

Are Girls Genetically Challenged in STEM Field of Study?: With Special Reference to Russian Society

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Abstract: Since time immemorial it is believed that girls are genetically challenged in STEM subjects i.e. Science, Technology, Engineering & Mathematics. And existing statistics and reports do support this claim that girls are genetically challenged in STEM subjects. A new study from Microsoft highlights that, based on interviews with 11,500 girls and young women across Europe, it finds their interest in these subjects drops dramatically at 15, with gender stereotypes, few female role models, peer pressure and a lack of encouragement from parents and teachers largely to blame.

In another report, according to research done by Girls Who Code, shows that the share of women in the U.S. computing workforce is projected to decline from 24 percent to 22 percent by 2025,

However Russia is an exception to this. According to the UNESCO report 29% of those in scientific research worldwide are females, versus 41% in Russia. In Russia, 15% of inventors are female, versus 4% in the UK. Thus, according to this report, the number of women inventors in Russia number more than three times that of other western countries. Another survey by Microsoft says that Russia, actively encourages its women and girls to nurture an interest in tech, maths and engineering, paving the way for gender equality in the tech industry and re-writing the potential of women in the working world.

Hence it is interesting to delve deeper into the matter which is portraying a very interesting picture as far as women and STEM subjects are concerned.

Keywords: Women, Women & Tech, Women in Russia

Overview

Countries around the globe admit that low participation of females in STEM studies and consequently in STEM careers has been a matter of concern. There is a convention, "Girls and Women are genetically challenged in STEM education i.e. Science, Technology, Engineering & Mathematics". This convention became real with present day cross-national and regional surveys which reveals gender differences in STEM education and learning achievement. It is nearly same participation in case of primary and secondary education but the gap is more apparent at higher levels of education, particularly in specific subjects. It is more acute in matter of choosing STEM as a career. According to UNESCO Institute for Statistics (UIS) data 2014-2016, the ratio of female students are only 35% in comparison to all students enrolled in STEM-related fields of study at higher education globally. One can observe the differences by disciplines also, as female enrolment is lowest in ICT i.e. 3%, natural science, mathematics and statistics i.e. 5% and engineering, manufacturing and construction i.e. 8%.^[i] But the situation is different in Russian Society. According to a UNESCO report, 29% of people in scientific research worldwide are women compared with 41% in Russia. In the UK, about 4% of inventors are women, whereas the figure is 15% in Russia. Thus, according to this report, the number of women inventors in Russia more than three times that of other western countries. Another survey by Microsoft says that Russia, actively encourages its women and girls to nurture an interest in tech, maths and engineering, paving the way for gender equality in the tech industry and re-writing the potential of women in the working world. If we observe the above data, we can easily say that girls and women are not genetically challenged in acquiring STEM education. If girls and women were genetically challenged in acquiring STEM education then the situation would be same everywhere. The difference in STEM education is not biological exactly. There must be other factors which are responsible. It can be more clear by analysing the prevailing situation in the world in comparison to Russian society. But before going to the details we must know what comprises STEM and its necessity in our life.

What comprises STEM?

STEM is defined in many ways. According to the U.S. government definition the term "STEM" refers to the physical, biological, and agricultural sciences; computer and information sciences; engineering and engineering technologies; and mathematics.^[ii] STEM in the context of education is a curriculum based on the idea of educating students in 4 specific disciplines in an interdisciplinary and applied approach rather than teach the 4 disciplines as separate and discrete subjects. They are science, technology, engineering and mathematics. As the STEM education begins while students are very young, STEM integrates these subjects into a cohesive learning paradigm based on real-world applications. That means it is a blended learning. This blended

learning environment separates STEM from the traditional math and science education. It shows students how the scientific method can be applied to everyday life. It encourages students to think computationally and focus on the real world applications of problem solving. At the Middle school level, the courses require more attention because student exploration of STEM related careers begins at this level. At the high school level, the program of study focuses on the application of the subjects. Courses are now made for preparation of post-secondary education and finally employment. Besides, subject-specific learning, STEM helps to foster inquiring minds, logical reasoning and collaboration skills. In the entire curriculum, one thing is common i.e. much of the STEM curriculum is framed in order to attract the underrepresented populations e.g. female students.

Necessity of STEM in our Life

STEM has been a part of our everyday lives in myriad ways. STEM pervades every corner of our lives. Science is found around us everywhere and each and every aspect of our lives is now enriched with Technology. Not only engineering remain the basic designs of roads and bridges, but also faces the problems of climate change. Now, it also does environment friendly changes to our home. Mathematics is present in every profession or occupation. Whatever activity we do in our lives, we use mathematics. STEM education spreads science literacy and helps in building critical thinkers that enables the next generation of innovators. Innovation leads to new products and services which directly and indirectly that sustain world economy or of any country. We are getting the benefits and facing the challenges of both globalization and a knowledge-based economy. In this scenario, scientific and technological innovations have become increasingly important.

