Access and Dropout in Engineering and Architecture Studies. A Preliminary Study with a Gender Perspective

Ana-Belén González-Rogado[1](✉), Susana Nieto-Isidro[2], and Alicia García-Holgado[1]

[1] GRIAL Research Group, IUCE, Computer Science Department, Universidad de Salamanca, Salamanca, Spain
{abgr,alicagh}@usal.es
[2] GRIAL Research Group, IUCE, Applied Mathematics Department, Universidad de Salamanca, Salamanca, Spain
sni@usal.es
https://ror.org/02f40zc51

Abstract. Engineering and architecture studies in Spain suffer a lack of enrollment that has been increasing last years, especially for women. This study tries to delve into the main reasons that lead young people to access engineering and architecture degrees, the primary sources of support when they decide to start these studies and what are the possible causes of dropout. By understanding these factors, we will be able to increase the interest and attractiveness of engineering and architecture degrees among young people, prevent the high dropout rate and facilitate the continuity of the students in their studies. The study was carried on for the whole sample and also separated the responses by gender to impulse a bigger presence of women. The results show "personal interest" as the leading cause for initiating these studies for both men and women. However, there is a wider variety of other reasons for women. "Family" is the primary support for this decision, especially for women. Regarding the primary reason for thinking about leaving studies, especially for women, "academic reasons" are the main difficulty.

Keywords: Engineering education · Gender perspective · Architecture · Dropout

1 Introduction

We are in a turbulent and interconnected world, with Agenda 2030 as a global action plan. The pandemic has affected this plan by increasing global inequalities [1]. The war situation in Ukraine has once again shaken the plan. Any movement at the local level has repercussions at the global level.

Countries need to strengthen themselves to minimize these effects. A country's strength will be higher the greater its capacity to offer an attractive and sustainable environment for those who live and work in the country, as well as for the business network. The European Commission measures this strength through the Regional Competitiveness

F. J. García-Peñalvo and A. García-Holgado (Eds.): TEEM 2022, LNET, pp. 431–439, 2023.
https://doi.org/10.1007/978-981-99-0942-1_44

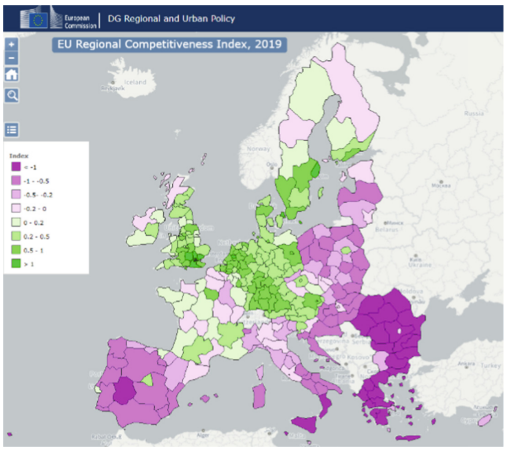

Fig. 1. Regional Competitiveness Index [3]

Index (RCI) and the World Economic Forum through the Global Competitiveness Index (CGI). Both point out that the most important thing is to increase people's well-being and improve their quality of life, for which improving the country's competitiveness is key [2, 3].

Spain needs to strengthen its competitiveness (Fig. 1). The skills provided by Science, Engineering, Technology and Mathematics (STEM) studies are essential to increase it. Its professionals contribute to sustainable development, innovate, boost social welfare and promote inclusive growth [4]. In 2019, 25.8% of university graduates in the European Union were in STEM degrees. Whereas in Germany they represent 36.9%, in Spain, they are below 20% [5]. Only just over a quarter are women in both countries [5].

STEM professional profiles are in great demand at all levels of education in Spain. In Middle and Higher Vocational Training, the employment rate of graduates in STEM professional families is 5.6% higher than in non-STEM professional families. It is higher in men (M) than in women (W) (79.2% M and 72.6% W) [6]. At University Degree level, graduates in STEM branches also have a higher employment rate than in Non-STEM branches: 5% higher in men and 3% higher in the case of women. The employment rate at Degree level presents slightly higher values for men than for women (88.7% M, 87.0% W). At Master's level, slightly higher employability values are found for STEM degrees (1.8% for men and 0.3% for women) than for non-STEM degrees. The employment rate for men who have studied a STEM Master's degree is 1.8 points higher than for women (87.0% M and 85.4% W) [6].

