STRATEGIES FOSTERING DEVELOPMENT OF INNOVATIONS IN THE AREAS OF STEM

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ABSTRACT: Science and technology ensure the progress in all areas of human life. Prosperity of the country is strongly linked with a proper application of STEM (Science, Technology, Engineering and Mathematics) fields. To achieve this goal, highly educated specialists both men and women are needed. Children should be exposed to science and technology from early childhood and the national educational policy has to take into consideration all levels of education. Graduate students should possess necessary amount of knowledge to be able later on to introduce into their reality the innovations of science and technology. Recently, a new system called K-12 is introduced in schools. Since the science is a strategically important field, therefore a significant fraction of students should study science and engineering what within a time can be converted into innovation and economic growth of the country. Special attention should be put on female students and the existing barriers that may inhibit them from studying the STEM fields. In this paper, a short analysis of K-12 educational system is performed and some best practices encouraging young people to study the STEM fields are presented. The under-representation of women scientists and engineers on the top positions in academia are also mentioned. Additionally, activities of two global NGO organizations (INWES and INWES-ERI), partners of operational type with UNESCO, whose primary objectives are to advance education in STEM are introduced.

Keywords: K-12 system, innovations, STEM, women's career

INTRODUCTION

Science, engineering and technology penetrate almost all aspects of modern life and are the key to solving many of today's most up-to-date and future human challenges. Education of the young generations in the highly competitive 21st century should involve both Science and Humanities although it is the science; however, that ensures civilization development. In October 1996 International Conference of Women Engineers and Scientists (ICWES10- International Conferences of Women Scientists and Engineers) was held in Budapest [Szemik-Hojniak]. Among many excellent lectures presented by the world reknown women scientists and engineers especially, the one particularly interesting was given by the civil engineer-baroness Platt of Writle of the United Kingdom [Georgiou, Platt]. In her lecture, she presented the main ideas of Science and Technology Program entitled "Realizing our Potential" prepared by the British Government Office of Science". It is worthwhile to quote few phrases from that report to underline how important is for the nation to educate young generation in a highly competitive 21-century: "The understanding and application of science are fundamental to the fortunes of modern nations. Science, technology, technology and engineering are intimately linked with progress across the whole range of human endeavour: educational, intellectual, medical, environmental, social, economic and cultural" [Georgiou].

Each Government should demonstrate initiatives of that kind and realize that prosperity and quality of life of the nation is strongly linked with a proper application of Science and Technology. Science and education, is a long-term process and, in a fact it has to begin from the early childhood provided by parents, neighbourhood, school and in general, by the society.

Education for Innovation

In today`s world, political, socio-economic, technological and environmental challenges, affect development of new attitudes in science, technology and IT methodologies. Observations show that the global competition for talents and resources already has begun and apart from well trained teachers also "Policy makers have a key role to play in helping to create the right conditions for the adoption of new technologies and knowledge" [Angel]. In the nearest future, new emerging markets will require new type of skills both from alumnees of highschools and university students.

Looking to the future and creating a new generation of scientists and engineers, we should take into account not only the worldwide issues of education in STEM but also identify key scientific ideas and practices in education of all talented individuals, i.e. men and women, minorities as well as persons with disabilities. To ensure rapid technological progress in the country, all of them have to be employed in various areas of the social life. National educational policy has to take into consideration all levels of education starting from the primary and secondary

schools and finalize on the highschools and universities. Certain intellectual level of students of all types of highschools and universities has to be ensured. Graduate students should possess necessary amount of knowledge, and ability to apply this knowledge to surrounding world to be able later on to introduce into their reality the innovations of science and technology.

May be in this place, the notion of innovation should be defined. We all understand that innovation is linked to the launch of new ideas and generally, it is a joint process.
Using multidimentional UNESCO definition [UIS**]**:

- Innnovation is a new or substantially improved product (good or service),
- A new marketing method
- A new technological process
- A new organisational method in business practices, workplace organisation or external relations.

As far as the place of a given country in global innovation is concerned, the first one is for Israel, where 4.4 % od its GDP is invested into science. The map presented beneath shows the Global Research and Development expenditure [in %] worldwide.