Advantages of STEM education

In the primary and intermediary level, STEM education develop skills like communication, problem solving, critical thinking, creativity and data analysis. With problem solving skills, students learn to analyze problems and then work to overcome those problems. Creativity gives direction to students to look at the problems in other ways and to think outside of the box. Inculcating these soft skills, STEM education helps students to flourish in their careers. As most of the careers require advanced mathematical ability and scientific knowledge and ability, it is better to introduce students to math and science at an early age. According to a recent data, Career in STEM subjects are growing at 17% more than any other field, and the unemployment rate for recent graduates in STEM are less than those with liberal degrees. The US Bureau of Labor Statistics (BLS) predicts employment in occupations related to these disciplines will "grow to more than 9 million between 2012 and 2022." This is an "an increase of about 1 million jobs over 2012 employment levels." Regardless of the level of education, i.e. high school diploma or associate or bachelor's or master's or doctoral degree, one can find a suitable occupation by studying the STEM subjects.^[iii]

Current status of girls in STEM field of study

Access to education for girls and young women has considerably improved throughout the world. Still disparities are continuing both among and within regions and countries. Specially, In case of STEM education, Gender differences are present at all levels of education. Though progress has been made, certain scientific and engineering disciplines remain overwhelmingly male. It is more visible as soon as subject selection becomes necessary. It is usually bad in upper secondary and become worse as the level of education increases. As per the UNESCO's STEM and Gender Advancement (SAGA) project report, the gender gap in science widens seriously in the transition i.e. from Bachelor's to postgraduate levels and into research and careers. The highest level of attrition can be found at post-doctoral level as women do not take up careers in their fields of study, despite the large amount of time invested in education prior to employment.^[iv] There are also huge regional and country level differences. The proportion of women enrolled in natural science, mathematics and statistics differ significantly i.e. from 16% in Cote d'Ivoire to 86% in Bahrain. High proportions of women are enrolled in engineering, manufacturing and construction in South-East Asia, the Arab States, and some European countries, while lower proportions are found in sub-Saharan Africa, North America and Europe.^[v] The status of girls and women in Russia is very good in STEM subjects. This is backed by a huge study of 11,500 women across Europe. According to that study, Russia was found to have a huge advantage when it comes to gender diversity in STEM. The advantage starts at home, where 62% of girls in Russia said both their parents talk to them about STEM. 60 percent of girls in Russia claimed that their teachers always talk to them about these topics. Because of this, girls in Russia become more interested in the subjects at an earlier age i.e. around 10 years old and 50% of Russian girls go on to say they would consider a career in STEM. School girls in Russia perceive STEM subjects as gender-neutral. When we take STEM as profession Russia also leads. In 2004, when the average global percentage of senior executive roles held by women was merely 19%, Russia was averaging at 42%. At present, globally 34% of companies have no senior female leaders, whereas there is not a single organization in Russia that currently doesn't have at least one women as a partner or holding an executive, directorial or C-Suite level role.^[vi] As per the reports and their data, there must be some factors present which created this regional as well as gender disparities.

Factors responsible for low participation of girls and women in STEM education

The number of female students in STEM studies are growing day-by-day, yet male students continue to outnumber them. Across the world, several factors influence girls' and women's participation, achievement and progression in STEM studies and careers. These factors can be broadly categorized into three factors. They are biological, social and environmental.

Biological factors: Many biological scientists said that it is only the biological factors e.g. brain structure and function, hormones, genetics, and cognitive traits like spatial and linguistic skills that underpin human learning, cognitive ability and behaviour. But the same research on biological factors, including brain structure and development, genetics, neuroscience and hormones, shows that the gender gap in STEM is not the result of sex differences in these factors or in innate ability. Rather, findings suggest that learning is underpinned by neuroplasticity, the capacity of the brain to expand and form new connections. Education performance, including in STEM subjects, is influenced by experience and can be improved through effective measures. Spatial and language skills, especially written language are positively correlated with performance in mathematics and can be improved with practice, irrespective of sex, especially during the earlier years of life. So it is now clear that girls and women are not genetically challenged in acquiring STEM education.

Social Factors: Researchers believe that negative stereotypes can lower girls' and women's aspirations for STEM subjects and careers over time. These negative stereotypes includes social, cultural and gender norms through which it has been believed.

Girls are often brought up with a belief that STEM are 'masculine' subjects and they are innately inferior to that of boys in this field. This can undermine girls' confidence, interest and willingness to engage in STEM subjects. However, Russia has encouraged STEM from an early age in girls.

Beliefs, attitudes and expectations of Parents can cause treatment of girls and boys differently. Parents having higher social and economical status or higher educational qualifications tend to have more positive attitudes towards STEM education for girls. Parents with lower education, social and economical status and parents of immigrant status and ethnic minority background or single parents have negative attitude towards STEM. According to the Microsoft study, 62% of girls in Russia said both their parents talk to them about STEM.

