U.S. workforce. The Bureau of Labor Statistics (2009) also pointed out that the workforce in STEM fields will continue to grow and projected that about 2.7 million new science and technology-related jobs will be demanded by 2018. Despite this rapidly increasing demand for STEM-related careers, a shortage of qualified STEM candidates continues to be of great concern (National Academy of Sciences, 2007). Although the reasons for this disconnect are many and varied, educational inequity is identified as one of the major causes of the so-called "leaky STEM pipeline" through which many ethnic minority youths fall through the cracks from science students to STEM career professionals (Oakes, 1990). Furthermore, without the opportunity to learn science in ways that are personally meaningful to them, many ethnic minority students decide that science just is not for them and voluntarily leave the STEM pipeline. Not surprisingly, educational research is replete with studies that show that ethnic minority youth tend to develop negative attitudes towards science and are considerably less likely to select science-related professions as their future careers compared to their peers (Norman, Ault, Bentz, & Meskimen, 2001). As Parmer (1993) found nearly 20 years ago, African American youth are strongly influenced by their perceived societal barriers and, as a result, develop limited occupational choices. Although statistics show that ethnic minorities have made gains in STEM professions in recent years, the lack of ethnic minorities in STEM fields is still problematic. In the recent report to the President (President's Council of Advisors on Science and Technology (PCAST), 2010), the council specifically pointed out that *African Americans, Hispanics, Native Americans, and women are seriously underrepresented in many STEM fields* (p. vi). The council further argued that "diversity is essential to producing scientific innovation and we cannot solve the STEM crisis the country faces without improving STEM achievement across gender and ethnic groups" (p. 3). This leads us to ask a very important and critical question: How can we create programs that motivate, engage, and capture the interest of low-income, ethnic minority youth such that they choose to study a STEM field? In this article, we discuss the importance and interplay of three constructs: science interest development, learning science for social justice, and out-of-school learning environments. When integrated together, these three constructs serve as a foundation upon which transformative learning environments can be built that support ethnic minority youth in pursuing STEM fields as future careers.

Developing Science Interest

Many low-income, ethnic minority students describe science as a discipline that generates negative feelings such as boredom, anxiety, confusion, and frustration. Even worse, some of these students feel that they are not "smart enough" for science. Yet there are many exciting projects underway that have found that ethnic minority students from urban, low-income communities do, in fact, develop sustained interest in science (Dierking & Falk, 2010); however, what the research also suggests is that interest in science is not always cultivated in traditional venues like school classrooms, and in fact, more often develops in out-of-school learning environments (Dierking & Falk, 2010). Recent work in counseling psychology and educational psychology suggests that the development of science interest occurs slowly and is full of fits and starts, but generally consists of four interrelated phases (Hidi & Renninger, 2006):

- triggered situational interest: short term, a spark
- maintained situational interest: prolonged
- emerging (less-developed) individual interest: personal mind-state, longer term, supported environment
- well-developed individual interest: long term mind-state- enjoy something very much.

Each phase has differing levels of value and affect and is dependent on the person's experience, temperament, and genetics. In terms of value, the first two stages are often externally generated, while the last two are more intrinsic to the individual. This is a novel way of considering interest and is derived from the Model of Domain Learning, specifically Opposing Theory, where expertise in an area corresponds to interest (i.e., if you are an expert on something, you must have an interest in it). Regarding affect, Hidi and Renniger (2006) go on to say that the earlier stages are characterized by affect, whereas the later stages are more cognitive and characterized by curiosity and a desire to return to the subject area. With respect to education, as interest develops, feelings of self-efficacy do as well: We can become more self-sufficient, raising questions and trying to answer them. It is also important to note that interest typically does not develop in isolation, but plays out through experiences, interactions with others, access to opportunities to explore and experiment, and solve problems that are meaningful and personally important (Ainley & Ainley, 2011). In terms of STEM career education, this is important because STEM self-efficacious individuals persist longer to complete a task, particularly in the face of obstacles. Finally, science interest has, indeed, been found to be a predictor for studying STEM (Tai, Liu, Maltese, & Fan, 2006).

Designing a Program to Generate Interest: The Role of Social Justice

In recent years, both policy makers and educators have focused much of their attention and funding on designing and implementing programs that engage youth in locally relevant problems. A number of successful curriculum projects have emerged but few utilize social justice as the lens through which scientific skills and thinking can be brought to bear to solve local environmental problems. Unfortunately, in many classrooms, the exploration of social justice problems for the purpose of learning science is time consuming and involves the interplay of many complex ideas which are difficult to explore in a meaningful way in a typically hour-long class; however, out-of-school time learning environments often have considerably more freedom (from both traditional curriculum and standardized testing), thus being conducive to engaging youth in solving problems that are personally important to them using a social justice lens. When youth are engaged in addressing social justice problems, learning becomes transformative in nature because youth develop skills that allow them to interrogate the world around them by calling out power hierarchies and injustices, moving beyond just solving a problem for class (Buxton, 2010). For the past six years, with funding from the National Science Foundation's ITEST program, we have been engaging urban youth in an out-of-school time program in which they conduct deep exploration of problems that affect their everyday lives. The core design principle of this work is to empower youth with a sense of competence and accomplishment, building on their strengths, rather than focusing on their academic weaknesses, while enabling them to apply scientific skills and knowledge to help their community. In the following sections, we present our model for urban science education, Social Justice for Talented Emerging Minds (SjTEM) program and present a single case study of a youth participant in our program to provide an example of how the youth navigate and grow through our program.

The SjTEM Program

We currently have 60 students from Boston Public Schools enrolled in the SjTEM program. A student typically joins the program in the 9th or 10th grade and is expected to stay in the program through their high school graduation. We recruit students who are not the best in their class, but are typically considered ***C*** or average students and are likely to be the first generation in their families to attend college. Most students are initially drawn to the program to learn more about college and navigating the college application process with little, if any, initial interest in considering STEM as a potential career. During their time in the SjTEM program, the youth are engaged in exploring science careers, developing scientific research skills, and learning how to better prepare themselves for college. The career development aspect of the program introduces students to the concept of STEM and 21st century skills and the importance of these in today's society. Additionally, they learn about the transferable nature of STEM skills, meaning that they are important and useful in a wide variety of academic disciplines and career fields. To support students in identifying potentially satisfying future careers, they also complete a number of interest and personality profiles such that they can begin to explore a person-environment fit between themselves and developing career considerations. At the core of the curriculum program are the opportunities for youth to apply their cultural resources and scientific skills to social justice issues that are related to problems in their communities. Not surprisingly, many youth often need a hook or a starter to begin the process of solving a complex problem; however, these hooks often emerge from the youth themselves with support from teachers in our program. From there, youth are provided opportunities and resources (e.g. technology) to solve their problem. The end goal of the program is for youth to become change agents for their community and their own lives by using scientific skills and knowledge to challenge injustices that they have either experienced or see in their everyday lives. This model is historically successful with Freire as an exemplar (Freire, 2007).

In one aspect of our program, youth have been learning how to use Geographic Information Systems (GIS) technologies to examine environmental injustices in the city of Boston. In the process of doing this, one set of youth was encouraged to look at how easy it was for them to access healthy food. This question emerged from a previous idea that low-income urban areas tend to not have the same access to healthy food as more affluent neighborhoods. The youth soon created a visualization that illustrated their limited access to full-service supermarkets (see Figure 2) which led to the difficult challenge of mobilizing change to address the inequitable access to healthy food. To that end, the youth suggested a market in the area which led our project staff to examine ways to support the youth in reaching their solution. This work soon led to a hydroponic food project (growing food with water and minerals as opposed to soil) in which the youth grow food and sell their produce at local area farmer markets.

In another project, students use CommunityViz (an extension of ESRI's popular ArcGIS software), coupled with field site visits and their own knowledge of the city, to propose development plans for vacant lots or rundown properties. CommunityViz allows youth to make interactive three-dimensional (3-D) models of real places as they are now and as they could be in the future based on specific site designs. Finally, the CommunityViz program is capable of providing a powerful visual interface which is valuable for communicating the urban planning process across the many groups of people who become involved in making decisions about the future of a place. This work was done with a local community development corporation, Madison Park Community Development Corporation (CDC), which led the youth to become the GIS experts for the Madison Park CDC, which in turn led the city of Boston to approve the Madison Park CDC's proposal for redeveloping a parcel of land located in the home neighborhood of many of the youth. Next, we present a case study of one of the youth participants. Sonya is representative of many of the youth in the SjTEM program being an ethnic minority, speaking multiple languages, and being from an educationally limited background, but highly motivated to attend college and attain a successful and satisfying career. Importantly, like many of the students, Sonya entered the program more interested in college exploration and preparation than science and had many of the same preconceived, unfavorable notions about science as described earlier (i.e. difficult, dull, boring, frustrating, etc.). Sonya had undergone the sort of transformation that we aim to see in our youth and, as such, is selected as the case exemplar for this paper.

The Case of Sonya

Sonya was a high school freshman, Latina female from a working- to lower-middle class socioeconomic status with parents from limited educational backgrounds. Neither parent had graduated from high school.

In reflecting on her time in the SjTEM program, however, Sonya clearly stated her initial lack of interest in science, although she did enjoy math: I hated science and technology . . . I thought engineering was about trains . . . but I love math.

During her early time in the program, Sonya's participation and interest in the SjTEM program was driven by enjoyable peer interactions and an expansion of her social circle. She had her established peer group, but also socialized often and comfortably with other students in the program. Academically, however, the social justice, urban planning and development focus, based on caring for and improving the local environment, appealed to and maintained Sonya's interests and facilitated her new engagement with science and technology. These experiences resulted in her changed perspectives regarding science and technology, including a newly found interest in and enjoyment of science, increased science confidence, and an understanding that she can use science to help others. These changes also influenced her most recent career interests which shifted to a number of service-oriented science and technology careers. In particular, regarding her growing interest and enjoyment of science, Sonya said:
Science could actually be fun. You can be outside, do graphs that you don't do in school. In school, [for math, you use…] only calculators and pencils. When you do work that is fun, it is easier to memorize. At school, you just get nagged to do things that aren't fun.

Importantly, Sonya attributed her new interest and perspective on science to the opportunity to engage in student-driven, hands-on, inquiry-based scientific activities which were unlike what she would be required to do in school science. Secondly, Sonya always considered herself smart and knowledgeable. These feelings of confidence and competence were now, however, extended to science. In the activity below, Sonya progressed through the work successfully and engaged her instructor to show the high quality of her work:
Sonya to Instructor: *Excuse me. Look, I did that.* [Sonya points to her computer screen].
Instructor: OK.
Sonya: *No pollution.*
Instructor J: Wow! Got more energy. More commercial energy. . . Looks like you got more jobs, too. Jobs and housing. Energy, water, barely any. And energy use...[Sonya points at the screen, leading Instructor J through each output indicator].
Sonya demonstrated great personal responsibility and investment in the quality of her work, including a PowerPoint presentation documenting her group's redesign of the city block, the environmental and social

impacts of their design, and documentation of their research team's activities. She showed pride in her work, not only the aesthetics of the design for the parcel of land, but the STEM-related results, such as level of pollutants and energy use. Throughout her time in the SjTEM program, Sonya emphasized that she "care[d] about the people," especially as many other students focused on tree plantings, neighborhood clean-ups and other actions intended to repair the physical environment. Meanwhile, Sonya intended to undertake actions meant to improve the lives of others. These altruistic interests reappeared, along with Sonya's newly developed science interest, and influenced her future career considerations which then included a number of people- and service-oriented science and technology careers. Sonya said:

I want something to do with medicine. . . . I [also] wanna be like a forensic, like, if someone dies, I wanna be able to know like how long ago was it. [Student: Like an autopsy]. Yea. And I also wanna see like, if there's a dead body, I want to be able to just look at it and be like, "Oh, this and this…" and basically make a story out of what happened by just looking at it. . . . I also want to study psychology . . . 'cause basically I took a class at [the university] in psychology . . . and they were talking about like little kids and when they have problems and I told the teacher that, honestly, all I think they do here is give little kids a whole bunch of medicine for no reason. They just want little kids to get an overdose which makes them even more crazy.

Sonya expressed an interest in medicine, a scientific career often identified by underrepresented females given the opportunities to interact with and help other people (Johnson, 2007). Similarly, with forensics and child psychology, there was the underlying motivation to engage with and help others. Overall, the social justice design of the curriculum and instructional activities of the CB program engaged Sonya's existing concerns about others and required student-driven, hands-on inquiry activities that appealed to Sonya's learning preferences. These positive experiences in science and technology resulted in notable changes in Sonya's interest and enjoyment of science, confidence in her science skills, and consideration of satisfying science and technology-related careers.

Needed Directions: Social Justice and Out-of-School Time

Many scholars (Moses & Cobb, 2001; Tan & Calabrese-Barton, 2010; Tate, 2001) have argued that it is a civil right for all youth to have the opportunity to learn science and mathematics. Utilizing social justice issues as an anchor around which science content is structured provides a unique way to empower youth to not only learn science but to become more interested in creating positive change by pursuing science as a career. Further, by challenging the assumption that school is the primary place where youth learn science, we, as educators, unlock an often underutilized time in youth's lives, namely out-of-school time experiences. In closing, by creating educational spaces where students can truly implement a solution and be able to follow that solution through to a conclusion is extremely valuable for youth. The reason for the value is that, more often than not, youth, in school, are often asked to generate a solution to problems, yet are unable to implement the solution; as a result, the entire exercise loses meaning and simply becomes another school activity. Yet, when youth are engaged in projects that are community-based and they can take actionable steps to make their community a better place to live, science content is no long disconnected from their lives but becomes an integral part of, not only their learning, but of their lives.

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APPENDIX on the following pages:
Figure 1: SjTEM Implementation Model.
Figure 2: Visualization of access to supermarkets compared to grocery stores for urban youth.

Figure 1: SjTEM Implementation Model.

