

## **REVOLUTIONIZING ARCHITECTURE: THE INTEGRATION OF 3D PRINTING TECHNOLOGY, VR EXPERIENCES, AIA AND VIDEO GAMES IN ARCHITECTURE**

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### **Abstract**

STEM fields, comprising Science, Technology, Engineering and Mathematics have been considered for many decades the core preoccupation of male specialists. Yet, beginning with the Second World War, when women started working in military facilities and factories, and took over lots of the masculine responsibilities, but also as a result of the publicity that many women in STEM received due to the simplification of access to communication, these disciplines have increased in interest also because they are associated with the level of inventiveness of a society, but more importantly, with the level of growth in social and economic fields.

Once big academic institutions have included in their curriculum gender studies and entrepreneurship for women, more and more girls have started considering the field of STEM as a possible future career. In the case of Romania, career path for women in STEM has been subjected to stereotyping, caused by the cultural and political values that Romania had before the fall of Communism. But today, due to access to information, access to international systems of education and scholarship programs dedicated to women in STEM, more and more girls are engaged in the field, with spectacular results.

The present study is an analysis of the most recent statistical data related to women's engagement in the field of STEM, certain comparisons with other countries from the Central and Eastern European region and in the final part offers a set of predictions about the future of girls in STEM.

**Keywords:** STEM education, gender studies, entrepreneurship for women, Hofstede's Dimensions of Culture, role models for girls, gender disparities

**JEL Classification:** I24, J16

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## **1. Introduction**

Today STEM education represents an important subject for societies, all over the world. Yet we have to admit that women are still underrepresented in many fields of activity, UNESCO suggesting that only 28% of women represent the percentage of the world researchers. Thus, the problem of education in STEM is the primary cause of this misrepresentation.

On the other hand, many cultures of the world are still putting a lot of pressure on women's role in the STEM field, as they are the subject of stereotyping, mockery and even bullying. Role models are still few, and they have a very small impact on the aspirations of young women. The only environment where changes have been made are in the field of entrepreneurship, in business field women being more and more appreciated for their values and there are efforts to put a more equal sign between male and female revenues, in order to achieve a more equal gender distribution of incomes.

There are different initiatives made by governments, non-governmental institutions, and entities at different levels, promoting girls and women in STEM. We can give the example of a robotics competition, that was developed in the United States of America twenty-five years ago, First Tech Challenge, that promoted the inclusion of girls in the field of STEM, and more specifically robotics, but there are also different educational programs like #Women in STEM, #Girls Who Code, #Black Girls Code, etc., that are all aimed at the same outcome: to encourage girls to pursue careers in the field of STEM.

The present article starts with a brief cultural overview of the most important causes of the gender discrepancies between cultures. It relies on Geert Hofstede's Country Comparison Tool, an instrument for the analysis of differences and similarities between cultures, according to the six indexes that the Dutch sociologist developed in the 1970s: Power Distance Index, Individualism vs. Collectivism Index, Motivation towards Achievement and Success, Long Term orientation and Indulgence vs. Restraint.

It then continues with a set of statistical data related to the number of girls and women in STEM fields, at European level, offered by the European Institute for Gender Equality, explaining the position that Romania has in this respect, while in the final part it offers a set of possible paths to follow for the younger members of the generation that is preparing now to pursue a career in the field of STEM.

## **2. Cultural overview on gender discrepancies**

According to Geert Hofstede's Dimensions of Culture, when comparing Romania, the second lowest European country on gender equality and Netherlands, which is the most gender equal country in Europe, we realize the magnitude of the difference. [1]

Hofstede's Dimensions of Culture represent a framework that the Dutch sociologist developed in order to better understand the differences that exist between cultures, with the particular focus on the labor force all over the world, but also help us understand our own behaviors, beliefs and values, that can be exploited in a positive way in the work environment.



Figure 1. Hofstede's Country Comparison Tool – Netherlands vs. Romania<sup>3</sup>

Romania scores 90 on the Power Distance Index, compared to the low score of 38 in Netherlands. This means that in Romania hierarchies continue to be important, as they are the direct result of a totalitarian political system that lasted in Romania after the Second World War and until the fall of communism in 1989.

By comparison, Dutch employees are independent, hierarchy being perceived only as an element of convenience, and leaders are seen more as role models and coaches for their followers. Power is not centralized, as Dutch culture nurtures egalitarianism and does not agree with the concept of authority.