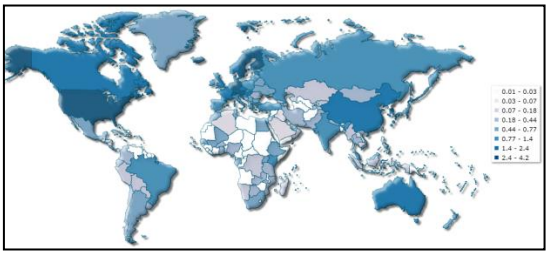

Figure 1. Global research and development expenditure into science (% of GDP) [UIS].

The corresponding values per country are gathered in Table1.

Table 1. Global research and development expenditure (% of GDP) invested into science [UIS].

Country	[%] of GDP	Country	[%] of GDP
Israel	4.4	France	2.23
Japan	3.47	China	2.01
Finland	3.31	UK	1.63
Sweden	3.30	Canada	1.62
Danmark	3.01	Italy	1.26
Germany	2.85	Russia	1.13
USA	2.81	**Turkey**	**0.92**
Australia	2.25	India	0.82
France	2.23	**Poland**	**0.80**

Innovations are strongly related to economic development and are the key factors to increase the profit, productivity, innovations and country`s GDP.

The young generation, i.e. graduates of high schools and universities need to be well prepared and creative to provide innovations later on. Thus, we have to know what all students should learn by the end of high school. It is interesting to note that nowadays, a new system, preparing youth for the universities, called K-12, raises popularity worldwide and is being already implemented in many countries. This specific teaching system is now a new educational mode that is somehow different from the conventional methods. It covers the education from kindergarten till the 12th grade and introduces a more significant common work between teacher and student than before. In K-12 system, the content and resources have changed to a significant degree and the teacher needs to arrange a lot of question-answer sessions and assignments that would lead to effective learning habits in students. Schools are now striving to invest as much as possible in their infrastructure to create the best learning conditions

for their students. Students, utilize these facilities to provide for themselves the optimum learning. Exploring one of the advices of the National Academies Report in the USA [Consensus Study Report], one may say that country`s talent pool can vastly increase by developing and improving K-12 science and education.

Educational programms of this system have to capture students' interest and provide them with the necessary foundational knowledge in the field. Educational programme in these classes should involve the following [Pellegrino]:

1. 1.Cross-cutting approach combining research with their common use in science and engineering,
2. Practices and participation in scientific and engineering projects
3. Fundamental ideas of exact sciences, life sciences, earth and space sciences as well as for engineering, technology, and the applications of science.

This task, places great responsibility on higher education institutions, and especially on those that train the teachers. We must remember, that the main purpose of the K-12 system is to enable all high school graduates to gain sufficient knowledge of science and engineering so that they could later on engage in public discussions about science, understand scientific and technical information, and continue careers in accordance with their interests.

Special activities should also be undertaken by Governments, National Foundations and Non-Governmental Organizations (NGO) that might help to improving teacher preparation. Certainly, many teachers need to be more provided with research experiences and an increased use of high technologies. Hence, special Programs Awarding for Excellence identifying outstanding science teachers (who could serve as models for the rest of school staff and play the role of leaders in the field of science and education improvement) are advised to establish [Madsen]. Regarding the female students, it is believed that the more information could be provided about scientific and engineering career at school, the younger women would take up natural sciences and engineering for their future studies.

Academic Knowledge and Social Empowerment of Women Scientists and Engineers

Europe

The economic growth largely relies on innovation and knowledge in science and technology what makes of science a strategically important field [Corsi, Saperstein]. In changing reality, science will continue its key role in development although it needs to undergo a sort of transformation, too. The inter-disciplinary cooperation between different institutions will be necessary and joint projects and programs may show to be relevant, particularly in situations when one partner has enough number of highly qualified scientists but small number of multi-disciplinary laboratories/equipment. The top country scientific institutions need to carry out more application-oriented research and faculty evaluation process has to be based on such criteria like number of patents, effectiveness of commercialization, technology transfer and others.