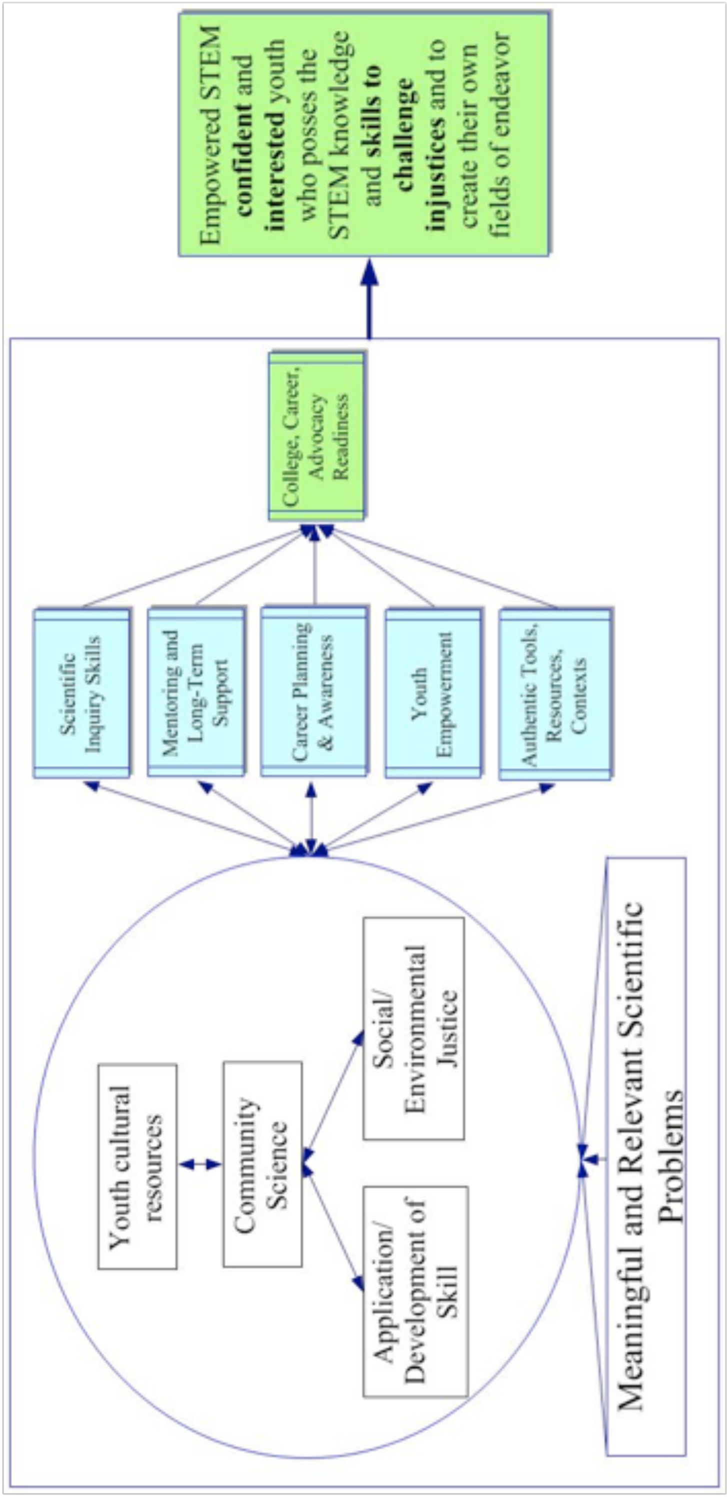
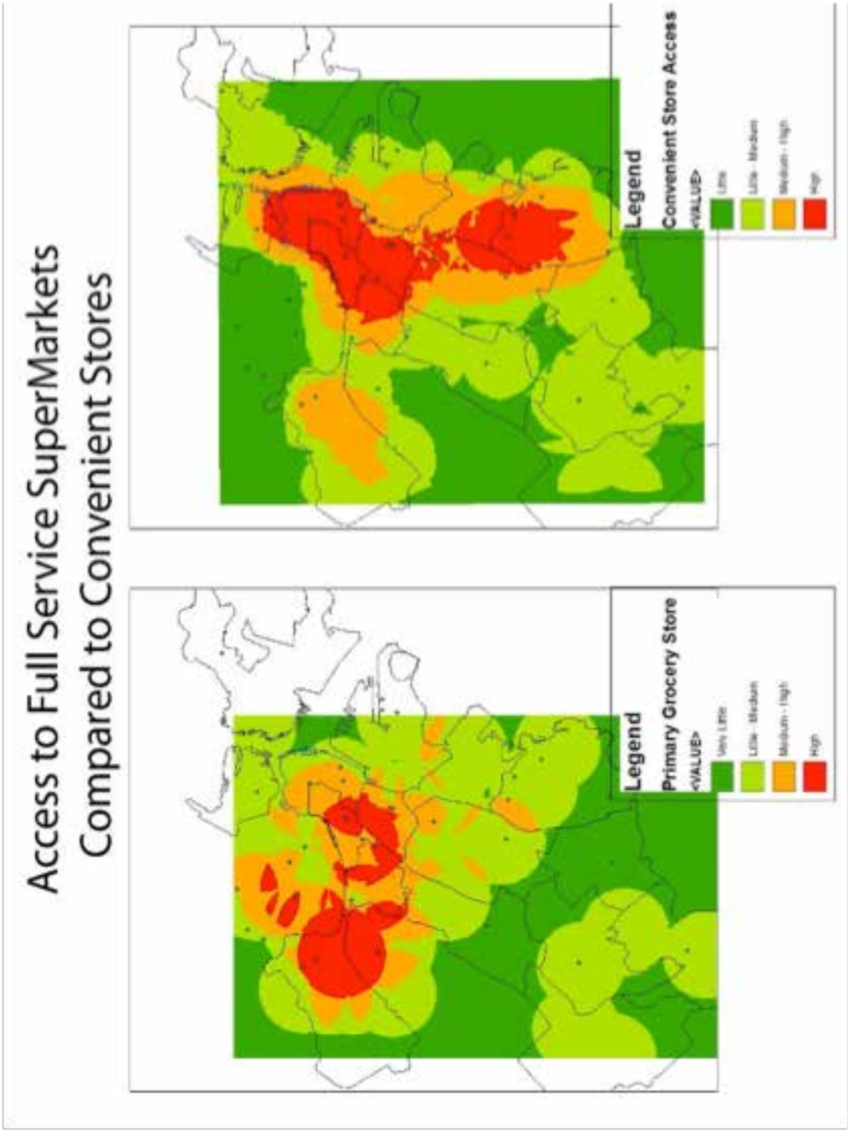


Figure 2: Visualization of access to supermarkets compared to grocery stores for urban youth.



Chapter 9

STEM RELATED CAREER DEVELOPMENT FOR EXPERIENCED WORKERS

by **Sally J. Power**

Career counselors and coaches have been aware for some time that our economy is in transition and have been urging individuals to expand their career management and development to adjust to these changes. Now the stakes are getting higher because jobs are scarce in many areas as we struggle with our third, and by far our deepest, *jobless* recession (Associated Press, 2013). These hard times can provide more motivation for individuals who have the capability to change their approach to career management and job hunting in order to maintain healthy careers.

This issue of the Journal is devoted to STEM-Centric Career Development. It is a timely subject because an increasing number of observers and researchers are pointing out that technology improvements may well be a major factor in our economy's slow job creation. For example, a recent series of articles in the ***Washington Post*** that were based on AP research concluded that the lack of job creation is largely because of technological advancements such as automation and concluded that the jobs lost will not return (Wiseman, 2013).

But, you say, hasn't automation been around for a long time? Why is the impact so much greater now? Brynjolfsson and McAfee (2012), in their very readable book Race Against the Machine, make the point in their second chapter that basic technologies (that is, technologies that create industries such as computers and computer software) advance according to Moore's Law which means that their capability doubles about every 18 months. Early in this doubling process things move relatively slowly from an outsider's perspective but as the advancements continue to be applied the doubling of capacity has much greater reach in the larger world. What we are seeing now is the result of years of slowly growing impacts in the area of automation. What this means to people well into their careers is that they should not ignore how technologies of all kinds are beginning to change their work because the impact will only get greater. Rather they should embrace the technology and learn to work with it. That will be where many of the new jobs will be created and how many individuals will stay relevant in the workplace.

This article will explore how individuals already well into careers can integrate their work experience with technological advancements to build career opportunities for themselves. Describing this process I will highlight options and topics that can become a check list for counselors and coaches to use working with clients to help them capitalize on unique opportunities that fit their particular work experience and career preferences (see Table 1 at the end of this article). I will also explore the particular challenges this kind of learning presents to experienced workers and how counselors and coaches can support clients who are engaged in such learning. This information can also help human resources staff identify what kinds of training and development can help individuals in their organizations make the most out of the technologies their work-organizations are adopting.

Identifying Career Opportunities Integrating Technology with Work Experience

Often when writing about the future, writers tend to assume that the change has already occurred: in this case that the jobs have been displaced by technology and none will be replaced. That kind of thinking ignores two important facts. First, it ignores that changes in the real world take time and lots of work. And second, it ignores the idea that human desires or other events may change the trajectory of any major change. After all, human society is not simply about the efficiency and exactness that technology offers; humans have many more goals in their work and production. Both of these facts create jobs in the real future as it evolves.

The first arena for possible career opportunities is assessing what technologies are present or entering the client's work niche. Specifically looking at what these technologies do now and what their limitations are. All software is built with assumptions about the work it is aiding and automation of all kinds is run by software. Identifying what those assumptions are, when and how they can negatively impact the organization or unit's goals, and how to work around those potential impacts can make individuals more valuable resources in their organizations.

Most workers see new software as an intrusion – a new method of doing the work that must be learned in order to get the work done – and from this perspective, it is making the work harder. Most software today has much more potential than that. For example, recognition of the software's limitations in achieving their employer's goals and developing work-arounds leads to new work opportunities. These potential opportunities include teaching others how to recognize situations where they will need to employ the work-around tactics, or help choose the next software to buy, or work as the conceptual lead for designing modifications to the software so it meets organizational goals better.

A second way to build on the technology is to identify customer needs it may solve that were not envisioned when the software was introduced. This may be software enabled services, or using new data provided by the software to do new things, or proposing a use of the human-time saved to meet additional customer needs.

The traditional assumption of most workers is that someone, somewhere in the organization has made all those determinations and the software chosen will do what management wants. That may have been truer in olden days when employers hired technical people to write software or develop technology just for their organizations (although software introductions from the IT department have been notoriously unsuccessful in business). But organizations seldom create software now unless it is the foundation of their competitive edge; they buy *off the shelf* technology and base their decisions on what sales people say their products do. Furthermore, most sales people and many managers have never really used their products so there has not been a real "road test" by someone who actually does the work and is focused on a specific organization's goals. Knowledge about the work niche is why experience is still an important component of the value of an experienced worker. You can highlight this knowledge for your clients by asking questions about the following aspects of their employer and helping them gather this information if they do not already have it:
what their customers (either internal or external to the organization) want,
what their managers want,
what the challenges are to meeting the expectations of both of these groups,
what the major variables are that influence the success of the work being done, and
how the work of their unit and organization distinguishes itself from its competition.
This requires individuals to re-interpret their more basic skills and knowledge into what I would call "enterprise-oriented" experience. Many mid-career and later-career individuals can do this with some prompting.

An Example of Integrating Technology and Enterprise Based Experience

Joe was a client who had entered his company some years ago by getting a position in their call center. He had done well and been promoted to call center manager. He liked the work and had a strong desire to help call center workers have better working lives so his career goal was determining how to build his career and employability as a call center manager. We assessed the different things that he did every day in terms of the future of call centers. This was when he realized that really listening to the sales people who visited him and learning about the differences in call center software would allow him to build an expertise in choosing software that could improve the work of large numbers of call center people. It also would make him stand out as someone with knowledge that could be useful in many different call center situations. Sales calls went from being a chore to much more focused, purposeful learning sessions.

Joe was not a programmer but he had deep knowledge of the enterprise's goals and challenges in terms of his call center work. He could use that experience-based knowledge to assess call center software. This is the kind of integration of work experience and technological tools that can allow individuals to benefit from their work with technology.

Almost all occupations and work niches are likely to have more technological innovations changing the way the work is done in the near future. Examples abound in a variety of fields. Administrative assistants can learn the fine points of their organization's survey software giving them a special expertise. Nurses and other healthcare professionals can build intimate knowledge of the electronic coding systems being used and provide new kinds of information to better patient care. Analysts of all kinds can learn the new presentation software and find faster and clearer ways to communicate the findings of their analyses.

There are three major areas in which individuals may need help recognizing how they might integrate their experience with technology to provide new career opportunities for themselves. First, they may need prompting to convert their knowledge of their working niche into "enterprise-based" foundation for their thinking. Second, they need to think more deeply about what the technology can do and not do, and how that matches with the goals of their unit or organization. You can assess whether individuals can do that kind of thinking by asking what problems they have experienced using the software or other technology used in their niche. Probe further about those problems and ask them how the software appears to be thinking (i.e., what assumptions does it appear to be making). Then have them test their thinking by observing more closely or experimenting if possible. And third, you can help them unleash their creativity to design "work-arounds" and decide how to share them to improve the organization's functioning.

The job possibilities are many for those who can embrace the technology and do the problem solving necessary for integrating it with work goals. Because technology is now developed for use in multiple industries/organizations, learning the fine points of a technology or software is a transferable skill. These technologies will not be adopted all at once by those doing the work; their adoption will move from small to large organizations or visa-versa and could easily move between industries or sectors. This process will take years so learning a technology and its assumptions well can provide some employment security.

Also, the process described here shows employers that the individuals are active learners who also can think about what is important to their particular organization. And, the adoption of change requires all kinds of jobs. For example: selecting which technology to adopt, teaching others how to use it, doing the actual transfer of information so it is accessible by the new system, and developing special applications or collateral, enabling technologies for various applications. People who show an aptitude for this type of learning can do all these kinds of jobs and more depending on their interests and career goals.

A prime challenge for individuals already well into their careers who want to integrate their work-niche technology into their career development is the relatively sophisticated learning required. This learning is deeper than simply learning how to use the technology as I hope my examples and narrative have shown. This learning is a second primary area in which counselors, coaches, and human resources professionals can facilitate individuals to make shifts to embrace and use technology to build their careers.

The Learning Challenge of the Technology-Enterprise Interface

The deeper learning about technologies needed for the kind of human-technology integration that will be the source of many jobs in the future is a challenge for most people already well into their careers. The reasons are almost infinite but one root source of the reticence is a lack of understanding of the increased acceleration that the impact of technology is likely to have on our working lives. So far, we have been able to use technology mostly to do what we have been doing faster and more inexpensively. But as Brynjolfsson and McAfee (2011) point out, we are likely to be entering a new phase where the changes will have increased impacts. More of the work will be *technology enabled*. Still the technology must be understood and managed by people to serve human needs.

To make that point with individuals, I often use the evolution of how we manage our money. A century and a half ago we were a cash economy and most people put their savings in their mattresses or bought jewelry. Then came banks and checks and we had to learn how to balance our checkbooks, then much more recently, credit cards. Now, many are moving to automatic, electronic payment systems. These electronic systems present us with much more sophisticated decision-making issues to use them effectively. For example, we have to deal with such questions as how we keep track of the discretionary funds we can spend on extras and the timing of automatic deposits and withdrawals. Note that the speed with which technological innovations in this area have come has accelerated and at each stage we have had to learn more complicated, new systems for our decision-making. Most of us faced with the march of technology and the need to spend money have learned and moved forward.

The situation is similar in our work niches. Technological innovations are and will be coming *on-line* with accelerating speed (we are probably at the credit card stage in terms of technological assists in most workplaces). Humans are still necessary components but we must work much more intimately with the technology and learn how to adopt and use it to achieve our goals.