Egalitarianism is a concept in political philosophy, and in Netherlands it is deeply rooted in different cultural, social, and political factors. First of all, the historical background, the Dutch Revolt against Spanish ruling of the 16<sup>th</sup> century, which conducted to the establishment of the Dutch Republic, a period fostering independence, civic responsibility and a culture of tolerance. One of the cultural factors that favored Dutch egalitarianism was the welfare state, providing social security, healthcare and unemployment benefits, which all resulted in a reduction of economic disparities. [2]

With a mixed economy, blending free market capitalism and strong labor unions, fair wages are ensured, which promoted economic equality. Last but not least, the fact that the

<sup>3</sup> <https://www.hofstede-insights.com/country-comparison-tool?countries=netherlands%2Cromania>

Netherlands. Was one of the first members of the European Union since its inception, offered a set of regulations and policies that promoted social and economic cohesion.

Compared to Netherlands, Romania is still in a transition period, lasting for more than thirty-five years, after a long period of feudalism, followed by a period of communist totalitarianism, that had deeply influenced its social hierarchies and collective psyche. The transition to the market economy after 1989, brought a dramatic change, as well as social and economic challenges, contributing to the social stratification. Today we have huge gaps between the rich and the poor, with very thin middle class layer representation.

Romania's workplace is still hierarchical, with a clear distinction between management and employees. Traditional gender roles are more pronounced, although there are strong efforts to promote gender equality. Yet, in the system of education one can still find middle aged teachers in the class admitting gender inequality and accepting it per se.

In point of Individualism versus Collectivism, Romania and Netherlands exhibit again a huge difference. With a score of 100, the maximum, Netherlands is one of the most individualist societies in the world, with a high preference for distant social ties, where individuals take care of themselves and their immediate families. By comparison, Romania scores 46, which makes it a collectivistic country, with long term commitment to the group (family, extended family, and friends). Loyalty to the group is one of the most appreciated traits, overriding any other rule or regulation. In a collectivist society, all members of the group are expected to take responsibility, and at entrepreneurial level management is the management of the group.

On the Motivation towards achievement and success, Netherlands scores extremely low, just 14, while Romania scores 42, which means it is a "relatively consensus society". While in Netherlands the work-life balance is extremely important, in Romania we value the concept of *work in order to live*, with higher levels of solidarity and a value for equality, yet not as high as Netherlands exhibit.

With a high score of 90, on the Uncertainty Avoidance Index, compared to 53 in Netherlands, Romania maintains rigid codes of belief and behavior and is extremely intolerant to unusual ideas and beliefs. There is an emotional need for rules, time is perceived as money, punctuality is strictly appreciated, particularly at entrepreneurial level and security is highly appreciated as an element of individual motivation.

Romania scores 32 on the Long Term Orientation Index, compared to 67 in Netherlands, which means there is a difference between Romanian normative culture and the Dutch pragmatic nature. Romanians are deeply rooted in traditions and focus mainly on short term achievements, while in the Netherlands people easily adapt to changing conditions, thriftiness, and perseverance in achieving results being the main traits of the Dutch labor force.

Last but not least, on the Indulgence versus Restraint Index, Romania scores 20, while Netherlands has a score of 68, which means Romania is a culture of restraints, cynicism and pessimism being the main traits, versus joy of life and fun in the Dutch culture. Romania does not put very much emphasis on the value of leisure time, and people have the feeling that indulging themselves might be wrong. By comparison, Dutch people possess a positive attitude to life, with a tendency towards optimism and willingness to realize their desires.

This brief cultural analysis can help us understand different aspects related to the entrepreneurial environment of Romania, which is deeply rooted in totalitarianism, is based on cynicism and is a pessimistic society, where the role of women in top management positions is still not completely appreciated and valued.

### 3. An Overview of Gender Differences

Statistically speaking, 37,4% of all STEM (Science, Technology, Engineering and Mathematics) students will pursue an entrepreneurial career path after graduation, with more male students (61,38%) of all graduates focusing on developing their own start-up business, compared to 17,6% of female graduates that consider starting a business after graduation.