Universities should create friendly atmosphere also for women pursuing their carrier in STEM fields. The under-representation of women in sustainable development by contributing to technological advancement, industrial and economic growth is of special concern. Their full participation may be achieved both through academic knowledge and social empowerment. To increase their representation, specific public policy and programmes need to be implemented and analysed from the point of view “of their content, justifications, and the environment in which they operate in a socio-economic context” [Mazur]. From the report of European Commission published in “SHE Figures 2015” [EC] and presented as the “Glass ceiling index (GCI)” in Figure 2, results that in many European countries there is an under-representation of highly educated women on the top academic positions. The GCI (0-1) is a relative index that compares proportion of women in academia (grades A, B, C) with the proportion of women in the top academic positions (grade A-full professor) in a given year. Walue of 1, indicates that there is no difference between the two sexes from the point of their chances to get promoted. When GCI<1-means that women are with grade A, in larger number than in academia generally and GCI>1 shows the “Glass Ceiling” and lower chances of women to be promoted. Thus, the higher the GCI values the stronger is “Glass Ceiling”.

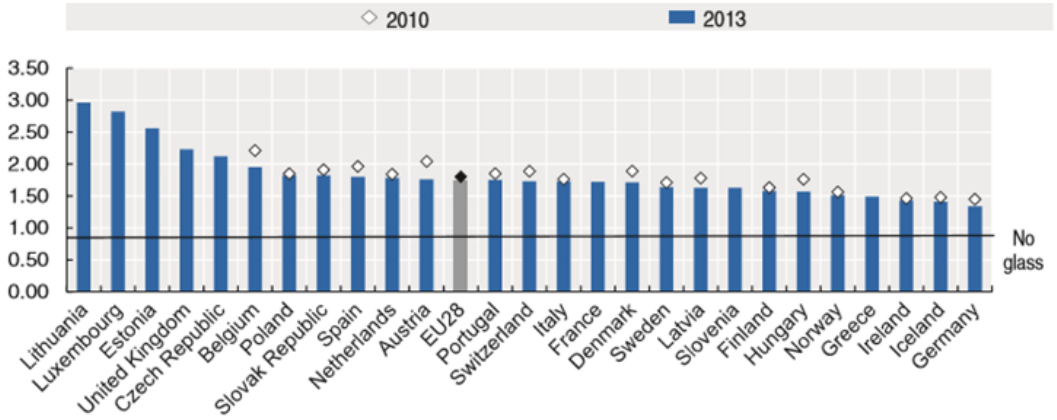

Figure 2. Women remain away from the top academic positions in Europe; "Glass ceiling" index (0.00-1.00) [OECD].

The European Commission working document on women and science reported that "Scientists have the longest period of qualifications, high level of career insecurity and international mobility as a key element of their careers" [Benchmarking Policy]. From these reasons, for women scientists to reconcile family responsibilities and work is very difficult.

In Europe, only 32% of researchers are women and women constitute 54% of teaching staff, but tend to be concentrated in the lower academic positions [MoRRI].

In the East Europe, women make up more than 50% of scientific population, thus they constitute a critical factor in development, especially because of their demographic strength.

Difficulties in advancements of women scientists, and academics means an inadmissible misuse of human resources. Although some of women have achieved academic knowledge, most of them do not hold decision-making positions. The reasons include: the lack of confidence, discrimination, and the lack of leadership training. One may conclude that highly skilled workforce of East Europe is not completely involved into economic growth.

Poland

General View

Accordingly to the Global Gender Gap Report 2015 [GGGR], Poland is characterized by the key indicators, as presented in Table 2.

Table 2. Key indicators of Poland [GGGR].

Total population (millions), 2015	38.00
GDP (US$ billions), 2015	429.52
GDP (PPP) per capita	23,952 USD
Population growth (%)	-0.12
Mean age of marriage for women	25
Overall population sex ratio(m/f)	0.94
Year women received right to vote	1918
Fertility rate (births per woman)	1.30

There are more women than men in Poland. Women constitute about 50% of the workforce. The population growth and the fertility rate are very low, indeed. Economic Participation and Opportunity of women and men in Poland [GGGR] are presented in Table 3.

Table 3. Economic Participation and Opportunity of Polish citizens [GGGR].