The challenge of learning how to learn is a second root source of the reticence on the part of already working individuals. Learning about the application of workplace technology to particular problems seldom comes with a course syllabus and technology handbooks. Establishing a direction for learning is a first step. Many people feel overwhelmed with all the technological changes and they mistakenly think they must learn everything about the technology as they likely did in more formal educational settings. Their response often is to throw up their hands and declare learning defeat. My suggestion is that they first develop their understanding of their work from an enterprise perspective and then pick a single technology they believe is or can have significant impact on their work. Using the problems or potential they see with the technology to guide their direction-setting, they can set about much more targeted learning. The second step is to gather resources and structure the learning. Questions counselors and coaches can ask are what resources exist in the organization such as IT personnel or individuals who are known to already be *power users*. Software sales people may also be useful resources. Another source that is relatively new but should be considered is the web. A great *starter* guide for such learning is ***The Edupunk's Guide to a DIY Credential*** by Anya Kamenetz (2011). Not only does she provide resources for all types of learning on the web, but in addition, she provides an excellent road map for structuring individual learning from goal setting to credentialing outside the formal school setting. It is a great resource on more independent learning and because we are generally not good at structuring or sticking with an independent learning process, this is an area where career counselors and coaches can be particularly helpful.

Finally, working adults are time-deprived. A major challenge for most will be to create the time to do the learning. The lucky thing for working adults is that enterprise focused learning can be considered part of their job. This time can be further expanded by their volunteering for or suggesting projects related to the technology they are trying to learn about. Again, because of the enterprise-based approach to the learning, such projects are more likely to be endorsed by management.

Conclusions

Increasing employability by embracing technological innovations at work and becoming more intimately knowledgeable about how to use them is a career path that will not fit all experienced workers. However, career counselors and coaches need to be alert to investigating this possibility with their clients. This is no longer just the prerogative of the young who are technologically inclined; our use of technology is increasingly integrated in our working world. The more sophisticated use of technology highlights the importance of another type of knowledge that is more common among experienced workers than those just entering the workforce. I have called that knowledge *enterprise-based experience* and it can allow experienced workers to see the limitations of the technology in achieving organizational goals as well as devise ways to get around those limitations. That can make them *power* users who are likely to be valuable employees because they can teach others how to use the technology more effectively, speed transitions and productivity increases by being able to do things with the technology that others cannot, and help make better technology-related decisions. This increases their employment security as well as the organization's success.

Clients may need help seeing the potential of integrating their knowledge as experienced workers with the technologies that will increasingly enable their work. Further, learning about the technology in a more sophisticated but applied way will also be a challenge. This article has attempted to highlight several ways this type of thinking can be encouraged and the multiple career options it can introduce.

We have long been told that individuals must take increased responsibility for their careers. The decline of job creation which signals a new phase in our economy's evolution and the progress of our technological advancements in the workplace suggest that the evolution of career management is also moving into a new phase. I call this phase *enterprising* career management. People, particularly experienced workers, now need to think about what new value can be created for work organizations and how they can prepare to provide that value. Technological advances offer one avenue for creating such new value and developing new jobs for themselves and others.

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APPENDIX on the next page:
Table 1: A Checklist for Career Counselors and Coaches Advising Experienced Workers About STEM Related Career Development

Table 1: A Checklist for Career Counselors and Coaches Advising Experienced Workers About STEM Related Career Development

Translating Work Experience into an Enterprise Perspective?
What customers (internal or external) want?
What management wants?
What the challenges are to meeting the expectations of both groups above?
How is the work of this unit/organization different from its competitors?
What technologies/software is the client using in the work?
What are the problems/limitations in using the technology from an enterprise perspective?
What can be the work-around to solve this problem/limitation?
What potential does the technology provide to achieve new customer needs?
Does it create new information?
Does it create time?
What job possibilities does this knowledge of the technology-human integration suggest?
A specialist job using the technology?
A training job using the technology given the specific needs of the enterprise?
A management job helping facilitate the change to this technology in another unit or organizations?
A job developing a new service/product and a customer base for the new data being generated by the technology or as a result of the possibilities because of the time saved due to the technology?
What challenges does the client face in learning about the technology?
Not realizing the importance of the accelerating impact of technology on work?
Setting a direction?
Feeling overloaded?
Focusing on the problem vs. learning it all?
Finding resources?
Finding local sources?
Finding web sources?
Structuring the learning?
Reflecting and redirecting the learning?
Time management and creation?
Seeing where volunteering opportunities exist?
Figuring out how to be credentialed?

Chapter 10

USING THE CAREER DECISION MAKING SYSTEM TO ENHANCE STEM OPPORTUNITIES FOR SECONDARY STUDENTS

by **Laurie A. Carlson** and **Bernadine Knittel**

The professional school counselor's role is multifaceted. School counselors are responsible for ensuring that all students reach their academic, personal/social, and career potential. With an ever increasing technological and global economy, it has become even more important for school counselors to help students consider and prepare for careers in the STEM field. Preparation for such careers often involves early and active academic advising that couples a student's interests, abilities, and skills with a school's curricular offerings. This article offers insight into how the Harrington-O'Shea Career Decision-Making System can be utilized with high school students to enhance STEM-centric school counseling. One of the primary roles of professional school counselors is to ensure that all students have access to strong academic advising and post-secondary workforce readiness strategies that provide them with optimal opportunities for success in the future. An ever-expanding and global market place, rich with careers in science, technology, engineering, and math, is a call to action for school counselors responsible for opening doors of opportunity to all students (Feller R. W., 2003a, 2003b, 2010a; Schenck, Anctil, Klose Smith, & Dahir, 2012). Due to the ever-changing expectations within the fields of education generally and school counseling specifically, school counselors face a steep challenge in effectively reaching those students they serve when it comes to career guidance and counseling (Schenck, et al., 2012). High school students consistently report that they develop particular career interests early in their high school experience and that they find family members to be most influential during the career identification process, while school counselors and other adults in the educational setting are identified as less helpful (Career Institute for Education and Workforce Development, 2002; Gibbons, Borders, Wiles, Stephan, & Davis, 2006). This finding is consistent with the results of a subsequent research study funded by the Bill and Melinda Gates Foundation and reported in the document ***Can I Get a Little Advice Here?*** offered online through the Public Agenda website (Johnson, Rochkind, Ott, & DuPont, 2010). The current article explores the intersection of career exploration through the utilization of the Career Decision-Making System (CDM), academic decision-making, and STEM-centric post-secondary planning through the window of two field-based case studies.

The Intersection of Career Exploration, Course-Taking, and STEM Engagement

High school students generally possess the career maturity necessary to engage in post-secondary and workforce readiness planning. Although the more modern concept of career choice readiness may not be appropriate for all high school students in the early grades, a higher level of career choice readiness has been linked to more successful post-secondary transitions (Hirshi & Läge, 2008). Career choice readiness is central to the task of selecting an academic program that allows for exploration while at the same time keeps a broad array of options open for the student.

Guiding students through the process of academic planning is a long-standing role of the school counselor and is a key component of promoting access and equity for all students (American School Counselor Association, 2012; Galassi & Akos, 2012). Research indicates that high school students tend to enroll in courses based primarily upon their likes and interests (Career Institute for Education and Workforce Development, 2002), making it even more important for the school counselor to actively guide students while making educational plans that will help them meet their short-term and long-term educational and career goals (Schmidt, Hardinge, & Rokutani, 2012).

Academic coursework in high school lays the foundation for future success in STEM-rich careers. Engagement in a comprehensive and rigorous academic program increases student academic esteem and skills that lead to future success in a competitive, global workplace. Undergraduate students who are more fully engaged in their introductory STEM courses are more likely to complete their intended program of study, and this engagement has its foundation in the experiences of these students during high school (Gasiewski, Eagan, Garcia, Hurtado, & Chang, 2012; Sciarra, 2010). Generally, subjective orientations, students with an increased perception of intrinsic value in math and science-related courses, tend to persist in them and develop further skills and efficacy in such subjects (Perez-Felkner, McDonald, Schneider, & Grogan, 2012; Sciarra, 2010). This is particularly true for female students who report a stronger belief that mathematical ability is innate and express a decreased valuation of math and science courses (Perez-Felkner, et al., 2012; Trusty, 2002). Academic experiences in general during high school do not attenuate gender differences present in post-secondary enrollment in STEM programs, yet completion of advanced secondary math courses in particular does have a positive effect on female students' enrollment in physical sciences, engineering, mathematics, and computer science majors during post-secondary education (Perez-Felkner, et al., 2012; Trusty, 2002). It appears, therefore, that enrollment in and completion of advanced math courses is particularly important for young women to stimulate and maintain their interest in STEM fields that are based in formal science and math traditions.

It is a mistake to constrict STEM-based fields to conventional and advanced math and science courses, particularly when a number of engineering and technology-rich careers fall into what is more traditionally considered vocational education and skilled trades, largely not requiring a four-year college degree (Feller R. W., 2003a, 2003b). For students on this STEM-rich path, relevant and applied learning experiences are particularly salient (Feller R. W., 2009). These applied learning experiences generally vary by school and district but may include such opportunities as vocational and distributive education, concurrent enrollment, work or internship programs, entrepreneurial school clubs, and other extra-curricular options (Feller R. W., 2003b; Fouad, 1995).

Using Formal Career Interest Inventories with High School Students
Multiple strategies should be utilized when considering the academic and career development needs of secondary students. Formal career inventories can offer insight into the interests, values, skills and abilities of youth as they prepare for their educational and vocational futures. In one survey of 417 high school counselors, 79.9 per cent reported using some form of paper-pencil career assessment tool, and 53.1 per cent have used some form of computer-based career assessment in their work (Freeman, 1996). Examination of vocational interests is a critical task for the career development of secondary students (Hirshi & Läge, 2008), and this tends to be a strong component of the most commonly utilized assessment tools including the Strong-Campbell Interest Inventory, the Kuder Occupational Interest Inventory, the Career Decision-Making Inventory, and DISCOVER (Freeman, 1996). Formal assessment measures should always be coupled with conversations around student perceived interests, skills, abilities and values in order to develop a more comprehensive picture of the student and to further the student's career self-efficacy (Hirshi & Läge, 2008).

The Career Decision Making System (CDM) was developed with the goal of enhancing a student's career development (O'Shea & Harrington, 2003). Harrington (2006) determined that two letter codes identified by 16-year-olds on the CDM were generally stable over a 20-year period with male's codes slightly more stable than codes identified by female students (Harrington, 2006). The strength of the CDM system is that it couples student-identified interests, skills, abilities and values with current and future educational plans as well as career specific information. This provides to the school counselor and student a tool for comprehensive, research-based career exploration and planning (O'Shea & Harrington, 2003). Freeman (1996) found that high school counselors rated the CDM as the most effective of all paper-pencil career assessment tools they had used.

Exemplary STEM-Centric Practices in School Counseling

Recent developments in the school counseling field, including the development and publication of the American School Counselor Association's National Model, have served to solidify focus on the career aspects of the professional school counselor's role (American School Counselor Association, 2012; Schmidt, et al., 2012). Three primary tasks emerge when considering best school counselor practice in providing effective services to students poised for a STEM career. First, school counselors should seek to expand their own STEM career awareness and knowledge (Feller R. W., 2010b; Schmidt, et al., 2012). Secondly, school counselors should work with students to examine student interests, skills, abilities and values so that meaningful and helpful career counseling can occur. Although formal assessments may be efficient when completing this step, one should consider that secondary students are by and large capable of identifying their primary vocational interest from short descriptors (Hirshi & Läge, 2008); therefore, school counselors should not be discouraged by an inability to utilize formal assessment instruments due to time and financial resources (Freeman, 1996). The third task for school counselors is to help guide students in an honest exploration of how their self-identified skills, interests, values, and abilities fit with STEM-rich educational and career opportunities (Feller R. W., 2010b Schenck, et al., 2012).

Using the CDM-R to Guide STEM-Centric Academic and Post-Secondary Planning

The Harrington – O'Shea Career Decision Making System (CDM) is a tool that utilizes self-reported skills, interests, values, and goals to guide career exploration and decision-making (O'Shea & Harrington, 2003). Originally developed and published in 1982, the CDM has gone through several revisions with the most recent comprehensive revision occurring in 2000. The paper-pencil and computer-based instrument were developed within an interactive internet environment in 2008 by Career Planning Associates and distributed through Pearson Education. Two years ago the authors conducted a quantitative equivalency study of the paper-pencil version and the internet version of the Career Decision-Making System with 9th and 10th graders in one local, comprehensive high school. The school counseling team was allowed to retain student results to aid in providing academic and career counseling to the students on their case load. The following case studies are offered to demonstrate the utilization of assessment results when working with individual students on STEM-centric academic and post-secondary planning.

Case Study 1 -- Willow

The first case study involves a female, self-identified Asian Native Hawaiian or Other Pacific Islander, who at the time of study was a freshman and is now a junior, ranked in the 96th percentile of her class with a cumulative 4.128 weighted GPA. Along with a strong Advanced Placement academic focus, she is involved in music, Knowledge Bowl, and a school sanctioned sport. Early on, Willow self-advocated by seeking my guidance on course selection, purposefully asking questions about college entrance requirements to ensure appropriate course enrollment that aligned with her post-secondary goal of attending college. The two career clusters Willow selected on the CDM were math-science and education followed by the four school subjects she liked the most which included music, math, science, and languages. In addition to identifying her career cluster and subject choices, Willow identified work values most important to her and recognized her strongest abilities. Willow's future plan at the time was to attend a four-year college or university. After completing the 120-item interest inventory, her highest career interests included the scientific and social interest areas -- equivalent to investigative and social using the RIASEC codes. The career clusters suggested for future exploration consisted of medical-dental, math-science, and social service. In reviewing her CDM results, I was curious to see whether the future plans that Willow had stated during her freshman year held true in her junior year. In addition, I reviewed course enrollment during her sophomore and junior year as well as course selections for her upcoming senior year. Since her course enrollment matched her identified school subjects as indicated on the CDM, I naturally assumed that Willow was actively planning to pursue a career focused in the math and sciences. Because there were no discrepancies between her CDM and course enrollment, I planned to center my conversation on her perception of her experiences in the math and science courses she had completed and whether she felt prepared to pursue her post-secondary goal. In taking a STEM Centric Career Development approach, it was important that our conversation include an informational piece on STEM; what that meant, and the many possible STEM disciplines available for her exploration. While reviewing her CDM results, Willow stated that she vaguely remembers completing the assessment during her freshman year. She confirmed her continued interest in math and sciences. Although she remains undecided regarding what major she plans to pursue, her interests include genetics, biology, and life sciences. When I asked about her interest in education, originally indicated as one of her career choices on the CDM, she was uncertain whether she would pursue education as a career, but articulated that should she decide to pursue education she would seek certification in secondary science. As Willow and I reviewed her course selection for her upcoming senior year, she remained confident of her selected courses: AP Biology, AP Calculus AB, Anatomy I & II, AP Literature, Economics, and Chamber Orchestra. Although she does not plan to pursue music beyond high school, it remains an important activity in her life. In reflecting on her courses in math and science, she felt these courses prepared her well and she was confident in her continued post-secondary focus in math and sciences. When I shared that her interests were all considered STEM disciplines, she had no idea what STEM meant. Based on her response, we spent time exploring the stemcareers.com website. She took note of this website by writing the URL in her planner. We agreed the next counseling session would be spent exploring the website further by looking for possible summer enrichment activities and programs related to her STEM focus. Additionally, I plan to spend time exposing her to the list of STEM disciplines available on O*NET as this may help her narrow her decision regarding which career path to pursue or may expose her to disciplines she had not yet considered. Along with reviewing possible STEM disciplines, I want her to consider the work values and abilities she noted on her CDM to ensure her chosen career path is congruent with her values of high achievement, prestige, and working with people as well as her mind. Willow's CDM profile, course-taking, and post-secondary plans presented a consistent and congruent picture of STEM interest grounded in traditional science. As you will see from the next case study, not all students present such a clear picture.