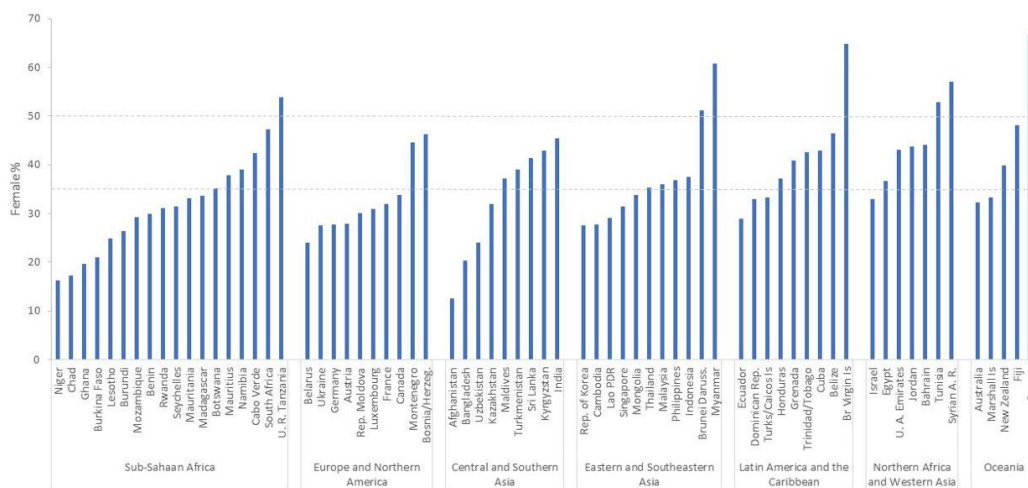


Figure 2. Share of STEM female graduates<sup>4</sup>

But the analysis of the gender differences within STEM fields highlighted a higher intention score for women who plan on becoming entrepreneurs, compared to men. “However, they present a negative score in human medicine, health, mathematics, and natural sciences. This

<sup>4</sup> <https://world-education-blog.org/2024/04/25/new-uis-data-show-that-the-share-of-women-in-stem-graduates-stagnant-for-10-years/>

result shows that women prefer to work in established organizations rather than become a traditional entrepreneur and start a venture”. [3]

In the particular case of women, the entrepreneurial career results from the analysis of a series of factors modeling the intention, based on the theories of Ajzen (1991) and Linan&Chen (2009) which suggests that the career in STEM is impacted by the following factors:

Entrepreneurial self-efficacy

University climate

Social context

Entrepreneurial learning

The academic system is aware of the importance of the role of women in business field and that is why there are different support systems to accommodate and facilitate their engagement in all aspects of the business life. It also depends very much on the culture nurturing this environment. For example, in Romania, where the present study takes place, we have the highest number of female graduates in the field of STEM: natural sciences, mathematics, engineering, information technology, constructions, etc.

In 2021, in the European Union, higher education female graduates (level 5-8 according to the International Standard Classification of Education – ISCED) in the field of STEM represented 32,8% of all graduates, 0,3% more than the previous year (32,5%).

But of all STEM field female graduates, most of them come from Romania, with 42,5%, followed by Poland with 41,5%, Greece 40,09% and Italy with 33,9%.

At the opposite side of the scale, countries with the lowest representation of STEM female graduates in European Union are Belgium 27,4%, followed by Spain and Germany with 27,7% and Austria 26%.

Data from Romania places our country at the forefront of the percentage of female graduates in the field of STEM, compared to the overall number of higher education graduate sin these fields. These results prove a significant progress in engaging women in careers in the field of STEM. Yet, we as a society, need to continue to engage women more in efforts of ensuring a balanced representation in STEM fields, but also to harness the potential of diversity in the scientific and technological progress of the country.

Claudine Schmuck, in her book *Women in STEM Disciplines*, includes Central and Eastern Europe in the same poll of evolution with East Asia, highlighting the dramatic increase in the number of women graduating from STEM fields, which is 80% higher today than 10 years ago. “The fact that the perimeter of analysis used is not constant doesn’t allow to consider in itself this growth as significant since it also reflects the fact that data is available for a larger number of countries, but it is interesting to observe that during the same period of time the total headcount of STEM graduates (men and women) has increased more slowly than that of female graduates (average 60% growth to compare with 80 %). Thus,

women share of all STEM graduates has increased from 43 to 48% (when health is included in the definition), but only from 30 to 34% when only EMC and science are included. Thus, the gender divide is not decreasing significantly in STEMS (EMC and science)". [4]

#### **4. Gender Discrepancies in Romania and How Role Models Overcome the Barriers**

The growing number of women who work in STEM fields, assure sustainable and equitable growth patterns in entrepreneurship and social entrepreneurship. These topics have been taken up in research, because of their importance in the employment of women across the world. Women nowadays show more interest in social entrepreneurship than men, which creates growth of positive social and environmental externalities. Overall, promoting female entrepreneurship creates an inclusive and diverse path, which others can approach by their example.

