Recent Advances in Psychology: An International Journal Peer Reviewed
2015, Vol. 2, pp. 92-101

ISSN- 2395-5465

Analyzing Current Status and Future Progressions for STEM-Centric Career Development Practices: Indian Scenario

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Abstract

India, the land of youth, has the opulence of being the world's largest global economy due to the benefit of reaping demographic dividend. But, the country is also facing the challenge of putting its younger population on the right career track. Young people with STEM (Science, Technology, Engineering and Mathematics) qualifications are in demand worldwide and are known to have better career prospects. The present study analyzes current status of Indian STEM-skilled workforce and their presence in the global market. It also shares best career development practices and support for educational institutions at all levels to generate STEM talent to meet future challenges.

Keywords: *STEM fields, STEM education; Indian Context*

The Science, Technology, Engineering and Mathematics (STEM) disciplines and careers are currently in high demand worldwide. It has been widely accepted that students who pursue their higher education in STEM fields have better career prospects, get better salary and have higher growth and development opportunities in the world of work. STEM- an acronym used for the fields of Science, Technology, Engineering and Mathematics- is considered to be the key to modernization, revolution and job creation across the globe. STEM Careers, known for innovation, entrepreneurship and competitiveness, drive a nation's economy and redefine overall standard of living. The present -day greatest advancements in our society from medicine to mechanics have come from the minds of those interested in or schooled in the areas of STEM disciplines.

As expected by U.S Department of Labor (2007 a & b), there would be a tremendous upsurge in the job openings in STEM related fields by 2018. The

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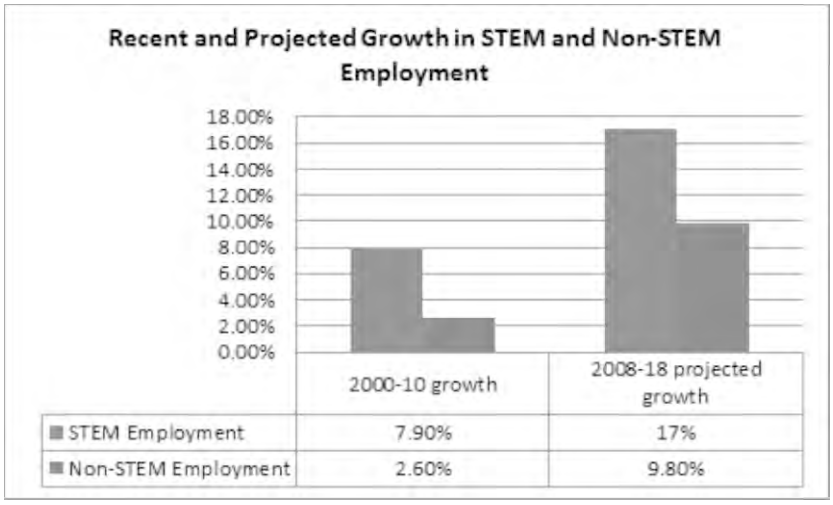
Department of Labor, U.S. expects approximately 1.2 million STEM related jobs by 2018, but, at the same time doubts the availability of such a huge number of qualified professionals to fill the jobs. This gap of demand and supply of STEM qualified professionals has raised the concerns to maintain the competitive position of America in the global economy. According to recent international comparisons, the US is ranked 35th in Maths education and 29th in science education worldwide. This depicts that the U.S students lag behind their foreign counterparts in STEM education, particularly those in India and East Asia. The recent spike of graduate students from India and China to U.S. shows that the two countries supply the largest number of students, accounting for approximately 45%, in the so called STEM fields (IIE, Open Doors, 2011).



Source: ESA calculations using Current Population Survey public-use microdata and the estimates from the employment Projections Program of the Bureau of Labor Statistics.

The present study aims to explore Indian panorama with regard to the interest of students and workforce in STEM disciplines and STEM careers. The objective is also to share the best career planning and development path for potential students in STEM fields at all levels to generate STEM talent to meet future challenges.

India is producing adequate numbers of graduates to meet workforce needs of STEM fields across the globe. While developed nations like US and UK are experiencing a dearth of STEM skilled manpower, India has greatly expanded and achieved success in amplifying the interest of its young students in advanced STEM

education. India graduates 400,000 new engineers each year. The Open Doors Report on International Educational Exchange, during the 2009/10 academic year shows that out of 104,000 Indian students studying at U.S. Institutions, about 74% were studying in STEM fields, contributing to U.S. competitiveness in science and technology.

The current projections for STEM domains indicate that STEM employment which has grown three times more than Non-STEM employment over the last 12 years will continue to grow twice as fast by 2018. STEM workers are also less likely to experience joblessness than their non-STEM counterparts. This brings a responsibility on the shoulders of career professionals and practitioners to encourage and support young students to enroll in high-demand STEM fields. Through this report, we propose certain recommendations that need to be espoused by Indian career professionals to position Indian students and workforce for STEM careers in a better way.