Case Study 2--David

The second case study represents a self-identify multi-racial (Caucasian/Hispanic) young man with a Traumatic Brain Injury (TBI) documented on his 504. David is soft-spoken, so Mom often advocates on his behalf; however, as a junior he continuous to grow more autonomous. Although David is not involved in extracurricular activities on campus, he enjoys working on cars with his father. He is ranked in the 34th percentile with a cumulative 2.441 GPA and has never failed a class, although he has earned several Ds. David initially took the CDM as a freshman and indicated that his two career choices were auto technician (skilled trades cluster) and construction laborer (manual cluster) within the crafts interest area -- converted to realistic in the RIASEC system. The school subjects he most liked included graphic design, Spanish, automotive, and drafting. The work values most important to him included creativity, independence, job security, and outdoor work. David listed his abilities as manual, mechanical, social and teaching. He noted his future plans were to attend a four year college or university. On the CDM summary profile, David's interest area scores were low in all six interest areas with crafts and social being his two highest, both with a score of 2. David did not list any career clusters to explore on his CDM profile. In comparing his CDM results with his course enrollment and projected senior course selection, I noted that David did complete elective courses in graphic design and drafting which were two of the school subjects he indicated on his CDM. Along with his elective choices, he also completed a year of Spanish. It was during his freshman year that David concentrated on elective courses that aligned both with his construction laborer career choice and the school subjects he selected on his CDM. It is unclear if David made these subject selections because of a true liking for the classes or because of familiarity with them through his enrollment at the time. David listed Spanish as one of his favorite subjects; however, he only took 1 ½ years of Spanish, which was interesting considering he took more courses related to physical education. Moreover, David did not take any courses in automotive, which was one of his career choices. When reviewing his senior course selections, I noted that David enrolled in the necessary academic courses to meet graduation requirements and took a variety of elective courses in the fine arts, physical fitness, communications, and consumer and family studies. He also planned to repeat Construction II. In addition to signing up for these courses, David applied for the local community college high school pathway program. His initial interest was construction; however this course was not an option because the community college did not offer it, thus David decided to enroll in the automotive program. Because there were noted discrepancies between his CDM results, courses completed and course enrollment, I planned to discuss this with him. Like Willow, David vaguely remembered completing the CDM as a freshman. As we reviewed the school subjects he indicated on his CDM as most liked, I pointed out the discrepancies on his transcript, especially his lack of enrollment in automotive courses. David disclosed that after consulting with his peers about the automotive course offerings, he made the decision not to enroll in any automotive courses because they had shared with him that the courses were very entry level and focused primarily on small engines. In his words, he saw those courses as only addressing *the basics*. David felt these courses would be a waste of his time since he already possessed mechanical abilities as a result of working with his father. He further made note that mechanics was one of his self-identified abilities on the CDM. In David's eyes it made more sense to focus his attention on completing his graduation requirements so he concentrated on completing the required core classes. When I asked about the discrepancy in Spanish, he acknowledged it was a hard course because of the memorization, which he struggled with as a result of his diagnosed TBI. He listed it as one of his preferred subjects because he truly wanted to learn how to speak Spanish due to his heritage. In order to accomplish this goal, David is using Rosetta Stone and working on learning Spanish outside of school. Although David was more interested in pursuing construction through the pathways program, he is excited about his automotive program next year. Enrollment in the automotive program allows him to attend his home high school part of the day and spend the other part of the day at the community college. In addition to increasing his knowledge of the automotive field and enhancing his mechanical skills, David is excited that many of his planned senior electives will be replaced with the automotive course. Because he only has two remaining core classes to complete, and at the time of enrollment he did not know of his acceptance into the automotive program, David picked random classes to complete his course selection. As we spoke about his automotive program, David shared he was feeling anxious because he knew this was a college course and the expectations and rigor would be much harder than his high school courses. His anxiety was attributed to his TBI and he was fearful he would have a hard time retaining the information. I told David I would contact the district TBI specialist and ask for tools and strategies David could utilize in his college course; he was excited to hear that I would help him put these interventions in place for next year.

Willow and David's CDM results provided me with useful data to help them plan for their senior year and future post-secondary exploration. With Willow, I was able to share with her possible STEM enrichment opportunities as well as help her explore additional STEM disciplines. With David, reviewing his results was the catalyst to having the conversation about his college course next year and what he needed to be successful. In addition, their CDM results provided us the opportunity to engage in rich discussions about their post-secondary goals and how I can best advocate for them.

Conclusion

The school counselor is at the center of meaningful student academic and post-secondary planning. It is critical that school counselors understand the myriad of opportunities available to students within the STEM fields so that they can help students prepare for an expanding, technologically rich, and global marketplace. Developmentally appropriate career exploration, informed academic decision-making, and dynamic post-secondary planning are all key components of preparing students for their futures in a STEM-rich world. Through the utilization of such tools as the CDM and STEMcareers.com, school counselors can engage students in a way that ensures the post-secondary and workforce readiness of every student.

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Chapter 11

RESOURCES FOR STUDENTS, EDUCATORS, COUNSELORS and PARENTS

by **Bradley T. Graham**

Over the past decade, leaders in the United States have been challenged to produce solutions for crises such as high unemployment rates, declines in skilled labor, deficits in the educational system, and the offshoring of jobs to other countries. Overall, this has created a fear that the increased global competition from emerging markets could be detrimental to U.S. economic superiority. Since 2011, President Obama has made an effort in his State of the Union speeches to embrace the notion that without a strong representation of science, technology, engineering, and mathematics (STEM) in our educational and workforce systems, the U.S. will be unable to remain economically competitive (Shchetko, 2013). As the integration of STEM increases in many daily jobs, the demand for more skilled labor has become a necessity. According to Georgetown University's Center on Education and the Workforce, it is predicted that the United States will need 8.55 million STEM jobs by 2018, a 17 per cent increase from 7.32 million in 2008 (Carnevale et al., 2010). As a result of this demand, it has become more apparent that advocating for increased STEM education, awareness, and interest is crucial.

In an effort to increase STEM awareness among students, educators, counselors, and parents, STEMcareer.com is a free website created to provide information on science, technology, engineering, and mathematics. This free website serves multiple functions by providing STEM resources and information on STEM initiatives, advocating for increased STEM education, and encouraging career engagement with diversity in these fields. The co-collaboration of individuals and groups dedicated to the disciplines of STEM have made STEMcareer.com a convenient resource offering regular blog posts on STEM related topics, teaching resources, media tutorials, and specialized STEM web links, just to name a few. With this continued effort, STEMcareer.com hopes to expand its outreach, encouraging greater involvement in STEM, thus helping individuals find meaningful careers that will ensure our global markets stay competitive and sustainable.

In many ways, educators, parents, and counselors alike play a huge role in influencing youth. Early on, messages about *who can do what* and *who should do what* are conveyed either intentionally or unconsciously by adults, educators, society, or those in power. As a result, certain populations of individuals gravitate towards certain careers, limiting the involvement of diverse groups. This is especially evident in careers related to STEM. For example, one of the biggest underrepresented populations in STEM fields are women. According to the United States Department of Labor statistics, women are attaining 57 per cent of all college degrees and 60 per cent of master's degrees (2009). And yet, only 20 per cent of women account for attaining bachelor's degrees in the areas of computer science, engineering, or physics (National Science Foundation, 2008, American Association of University Women, 2010). Similar statistics can be found with other subordinate groups, where the encouragement to enter these fields or peer representation for effective modeling is limited.

One way that STEMcareer.com promotes STEM awareness is through blogging. According to a brief definition, *blogging* is a discussion or informational site published on the worldwide web http://en.wikipedia.org/wiki/World_Wide_Web and consisting of discrete entries *(posts)* typically displayed in reverse chronological order (Blogging, 2013). In the case of STEMcareer.com, blogging consists of posting and updating recent news articles that pertain to STEM in order to promote, educate, and advocate for the advancement of these fields. As a result, viewers do not have to go far to get the latest information, which may include topical articles about government, jobs, education, viewpoints, industry, and advancements related to STEM. STEMcareer.com maintains a continued effort to seek out articles that highlight involvement of all people in STEM, particularly those groups from underrepresented populations.

In addition to blogging, STEMcareer.com uses social media to relay content to other websites, such as Facebook, Twitter, and LinkedIn. When content is published on STEMcareer.com, articles are pushed to these social media sources to help expand the outreach beyond the website itself. As a result, viewers do not have to directly come in contact with the site itself in order to stay connected to STEMcareer.com and its resources.

Educators, career counselors and advisers can benefit by using STEMcareer.com, even if STEM knowledge isn't one of their sources of strength. To help teachers and counselors educate students or clients about different career options STEMcareer.com exposes students to a variety of web links that can assist them in cultivating career direction through assessment. Guidance from professionals can assist students in navigating the site and generating self-awareness; however, STEMcareer.com's user friendly layout makes it an easy resource for students looking for ideas about STEM careers, choosing colleges, information on scholarships, or links to internship websites. For educators, STEMcareers.com offers ideas about extra-curricular activities for students in elementary, middle, and high school. Many of these activities include yearly science competitions put on by government entities like the National Aeronautics and Space Administration (NASA) and the United States Department of Energy.

STEMcareer.com also provides a free PowerPoint presentation called ***STEM and You*** that was designed by Rich Feller and Andrea K. Greenwall Shreve of Colorado State University. This presentation allows counselors and educators to customize the template the way they see fit with the hopes of drawing interested students into the world of STEM. ***STEM and You*** provides an overview of STEM, its careers, links to testimonials of those in STEM careers, the importance of STEM in our society, the rewards of a STEM career, and much more. The goal of STEMcareer.com is not to establish short-term profit, but rather, to invest in education. The real investment is making sure that people find meaningful careers, are able to provide for their families, and ensure that our global economy stays competitive.

In the university setting, career counselors and academic advisors can use STEMcareer.com in order to assist students in becoming clearer on the opportunities that exist within STEM fields. College is usually a setting where students are exposed to new ideas and a place where personal identity is further established. Assisting students in career exploration and self-awareness and giving them the tools to effectively navigate the job market can help students save both time and money within their educational pursuits.

STEMcareer.com offers easy access to STEM field descriptions by offering links to sites like O*Net Online (onetonline.org). O*Net provides general to specific descriptions of STEM jobs outlining the tasks, skills, education, and interest codes related to each job. Interest codes on O*Net can be used with the results from the assessment developed by John Holland and the Holland Occupational Themes (R.I.A.S.E.C.). Assessments often given in career center settings like the Strong Interest Inventory or the VISTa life/ career card sorts can assist a student in determining what their Holland code is. Many career counselors are already familiar with this theory, which maintains the idea that *personalities seek out and flourish in career environments they fit [in] and that jobs and career environments are classifiable by the personalities that flourish in them* (American Psychologist, 2008). Although a career decision should not be solely made on assessment results alone, individuals that reside in STEM careers can have a high instance of Realistic (R) or Investigative (I). Often times, exposing a student to this type of information, combined with the validation of an assessment, can spark an interest that encourages career exploration.

STEMcareer.com also provides direct access to The Career Cornerstone Center (careercornerstone.org). This website offers information on science, technology, engineering, mathematics, computing, and healthcare careers. All too often, students can be overwhelmed by the generalization of words like *science* so Career Cornerstone Center provides examples of specific STEM careers. This website broadens the scope of what can be done within each STEM field. For instance, under "science", the site conveys the message that careers from medicine to manufacturing can be attained. When linking to a particular STEM discipline within Career Cornerstone Center, individuals can access Podcasts, lists of potential employers, career path forecasts, and professional organizations. Having all of this information in one place makes STEMcareer.com an easy way for counselors and advisers to be efficient with their time and provide a meaningful resource to their clients.

Over the past decade, we have seen unemployment rates go from a low of 4.4 per cent in October of 2006 to a high of 10 per cent in October of 2009 (Bureau of Labor Statistics, 2013). As of February 2013, the current unemployment rate is 7.7 per cent (2013). Even though the U.S. economy is showing a decrease in unemployment, these numbers are still far too high for many to be unconcerned. If individuals are interested, careers in STEM can offer sustainable jobs that can help support living wages, provide meaningful careers, and help an economy in need. Obviously there are other factors that contribute to maintaining a strong economy, but encouraging our youth and dislocated workers to embark on careers in STEM can only be a benefit. STEMcareer.com seeks to be part of the solution by continuing to provide valuable resources for more and more students, educators, counselors, and parents.

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Chapter 12

APPLYING LESSONS LEARNED FROM WOMEN and MINORITY STEM RETENTION TO BUILD THE NEXT GENERATION of STEM INNOVATORS

by Marie Zimenoff

In today's job market, it may be hard to believe that there is a shortage of workers. However, in many STEM (science, technology, engineering, and math) professions, employers are not finding the talent they need to stay ahead of increasing global competition. This article will explore reasons the United States continues to fall behind in awarding STEM degrees and retaining professionals in the field. It will also propose actions career practitioners can take with students and working professionals to change the tide. These are practical interventions career professionals can use with STEM students and professional clients today to help them persist in the field. They are based on research and the success of programs focused on the retention of women/minorities in STEM degree programs.

Background

An outlier in the employment supply/demand. In a 2012 report, the President's Council of Advisors on Science and Technology (2012) announced that the current rate of training scientists and engineers would result in a deficit of 1 million workers to meet demands in the next decade. This is no problem of the future, however. There are more vacancies in STEM fields today than there are STEM degree holders. For example, Cisco employs 24,000 engineers in the United States alone and Silver Lake Partner's companies employ 87,000. Yet the United States graduates only 86,000 engineers annually (West, 2011). Furthermore, an average of 30 per cent of openings in large metropolitan areas are in STEM fields where 11 per cent of the population have a STEM degree (Rothwell, 2012).

