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María Luisa Sein-Echaluce Lacleta, Ángel Fidalgo Blanco y Francisco José García Peñalvo (coords.)

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Study of the influence of the socioeconomic context in STEM careers with a gender perspective

Estudio del impacto del entorno socioeconómico en las carreras profesionales STEM con un enfoque de género

Nerea Portillo Juan[1], Javier Olalde Rodríguez[1], Olga Sánchez Moreno[2], Vicente Negro Valdecantos[1]
nf.portillo@upm.es, j.olalde@alumnos.upm.es, olga.sanchezm@alumnos.upm.es, vicente.negro@upm.es

[1]ETS de Ingenieros de Caminos, Canales y Puertos
Universidad Politécnica de Madrid
Madrid, España

[2]ETS de Arquitectura
Universidad Politécnica de Madrid
Madrid, España

Abstract- Professional development is strongly determined by the socioeconomic context. This dependence is more pronounced in STEM disciplines. This paper aims to provide a real picture of the Spanish university in technological careers with the goal of seeing what profiles are lacking in these careers. A survey in different Spanish universities was carried out and it was proven that the socioeconomic profile of STEM university students is limited. The great majority, around 80%, come from high socioeconomic backgrounds. In addition, their parents have already studied at university and many of them STEM degrees. In the case of women, the presence of female references is essential, since 95% of the references of women in technology are also women. After demonstrating that there is indeed a socio-economic imbalance in these careers, it was proposed to develop education plans that raise awareness and training in these subjects in disadvantaged socioeconomic environments.

Keywords: Socioeconomic status, career development, STEM, University education, gender roles, social inequalities

Resumen- El desarrollo profesional está muy condicionado por el contexto socioeconómico, especialmente en las disciplinas STEM. Este artículo tiene como objetivo ofrecer una imagen real de la universidad española en las carreras tecnológicas con el propósito de identificar qué perfiles escasean. Se ha realizado una encuesta en las universidades españolas y ha quedado demostrado que el perfil socioeconómico de los estudiantes universitarios en STEM es limitado. La gran mayoría, alrededor del 80%, proviene de entornos socioeconómicos altos. Además, sus padres ya han cursado estudios universitarios y muchos de ellos en carreras STEM. En el caso de las mujeres, la presencia de referentes femeninos es fundamental, ya que el 95% de los referentes de mujeres en tecnología también son mujeres. Tras demostrar que, efectivamente, existe un desequilibrio socioeconómico en estas carreras, se ha propuesto desarrollar planes educativos que fomenten la concienciación y la formación en estas disciplinas en entornos socioeconómicos desfavorecidos.

Palabras clave: Entorno socioeconómico, desarrollo profesional, STEM, educación universitaria, roles de género, desigualdades sociales.

1. INTRODUCTION

The first studies on professional and vocational development date back to 1959 with The Theory of Vocational Choice (Holland, 1959). Later, in 1994, The Social Cognitive Career Theory, that is the base of most vocational studies today, was developed (R. W. Lent, Brown, & Hackett, 1994). Since then, different researchers have studied the career barriers and contextual factors that may alter professional development. Most of the scientific studies carried out so far have developed predictive models based on variables obtained from national statistics or school surveys to assess the influence of each factor on children's careers.

In this case, this study, instead of making a predictive model from the perception and intentions of the children, it presents a real picture of the university situation in Science, Technology, Engineering and Mathematics (STEM) careers, of what profiles actually exist in these careers. To this end, a series of surveys were carried out in Spanish universities and statistically analysed, developing a model that corresponds to the real situation of universities in Spain and that can be extrapolated to other countries. In addition, the case of Spanish university is of particular interest because it is one of the higher education systems that has experienced a strongest increase in the last decades and it seems reasonable to assume that this massive university system must facilitate the access of people of low SES (Rahona Lopez, 2009). However, this is not always the case and it has been proved that this expansion does not always improve social equity because it sometimes disproportionately benefits higher social classes (Heath, 2000; McCowan, 2007).

To the authors knowledge, it is the first time that a true picture of the university STEM career situation in Spain is provided after the expansion of the university system. Given the development of STEM disciplines and the importance they are acquiring in society with new applications such as artificial intelligence, big data or the development of new technological systems, it is essential to understand the barriers for students in these careers so as not to lose talent in social groups that have greater difficulties in accessing these fields.