Stem Fields And Occupations

The National Science Foundation (NSF, 2005) defines STEM fields broadly, including not only the common categories of mathematics, natural sciences, engineering, and computer and information sciences, but also such social/behavioral sciences as psychology, economics, sociology, and political science (Green 2007). However, many researchers (Kuenzi, Matthews, and Managan, 2006) have focused STEM fields to mathematics; natural sciences (including physical sciences and biological/agricultural sciences); engineering/engineering technologies; and computer/information sciences, thus excluding social/behavioral sciences from the definition of STEM fields. For the current paper, we will limit our focus to Science, Technology, Engineering and Maths fields as STEM fields. The present paper focuses on these areas as they are deeply intertwined in the real world and are related to hands-on problem-based learning. The world-wide trend indicates that the fastest-growing and highest-wage jobs in future years will be in STEM fields and all employees will need to utilize STEM skills for problem solving in a wide range of industries.

The world-wide studies document the following facts about STEM fields and STEM jobs (U.S. Department of Commerce, Economics and Statistics Administration, 2011):

In 2010, there were 7.6 million STEM workers in the United States, representing about 1 in 18 workers.

STEM occupations are projected to grow by 17.0 percent from 2008 to 2018, compared to 9.8 percent growth for non-STEM occupations.

STEM workers command higher wages, earning 26 percent more than their non-STEM counterparts.

More than two-thirds of STEM workers have at least a college degree, compared to less than one-third of non-STEM workers.

STEM degree holders enjoy higher earnings, regardless of whether they work in STEM or non-STEM occupations

The Standard Occupational Classification, SOC Manual (2000), has detailed the major STEM occupations and their SOC Codes. Broadly identified, the STEM occupations are grouped under the following four main headings:

Computer and Math Occupations: The occupations included under this category are computer scientists and system analysts, computer programmers, software engineers, database administrators, mathematicians, operation research analysts, statisticians, operation research analysts etc.

Engineering and Surveying Occupations: This includes occupations like aerospace, agricultural, biomedical, chemical, civil, electric, environmental, industrial, marine, mechanical and many other types of engineers. Engineering technicians and surveying and mapping technicians are also included under this category of SOC.

Physical and Life Sciences Occupations: Agricultural and food scientists, biological scientists, foresters and conservation scientists, astronomers, physicists, geoscientists, biological technicians, and other physical and social science technicians are included in the category of physical and life science occupations.

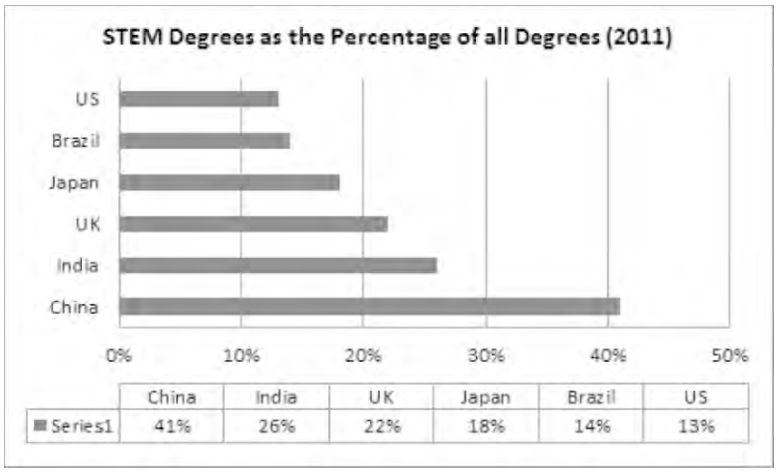
STEM Managerial Occupations: Managerial positions related to computer and information systems, natural sciences and engineering are included in this category.

Across all levels of educational attainment, the largest group of STEM jobs is within the computer and maths fields, which account for close to half (46 percent) of all STEM employment. Second are engineering and surveying occupations with one-third of all STEM employment, while 13 percent are in the physical and life sciences, and 9 percent in STEM management jobs.

Stem Literacy In India

India, a young country, has the plushness of being the world's biggest worldwide economy because of the advantage of harvesting demographic profit. However, the nation is confronting the test of putting its more youthful populace on the right career path. As per the survey report of Manpower group (2014), the country holds the third ranking in terms of talent crisis globally, next to Japan and Peru. On the one hand, where the country produces one of the largest pools of engineers each year, on the other, the country is expected to see an acute shortfall of engineers ranging from 1.5 to 2.2 million by 2020, putting a halt at the economic reforms. The size of India's tech sector is expected to grow more than six fold in coming seven years.