Growing numbers in STEM still cannot compete. Although the number of degrees awarded in STEM fields has increased, it is not keeping up with the pace of other degrees. The National Science Board (2012) found that from 2000 to 2009, degrees awarded in the United States increased 29 per cent. Engineering and natural science degrees awarded grew 19 and 21 per cent respectively, while the social/behavioral sciences saw a 34 per cent increase in degrees awarded. The computer sciences and engineering are failing to compete for students' attention, as degrees awarded in those areas have the slowest growth at 3 and 19 per cent, respectively.

America's competitive position internationally when it comes to employing its professionals in the STEM field is also lagging. China graduates 10 times as many engineers as the United States, and in many Asian countries 21 per cent of college degrees are in engineering compared to 4.5 per cent in America (West, 2011). These disparities continue when science and engineering are combined, with percent of degrees awarded in the two areas in Korea (38 per cent), Germany (33 per cent), and England (27 per cent) greatly outweighing the 16 per cent of U.S. graduates earning these degrees (West, 2013).

Programs already in place. Improving STEM education in the United States has been a focus of politicians and educators, with the President launching programs including a $4.35 billion *Race to the Top* competition and an *Educate to Innovate* campaign which includes many public-private partnerships (Office of Science and Technology Policy [OST], 2011). Efforts started years ago by the National Science Foundation (NSF) to retain women and minorities in engineering have been expanded to provide best practices for K-12 educators to prepare the *next generation of STEM innovators* (National Science Board [NSB], 2010). These Presidential and NSF efforts put special emphasis on attracting women and other underrepresented populations to STEM fields. Increasing the participation of women and girls in STEM, and their persistence in the field, is also a historical area of focus, perhaps because it appears to be low-hanging fruit. Walk the halls in any engineering department today, and the lack of females going to and from classes is apparent. In fact, according to Beede et al. (2011), engineering has the lowest participation of women who account for only 14% of engineering professionals working in the United States. Across all STEM fields, women have held less than 25 per cent of the positions consistently over the last decade although their representation in the college-educated workforce as a whole has grown from 46 to 49 per cent (Beede et al., 2011).

The economic cost of the U.S. professionals lagging in STEM. STEM jobs are taking longer to fill than non-STEM jobs despite the 7.7 per cent seasonally adjusted unemployment rate reported by the U.S. Bureau of Labor Statistics in February 2013. For companies, this means spending additional resources to seek out candidates when they do not receive qualified applicants and to create lucrative packages to lure candidates from competitors, or in the case of the computer industry, from college.

The Wall Street Journal reports companies recruiting students before the end of the freshman year with *limo rides to bars, $500 cash giveaways, and raffles for iPads* (Ante, 2012). These recruiting tactics, compared to those of professional sports teams, are using resources companies were investing elsewhere just a few years ago.

Beyond the cost to individual companies, the relatively low participation of U.S. professionals in STEM impacts the U.S. economy on a larger scale. On average, a professional in the STEM field earns 25 per cent more than their non-STEM peers and have only a 5.5 per cent unemployment rate (West, 2011). Women benefit proportionately more from employment in the STEM field, earning 33 per cent more than their female peers in other fields. Interestingly, STEM training alone adds to earning potential, with both men and women earning more (12 and 9 per cent, respectively) with a STEM degree regardless of their field of employment (Beede et al., 2011).

Lastly, STEM workers are disproportionately involved in creating and running successful tech companies and driving economic growth through entrepreneurship. Wadhwa, Freeman, and Rissing (2008) found that bachelor degrees play a large part in the success of startups. Earning a degree is the largest contributing factor to revenue ($5.7 million in 2005 for all startups and $2.2 million for startups founded by high school degree holders) and job-creation (an average of 42 employees for all startups compared to 18 employees at those founded by high school degree holders). The economic impact of STEM degree holders is not insignificant.

Why Women Fail to Persist In Stem Fields (and Why Millennials May, Too)

In addition to the too recently debunked myth that women lacked the aptitude to succeed in STEM, lack of interest has been one of the stereotypical reasons given for women's lack of participation in STEM. Historically in America, women have been raised to have more interest in people than things, in some ways mirroring their higher participation in the natural and behavioral sciences (earning up to 40+ percent of the degrees in these disciplines which have more obvious human applications) than in engineering, where they earn 14 per cent of the degrees, and computer information, where they earn 26 per cent of the degrees (Didion, Frehill, & Pearson, 2012). If STEM fields are lagging in awarding degrees, especially to females, it is not entirely due to lack of interest. The President's Council of Advisors on Science and Technology (2012) claims fewer than 40 per cent of all students entering college intending to major in a STEM field complete a STEM degree.

Theories around the exodus from STEM majors include lack of preparation for the rigorous courses, grade inflation in other majors, lack of hands-on/interactive learning in early STEM college courses, and the climate in some STEM majors which have historically turned away women and minorities (Didion, et al., 2012; Drew, 2011). Beyond attrition in the earning of STEM degrees, further retention problems exist when these individuals enter the workforce.

Work-life balance. The higher percentage of women leaving the STEM profession has been connected to their heightened focus on work-family, or now more commonly called work-life, balance (Williams & Ceci, 2012). Although much of the research in this area comes from the academic realm, demands in the corporate world and similar issues caused by stopping out of the workplace for family plans have led women to choose employment options outside of STEM. This is one of the key issues that may contribute to similar attrition within the Millennial generation who rate work-life balance among the top-five values in their career satisfaction (Ng, Schweitzer, & Lyons, 2010).

Climate. A related issue is the educational and workplace climate, where programs to recruit and retain women in engineering have focused for many years. This problem is a function of lacking examples for these women, failing to provide opportunities for them to connect with others like them, and an overriding cultural judgment of whether or not they belong. Female students have described the culture of graduate STEM programs as *isolating* and expressed their concern about a *lack of appreciation in the field* (Didion et al., 2012, p. 28). In addition to women's possible perception of a lack of appreciation, new research by Moss-Racusin, Dovidio, Brescoll, Graham, and Handelsman (2012) has indicated that male and female hiring managers may be biased against hiring women into STEM fields.

Although current programs and research have focused on perceptions of females in the sciences and engineering, the perception of engineers and scientists in America versus other countries highlights that U.S. treatment of these professions has added to the problem (Mraz, 2009; Savitz, 2011). Millennials, who place high value on advancement (Ng et al., 2010), may not flock to a field that is not held in high regard in the corporate world, or may be highly particular in the companies they choose, to ensure their contributions will be valued.

Practitioner Areas of Focus

Education in economics. *Make the business case for STEM professions to students and parents*. Since STEM workers earn a premium of 25 per cent over other workers and have only a 5.5 per cent unemployment rate, there are strong economic incentives for students to get into STEM fields (West, 2011). Despite individual stories about job seekers in STEM who are struggling to find positions, the data is clear . . . STEM degrees have a positive impact on one's earning potential. Career professionals can use this data to educate parents and Millennials, who are seeking career fields that will provide financial stability.

Improve instruction and performance. *Share and apply proven teaching techniques and encourage students in STEM courses*. Research around the best teaching techniques for STEM subjects are now widely available (NSB, 2010). These recommendations focus on inquiry-based learning, real-world problem solving, and early introduction to STEM, especially exposure to engineering activities. In addition to improving the instruction of STEM courses, research by Zhang, Schmader, and Hall (2012) has shown teaching students interested in STEM about stereotype bias can have an impact on performance. School counselors and advisors can use this information as tools to encourage the performance of both girls and boys interested in STEM education paths.

Promote career and technical education. *Educate all ability levels about the range of options in STEM and supporting professions*. The transition from high school to work or college is where the largest drop off in STEM interest occurs (Hill, Corbett, & St. Rose, 2010, Chapter 1). Some of this drop may be attributed to students who are not financially capable of, or interested, in attaining a four-year degree. Fortunately, there are many STEM and STEM-support professions that do not require a four-year degree which can provide career opportunities for students. Career professionals can engage in improving the perception of career and technical education within their schools and with the parents and students for whom these technical degrees may be a better match.
Get students involved outside of class. *Help students seek out hands-on opportunities early in their educational careers*. New reforms in K-12 education have incorporated fun, hands-on projects to attract students to the STEM field. Changes in early college coursework will be slower to react. Students are more likely to persist through the highly theoretical "weed-out" classes if they are engaged in on-campus research or corporate internships early in their college career. Fortunately, this is something students can seek out and career professionals can help them identify these opportunities.

Build individual confidence. *Enhance the confidence and self-esteem of STEM professionals at all levels*. While we wait for gender biases and the perception of STEM professionals to change in the United States, an individual professional's self-esteem will be a key factor in combating group- and self-stereotype bias and *grade-inflation* attrition. If career professionals can help students and professionals weather the storm of being a *nerd* in school, earning a few *C* grades in college, and being the only woman on the engineering team, it will be one step in the right direction.

Increase corporate partnerships. *Promote and instigate corporate partnerships within school and university settings*. These partnerships can be more than a foundation for internships and positions; they can help provide a more balanced insight to the makeup of a successful STEM professional. Faculty will, by their very nature, praise and give positive feedback to students who perform well in their classes. Classroom performance, however, is a limited factor in predicting a student's success in their chosen STEM industry. Career professionals can help create a buffer for students being lured into other majors or subjects where higher grades are more easily achieved by connecting students to professionals in the field. Career specialists may even purposely seek out STEM professionals who did not have the highest GPA, to talk about their success in the field, factors that contribute to this success, and why they enjoy the profession.

Connect students/professionals with mentors. *Assist STEM students and new professionals in identifying mentors in the field*. Increasing corporate partnerships in the college setting can also provide the opportunity for students to find a mentor in the field. In identifying a mentor, a career professional can help a student who is struggling to see the application of the coursework. Likewise, for new professionals, a mentor outside of their work team can act as a sounding board for handling conflicts in the workplace and advocating for their career.

Assist with work/life planning. *Support STEM students and young professionals in navigating work-family (work-life) planning*. As work-life balance becomes an increasing concern for those entering the workforce, the need for career professionals to support these needs in navigating the workplace also increases. The need is especially high for female students, who are highly likely to make the decision to change their career trajectory in college or early professional career as plans for family start to form. By being open to discussing these issues with young men as well, career professionals may help both sexes understand how to set boundaries with their work early while still excelling in the workplace.

Arm professionals with sales skills. *Teach STEM students and professionals to sell their own value*. One of the main reasons sales people earn more than engineers is their skill at tying their efforts to business results. If a next-generation technology was never created to meet market requirements, could a sales person increase sales by millions? Probably not. However, most engineers and scientists wince when you suggest that their efforts had anything to do with those gains in sales. As career professionals, we can work with these professionals to communicate this value in a way that is comfortable for them while not diminishing their value. In addition, career professionals can aide STEM professionals in advocating for themselves, and using their accomplishments as leverage to ask for the salaries they deserve.

Work with companies to improve hiring practices. *Help companies understand biases and how to attract the best talent*. Companies like Google have become trend-setters in creating environments that attract talent. They offer amenities that pull at the desire of Millennials to have work-life balance and new problems to solve. As consultants, career professionals can work with companies to create similar solutions. Specifically for attracting women and Millennials, career professionals can work with companies to communicate the human impact of their work and each employee's contribution to making that difference in society. As companies increasingly feel the pain of not being able to find the talent they seek, career professionals may also be involved in the design of training programs.

Help professionals consider entrepreneurship as an option. *Put entrepreneurship back on the list of practical career moves for experienced professionals*. The data for entrepreneurship shows that those who are the most successful in inventive entrepreneurship have a bachelor's degree and are an average age of 39 (Wadhwa, Freeman, & Rissing, 2008). There are many misconceptions about entrepreneurship, its risk, and the *type* of person one must be to be successful. Just as many different personality types can be successful within a career field, they can also succeed as entrepreneurs. We as career professionals can help them identify their weaknesses, understand the risks, and build plans to mitigate both based on their strengths. This is not to say that entrepreneurship is for everyone, and, it can be explored more fully as an option if we take a practical approach with each client.

Future Research

There are claims that the STEM shortage is a political or corporate ploy to drive down the cost of these professionals (Lowe, 2012). However, none of these claims provide data. It is probable that specific areas within STEM are not in demand. Identifying these fields through job openings, application numbers, or time-to-fill data could guide funding and recruitment efforts. Additional research is also needed in the corporate workplace, where women are under-represented. Although the research from academic settings can be enlightening to the reasons women are not entering and persisting in the STEM workforce, there may be other factors at play which could be useful in developing strategies for retaining all STEM professionals in the future.

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Chapter 13

CAREER ADVISING WORKSHOP EXERCISE for SOFTWARE ENGINEERS

by **Todd Sedano** and **Mikelynn Romero**

The Challenge: Helping STEM Students Develop a Job Search Focus
Carnegie Mellon University's Silicon Valley Campus (CMU-SV) attracts science, technology, engineering, and math (STEM) students who want to make an impact in Silicon Valley, an area known for its innovative and entrepreneurial culture. The goal of the various CMU-SV masters programs is to provide a transformative educational experience – one that changes how the students perform in the workplace. The students are immersed in a *learn-by-doing* environment that makes them valuable members of the workforce as they graduate with practical experience in high-demand technical areas.

Despite this *state-of-the-art* graduate education in software engineering and software management, when it comes time to find employment, these students are often confused about career direction. When asked, *Tell me about your ideal job,* many of the students describe generic software developer or software manager positions that, in reality, vary widely within the software industry. While they are full of enthusiasm and passion for the subject matter, some students have no clear notion of how to map passionate job activities into the job search, and they are often overwhelmed by the number of job postings in the software engineering and software management fields.

Some students seek STEM positions because they recognize those jobs are in high demand, not because they are naturally drawn to the profession. Some international students know that STEM jobs may offer easier visa transition and employment stability in the United States. But these students do not know how this new degree will compliment their previous degree, fit into a career trajectory, or to what extent they can use their new skills in a variety of jobs. For these students, starting the job search is difficult since *getting a high tech job* is difficult to translate into a concrete job search strategy.

The challenge is connecting the student's new skills to actual open jobs in the workforce. This requires categorizing a plethora of jobs into areas of common skill, activity, and personality. The various career development exercises and tools typically used to assist students in their searches often contain generalized results pointing to broad job types, and therefore do not appear to be tools to help software engineering and software management students find specific examples of what jobs they should explore. Another example of this issue is found in the Occupational Information Network (O*NET) listings for software developers, specifically 15-1131, 15-1132, and 15-1134, which are very general in nature. A career advisor cannot further guide a student into the software industry based on this information. Career advisors are experts in the process of identifying a career, counseling on how to find a job, and instilling networking skills. CMU-SV's career advisor is not an expert of every aspect of the software development process, as she has never professionally written software. When students ask for advice and guidance, she relies on domain knowledge and experience in working with previous students. The current job index does not provide enough detail to guide a student into the software profession, a challenge as these students have a small window of time (12 months) to finish their education and find a job.