Type of data	F	M

Labour force participation	48%	61%
Income (PPP USD)	8,769	14,147
Legislators, senior officials, and managers	34%	66%

There is no illiteracy in Poland, and Polish women are in majority responsible for primary and secondary education. In general, they have a higher educational attainment than men.

As it is demonstrated in Table 4, the political empowerment in Poland looks more and more optimistically. In the last 20 years, Poland had three female prime ministers and generally an increasing percentage of women occupy with politics.

Table 4. Political Activity of Polish men and women [GGGR].

Political Activity	F	M
Parliament	27	73
Ministerial positions	22.5	77.5

It is important to note that in Poland, women have a full access to education. On their own decision it depends whether they choose it or not. Nevertheless, in spite of such possibilities, Polish women are still substantially underrepresented on the higher ranks of scientific and academic career [Reszke,]. About 20% of them work in technical sciences, 40 % in social sciences and 40% in medical and agricultural sciences [18]. Such statistical distribution is caused by a traditional rather than a liberal model of woman and her role as a „wife, mother or housewife" in Polish society. Due to stereotype ideas, professionally or publicly active woman, in many cases, does not receive a suitable encouragement neither from the men`s side nor from women in general. Since the collapse of the Communism in 1989, however, significant socio-economic changes took place in Poland and more rarely professions are divided into "feminine" or "masculine", as it used to be.

Statistics shows also that about 61 % of women scientists are married, 15% are divorced or in separation, 16% are single, and 8% are widows. They have one (33%) or two (30%) children, rarely three or more (5%) while 31% has no children at all [Iwaszczyszyn].

In conclusion, majority of Polish women scientists are married, have a small number of children and the most important for them is to have a happy family life and to keep equilibrium between profession and family obligations.

University of Wroclaw as a Case Study

One of a basic measures of high school development is the number of its students. In the 300 years history of the University of Wroclaw (founded in 1702) including 50 years of its post-was history, one may distinguish several periods of increase and decrease of the number of students. A dangerous permanent decrease of about 500 students per year took place around 1978 and lasted till 1985 [Zagożdżon]. It was an unprecedented phenomenon in the whole Poland. Those years in Poland, in the time of communist governance, were characteristic of a deep regress both in science and in high education. After, 1985, the number of students including the female students was slowly increasing every year.

The last statistical data on employement at the University of Wroclaw as demonstrated in Table 5, are the following:

Table 5. Employment at the University of Wroclaw (status quo on 31 December 2015 [BIP, Krzykawiak]).

Number of academic teachers:	3496
Full professors	261
Associate professors	307
Lecturers	542
Phd doctors	1017
Others (assistants, librarians, technical personel…etc)	1498

Total number of students:	32 000
Female students (%)	65
Residents	20 307
Evening & external students	11 250
Foreign students	806
PhD students	1334

An average number of female students at the University of Wroclaw is about 65 % and is slightly higher than statistical value (51.4%) for the whole Poland in years 2013-2014.

Women constitute also a large percentage of those completing the higher education. At the University of Wroclaw, the number of graduated female students in Mathematics, Physics and Chemistry is 78%, 29% and 69%, respectively. The least in Physics (29 %) indicates a significant underrepresentation of women in this „non-feminine" discipline. For comparison, in the Humanities, traditionally considered to be the female-dominated area [BIP], the number of diplomas given to them considerably exceeds those in natural sciences and reaches almost a 100 % [BIP]. At the University of Wroclaw, women constitute 15 % of full professors but in the Faculty of Chemistry this value, hopefully, approaches 30 %. Nevertheless, despite that women account for half of the university graduates they represent a minority at higher university positions. As prof. Etzkovitz, American sociologist, explains "They disappear in disproportionate numbers at each stage of the academic ladder"....a phenomenon often referred to as the "leaking pipeline" [Etzkowitz,].

A discussion whether being a wife and a mother excludes academic excellence and career progress is still opened in Poland especially that this situation is likely to almost all post-communist countries of East Europe. Accordingly to European Comission raport in 2013 [BP] among 25 countries involved in this report, only 5 of them (Romania, Turkey**,** Latvia, Portugal and Finland) have proportion of women full professors above 20%. This raport indicates also that in these countries also number of female PhD graduates are higher than in others. Hence, one may directly conclude that the more female PhD graduates is at the university, the higher percentage of females attain the title of full professor.