2. CONTEXT & DESCRIPTION

Technology, science, and engineering are essential sectors in today's society. To advance not only these fields but also social and economic conditions, we must ensure equity and equal opportunities in education, regardless of socioeconomic background. Achieving this requires a clear understanding of

the current educational landscape in universities. This study aims to assess the state of STEM education in our universities, serving as a foundation for developing new educational frameworks and initiatives that promote equity in these fields.

Differences in social class and economic status are more pronounced in STEM careers compared to other fields. STEM disciplines are often perceived as more challenging, which may discourage young people from low socioeconomic backgrounds from pursuing them due to the perceived risk. In addition, among the minority groups in STEM careers, women are also prominent. STEM field is one of the fields where gender stereotypes are even more present and where women are more underrepresented. Therefore, young girls from low SES are the most vulnerable social group referring to STEM careers, they bring together the two main barriers to career development, the social and the gender barrier (Figure 1).

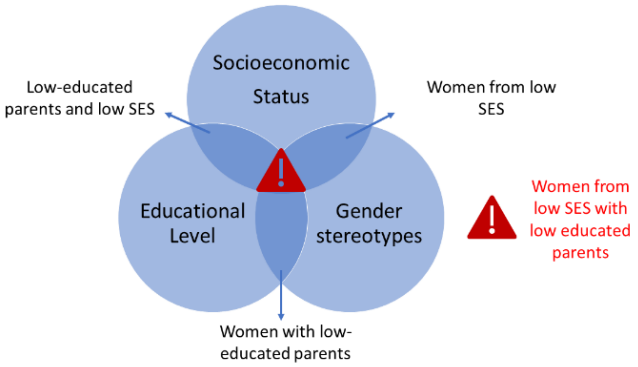

Figure 1. Threaten social groups in STEM careers.

To conduct the present study, a survey titled "Influence of the socioeconomic environment on STEM careers" was designed. The authors of the research paper developed a list of interview questions according to the main principles of survey design. First, a draft of the survey was proposed to be reviewed and corrected by psychologists and sociologists to present the final version of the survey. Similar to previous studies (Fouad & Kantamneni, 2008; Hwang, Lee, & Jung, 2019), individual-level, gender-level, group-level, economic-level and societal-level influences were explored.

In the final version of the survey there was a total of 26 questions. This final version was passed in a pilot survey to a total of 20 people and once validated, it was sent to the main technical universities in Spain for distribution to their students and teaching staff. Of all these universities, only a few were receptive to distributing the survey due to the internal policies of these universities, so other means of distribution such as university classes or social networks were also used.

One hundred forty-one people with STEM careers participated in this study, 77 women, 63 men and 1 non-binary identity. 72% of the participants were between 18 and 26 years old, 22% between 27 and 37 years old and the remaining 6% were older than 37 years old. The questions of the survey referred to:

- *Demographic Data:* Data on gender, nationality, age, degree and university
- *Parents Education.* Participants were asked about their parents level of education. A scale of 1 to 3 developed by the authors of the article was used to create a parents education variable.
- Socioeconomic Status (SES). To measure the SES of the participants, a five-point scale was used going from 1 (very low socioeconomic status) to 5 (very high socioeconomic status). This scale was made using the self-reported socioeconomic status of the participants.
- *Family and friends' support*. A scale from 1 to 3 was used to assess the family and friend's support, with high scores representing a supportive environment.
- *Self-Efficacy.* The self-efficacy scale used on this article is based on Britner and Pajares (2001, 2006). It is a scale from 1 to 5 which assesses how the participants perceive their performance in science, technology and mathematics subjects; with high scores representing high levels of self-efficacy.
- *Career Development aspirations*. With this parameter the attitude of the participants towards professional promotion and leadership positions was measured. It was based on the Career Aspiration Scale (CAS) from O'Brien (1996). A scale from 1 to 5 was used to measure career aspiration, with high scores representing high career aspirations.
- *Career Development incentives*. To develop this scale, the main STEM references of the participants and if the parents were involved in STEM activities or had jobs related to science were considered. A scale from 1 to 3 was used, being 3 the maximum number of incentives to pursue STEM careers.
- *Gender-roles.* Finally, gender-role attitudes in the family and social environment of the participants were analysed on a scale from 1 to 3, with high scores representing social environments with a weak gender role.