In Spain, only 24% of undergraduate students study a STEM degree and 22.8% study a STEM Master's degree [6]. STEM studies and, more specifically, Engineering and Architecture studies are not very popular among students [6]. The percentage of women, at university level, is around 25% of these values.

What are the factors that influence young people to choose university studies? High employability may be one reason, but it is not the only one. Many other factors influence students: personal preferences, social, family, economic motives or academic quality

[7–9]. Moreover, some prejudices negatively influence the choice of studies [10, 11], as students must believe that they can succeed in a career to achieve it [12].

Given the lack of STEM vocations, many areas are working to increase the number of students in these careers [13, 14], especially women [15–18].

In this paper, we analyze these factors to determine whether we can impact on them. We need to motivate students to take up engineering and architecture studies. We need to improve the competitiveness of our country. We need to increase the number of graduates in STEM degrees, mainly in Engineering and Architecture. We need to balance the presence of men and women in STEM studies.

2 Context and Methodology

The study has been carried in a small and controlled environment, using the participants' responses in the Project "PAC 2021 INMUJERES, Engineering with a gender perspective", supported by the Women's Institute of the Ministry of Equality of the Government of Spain. The participants, a sample of students and teachers of the Polytechnic School of Zamora (University of Salamanca, Spain) completed an adaptation of the GENCE questionnaire (GENder perspective in Computer Engineering). This validated questionnaire seeks to measure students' perceptions of gender differences in the computing sector, academically, socially and professionally [19]. The original version of GENCE questionnaire is specific to computer students, however, the questions referring exclusively to this field were adapted in their wording to apply them in an engineering context. For this paper, we have used some questions from the one adapted for the engineering and architecture students. These questions are related to the reasons for initiating engineering studies, the main sources of support for this decision and the possible causes that could lead them to consider leaving their studies.

The Polytechnic School of Zamora (EPSZ) is a very appropriate context to carry out this preliminary study since the students are enrolled in seven different engineering and architecture programs with a great diversity of professional fields [15]. In EPSZ, 25.16% of the students were female in the academic year 2021–2022. The total population was 476 students. The number of respondents ($n = 131$) includes a significant percentage of women (fifty percent, more or less), allowing us to explore their views on our research interests. As this is a preliminary study, a simple frequency analysis has been carried out on selected items of the whole questionnaire.

3 Results

A total sample of 131 engineering and architecture students from the Polytechnic School of Zamora (University of Salamanca, Spain) initially answered the questionnaire, but only 95 of them gave enough data to analyze their responses properly. Moreover, as one of the interests of this study is to explore the differential answers given by men and women, we have filtered the whole sample (95 respondents) to use data which are well gender-identified. So, the answers finally considered correspond to 91 students, 44 men (48.3%) and 47 women (51.7%).

For each question, firstly, the results for the whole sample will be shown; secondly, it will be taken into account the gender perspective, the type of career or other filtering added to enrich the study.

3.1 Reasons to Choose Engineering or Architecture Studies

The first item of the questionnaire analyzed is the reason why the respondents chose to study engineering or architecture studies. The data, which have a free-text format, have been rearranged into four main groups: having a good job or professional opportunities, called "employment", personal interest, motivation, enjoyment, etc., called "personal interest"; family tradition or a family member who being an engineer/architect, called "family"; and "other" (Fig. 2-a).

These results are important for our purposes since the main reason for studying engineering or architecture in the entire sample is personal interest, enjoyment of scientific and mathematical subjects, construction or programming in childhood, etc. Following this idea, initiatives at school that allow children to manipulate different elements to build structures, programs, and make science more interesting and closer to their lives, could increase interest and enjoyment in these subjects and attract young people to study engineering or architecture.