As per the report of Accenture Institute for High Performance Analysis (2011), STEM literacy and talent worldwide has a unique scenario where the emerging market economies are accelerating their production of STEM graduates much faster than the US and other developed countries. China and India top the first two positions globally when counted for producing the world's STEM graduates. In India, 26 percent of all new university degrees awarded are in science and engineering. Comparable figures are 41 percent in the China, 13 percent in the US, and 22 percent in the UK.



Source: Accenture Institute for High Performance Analysis

Chinese and Indian universities may not all be of comparable quality to each other, let alone the top universities in developed countries, but they still graduate most of the world's STEM talent. The sad truth, though, is that the tech boom arguably produced technical talent that has served other nations better than it served India, as more engineers emigrated abroad. And the majority of India's schools do not operate at such an elite level. The Wall Street Journal reported in 2011

that 75 percent of India's tech grads aren't qualified for jobs in the very high-tech global industries India has become famous for.

It is pertinent to point out that besides the fact that India is topping the global charts for producing the STEM graduates but the country's school education system is placing increasing emphasis on the two end-subjects of the philosophy acronymed STEM, neither engineering nor technology is a part of regular curriculum of pedagogy in India. Notwithstanding the marginal scopes of vocation training through work education scheme, not much time or effort is spent on exposure to engineering or technology during secondary or higher secondary schooling. Of course a section of students may and do opt for diploma or certificate level trade training after class X or XII level public examination, and even choose technical streams like pharmacy or engineering as a specialization stream during Higher Secondary (class XI-XII), regular curriculum during class I to XII does not include special/dedicated courses for educating pupils in basics of engineering or technology

A study conducted by the National Institute of Advanced Studies-Gifted Education Programme (NIAS-GEP, 2010), in Bengaluru was an attempt to understand the subjects of interest and aspirations of children shortlisted as gifted in different branches of STEM, from Karnataka. The research team interviewed 16 gifted children, comprising 12 boys and 4 girls. These children belonged to the age group of 8-14 years, and were identified following NIAS-Multistage Gifted Education Protocol. Although 16 children may appear to be a very small sample, it should be noted that children gifted in STEM comprise only a small portion of the population and our focal group has been shortlisted from school children of the entire state. Results of the study were interesting; majority of them had mathematics, physics or chemistry as their favorite subject and more than half of the total participants loved mathematics. One thought-provoking point noted was that none of them suggested biology or any branch of biological sciences as their favorite subject. At the same time a few chose geography and economics, although their strength was science. Along with the passion for science, some of them had additional interests in music, sports (especially cricket) and the English language. About half of the total participants wished to take up professions requiring expertise in science like scientists, professors or technocrats in future. This shows the potential and interest of Indian students in the STEM fields that need to be channelized in the right direction to leverage the competitive benefits.

Interventions: Some Proactive Measures

With regard to initiatives on Science Technology Engineering and Mathematics (STEM) in India, some proactive measures have been initiated in the recent past. Innovation in Science Pursuit for Inspired Research (INSPIRE) program sponsored and managed by the Department of Science & Technology for attracting young talents to the excitements of a creative pursuit of science as a career option and building the required critical human resource pool for strengthening and expanding the Science & Technology system and R&D base in the country. INSPIRE Scheme includes three components: (a) Scheme for Early Attraction of Talents for Science (SEATS), (b) Scholarship for Higher Education (SHE) and (c) Assured Opportunity for Research Careers (AORC). The target is to enroll 0.2 million school children in the age group of 10 to 15 years, offer INR 5000 per child as scholarship and spread the awardees country wide (at least two students per secondary school during the next five years).

Kishore Vaigyanik Protsahan Yojana (KVPY) is an on-going National Program of Fellowships in Basic Sciences, initiated and funded by the Department of Science and Technology, Government of India, to attract exceptionally and highly motivated students for pursuing basic science courses and research career in science. Homi Bhabha Centre for Science Education has been made the country's nodal centre for Olympiad programs in mathematics and sciences. The programs aim at promoting excellence in science and mathematics among pre-university students. The other national-level initiatives like Jawahar Navodaya Vidyalaya, National Talent Search Examination have also been launched to identify children possessing high-ability learning or talent in STEM.

Intel India has recently launched the National Science, Technology, Engineering, and Mathematics (STEM) Acceleration Programme to strengthen STEM education in the country. The programme endeavours to focus on initiatives aimed towards promoting creativity, innovation and a Do-It-Yourself (DIY) attitude amongst students across the country through a wide array of STEM-centred initiatives and resources designed to inspire better learning and student discovery. It also endeavours to accelerate STEM-based governmental and non-governmental programmes in an effort to encourage student interest and participation in STEM related subjects. As a part of this programme, Intel India signed a Memorandum of Understanding (MoU) with The National Council of Science Museums in an effort to strengthen the research culture for students across the country and build innovation resources. As a part of the MoU, Intel India and NCSM shall endeavour

to collaborate on initiatives that will help promote the spirit of innovation and creativity with young people in India. These collaborative initiatives would include setting up of a 'Galileo Corner' at select NCSM's innovation centers, Intel IRIS National Science Fair's affiliation to the zonal Science Fairs by NCSM and a 'Science Week' focused on STEM related activities at NCSM centres.