Networking and Non-Governmental Organizations

Nowadays, different social platforms including those of academic type (Research Gate, Academia, etc) enable the networking of scientists worldwide. In academic world, it is not enough to be smart and work the full day long, to make it to the higher rank of professional ladder. Important are connections and networking between collegues from different fields and specializations since it rises up the chances attaining the top position at academia or university.

INWES - International Network of Women Engineers and Scientists (www.inwes.org)

In today's world, rapid technological change and international competitiveness require the full participation of educated women in the country's development. This issue was analyzed during, the World Conference on Science for the 21st Century in Budapest 1990, convened by the UNESCO and the International Council for Science. During this meeting, the "*Article 90*" was adopted encouraging special efforts to be made toward the establishment of an international network of women scientists and engineers. It has happened that through the support and encouragement of the Canadian Commission for UNESCO, and a successful grant from UNESCO, 20 women representing 10 countries and 8 organizations met in Canada, in May 2001, to explore the creation of such a network. During the ICWES12 (International Conference of Women Engineers and Scientists) in Ottawa, July 2002, delegates from all over the world supported the creation of the INWES, i.e. International Network of Women Engineers and Scientists. The vote from representatives of 30 countries was unanimous. The author was in the first Interim Board and in two consecutive terms (2002-2011) served as the INWES Board Director, representative of East Europe Region.

In April 2003, INWES was incorporated as a non-profit corporation under the laws of Canada. INWES is a global network of organizations for women in Science, Technology, Engineering and Mathematics (STEM), reaching nowadays over 60 countries worldwide and about 300 000 members. INWES is a not-for-profit corporation, governed by a Board of Directors, representing organizations, corporations, universities/ institutes, and individual members in 12 global regions. The main INWES mission is to strengthen the capacity of individuals, organizations, and corporations; to influence policies in STEM worldwide and encourage the education, recruitment, retention,

support, and advancement of professional women and students through an international network of organizations and experts.

In April 2008, INWES became an official NGO partner of the operational type with UNESCO while in April 2017 has received the consultative status with the Economic and Social Council (ECOSOC). INWES is the only one NGO organization on women in science and engineering with this ECOSOC status. It gives many possibilities for the INWES members to have a contact with the United Nations Secretariat and to be engaged in the various UN programs, funds and agencies.

As for now, this partnership involved a dynamic cooperation through helping women and girls worldwide to have access to education, especially in Science and Engineering. So far, apart from its annual activities (educational programs, regional workshop and symposia…) INWES organized several global conferences, so called ICWES (International Conferences on Women in Engineering and Science) conferences:

In 2002-Ottawa (Canada), 2005-Seul (South Korea), 2008-Lille (France), 2011-Adelaide (Australia), 2014-Los Angeles (USA) and in October 2017 the next conference will take place in New Delhi (India).
The Board Directors are leaders of different INWES Committees like:

- Project Committee - to identify opportunities to collaborate with organizations and corporations in providing programs, projects, and different events;
- Communication Committee - to share good practices among members by providing resources for professional development, and distribution of materials; to ensure appropriate representation of women on international and regional decision making fora,
- Advocacy Committee - to establish a worldwide web portal for information on women in STEM (www.inwes.org)
- Conferences Committee -to organize global ICWES conferences and Regional meetings, to collaborate with UNESCO and others on international campaigns to raise awareness about STEM issues and others.

The INWES branches were created already in Asia, Africa, Europe and in the USA it is under preparation.

INWES Regional Symposium on Women Scientists and Engineers of New EU Countries and Eastern Europe; "Strategies for a Highly Skilled Global Workforce"- June 2007, Wroclaw, Poland

The above mentioned reasons and the membership of Poland in European Union (since 2004), obliged the author, a women researcher, at that time in service as the INWES Board Director for East Europe Region, to organize in Poland Symposium on Women Scientists and Engineers. This, with the help of Ministry of Science and High Education of Polish Republic, University of Wroclaw, City Mayor of Wroclaw and CIDA (Canadian International Development Agency), was held at the University of Wroclaw in June, 2007. The Symposium objectives has been chosen to respond to the abovementioned problems as well as to establish the strategy that could increase the number of young people studying science and engineering and to retein women in careers in STEM fields. Discussion on the issue of balancing career and family responsibilities was also carried out and women saw a variety of models on how to balance family and career.