Both education system and schools play a central role in creating girls' interest in STEM subjects. They must play well in facilitating equal opportunities to access and benefit from quality STEM education. Teachers, learning materials, tools and equipment, assessment methods, are all critical in creating girls' interest in and engagement with STEM studies and, ultimately, STEM careers. As per the Microsoft study report, 60% of girls in Russia claimed that their teachers always talk to them about these topics and this generated interest in the STEM subjects.

Both family and education system helps girls and women the Self-selection bias i.e. to pursue or not to pursue STEM studies or careers. The sex of STEM teachers matters too. Mother at home and Female STEM teachers at school have a positive impact on girls' performance and engagement with further STEM studies and careers. Girls can perform better by taking into consideration the teaching strategies, learning needs of girls and women. They also do better when teachers have high expectations of them in STEM subjects and treat them equally with boys. Nevertheless, girls can not learn better in STEM, when teachers hold stereotypical beliefs about sex-based STEM ability. Girls in Russia become more interested in the subjects at an earlier age i.e. around 10 years old and 50% of Russian girls go on to say they would consider a career in STEM.

Learning contents, Assessment contents, tools and processes must be gender-balanced and take account of girls' interests to increase girls' interest in STEM. For example, linking abstract concepts with real-life situations, Hands-on activities in laboratories, can enhance girls' interest. Though these days there is an increasing role of information, communication and technologies (ICT) in the STEM education, more attention must be provided to ensure that girls have equal opportunities to avail ICT education. Psychological reactions to exam, such as mathematics anxiety is more common among girl students. It must be look after with care. Finally, the assessment of STEM learning needs to be free from gender bias and encouragement is there. School girls in Russia perceive STEM subjects as gender-neutral.

Learning Environmental Factors:Conducive learning environments can increase girls' self-confidence and self-efficacy in STEM field of study. They should have exposure to real-world learning opportunities like extra-curricular activities, field trips, camps and apprenticeships, which can help inspire and retain their interest. As the goal is to create students' interest into these subjects, they must be standards-based, structured inquiry-based and real world problem-based learning. In order to develop the self interest, there is also an emphasis placed on bridging in-school and out-of-school STEM learning opportunities. Along with the growth in specialist research institutes, technical education must be made available to everyone including women. Women must be encouraged to pursue careers in this field. Media representations of women helps in delving more women into the STEM careers.

In Russia, STEM is a cultural pride. It dates back to the Soviet Union. At that time, science was considered a national priority in Russia. In the 1960s subjects like maths and the sciences were championed in Russia, ahead of languages or the humanities. As a result between 1962 and 1964 some 40% of chemistry PhD's in Russia went to women. Because of this Russia saw a generation of female leaders in STEM emerge, like Valentina Tereshkova, the first woman in space, whose work further inspired young girls to choose the subjects. 55 percent of Russian girls feel there are encouraging role models out there for them.

So from all the above factors we can easily conclude that girls and women are not genetically challenged in matter of STEM field of study. There are social, cultural and environmental factors responsible for low participation of the girls and women. This situation can be changed by appropriate interventions.

Measures should be taken to Attract and Retain more women in the STEM field of study

It is only our perceptions and unconscious beliefs about gender which leads to a convention that women are genetically challenged regarding STEM area of study. We have to change stereotypes, our bias, and other cultural beliefs to make a change. Some measures should be taken to bring and retain more girls in STEM like Inform the girls about the female role models in STEM careers, talking about the greater numbers of girls and women who are achieving at higher levels in STEM than ever before, and figure out the lack of gender difference in performance in STEM subject. Family and education system must motivate the girls that intellectual skills, including spatial skills can be acquired. For this the effort of the girl students should be praised in stead of their intelligence. They must create a growth-mindset environment both in the house and at the classroom.

At the college level, the education system must recruit more women faculty into the STEM subjects. STEM courses in colleges should give emphasis on real-world applications of STEM work. College and Universities must sponsor seminars, lunches, and social events to help integrate women into the STEM. These are some measures which can be taken in order to make more participation of girl and women in the STEM field of study and over some period people can change their views that women are genetically challenged in case of STEM subject of study.

References:

[i] <http://data.uis.unesco.org/>

[ii] Students Who Study Science, Technology, Engineering, and Mathematics (STEM) in Postsecondary Education, Xianglei Chen MPR Associates, Inc.

[iii] What is STEM Education?, By Elaine J. Hom, LiveScience Contributor, February 11, 2014

[iv] STEM 101: Intro to tomorrow's jobs, Dennis Vilorio, Occupational Outlook Quarterly, 2014.

[v] <http://www.unesco.org/new/en/natural-sciences/priority-areas/gender-and-science/improving-measurement-of-gender-equality-in-stem/stem-and-gender-advancement-saga/>

[vi] Yandex interview: Russia leads for women in tech, Charlotte Trueman, 2017.