As part of the CMU-SV masters program orientation, the authors sought to provide concrete guidance to address this critical question. However, after extensive research, the authors were unable to find an appropriate exercise or instrument that would help students develop a focus within the industry as they pursued their graduate studies at CMU-SV. To solve these problems, the authors created a workshop to advise CMU-SV STEM graduate students to articulate their ideal job description by mapping the six Holland Codes to correspond with the software industry.

STEM Information and Its Role in Helping Workers Compete

The science, technology, engineering, and math (STEM) fields play an important role in Silicon Valley, known for its innovations and entrepreneurial culture. An increasing number of students are enrolling in STEM programs at universities, including Carnegie Mellon University in Silicon Valley, which offers graduate degrees in Software Engineering, Software Management, Electrical and Computer Engineering, and Information Technology. But the recent increase in students enrolling in these programs may not be enough. It is estimated that the United States will create eight million new STEM jobs by 2018 (Carnevale, Smith, & Strohl, 2010). A recent U.S. Department of Commerce report shows that in the past decade STEM jobs grew at three times the rate of non-STEM jobs, and that STEM workers have greater job stability. Occupations in these fields are expected to grow by 17 per cent by 2018, nearly double the rate of growth in non-STEM occupations (Langdon, McKittrick, Beede, Khan & Doms, 2011). And locally, STEM jobs will account for six percent of all jobs in California by 2018, with a total of 1.1 million STEM jobs, up from 894,860 in 2008 (Carnevale, Smith, & Melton, n.d.).

Employers throughout Silicon Valley understand that to remain globally competitive in an innovative economy there must be a reliable talent pipeline producing well-qualified STEM-competent workers. Most jobs now require science and math competencies, the use of technology and critical thinking skills, computational training skills, project-based learning, and working virtually to solve issues and problems.

Educational Context of the Romero-Sedano Exercise

The educational objectives of CMU-SV's graduate programs focus on substantially increasing the leadership potential and the business and technical relevance of software professionals, greatly expanding their career opportunities. To achieve this goal, students need to master modern software engineering and product development methods, learn to align project decisions with business goals, and develop the communication, teamwork, and negotiation skills critical to successful technical leadership. The students achieve these skills through authentic project work reflective of real-world scenarios. The programs use *learn-by-doing* and *story-centered curriculum* pedagogy as the mechanism for the students to acquire these skills. The programs minimize the transfer between the educational experience and the workplace by situating the student in a realistic, problem-centric context (Bareiss & Sedano, 2009). Whenever possible, students experience the learning objectives by executing a real-world or synthetic project. If implementing a project is too time consuming, then the faculty simulate the learning. Thus, the students create authentic work products in a team setting, which is exactly the way they will be required to perform in industry.

Goals of CMU-SV Student Orientation

At the beginning of each new graduate program, CMU-SV hosts an Orientation for new students. The purpose of Orientation is to introduce incoming students to the culture and norms of the unique campus experience. The goals of Orientation are to welcome the students and have them feel part of the campus community, start the team formation process by equipping students with skills to build high performing teams, and communicate core values on how to run effective meetings. The goal of the exercise is to give students an opportunity to start thinking about their career goals and how the graduate program will impact their career goals.

STEM and Holland Codes

During Orientation, the authors wanted an exercise that would tackle an important topic from day one – what will the students do after graduation? When asked, *tell me about your ideal job,* most students would describe a stereotypical software development or software management position that would apply to many job postings in the software industry. When the students start their job search, they can struggle with filtering appropriate positions from the morass. Some can rely on necessary technologies (e.g., *I want a Java position*) or types of companies (e.g., *I want to work for Apple*), yet others simply don't know where to start. Typical job descriptions sometimes do not help as companies will list technical requirements, such as programming languages and technical frameworks which are often overly ambitious or just plain wrong. For example, if a programming language was invented five years ago, it's impossible for anyone to have eight years of experience with it, but students will see job postings with that requirement. When considering job activities, there is little guidance to which ones are more important to the employer. The authors needed a way to start the conversation about career planning from a different perspective. Often the sheer number of job postings in software engineering and software management fields overwhelms the students. After the authors were unable to find an exercise to accomplish this goal, the authors created a variant of Richard Bolles' (2012) *Holland Party Game* for software professionals.

Romero-Sedano Exercise Description

The *Holland Party Game* was presented to the students as a fun exercise that was non-threating in tone and that had no perfect answers. The six different groups (Realistic, Investigative, Artistic, Social, Enterprising and Conventional) were described to the students, who then identified their top three Holland Codes. The authors hung up large sheets of papers around the room with a letter representing each Holland Code. The students were then divided into groups based upon their top Holland Code. If a group had more than eight people in it, the group was subdivided into two separate groups. After the students discussed what they had in common in the software industry, each group verbally generated their ideal job description. Each group reported back to everyone in the workshop.

Romero-Sedano Exercise Results

Before the event, the authors suspected that certain job activities would show up in certain groups. For example, the authors expected that people who love solving bugs and problems in software would be in the "Investigative" group. Instead of biasing the participants towards our initial thoughts, open-ended prompts were purposefully provided to the students. After transcribing the session recordings, the authors mined the data looking for trends and patterns. Eventually, the authors classified the responses into three categories, ***Attitudes and Career Values, Passionate Activities,*** and ***Job Types.*** For our next orientation, the authors will begin with this framework and validate whether people in each specific RIASEC group resonate with it or not, and ask how to improve the framework. Here's an example of using this framework: a student realized that she had artistic tendencies and should explore creative fields in the software industry. She searched for jobs that utilize her technical skills as well as her artistic side. She is now employed in a startup working in User Interface design and programming, and she feels more satisfied than if she had taken any another position.

Initial Results by Holland Code

The following are the initial results of the matching of software industry skills with the Holland code descriptions:

Realistic

In general, realistic people are *the doers*. They tend to follow tradition, have common sense, and take a more practical approach to life. They tend to have mechanical or physical abilities, enjoy operating equipment or machinery, using tools, and working outside (Bolles, 2012).

Realistic in the Software Industry

Attitude / Career Values:

Works an idea from inception to customer delivery
Prefers autonomy (e.g. the freedom of an early startup)

Passionate Activities:

Building software that solves real problems
Getting things done
Problem solving
Developing open source software and getting paid for doing it

Job Types:

Developer
Sponsored open source contributor
Startup software engineer
Senior software engineer
Principal software engineer

Investigative

In general, investigative people are *the thinkers*. They love to learn, analyze, solve problems, and conduct research. They tend to be independent and inquisitive (Bolles, 2012).

Investigative in the Software Industry

Attitude / Career Values:

Finds the best solution
Works with data
Is intuitive

Passionate Activities:

Problem solving, digging into problems
Scaling software

Understanding how software works at every layer
Understanding the big picture of code
Writing future-proof code that will deal with future requirements and changes
Designing algorithms

Job Types:
Developer
Field engineer (someone who troubleshoots client installation issues)

Artistic

In general, artistic people are *the creators*. They appreciate art, creativity, innovation and self-exploration. They enjoy various types of work related to fine arts, visual arts, writing and anything that utilizes the imagination. They prefer a more independent and unstructured approach to life (Bolles, 2012).

Artistic in Software Industry

Attitude / Career Values:
Prefers blurring the boundaries, prefers the messy blends
Wants to work in an environment where failure is ok, otherwise experimentation is impossible
Needs empowerment to try new ideas

Passionate Activities:
Trying new things and enjoying variety
Exploring alternative ways and mixing things up
Welcomes feedback on ideas
Writing user narrative stories and scenarios
Solving problems

Job types:
Developer
Product owner / Product
Story card writer
User interface designer

Social

In general, social people are *the helpers*. As good listeners, they enjoy helping, teaching, and training. They enjoy working in team-oriented situations. They possess good written and verbal communication skills (Bolles, 2012).

Social in Software Industry

Attitude / Career Values:
Loves bouncing ideas off other people

Passionate Activities:
Collaborating
Demonstrating

Performing code reviews
Pair programming
Mentoring
Job Types:
Developer
Team lead
Scrum master
Inter-team liaison
Sales engineer (an engineer who supports the sales team, visiting prospective clients)
Connector or Linker

Enterprising
In general, enterprising people are *the persuaders*. They lead, influence, persuade and motivate others. They thrive on taking risks and making decisions. They enjoy power and status. They take a spontaneous approach to things. They tend to have good verbal skills and enjoy meeting new people. They enjoy the limelight such as public speaking and being in front of people (Bolles, 2012).
Enterprising in Software Industry
Attitude / Career Values:
Takes initiative
Is in control and in charge
Manages the end-to-end responsibility for a product
Passionate Activities:
Managing people
Leading teams
Strategizing
Building up products
Starting a company
Job types
Team lead
VP of Engineering
CTO
CIO
Entrepreneur

Conventional
In general, conventional people are *the organizers*. They love organization, accuracy, and efficiency. They work well with data, numbers, finances, process, and procedures. They follow through on tasks and issues. They prefer structure and are methodical in their approach (Bolles, 2012).

Conventional in Software Industry

Attitude / Career Values:

Creates and adheres to processes
Does it step-by-step
Passionate Activities
Planning and organizing a software product
Designing a system from requirements to quality code

Job Types:

Developer
Process manager
Project manager
Sample Sizes

The workshop exercise was done twice with two different student populations in each round (see **Table 1**). Interestingly, the Occupational Information Network (O*NET) listings for software developers, 15-1131, 15-1132, and 15-1134 have the interests IRC, CIR, and IC. 51 per cent of our students listed one of these Holland Codes as their top code.

Table 1: Numbers & Percentages of Students in Workshop

Holland Type	Round 1 Software Management	Round 2 Software Engineering
Realistic	01 (03%)	12 (24%)
Investigative	07 (26%)	16 (33%)
Artistic	12 (44%)	13 (27%)
Social	01 (03%)	04 (08%)
Enterprising	05 (19%)	02 (04%)
Conventional	01 (03%)	02 (04%)
Total	27	49

The creation of this particular exercise was only possible by the joint collaboration of a career adviser and a faculty member with expertise in the domain. Each brought their insight into how to advise STEM graduate students and what opportunities exist for them in Silicon Valley.

Future Research

The following tasks will be helpful in coming years to execute this exercise, including:

- Use a formal assessment to verify the student's Holland Type, instead of an informal Holland Type handout
- Create pre and post surveys to measure changes in the students' positions
- Try this with a different discipline
- Alter the room activity to have the participants validate the Attitudes, Passionate Activities, and Job Types in the framework results

Conclusion

The implementation of the modified Holland Party Game into the CMU-SV Orientation was an excellent strategy to benchmark the starting point of the new class and their views on career goals and what professional opportunities they have identified. The activity has already resulted in more traffic to the CMU-SV Career and Professional Development Center, as well as more students who are ahead in terms of their career research compared to students from prior years. Adapting the Holland Party Game to the software industry enabled CMU-SV students to clearly articulate those aspects of software development and product development that most appealed to them. This exercise served as a starting point for career planning discussions and reframed the question *what is your ideal job* to *what do you most enjoy about your profession?* Once students understood which job functions invoked their professional passion, they were able to selectively target jobs that reflected their professional priorities.

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Chapter 14

CREATING a CULTURE of CAREER DEVELOPMENT in CORPORATIONS

by **Bill Huffaker**

I've heard many senior managers in corporations proselytize that employees need to drive their careers. But, as corporate career development practitioners, we know that effective career development programs in corporations are built on the premise of shared responsibility among employees, managers, and the company. However, this so-called partnership model is problematic on several fronts. Frankly, while it's convenient to absolve the organization and managers from any responsibility to support their employees' career aspirations, the reality is that employees, especially those who are early in their careers, don't know *how* to manage their careers. Furthermore, managers are notoriously inept at supporting the career development of their direct reports. In fact, in many respects, the organization dis-incents managers for developing their reports' careers. In this three-part series, I'll suggest pragmatic interventions that corporate career development practitioners may use to catalyze the partnership model in organizations. The first submission deals with creating a shared leadership mindset for career development.

Careers unfold within the context of organizations. The superstar in one organization can be a dud in another. A multitude of factors can influence an employee's career success in an organization, such as the stage of an organization's lifecycle (e.g., high growth, decline), industry (e.g., high-tech, financial services), and size (e.g., multi-national, small start-up). The most germane lever (and derailer) for successful career development programs is the collective mentality of leaders running the company. Leaders have a profound influence on the company's culture and its operating norms. Corporate career development practitioners quickly discover that leaders within the same organization typically offer very different advice to employees who seek their counsel. Often leaders can't help projecting their own career experiences onto the employee. In my work with corporations, I've listened for typical *tension points* in a company's career development culture and have noticed the following disparate opinions across leaders:

Promotions vs. lateral moves. Most employees don't want to work for a company where there is no chance of promotion. Of course employees want to advance their careers, but the organization is indeed a pyramid.

There are fewer slots toward the top, and, those slots are expensive. How does an organization balance the limited number of promotions with the career advancement aspirations of most employees?

Technical knowledge vs. breadth of experience. Employers want the world's foremost expert in an obscure field (e.g., a seat engineer for an automaker) who is also an extraordinary people leader. These attributes aren't mutually exclusive; however, it's rare to find an employee who excels in both.

Build vs. buy. In tough times, organizations have dialed back investing in the development of people who have been loyal to the company. We've failed to help employees keep their knowledge and skills fresh. We feel guilty passing them over when we have a new, more senior opening. At the same time, we balk at the expense of hiring someone externally who doesn't understand our way of doing things.

Playing it safe vs. taking a risk. When we have an opening, do we tilt the scales toward a high-performing internal candidate who may be 75 per cent ready for the job, or do we go for the external hire who is 125 per cent qualified for the job and is interested in the position because in some professions, supply exceeds demand?

Meeting today's needs vs. investing in the future. We live in a world of quarter-to-quarter results. Managers typically have an immediate need to fill a vacancy with a candidate who comes with a very short learning curve. Often, companies don't marry up job opportunities with the development needs of employees, and instead, fill jobs immediately within a silo.

Competencies vs. experiences. We develop employees according to our often arbitrary and untested golden set of leadership competencies. Of course employees need to sharpen their competence in leadership attributes; however, they also need to benefit from working in a variety operating environments. The organizational backdrop in which employees perform is an often forgotten piece of the development equation.

Moving roles vs. in-role development. We tend to have a bias toward moving employees into new roles to foster their career development rather than emphasizing stretch assignments that develop employees' capabilities within their current roles.

Mastering their craft vs. moving cross-functionally. Employees tend to want a variety of challenges over time across multiple domains. But, some managers believe employees should behave like robots and do the same job for years through multiple business cycles.

Transparency vs. mystery. Many employees are in the dark about how employment-related decisions are made. They don't understand what criteria are used to promote employees and often promotional decisions are made by senior managers without soliciting the input of the community members within an employee's profession.