Polish universities decision makers and administrators such as rectors, vice-rectors and deans were also involved in panel discussion on how to promote natural sciences amongst highschool boys and girls. More than 70 women scientists and engineers from 22 countries participated in this Symposium. Those were women of East Europe and Russia, some of West Europe, USA, as well as those of Canada, Asia and Africa.

The post symposium recommendations included the following:

1. Identify factors that facilitate or inhibit :
    a) progression into IT or STEM PhD programs.
    b) completion of STEM PhDs.
    c) career advancement and retention in STEM.
2. Start-up with cooperative efforts with worldwide known STEM Organizations, including American Association for the Advancement of Science (AAAS), UNESCO, ***World*** Federation of ***Engineering Organizations*** (WFEO), International Network of Women Engineers and Scientists (INWES), Society of Women Engineers (SWE) and others.
3. Organize profiled highschools in direction of Mathematics, Physics and Chemistry.

4. Send enthusiastic and interesting men and women scientists/ engineers as the role models to several highschools to encourage teenagers to study natural sciences or engineering.

In a fact, representatives of scientists and engineers should be attached to secondary schools to work with teachers and simultaneously to eliminate the myth that to be a scientist or an engineer is either too difficult or for female students it is unfeminine. The last, is a very real fear in the minds of teenage girls. Regarding importance of the role models for teenagers, T*he Catalyst* [T*he Catalyst*] published analysis where the surveyed women identified "lack of senior or visibly successful female/male role models" in 64% and "lack of mentoring in 61%, as among the most important barriers to the advancement of women in academia and industry. A good example may be, the civil female engineers from the university of Technology in Warsaw who presently keeps the position of the Chief of Polish Petroleum "ORLEN" Corporation said that "she was fascinated by the work of her father, a civil engineer", which prompted her to study engineering. She later completed a master of science with distinction in structural steel design and PhD at the Technical University in Warsaw [Żochowska].

INWES-Education and Research Institute (INWES-ERI, www.inwes-eri.org)

INWES is a not-for-profit organization and therefore from time to time may experience some financial problems. and thereforhence, it has been decided to establish a separate, sister organization to better achieve its objectives with regard to funding education in STEM. INWES-ERI was established in 2006 and in 2007 was incorporated by letters patent under the Canada Corporations Act. In 2008- the Institute was designated as a Charitable Organization in Canada (BN# 82690 2751 RR0001) while in 2011, was also registred as a not-for-profit 501c3 organization through reciprocity by the United States of America. The Institute is governed by a Board of Directors, and activities are planned and administered through four committees: Program, Nomination, Finance and Communication.

INWE-ERI goals are the following:

1. awarding scholarships, bursaries and grants for students (boys and girls) wishing to study in one of STEM fields,
2. carrying out research in both developed and developing countries concerning the fields of STEM - publish the results.
3. acting as a resource centre and database for information concerning education in STEM fields and collecting best practices in encouraging students to study them.
4. developing and maintaining a website to raise public awareness concerning these fields of study and to make the results of research available to the interested public.

INWES-ERI-recent activities involve, workshops, debates, quizzes, and essay competitions (Canada, Africa), developing numerous recommendations to facilitate young generation, and particularly for females, to study STEM fields and to make women more visible at all levels.

Other Forms of Bringing Children and Young People Closer to Learning

Long Term Cooperation Between Universities and Highschools to Raise the Profile of Science in the School.

University of Wroclaw has such a 30-years lasting cooperation with one of the best Wroclaw highschools -"XIV LO Wroclaw" what for different universities of the Wroclaw Academic Center gives the best students. Learning exact science (e.g. chemistry, physics, informatics…) in well-equipped university laboratories and having a direct contact with academic staff, brings very positive educational results both for schools, and universities.

Apart from teaching highschool students at universities, there is a good practice of sending enthusiastic and interesting man and women scientists/ engineers to several highschools to encourage teenagers to study natural sciences or engineering and to serve as the role models, particularly for female students.