The same analysis has been done considering the gender of the respondents (Fig. 2-b). Analyzing men's responses, "personal interest" is the main reason to choose engineering or architecture studies; given by 30 of the 47 respondents (63.8%) versus 8 (17%) who mention employment. Women's responses also follow this distribution, but with less amount of personal interest reasons, given by 25 of the 44 respondents (56.8%) and a larger number of "other" reasons, including the "desire of being more women in engineering studies". Comparatively there are no statistically significant differences.

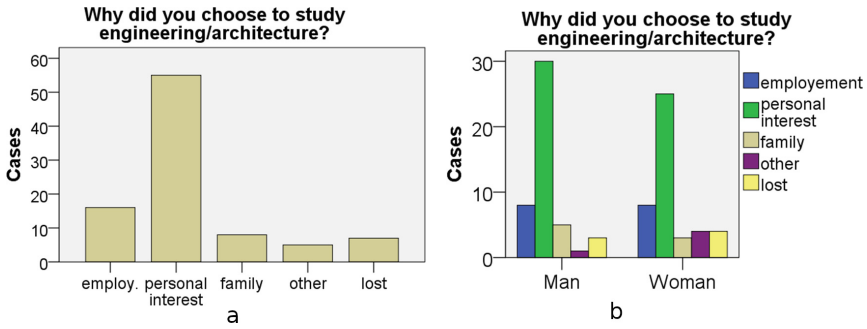

Fig. 2. Main reasons to choose engineering/architecture studies.

3.2 Support Initiating Engineering or Architecture Studies

The second item analyzed is the main supports for the decision to start engineering studies. The data have been rearranged to distribute the detailed answers into three main

groups: family (mother, father or both, or another member of kin), non-family (friends, teachers) and nobody (their own decision) (Fig. 3-a).

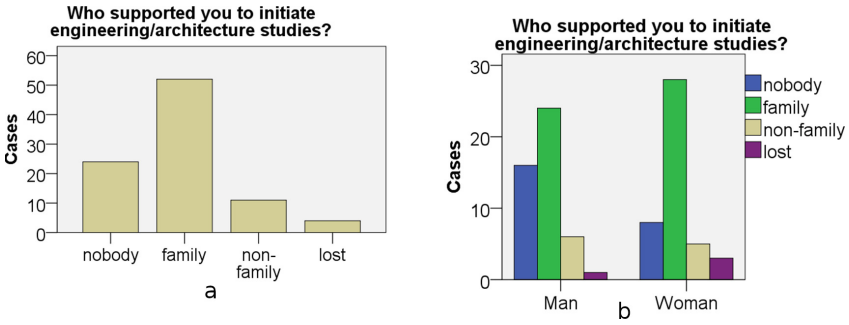

Fig. 3. Support to initiate engineering/architecture studies.

As can be seen (Fig. 3-a), the primary support for the whole sample corresponds to the familiar environment of the respondents, followed by the "nobody" item, that is, the personal decision of the respondents. Among the 11 "non-family" answers, only three correspond to teachers. These results show how, although familiar reasons are not the main impulse for young people to choose engineering or architecture studies, family does become very important as a source of support after taking that decision.

When analyzing the same question but distinguishing between men and women, the results are shown in Fig. 3-b. As can be seen, although family support is the main answer for both genders, men show a more significant number of "nobody" answers compared to women (16 women out of 47, 34.0% vs 8 out of 44 men, 18.2%). Women feel more supported by their families when starting engineering studies (28 women out of 44, 63.6% vs 24 out of 47 men, 51.1%), although these differences are not statistically significant.

3.3 Dropout Engineering/Architecture Studies

The third question which has been analyzed looks for the reason for dropout engineering or architecture studies. The proportion of Yes/No/Lost answers for the total sample and gender is shown in Table 1.