The gender gap still remains large in most economies, despite the potential benefits. This gap persists worldwide, with women owning one in three businesses, both in developed and developing economies. A fact that everybody knows is that women are misrepresented in economies with less income, where they do not have as many chances as men do to start a new business.

Research performed at international level has shown that the barriers women have to face in order to achieve their goals in entrepreneurship are two time more difficult than in the case of men. There are several obstacles that men do not have, and that is the reason why gender gaps in entrepreneurship form. Women have less access to capital, business opportunities, networking and are less likely to start their own business. But women cross these barriers, and one great example is the new concept, called "*momprenneurship*", which means entrepreneurship done by mothers, which shows women's capability to handle critical situations and also take care of their families. The solutions to this problem is to identify the key barriers and to promote female entrepreneurship until governments introduce policies which reduce these gender gaps.

This new concept is relevant for Romanian women, where constraints such as taking care of children or elderly prevent them from managing their own businesses. It is very important to develop an understanding of their experiences and realities, in order to lead by example and grow the numbers of women involved in business.

In the particular case of Romania, totalitarian way of thinking still persists in the mentality that women have to choose between family or career, or at least to make some sacrifices and choose a path that is more in favor of family responsibility, children's education and caregiving.

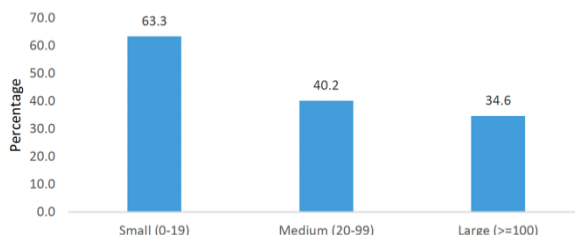


Figure 3. Percentage of female owners by company size<sup>5</sup>

As it can be seen from the statistics, there are fewer representatives of the big companies in Romania, compared to the small enterprises. That is why, especially for the young generation, role models are extremely important. In this respect we can mention a couple of successful women from different fields, bankers, mathematicians, economists, etc, that lead the next generation of female entrepreneurs:

**Anca Vlad** is the founding president of the Fildas-Catena Group, which includes one of the biggest chains of pharmacies in Romania. She is one of the most influential Romanian businesswomen, with vast experience in the pharmaceutical industry.

**Veronica Savanciuc** is the co-founding president of the Lowe Group Romania, one of the most important advertising agencies. Veronica is a prominent figure in the advertising and communication industry.

**Mirela Iordan** is the general director of Pfizer Romania, with an impressive career in the pharmaceutical industry, leading the operations of one of the biggest pharmaceutical companies in the Romanian market.

**Cristina Bâțlan** is known as the founder and owner of Musette, one of the most well-known footwear and fashion accessories brands in Romania, which has even managed to extend internationally.

**Rucsandra Hurezeanu**, known as the CEO of Ivatherm, is a doctor and entrepreneur in the field of dermato-cosmetics. Ivatherm is the first Romanian brand of dermato-cosmetics, which uses thermal water from Herculane.

**Măriuca Talpeș**, co-founder of Bitdefender, together with her husband, is one of the most successful global cyber security companies worldwide. She is a mathematician and CEO of a company that is engaged in the process of digitalization of education and production of modern interactive textbooks for public and private schools in Romania.

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<sup>5</sup> World Bank Enterprise Survey 2018–2020, <https://login.enterprisesurveys.org/content/sites/financeandprivatesector/en/library.html>.



## 5. Conclusions

The world in which we live, which is becoming more and more digitalized and where sooner or later human activity will be replaced by artificial intelligence, still needs the direct input of specialists in the field of STEM, both men and women.

The gender gap existing in Romania between men and women in STEM fields, which has a direct impact on the number of women engaged in entrepreneurial activities, can be overcome by implementing different strategies to nurture a supportive environment. By developing targeted governmental policies to promote gender equality, like scholarships for girls in STEM, an inclusive curricula and anti-discrimination laws as well as developing mentorship programs in which successful businesswomen and generational leaders are involved, can be a solution towards an appropriate guidance for the younger generations. Yet, stereotypes still persist in the society and probably there is needed one more generation of successful girls and women in the field of STEM that need to provide outstanding success in order to change the mentalities.

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