Organizing Mass Science Events for Children and Youth

A good example may be the case of the Wroclaw Academic Center where since 1998 till nowadays, both in Wrocław and in the surrounding towns, a mass scientific event called Festival of Science every year takes place. It involves enthusiasts of science from all university faculties, university researches (professors, doctors, phd students…), student scientific associations, Wroclaw and regional authorities and the school teachers. It takes 8 days in the city of Wroclaw and then extra two-days presentations in 4 towns of the region of Lower Silesia

(Wroclaw is its capital). School pupils and average tax payers participate in this event and find the answers on the cuttingedge civilization dilemmas of the contemporary world. The Festival of Science offers proposals in the form of lectures, experimental demonstrations, discussions, galleries, expositions…etc, from all scientific and engineering disciplines including such *avant gard* fields like Bio-, and Nano-technology. Humanities, legal sciences, socio-political, medical, economic, and art disciplines are also presented to a significant extent. Young people and especially school pupils have a chance to meet with science and engineering to decide later on whether to choose them for their studies or not.

Children`s Universities (UD)

In Poland, since 2007, the so-called Children`s Universities in several Academic Centers like Warsaw, Cracow, Wroclaw and Olsztyn have been established. Classes are conducted by scientists, specialists in various fields, artists and entrepreneurs and children have chance to participate in lectures and workshops trying to discover and understand the world around them. Already 20,000 children aged 6-13 years have taken part in such studies, learning many areas of science in an active and researching way. The content-related program is checked out by the Scientific Council, which together with Organizational Committee of a given UD elaborates the university program and invites the corresponding lecturers. Each year, around 500 researchers and specialists carry out more than 500 lectures and 600 workshops for children coming to colleges and universities.

Science Centers

In Poland there are four Science Centers and the most reknown is the first one, i.e. the Copernicus Science Center in Warsaw. Their goal is to promote and popularize science. These are not musea. There are no showcases or guides. Visitors can learn about the laws of nature by conducting their own experiments in interactive exhibitions. It's a space that inspires visitors to observe, experience, pose questions, and seek the right answers. It depends on how much one wants to take from this. In Copernicus Science Center in Warsaw, there are over 400 exhibits. Although at first glance we can get the impression of chaos, the exhibits are grouped thematically. The boundaries between them are fluid, as in the world around us. The most interesting things happen at the junction of science, interpenetrate and complement each other. Exhibitions in the Scientific Centers are like a living organism that is constantly changing. These places are very popular amongst pupils and high school students and tickets must be purchased well in advance.

CONCLUSIONS

The advancement of today`s cutting edge technologies along with the present and future international competitiveness, requires to ensure an appropriate education of young generation, specifically in exact sciences such as Mathematics, Physics, Chemistry and engineering. Children –boys and girls-should meet with science and technology as early as possible so they can further stimulate their ability to continue learning and research in STEM. The educational process of young people must develop intellectual potential, in particular creativity that should be directed to future innovations, invention and decision-making. The continued increase of scientific and technical knowledge should be ensured not only at grammar schools and highschools but also by the contacts and career orientation with universities, technical schools and high-tech industries. An additional help in popularization of science among the youngest generation are the Children`s Universities and Scientific Centers.

Public media also can help by inviting both female and male scientists/engineers into the STEM programs. They may play a role models for the young people, directing them to the right career path. Particularly, women scientists should get prominent positions in the programs related to science and technology, so they can represent the points of view of women, and serve as role models.

Beyond the abovementioned efforts fostering development of education and science, a great importance to increase the innovations has the innovative society. In such societies important are also certain psychological factors such as:

1. The social trust - the basic factor of innovative society- that is directly related to:
    - willingness to use new technologies
    - spontaneity and social openness
    - higher level of mobilization and activity
2.The social capital - factor of development of quality of life and civilization competences
3.The role of leadership in creating conditions for the development of innovation.

All these factors will provide strength, prestige and prosperity for the country.

REFERENCES

Angel G.(2017 May), *New Technology Still Underused by Businesses*. Retrieved from: http://www.oecd.org/industry/the-next- production-revolution-9789264271036-en.htm.