Table 1. Question "Have you thought about dropout your studies? by gender

	NO	YES	LOST	TOTAL
Total sample	49 (53.8%)	37 (40.7%)	5 (5.5%)	91
Man	26 (55.3%)	20 (42.6%)	1 (2.1%)	47
Woman	23 (52.3%)	17 (38.6%)	4 (9.1%)	44

The main answer to the question about dropout engineering/architecture studies is "No" for both genders, but the proportion of men who have thought about dropout their studies is more significant than women's (42.6% vs 38.6%), although they are not statistically significant.

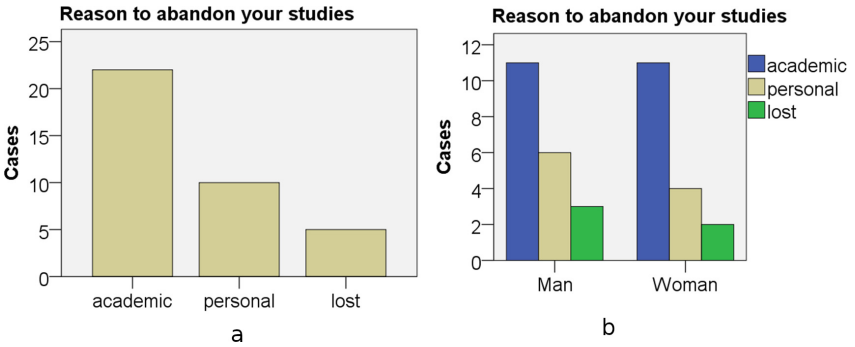

Fig. 4. Reasons to drop out of engineering/architecture studies.

To enrich these results, we have analyzed the main reasons given by the "YES" respondents. The answers were given in a free-text format, so have being rearranged into two main categories, namely "personal" reasons (lack of motivation, economic reasons, age, etc.) and "academic" reasons, mainly the difficulty of the subjects, bad academic results, etc. The results for the whole sample and considering gender are shown in Fig. 4-a.

The main reasons to think about dropout engineering studies are the academic ones: the difficulty of the subjects is the top mentioned reason. This proportion stays when the same question is analyzed considering the gender, but the percentage is bigger for women (11 out of 17, 64.7%) than for men (11 out of 20, 55%) (Fig. 4-b). Women seem more affected by the difficulty of subjects or bad academic results than men [20, 21].

4 Conclusions

The competitiveness and strength of our productive fabric must be improved and increased to ensure the future development of our country in a globalized world with high technological development. This goal involves strengthening science and engineering research and increasing student enrollment in STEM studies, as they constitute the future workforce and investigators [4]. Furthermore, increasing the number of women in these studies is especially important given their low representation in engineering and architecture careers [5].

This study intends to be a preliminary look at the main reasons for entering, staying and dropout engineering and architecture degrees, to design strategies to improve the attractiveness of these careers for young people, especially young women. In this respect, the main reason for starting engineering or architecture studies is "personal interest" [22] more than having good employment [7]. This personal interest has been developed in

school ages, so initiatives that lead to improve the resources of STEM teachers, enhance the quality of science-related experiences in the classroom and increase the pleasure of building, programming or exploring scientific experiments could be helpful to increase STEM vocations at an early age.

When analyzing persistence in engineering and architecture degrees, the difficulty of the subjects is mentioned as the main reason that leads students to think about leaving their degree [23]. Although family is the major support factor when initiating engineering or architecture studies, greater academic and institutional support during the career probably would increase students' persistence when they face the most difficult subjects [24].

The gender perspective enriches the study by lightning the difference between men's and women's points of view and experiences when studying engineering or architecture. For example, women mention a greater variety of reasons to start these studies and show more persistence, but they are more affected by bad academic results [20, 21], perhaps because they consider themselves as less capable of studying engineering degrees [25].

Regarding future works, further actions need to be done to increase the training of women in this field should be focused on overcoming this belief.

Acknowledgements. This work has been possible with the support of the Women's Institute of the Ministry of Equality of the Government of Spain. PAC 2021 INMUJERES, Engineering with a gender perspective (reference number: 35/7ACT/21).