Mobility vs. staying put. Especially in global companies, we ask employees to be willing to pick up their lives and move around the world at the drop of a hat. If they are unwilling to relocate, we tell them that their career opportunities are limited.

So in the midst of unrelenting systemic change, how can we begin to address these issues? Of primary importance is ensuring the alignment of key senior leaders on career development, and this can be accomplished with a simple and engaged career culture conversation. To tee up the discussion, create a simple self-assessment on a handout with these career development tension points plotted (e.g., promotion lateral). Begin by explaining the dimensions as they relate to your organization. Ask if other dimensions should be added.

Ask each participant to reflect on how career development is currently defined at the company on each dimension and to place an ***A*** on the continuum. Then ask them to place a ***B*** on the continuum where they believe the company needs to evolve. Debrief the assessment by asking facilitative questions like, *Where are A and B farthest apart and why? Where are they closest together and why?* Typically, as a result of the dialogue for each dimension, a lively discussion ensues and leaders discover that they each have a differing perspective. Encourage them to debate and drive toward a common mindset on these tension points, as well as prioritize the ones that are most troublesome to the organization and its employees. Be sure to capture agreements as they are made.

Following the debate, move the dialogue into brainstorming potential solutions to the issues identified. To close the session, summarize the agreements made, the prioritized issues, and ideas to explore further. Ask for volunteers for each issue to form small teams to develop and propose initiatives to the broader group at a later date.

Summary

When it comes to careers, there is a tendency among senior leaders to construct a world that is full of *hard and fast* rules. As corporate career development practitioners, we know that career development is at the liminal space between art and science. Left unexplored and fragmented, the opinions of senior leaders in an organization can drastically affect the efficacy of career development programs. Driving toward a shared leadership mindset across a complex set of paradoxes and compromises will not only transfer accountability from the career development professional to business leaders but will also drive a career development culture of the corporation, serving as a solid foundation for managers and employees to perform their role in the partnership model.

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Chapter 15

HIRE EDUCATION: STEM and the TRANSPORTATION INDUSTRY

by **Janice M. Tkaczyk**

A recent survey from STEMconnector® and My College Options® (2012) showed one out of four high school freshmen indicated an interest in STEM. The study also showed 57 per cent of these freshmen lost interest in STEM careers before their senior year. In addition, 60 per cent of college students in STEM majors are graduating in non-STEM careers.

With all of the energy, expertise, and enthusiasm being placed on STEM, one would expect to see more students flocking into and staying in rigorous high school academic programs in science, technology, engineering, and math, but that is not the case. More students should be entering and completing these majors at the post-secondary level, but they are not. Why is this? Perhaps because we still have students asking along the way, *When will I ever use this?* or *Why do I need to learn this?*

In an ***Education Week*** article, Jan Morrison and Raymond V. "Buzz" Bartlett (2009) state that lacking good answers to their questions, students may tune out of school entirely. Effective STEM can counter this impulse. It recognizes that learning occurs most easily when students genuinely interact with ideas.

Better Connections: Our first task is to build connections between subject matter and career applications. Students need genuine and relevant classroom and after school activities if they are to have that, *Aha! moment* and understand that what they are learning will make a difference. *Through an integrated approach to STEM education focused on real-world, authentic problems, students learn to reflect on the problem-solving process. Research tells us that students learn best when encouraged to construct their own knowledge of the world around them. It is through integrated STEM projects that this type of learning can occur.* (Satchwell & Loepp, 2002)

Bigger Picture: Next steps are to expand our definition of STEM to counter the rise in apathy and concern over poor STEM completion rates. Students need to understand that STEM careers include more than bio-science and nanotechnology. Not all students who are proficient in science, technology, and math in high school want to pursue these rigorous majors that require a four-year education. Auto technology is every bit a S.T.E.M. career as these sophisticated science options and does not require four years of college. *Fixing cars has gone high tech. A laptop computer is becoming as important a repair tool as a set of socket wrenches,* said Chris Woodyard, automotive reporter for ***USA Today.***

Suggestions from the field:
As a retired high school counselor, I spent thirty of my thirty-five years in public education at a regional technical high school. I now work for Universal Technical Institute, Inc. (UTI), the nation's leading provider of post-secondary education for students seeking careers as professional automotive, diesel, collision repair, motorcycle and marine technicians. My focus is engaging teachers and professional school counselors in conversations about STEM and career opportunities in the transportation industry. I listen to what they are doing with inadequate budgets and limited time. I have gathered some wonderful ideas from them. Here is what I have heard.

We need to do the following:
- Reduce CTE stigma.
- Add relevance through partnerships.
- Value all forms of postsecondary education.

Reduce CTE Stigma
Our messages to students must place a value on both work and further education. Auto technology is one example of a career sector that is in the process of *re-branding* itself. The popular perception of the industry is that it is a relic of the past that is lacking innovation or good career opportunities. Nothing could be further from the truth.

In his book, ***Shop Class as Soulcraft,*** Dr. Michael Crawford (2009) offers a serious message about how our efforts to create a college-going culture need to include all post-secondary options, not just two and four-year colleges. If we don't place a value on technical education, it comes off sounding like a consolation prize for those who aren't quite as smart as some of their peers. Career and technical education (CTE) classes are still considered *alternative education* by many educators and parents.

Consequently, students tend to think the same way. We still hear educators referring to CTE education as only an option for their special needs students; excluding all others. Some students may be struggling (and labeled special needs), because no one is teaching to their learning style. Academically talented students may be perfect candidates for transportation careers, but simply don't know anything about these career opportunities.

The job outlook is strong. Qualified technicians are in demand. In fact, the U.S. Department of Labor reports there will be approximately 1.3 million jobs in the collision, automotive, motorcycle, and marine industries in the United States by the year 2018.

Salaries are good. Starting salaries depend on many things, such as where an entry-level technician lives, how well he/she did in school, his/her work experience and employer demands. For example, the Bureau of Labor Statistics reports the current national median annual wage for an automotive service technician is $38,560. (http://www.bls.gov/ooh/installation-maintenance-and-repair/automotive-service-technicians-and-mechanics.htm)

Academic rigor is important. In a research article published by the Center for Automotive Research in 2011, STEM subjects are reported to be a requirement for the advanced manufacturing and automotive workforce of the future. *Automotive technology is rapidly evolving and along with it the qualifications necessary to perform this job,* the Center said. *The environment is technology driven. Forget the image of wrenches and oil-soaked rags. In its place, picture diagnostic computer equipment, infra-red engine analyzers, compression gauges, and other complex devices. This is what is needed for today's vehicles.*

Add Relevance through Partnerships

So how can we increase the relevance of what we are teaching? First we need to partner. And we don't even need to leave the building! Start with our professional school counselors. Each academic department head should sit down with a counseling representative and share the department's four-year curriculum. The purpose of this review is to determine where the best crosswalk/interception points are to bring in speakers, to add career lessons, and to consider field trips. Professional school counselors have the training and expertise in this domain. With their support students can then begin to make the connections between what they are learning and applications in the real world. Nearly one third (31 per cent) of teens indicated that they may be discouraged from pursuing a career in STEM because they do not know anyone who works in these fields.

By hearing from men and women in the community about how they use algebra, computer science, and chemistry, for example, students will understand the *why* of the material they are learning. These local experts can share real problems from the workplace that will engage students in figuring out solutions, allowing them to work in teams and involving them in their community.

We need to open our doors and take advantage of these business and industry partnerships. We often just need to ask! Civic clubs such as Rotary and Kiwanis are eager to offer speaker panels on careers. They want to be a part of your career/college fairs. They will often help with expenses for field trips, equipment, and scholarships. They will take students for job shadowing. These half-day *shadow* days with someone in a field of interest is an excellent way to deepen student's awareness of possibilities for them after high school. Corporations and large companies have the means and are eager to support school district initiatives once they understand the goals and the value to student success. If community resources are difficult to secure, there are web sites to supplement these options. One of my favorites is www.stemcareer.com. Many contain videos and live chats, allowing students a robust experience as they collect information on career pathways that match their interests, abilities, and aptitudes.

Teaching Partnerships: In too many schools we are still teaching in silos, with students going from class-to-class, one subject at a time, working alone at a desk. As we know, in the real world students will interact with others, work in teams, and apply multiple levels of academic knowledge in integrated problem-solving. We need to open our doors, walk across the hall, and develop classes using at least two of the STEM metrics. Schools where teachers work in multi-disciplinary teams have demonstrated that students can still learn content while combining multiple metrics. Flipped classrooms are evidence of our ability to reintroduce problem-solving and creative experiments back into our student's experience.

For those with CTE programs, the crosswalk is even more exciting. Imagine bringing your computer science classes or your math classes down to the Automotive Program where the instructor demonstrates the application of geometry in front-end alignment. Recently, I was in a high school Auto Technology class in Texas where a student was demonstrating how the car and the software on his laptop were *talking to each other* during diagnostics. His audience was composed of computer class students from another part of the building.

Mr. Neal Steinkrauss, one of our automotive instructors from the Norwood, Massachusetts campus shared some of the new applications with me the other day. Imagine student's excitement at learning the following: *The high-end cars of today have over 40 sensors and 50 computers all interacting as we drive. The cars of today are now safer and more convenient than ever before. There are systems that let us know if there is a car in our blind spot but above that, if we start to go into that lane it will pull us back into our lane so we do not hit the car we cannot see. We have a system that knows if we are about to have a crash. It gives us a warning but then, over the network, fully applies the brakes, rolls up the windows, tightens the seatbelts, closes the sunroof, adjusts the seats to a safer posi-*

tion, all because one system can talk to the entire car. After the crash the interior lights, and hazard lights are turned on, the doors are unlocked, and the car calls for help.

We have also used technology to help clean up car emissions. With fuel injection, a closed loop feedback system and our newest catalytic converters, todays cars turn carbon monoxide, hydro carbons and NOx [noxious oxide] into carbon dioxide and water. This gives us better performance, lower emissions and good fuel economy. The vehicles of today have combined navigation, convenience and safety through the use of technology. This has resulted in an ever increasing need for advanced training for anyone servicing these vehicles. Lately, more and more cars are equipped with Cloud computing systems. Along with all the normal benefits that brings, there are added features like geo fencing (a dynamically generated radius around a store or point location) and speed alert (a system that lets the driver know when he has reached the maximum speeding limit). Talk about the use of STEM! At UTI, we host workshops for CTE instructors called Internal Field Trips (IFTs). They are fun and free. There is no better way to demonstrate academic application and career pathways. We are encouraging Auto Technology teachers to *re-brand* their programs as STEM programs, demonstrating the crosswalk between academics and what students are learning in their labs. Universal Technical Institute has developed both STEM tours and STEM workshops to encourage students to see the relationship between the subjects they are taking and the transportation industry. Both our campus tours and our classroom workshops demonstrate the wide-range and strong outlook in STEM related careers.

Value all forms of Post-Secondary Education

Tim Murray, Lieutenant Governor of Massachusetts, also commented on the need for STEM education during a recent Massachusetts School Counselors Association Conference. *Just because four years of college worked for you, doesn't mean it is the only or best option for all of your students,* he said. What is our messaging to our students? What schools do we allow in our building? What opportunities do our students have to meet with admissions representatives and visit campuses? Do we have current information on all schools? High schools need to have relationships with admissions representatives at community colleges, state and private colleges as well as universities and technical schools. This is a pretty tall order! Fortunately, the National Center for Educational Statistics (www.nces.ed.gov) College Navigator section provides comprehensive and up-to-date information on all schools; costs, retention rates, completion rates, and default rates, to name a few. Dr. Richard Lapan of UMass Amherst did a recent study and determined that school counselors are at the center of student's career and post-secondary decision making.

He warned us that we need to be careful that our attitudes and beliefs do not color student's interests and personal preferences as they plan their futures. Data on completion rates indicate that we still have a lot of work to do, as it indicated lackluster college completion results. Even those that track a representative sample of students who enter college for the first time in a given year show only 49.4 percent success rate.

Conclusion

We know there are plenty of STEM jobs in a wide range of careers, from engineering to auto technology. Salaries for these STEM jobs are strong and not all require four years of post-secondary education. We know we have people-partnership resources right inside our school buildings! Community partners are waiting for our call. It's time to open some minds, some doors, and some career pathways! It is time to answer the question, *When will I ever use this stuff?*

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Chapter 16

AN INTERNATIONAL VIEW OF CAREER DEVELOPMENT: Interventions Addressing Global Competition in the STEM Marketplace

by **Jennifer Long** and **Rich Feller**

Career Development From A Global Perspective

Over the years, career theorists have modified early approaches to career counseling and developed new ones in response to the changing needs of career clients. The result has been an expanded number of models and techniques that are available to career counselors. Major influences on contemporary career counseling practices have been globalization and the recognition of the importance of cultural context in career development. Employing a career development strategy or counseling intervention requires contextual consideration beyond individual client differences, as cultural and environmental contexts need to be identified and considered when developing and applying career interventions.

At a nationwide and global level, there is a clear need for increased investment in career interventions to fill skill deficits, generate innovation, and jump-start workforce development around the world, notably STEM-focused initiatives in the fields of Science, Technology, Engineering, and Mathematics. Competition and innovations within STEM fields at a global level drive the need for increased investment in STEM education and career planning. According to the National Science Foundation, *"In the 21st century, scientific and technological innovations have become increasingly important as we face the benefits and challenges of both globalization and a knowledge-based economy. To succeed in this new information-based and highly technological society, students need to develop their capabilities in STEM to levels much beyond what was considered acceptable in the past"* (National Science Foundation, 2007, p. 2). Specific emphasis has been placed on the need to better educate and engage youth in problem solving and innovative thinking that goes hand-in-hand with STEM fields. The Organization for Economic Co-Operation and Development (OECD) (2010) strongly acknowledges that *"following a severe recession the need to help young people into work is a major objective for OECD countries and their education systems"* (p. 3). In the United States, *"educators and employment experts currently* *use the word* **crisis** *to describe America's present status with regard to generating a productive and relevant 21st-century workforce"* (Schmidt, Hardinge, & Rokutani, 2012, p. 25). Promoting investment in STEM-centric initiatives, Hira (2010) asserts that "it is broadly accepted that the scientific and technical workforce plays a critical role in increasing our standard of living, ensuring national security, and solving some of society's most pressing problems" (p.950).