Despite its methodological rigor, the study is not without limitations. The most notable constraints pertain to the relatively modest sample size and the reliance on self-reported data, which may introduce perceptual or response biases. Although the sample of 141 individuals from various Spanish universities offers valuable insights, a larger and more diverse sample would enhance the generalizability of the findings. Nevertheless, due to the limited cooperation, expanding the participant pool was not feasible within the scope of this study.

3. Results

Following the administration of the survey, all collected data were systematically analyzed. The first stage involved a statistical examination of the previously defined variables, where means, standard deviations (SD), and correlation coefficients (r) were calculated.

Parents education is related positively to SES (r=.210), family and friends support (r= .367), self-efficacy (r= .241), career incentives (r= .332) and non-gender role attitude (r= .149).These associations align with expectations, as higher levels of parental education often reflect more advantageous socioeconomic conditions. University-educated parents tend to have better employment opportunities and higher income levels. These favorable conditions often foster higher self-efficacy, stronger support systems, and increased motivation to

pursue STEM-related careers. Importantly, university-educated parents are more likely to view higher education as both attainable and valuable, and they tend to encourage their children to follow a similar academic path. Having relatable and successful figures strengthens the belief in one's own capabilities and enhances confidence.

The same explanation applies to the measure SES. SES is also positively correlated to family and friends support (r= .292), self-efficacy (r= .174) and career incentives (r= .125). One significant challenge faced by individuals from lower socioeconomic backgrounds is the perception of university, especially STEM degrees, as a financial risk rather than an investment. For families with limited economic resources, the cost of higher education may outweigh perceived benefits particularly when there are no role models. This lack of reference and assurance reduces the likelihood of support from the family environment.

Finally, referring to non-gender role attitudes, they are positively correlated to parents' education (r= .149) and career aspiration (r= .155), while there is not significant correlation to the rest of the variables. Typically, higher educational attainment is associated with greater exposure to diverse perspectives and a lower prevalence of traditional stereotypes.

Focusing on parental education, approximately 55-60% of participants reported that at least one parent held a university degree (Table 1). Among these, 60% of the fathers and 30% of the mothers had completed STEM-related studies. When narrowing the analysis to participants aged 18–26, this percentage increased notably, with around 70–80% reporting that their parents had university-level education. Figure 2 shows the number of generations of the sample that had university education.

Table 1. Parents education.

	Father	Mother
University education	61.43%	56.74%
Technicians	13.57%	16.31%
Primary education	25.00%	26.95%

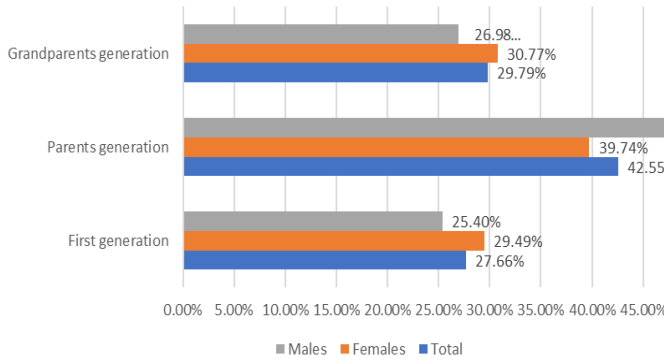

Figure 2. Number of generations with university education.

In addition, the inspiration, and references of the participants to pursue STEM careers was also analysed. Among the women surveyed, 40% reported having individuals who inspired or guided them in choosing a STEM path. Strikingly, 95% of these women identified female role models as their primary source of inspiration. In contrast, 38% of the men indicated having such references, with only 55% naming women among their sources of inspiration. These figures highlight the crucial role of gender representation in shaping aspirations and career trajectories, particularly among female participants.

Table 2 shows the employment status of the participant's family and Figure 3 the self-reported economic situation of the participants on a scale from 1(very poor) to 10 (very affluent). As can be seen, almost all the participants enjoyed an affluent economic situation. The great majority of them self-reported an 8 in economic situation. Only 3.55% of the fathers were unemployed, which is a very low rate compared to the unemployment ratio in Spain (16.1%). In the case of the mothers, the unemployment rate was higher because most of them were engaged in household chores.

Table 2. Parents employment situation.