BIP, Office *of Public Information*, University of Wroclaw (2015), (Poland), www.uni.wroc.pl

BP, Benchmarking Policy Measures for Gender Equality in Science-Luxemburg (2013); Office for Official Publications of the European Communities. Retrieved from: http://ec.europa.eu/research/science-society/document_library/pdf_06/benchmarking- policy-measures_en.pdf.

Consensus Study Report (2005) *Rising Above the Gathering Storm:* Energizing and Employing America for a Brighter Economic Future., Washington, DC: The National Academies Press. https://doi.org/10.17226/11463.

Consensus Study Report (2005), *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.*, Washington, DC: The National Academies Press. https://doi.org/10.17226/11463.

Corsi, C., Akhunov.A. eds. (2000) *Innovation and Market Globalization, The Positions of SMEs*, IOS Press, NATO Science Series.

Etzkowitz, H. (1989). Entrepreneurial Science In the Academy: A case of the transformation of Norms, *Social Problems*, 36, (No 1), p.12-18.

European Comission-*She_figures_2015-final.pdf*. Retrieved from: https://ec.eu/research/swafs/pdf/pubgenderequality/shefigures2015-final.pdf

Georgiou, L. (2000), The United Kingdom National System of Research, Technology and Innovation, in Public Research and Innovation Policies. *An International Comparative Analysis*, ed.by Laredo P., and Mustar P. Economica International/Brookings Institution Press.

GGGR, *The Global Gender Gap Report 2015.* Retrieved from: http://reports.weforum.org/global-gender-gap-report-2015/report-highlights/.

Iwaszczyszyn, K, Konecka, E., (1986). *Kobiety Polskie*. Ed.Książka i Wiedza,Warszawa.

Krzykawiak K. (2015), unpublished data from Public Relation Section of the University of Wroclaw, Poland.

Madsen, L.D, Tessema, G.X., (2009). The next generation: Education and broadening participation in science and engineering", *J. Electroceram*, 22, 8-12.

Mazur, A. (2002) *Theorizing Feminist Policy*, Oxford University Press.

MoRRI, *Monitoring the Evolution and Benefits of Responsible Research and Innovation* (2016). Retrieved from: http://www.technopolis-group.com/wp-content/uploads/2016/12/2171-D2_3-Gender_Equality.pdf.

OECD, Organisation for Economic Co-operation and Development, Frascati Manual (2002), *Proposed Standard Practice for Surveys on Research and Experimental Development, The Measurement of Scientific and Technological activities*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264199040-en.

Pellegrino, J.W., Wilson, M.R., Koenig, J.A. and Beatty A.S., (2014) *Committee on Developing Assessments of Science Proficiency in K-12*; The National Academies Press, Washington, D.C., ISBN 978-0-309-28951-1.

Platt, B.C. (1966). Women into Science and Engineering. *Preprints of ICWES10*, p.9-12, ed.Cs. Banyasz, Budapest, Hungary.

Reszke, J.(1991). *Nierówności Płci w Teoriach*. PAN, Warszawa.

Saperstein, J. and Roauch, D. (2002). *Creating Regional Welth in the Innovation Economy: Models, Perspectives, and Best Practices*, Financial Times Prentice Hall.

Szemik-Hojniak, A. (1996). Women in Science. *Preprints of ICWES10*, p.173-176. ed.Cs. Banyasz, Budapest, Hungary (1996).

The Catalyst, Women in Leadership: A European Business Imperative (2002), Retrieved from: http:// www.catalyst.org/system/files/Women_in_Leadership_A_ European_ Business_Imperative.pdf.

UIS, *The UNESCO Institute for Statistics Summary Report* (2017, May), UIS Innovation Data Collection, p.19, Retrieved from http://uis.unesco.org/sites/default/files/documents/ip37-summary-report-of-the-2015-uis-innovation-data-collection-2017-en.pdf.

Zagożdżon, A.(1989) *Studia nad Przeszłością i Dniem Dzisiejszym Uniwersytetu Wrocławskiego*, ed.PWN, Warszawa -Wroclaw.

Żochowska, R. (2005). Winners and Losers: Gender Contracts in New Political Economic Situation. *International Journal of Sociology*, 35 (1), 3-39.