Feller (2011) notes that *"in a high-performance global workplace, being mediocre or without passion is not a good place to be regardless of title, credential, or seniority"* (p. 6). Therefore, career development initiatives are critical to a country's prosperity as a lifelong strategy for individuals, talent management within organizations, and as a human resource issue within national economies (Feller & Peila-Shuster, 2012). Career development has the potential to foster efficiency in the allocation and use of human resources, as well as promote social equity through expanding educational and occupational access (Watts, Dartois, & Plant, 1986). Specifically, investment in STEM related interventions support developing countries to *"find greater wealth creation when delivering research and development, design, marketing and sales, and global supply chain management. Here the technical STEM skills receive greater compensation and provide more security and potential within a dynamic workplace"* (Feller, 2011, p. 6)

Within this initiative, specific attention is paid to the changing nature of the global workplace, a community partnership approach to public investment in career interventions, the advancement of the STEM workforce through lifelong career engagement, and the value of vocational education and training. A diverse perspective of career guidance, looking both within and beyond traditional career intervention is suggested here, with a specific emphasis on propelling workforce growth and innovation through STEM initiatives. Additionally, a 10-step checklist is included for STEM program developers and policy makers building and evaluating community-based career intervention efforts. As career development approaches its second one-hundred years as a discipline, more inclusive models will need to address issues such as diminished talent pipelines to meet STEM career needs, skill mismatches, limited job options, global careers and mobility, career as life design, and work's role as a birthright if the ***Coming Job Wars*** (Clifton, 2011) are to be mediated.

The Changing Nature of the Global Workplace

Within a global workplace undergoing structural transformation, career interventions cannot overlook the systemic changes impacting individual opportunities. Economists Krugman (2012) and Reich (2010) argue that workplace opportunities are limited by a decrease in aggregate demand, corporate greed and financial deregulation. Others typically respond with suggestions that government regulation and taxation negatively impact business investments and job creation (Boehner, 2011). An additional component to the changing workplace is to recognize a worldwide restructuring of the way workers earn a living, access products/services from the internet, and access value-added information outside of formal learning institutions.

As *"low-performance workplaces find more routine work being done by less skilled people and machines, which are more easily automated, outsourced, and competing with world wages"* (Feller, 2011, p. 6), viewing the workplace through Pink's (2005) lens offers a new way to conceptualize how individuals need to market their assets. Pink argues that the workplace is dramatically shaped by three factors: (a) automation taking place in *rule based jobs* where standardized responses can easily be automated, (b) Asia's ability to provide an expanded workforce, and (c) material abundance within the world creating more demanding and discriminating consumers seeking design and emotional connection to products. In response, he urges all workers regardless of where they work to find within themselves answers to the following three questions: (a) Can someone overseas do it cheaper than you can? (b) Can a computer do it faster than you? and (c) Is what you're selling in demand in an age of abundance? These questions must now be addressed by individuals and organizations around the world in order to stay relevant in the global marketplace.

Incorporating the nature of such changes and diverse workplace expectations at the local level, and understanding the impact of the changing nature of work on careers shapes the focus of career guidance providers and the ability to provide timely and differentiated career interventions.

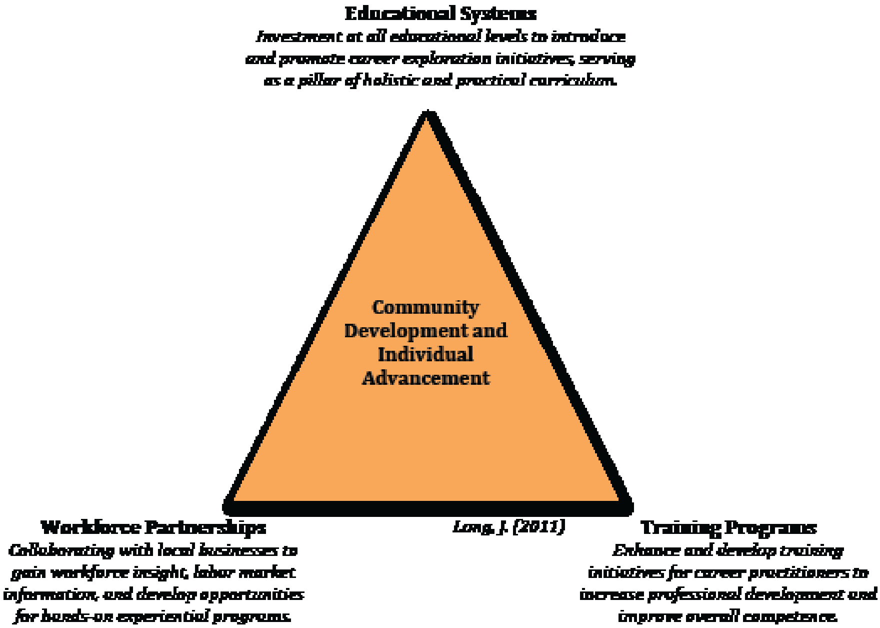
Public Investments in Career Interventions and Policies

Career development operates at the interface among individual aspirations, competency development, cultural expectations, labor market needs, and employer demands. The European Lifelong Guidance Policy Network, the OECD, and the International Centre for Career Development and Public Policy are three of many groups working to support policy to advance career and workforce development. They are driven by the belief that public investment supporting career guidance providers and building career development interventions bring value to society, employers, and students navigating the school-to-employment transition. While promoting international career interventions, it is advantageous to consider three very critical components to fostering career development in any country: educational systems, workforce partnerships, and training programs for career practitioners. Education systems are investments at all educational levels to introduce and promote career exploration initiatives, serving as a pillar of a holistic and application-based curriculum. Workforce partnerships involve collaborating with local employers to gain workforce insights, labor market information, and develop opportunities for hands-on experiential programs. Training programs promote enhancing and developing training initiatives for career guidance providers to increase professional development and improve overall competence. The concept of a community partnership approach considers the localization of these three dimensions, with sensitivity to cross-cultural experiences. As communities seek to compete on the quality of goods and services they provide and develop a well-rounded workforce, investment from multiple community stakeholders will support a *"well-skilled labour force, with a range of mid-level trade, technical and professional skills alongside those high-level skills associated with university education"* (OECD, 2010, p.9).

Since regional social, political and economic conditions define careers and career services, **Figure 1** presents a model to be accommodated and applied to existing cultural conditions, values, and various levels of leadership, with a focus on development, global economic stability, and growth. Providers of career development must adapt and apply career interventions given specific community contexts and cultural norms, to promote individual and systemic life span development. Evidence of local leadership, a focus on individual empowerment and engagement, and an expectation of public and private investments by local entities is essential for program development.

Long's (2011) **Promoting Public Investments in Career Interventions: A Community Partnership and Development Approach** model highlighted in **Figure 1** represents a triangular connection among investment within educational institutions, training programs, and workforce partnerships to support the systematic development of career interventions at the direct service level, as well as around the world. The model presents a holistic approach to develop more engaged and informed citizens, and career interventions through partnerships and investments by all community stakeholders. Within the United States, the National Science Board has acknowledged the need for partnered and holistic investment in addressing the STEM crisis, highlighting that *"the window of national opportunity is open for implementing this bold new action plan to move STEM education into the 21st century- the time for all in the Nation to act together to make this a reality is now"* (National Science Board, 2007).

Figure 1: Promoting Public Investment in Career Interventions: A Community Partnership and Development Approach



Advancing A STEM Workforce: Lifelong Career Development

A paradigm shift to include lifelong career development and self-directed career management is influencing many career interventions in countries around the globe. From the recommendation of the Organization for Economic Co-operation and Development (OECD) (2004a), the European Union (EU) has embarked on a cross-national effort involving over 30 countries to provide lifespan access to quality career planning and management services. Lifelong learning is recognized as essential to creating and maintaining economic competitiveness within knowledge-based economies (European Centre for the Development of Vocational Training, 2011). "Due to the speed at which these fields advance, STEM careers require the ability and determination to engage in continual updating of one's knowledge and skills", rendering a lifelong career development approach necessary to support effective STEM workforce development initiatives (Feller, 2011, p.11).

As an opportunity to promote national development, STEM *"is about social mobility, not just for a few select learners or those fortunate to access STEM programs or mentors. STEM-centric career development* *focuses on helping all students achieve and access STEM skills, mentoring, networking, and informal learning opportunities"* (Feller, 2011, p.11). Hira notes that the talent pool for STEM careers within the United States is the *"lifeblood of the STEM workforce system"* (2010, p. 956), yet current reports from the STEM Workforce Data project reveal that the *"STEM talent pool is not representative of the American labor force"* with women and minorities, including African Americans and Hispanic Americans, underrepresented within these career fields (Hira, 2010, p. 956). The STEM Workforce Data Project promotes investment in increasing federal research funding, increasing undergraduate and graduate scholarships within STEM degrees, government procurement to increase spending around STEM fields to enhance STEM labor opportunities, lifelong learning and continued education to increase skill development to meet workforce needs, improving the participation of women and minorities in STEM careers, maintaining current growth rate of STEM foreign workers, and increasing access to STEM careers for individuals with diverse backgrounds and experiences (Hira, 2010, p. 957-958). In response to the *"perceived national crisis"* regarding the talent pool and overall state of the STEM workforce, significant investments have been made by the *"National Science Foundation, federal and state departments of education, as well as the Department of Defense"* to address this crisis and increase educational and workforce opportunities to promote STEM careers and the resulting innovations (Schmidt, Hardinge, & Rokutani, 2012, p. 26). Innovative investments in the development of an engaged and thriving STEM workforce continues to be necessary, as *"the STEM education improvement 'community' is not a cohesive community but rather an unconnected array of individuals and partial social networks that have not been effective in bringing about systemic widespread change"* (***Mobilizing STEM Education for a Sustainable Future,*** 2009, p. 1).

At a global level, investments in STEM careers, vocational education, and essential skill development *"means an effective partnership between government, employers and unions to ensure that the world of learning is connected at all levels with the world of work"* (OECD, 2010, p.11).

Figure 2 provides STEM program developers and policy makers, as well as external agencies, 10 recommended steps for building and evaluating career intervention efforts.

Figure 2: Ten-Step Checklist for STEM Program Developers and Policy Makers Building and Evaluating Community-Based Career Intervention Efforts

This checklist services program developers and policy makers, as well as external agencies, by outlining ten recommended steps for building and evaluating career intervention efforts.

1. Complete needs assessments with input from the local client base, workforce development, and career counselor and specialist training partners.

2. Establish commitment of the local community to the development of a comprehensive career profession, well informed by education and labor market information.

3. Institute local and/or national leadership and organizational structures dedicated to providing adequate resources for career guidance and proactive delivery.

4. Clearly establish guidelines and provide oversight to ensure support for current and objective labor market information.

5. Ensure that objective sources of information about careers, course alignment, and access to education, training and professional development opportunities are available to all.

6. Utilize partnerships at the community level to build and deliver a comprehensive framework of career guidance.

7. Thoroughly review promising practices across similar communities.

8. Identify consultants and professional development trainers to assure sensitivity to local and cultural issues.

9. Establish that training for career counselors and specialists meet both international standards and local expectations.

10. Develop a system of evaluation including inputs from all community partners and clients to assess clearly defined outcomes and expectations.

Vocational Education and Training: Global Value, Global Access

Career and Technical Education (CTE), also understood as Vocational Education and Training (VET) programs in much of the world, are recognized for their value added to individuals, employers, and overall community development initiatives. These programs rely on strong public and private partnerships, specifically in the STEM fields, that allow for community needs to be accommodated while connecting to a larger human resource plan. *"Increasingly, countries are recognizing that good initial vocational education and training has a major contribution to make to economic competitiveness",* as unskilled jobs are fast disappearing because they have been replaced by technology or labor costs within less developed countries (OECD, 2010, p.9).

Yet, VET continues to be underutilized and underappreciated as a beneficial and legitimate form of education in what could be called a *college for all* (Rosenbaum & Person, 2003) promotion by many. According to the MEDA-ETE regional project (2007) focused on career guidance, historically Technical and Vocational Education and Training (TVET) programs have been seen as a remedial step for those unable to perform in an academically rigorous environment. The low opinion of such programs has, thus, resulted in historically low quality and strategic development of TVET curriculum. It is important to address the prevailing negative mindset toward vocational training programs as well as their ability to increase accessible and valid options for learners. Working to change attitudes and perceptions of such programs is needed in every corner of the world.

Additionally, it is unwise to become trapped in the dualistic framework of VET or *college for all,* asserting that either are a panacea for all individuals, all communities, and/or employment over a lifetime. Individual needs, labor market demands, the availability of educational resources, and the variability of career options all impact suitability of or interest in quality VET and other educational/training programs.

Drawing from one case study, Arulmani and Abdulla (2007) explored the mindsets of young people in the Republic of Maldives to understand motivations surrounding employment and career development. They found unemployment rates to be impacted by the observation that *"skilled job opportunities are not taken by Maldivians"* (p. 85). This appeared to result from prevailing *"socio-cultural factors that foster negative mindsets and do not allow the pride of young Maldivians to accept skilled jobs"* (p. 86). Through the deployment of the *Yes* Social Marketing Program, this case study found that a combination of social marketing and career guidance *"had the strongest impact on the attitudes targeted"* (p.103). The market was segmented into four target groups, including unemployed/unoccupied youth grade 7-12, parents, employers, and training providers, to whom social marketing messages were systematically deployed to build the *Youth Employment Skills (Yes)* brand around positive and empowering attitudes toward life and career development (p.89). This campaign positively branded career development and skills training, resulting in a *"ripple of freshness and positive orientations toward work and employment that was felt across the nation"* (p. 95). Continuing to identify successful approaches to combating negative and limiting perceptions regarding quality vocational training programs is critical to maximizing the potential of vocational education and supporting STEM workforce development.

Recently, there has been an increased awareness of the need to invest in TVET/VET education and, *"efforts are being made to reform TVET as an instrument for developing a knowledge-based economy"* (MEDA-ETE, 2007, p. 26). Investment in vocational training programs enhances economic advancement and marketplace competition by creating diversified labor markets. Specifically, TVET/VET programs have been implemented and proven to be impactful in a variety of countries. Recent initiatives in Turkey, Algeria, and Morocco have focused on increased strategic marketing through enhanced program orientation, workshops, advertising materials, and in-person opportunities for individuals to receive detailed information specific to their needs (MEDA-ETE, 2007, p.35). Vocational education programs provide hands-on practical experience and job/field/technical training, which is heavily connected to building skills for and developing knowledge of the workplace. Through the development of a broad range of skills and competencies, VET programs *"provide the foundation for lifelong learning, effective citizenship, and a successful career"* (OECD, 2010, p. 14).

Summary

A core of career programing and services exists, and an expanding number of career interventions are being documented through case studies revealed through journals, professional associations, and additional resources promoting career development initiatives. Strong commitments to developing the competencies of career counselors and specialists, and commitments to community-based partnerships hold great potential of enhancing career interventions within varied cultural contexts. Community supported lifelong career development, STEM-focused career interventions and curriculum, and VET/TVET programming are essential aspects of effective career interventions. As the U.S. and other nations continue to be challenged to define their role in an increasingly competitive global marketplace, *"embracing a STEM-Centric career development orientation is necessary if career development is to build bridges across the community and beyond"* (Feller, 2010). To the degree that career interventions can reach their promise of furthering individual and organizational success, communities, the workplace and the world will continue to transform and develop. Focused career interventions can enhance labor market outcomes, innovate and expand business initiatives, promote active and involved citizenship, foster economic growth and sustainability, and impact a community's global footprint.

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