Microsoft India has launched several student-focused programs in the country to enable students improve their lives through the use of technology. India has the highest number of Microsoft Certified Professionals (MCPs) with over 341,000 certifications awarded in the last three years on end-generation technologies. Microsoft Research India has engaged over 15,000 students to help them explore careers in research and innovation. Microsoft Innovation Centers (MICs) were launched with a vision of driving innovation and providing incubation and expert hands-on support on Microsoft technology innovation, research, and software solutions with an aim of creating a pool of student technology experts across India. Currently 49 MICs across India serve as innovation hubs at select colleges and technology institutes.

The National Institute of Advanced Studies (NIAS), Bengaluru, conceived, developed and implemented a Gifted Education Programme (NIAS-GEP; http://www.prodigy.net.in/) in 2010, with financial assistance from the Office of Principal Scientific Advisor, Government of India. NIAS-GEP identified children gifted in STEM, belonging to the age group of 3-15 years, from different parts of the nation following appropriate and state of-the-art methodologies. In addition, NIAS has been developing material for training children and their teachers as well as to create awareness about the giftedness across the nation, in collaboration with various governmental and nongovernmental agencies. This was the first of its kind attempt in India to conduct a comprehensive study of various aspects of Indian children gifted in STEM, besides creating equitable educational opportunities for them.

Looking Ahead: Inerventions: What Needs To Be Done?

This report does not just document the problem of demand-supply mismatch in the global market for STEM talent and India's situation of STEM literacy and talent, it is also to show what necessary initiatives can be taken by policy makers across various levels of educational institutions to generate, find, access and develop essential talent. Many interventions should be designed starting from the level of schools to universities to meet the market deficit of STEM qualified pool.

The government should plan an increasing investment in STEM programs as a national agenda. Currently, The Government of India is investing just 0.88% of its GDP in science research compared to 7-8% for the US and 3-4% for South Korea. Of that, nearly a quarter is spent on basic research that has little to do with innovation or economic growth (China spends just 5% in comparison). The statistics indicate that the country has thus far been way behind in STEM (the education disciplines Science, Technology, Engineering and Mathematics) investment and needs to invest more to leverage the benefit of its STEM talent.

The STEM teaching force should be enhanced in the country to train the young minds and motivate them to contributing for Indian economy. It's true that STEM courses are typically more academically rigorous than the social sciences and humanities, and inadequate teacher qualification is a common hurdle for schools and universities looking to include more high-level STEM courses in their curriculum. Both, students and teachers, should be offered professional development products like lab simulations, games, tutorials, podcasts to increase their technological knowledge and mastery of advanced STEM subjects. STEM specific organizations should offer team projects and real world internships at a business or in the public sector to produce more business-ready STEM talent in the market.

Besides, more number of seats should be allocated at higher education to enlarge the pool of students pursuing degrees and careers in STEM fields. At the broad level, a large-scale STEM based curriculum should be designed for students that includes more STEM subjects and supplementary materials related to it. Students should also be provided with virtual mentorships from the STEM-specific experts at universities and corporates. The content-specific programs should be encouraged to bring students into direct contact with STEM professionals and real world work, so that they can better understand the reality and value of STEM careers.

A comprehensive STEM education program should be instilled across secondary and senior school levels extended to the undergraduate and post graduate university levels. The education system should be made more flexible to enhance the creativity and innovation over scores or marks. The students should be encouraged to pursue research-based projects in schools, and universities to foster the spirit of innovation among students. The government should also provide research-linked scholarships to the students involved in STEM-based projects. Besides, the private sector should also come forward in its involvement in furthering

STEM proficiency in young minds. The companies should collaborate with research and educational institutions relevant for their industries and create commercialization paths for deserving projects. The innovative minds engaged in industry-specific STEM-research should be paid competitive salaries and stipends to have autonomy and less of worries to pursue their field of interest.

The education institutes should also encourage integrative, interdisciplinary method to incorporate basic science and mathematics concepts with technology and engineering digital tools. This will help children to learn the concepts in practical way as applicable in real-world scenario. The inter-disciplinary learning across the STEM fields can be initiated as a project-based learning where actual 21st Century skills required for design thinking and system perspectives can be learnt by students. This will also help in the development of analytical mind and give them solid foundation for problem-solving and innovation.

Clearly, these new types of programs and courses of study will only help to fill small dents in the talent-supply problem so far. Over time, however, such innovations should be expanded to fill the global need for STEM graduates who are also ready to step into business roles.

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