	Father	Mother
CEO	17.02%	7.19%
Employee of a public company	19.15%	26.62%
Employee of a private company	44.68%	25.90%
Unemployed	3.55%	18.71%
Others	15.60%	21.58%

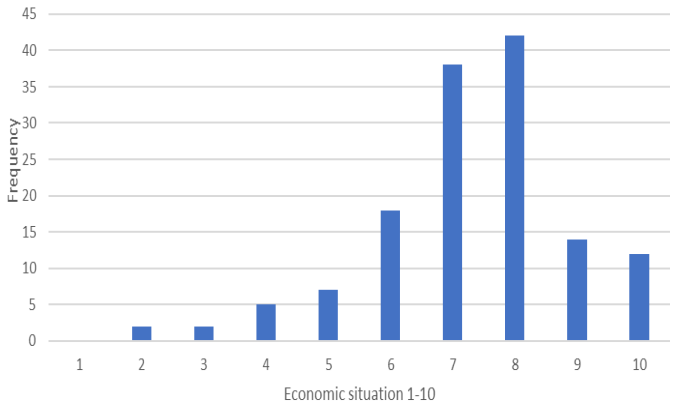

Figure 3. Self-reported economic situation from 1 to 10, being 10 the best economic situation.

Based on the survey results and subsequent data analysis, a clear socioeconomic profile has emerged for individuals pursuing STEM disciplines in Spain. This study reaffirms what could have been predicted in previous socioeconomic models. Professional development is mainly determined by the social and economic environment and the level of education of the parents. This is even more so in technical disciplines, which means that a lot of talent is being lost.

Three essential patterns have been identified in professionals dedicated to STEM disciplines in Spain: (1) A high percentage have family members with backgrounds in technology or science, (2) Most come from households with high socioeconomic and educational levels, and (3) They generally benefit from a supportive home environment. In addition, in the case of women who are dedicated to STEM, another significant pattern has been found: (4) almost all the women interviewed

have close female references who have motivated them to study these disciplines.

After confirming that the socioeconomic profile of a person dedicated to science is a high socioeconomic profile, it is necessary to study how to promote this type of studies in low socioeconomic environments that present difficulties. In addition, in the case of STEM disciplines we must add the problem of the gender gap, it has been demonstrated in the survey that having female references is practically essential to study a career of this type, so it is necessary to make visible the female scientific talent to address this gap.

4. CONCLUSIONS

In recent years, numerous initiatives have emerged to encourage women to pursue STEM careers. However, most of these programs primarily benefit women from high socioeconomic backgrounds—who, as it has shown, face significantly fewer obstacles in accessing these fields. This highlights a critical gap in outreach efforts, as young women from low-income backgrounds, who face both social and financial barriers, often remain underserved.

Socioeconomic background and parental education levels play a decisive role in shaping students' career aspirations. Research indicates that students develop their academic motivations as early as primary school, and by secondary school, they are required to make crucial decisions about their future educational paths. Therefore, it is essential to implement more targeted programs that actively promote STEM disciplines in schools located in low-income neighbourhoods. These initiatives should focus on engaging at-risk social groups from an early age, providing them with mentorship, resources, and exposure to STEM opportunities. By working with children from a young age, we can help break down the systemic barriers that prevent them from envisioning and pursuing careers in STEM. Ensuring equity is essential in education and we should work since the early stages of education.

In response to this challenge, the authors of this paper propose a structured program aimed at fostering STEM vocational interest among children and adolescents from low socioeconomic backgrounds. The initiative would be implemented throughout the academic year in schools located in underprivileged areas and would rely on university students acting as volunteers. This volunteer-based model fosters a mutually beneficial environment in which both school students and university participants gain valuable experience and insight. The fact that the program is led by young volunteers can also create more relatable role models and facilitate stronger connections with participants.

The program is structured around two main age groups. For students from 3rd grade of Primary School to 3rd year of Secondary School, the focus of the program is on creating a playful and engaging introduction to science and technology. At this stage, the goal is to spark curiosity and excitement through interactive, hands-on learning. Activities can include practical STEM workshops, science-based contests and gymkhanas, or creative construction projects. For students from 4th year of Secondary School to 2nd year of High School, the program takes a more focused and supportive approach, recognizing that students at this age are beginning to make important academic and career decisions. The objective here is to guide them through this process by providing meaningful support and exposure to real-life experiences. Activities include career guidance talks; mentorship and personalized counselling; and interactive sessions with university students and professionals.

In addition, a strong emphasis is placed on enhancing the visibility of female role models in STEM. Women will play a central role in the program's delivery, and dedicated sessions highlighting successful women in science will be organized both in schools and universities. These efforts will be complemented by visibility campaigns on social media, ensuring that young girls see diverse and inspiring examples of women thriving in STEM fields.

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