References

1. United Nations: The Sustainable Development Goals Report (2020). https://unstats.un.org/sdgs/report/2020/The-Sustainable-Development-Goals-Report-2020.pdf. Accessed 1 July 2022
2. Schwab, K. (ed.): The Global Competitiveness Report. World Economic Forum (2019). https://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf. Accessed 4 July 2022
3. Annoni, P., Dijkstra, L.: The EU Regional Competitiveness Index. Publications Office of the European Union (2019). https://ec.europa.eu/regional_policy/sources/docgener/work/2019_03_rci2019.pdf. Accessed 4 July 2022
4. Bello, A.: Las mujeres en Ciencias, Tecnología, Ingeniería y Matemáticas en América Latina y El Caribe. ONU Mujeres (2020). https://lac.unwomen.org/sites/default/files/Field%20Office%20Americas/Documentos/Publicaciones/2020/09/Mujeres%20en%20STEM%20ONU%20Mujeres%20Unesco%20SP32922.pdf. Accessed 4 July 2022
5. Álvarez, M.: ¿En qué países europeos son más reconocidos los graduados en STEM? Fundación CYD, February 2022. https://www.umultirank.org/blog/In-which-European-countries-are-STEM-graduates-most-highly-recognised/. Accessed 4 July 2022
6. González-Cervera, A., González-Arechavala, Y., Martín-Carrasquilla, O., et al.: Estudios STEM en España y participación de la mujer. La Formación Profesional STEM, una oportunidad de futuro. Cátedra para la Promoción de la Mujer en vocaciones STEM en la Formación Profesional para la Movilidad Sostenible (2021). https://www.comillas.edu/images/catedras/mujer-STEM/publicaciones/EstudiosSTEM_en_Espa%C3%B1a_y_participacion_de_la_mujer_dic_21-1.pdf. Accessed 4 July 2022

7. González López, I.: Motivación y actitudes del alumnado universitario al inicio de la carrera ¿Varían al egresar? Electron. J. Res. Educ. Psychol. **3**(1), 35–56 (2005). https://doi.org/10.25115/ejrep.v3i5.1154
8. Araya-Pizarro, S.C., Araya-Pizarro, C.R.: Factores que influyen en la decisión de estudiar ingeniería comercial según la perspectiva del alumnado de los sistemas público y privado de la Región de Coquimbo, Chile. Formación Universitaria **13**(2), 73–82 (2020). https://doi.org/10.4067/S0718-50062020000200073
9. Maphosa, M., Doorsamy, W., Paul, B.S.: Factors influencing students' choice of and success in STEM: a bibliometric analysis and topic modeling approach. IEEE Trans. Educ. (2022). https://doi.org/10.1109/TE.2022.3160935
10. Barberá, E., Candela, C., Ramos, A.: Elección de carrera, desarrollo profesional y estereotipos de género. Revista de Psicología Social **23**(2), 275–285 (2008). https://doi.org/10.1174/021347408784135805
11. Verdugo-Castro, S., Sánchez-Gómez, M.C., García-Holgado, A.: Opiniones y percepciones sobre los estudios superiores STEM: un estudio de caso exploratorio en España. Education in the Knowledge Society (EKS) **23** (2022). https://doi.org/10.14201/eks.27529
12. Lorenzo Rial, M., Álvarez-Lires, F.J., Álvarez-Lires, M., et al.: La amenaza del estereotipo: elección de estudios de Ingeniería y Educación tecnocientífica. Opción: Revista de Ciencias Humanas y Sociales **32**(9), 54–76 (2016). https://www.redalyc.org/articulo.oa?id=31048482003. Accessed 4 July 2022
13. Domènech Casal, J.: STEM: Oportunidades y retos desde la Enseñanza de las Ciencias. Universitas Tarraconensis. Revista de Ciències de l'Educació **2**, 154–68 (2019). https://doi.org/10.17345/ute.2019.2.2646
14. García-Holgado, A., Camacho Díaz, A., García-Peñalvo, F.J.: Engaging women into STEM in Latin America: W-STEM project. In: Conde-González, M.Á., Rodríguez Sedano, F.J., Fernández Llamas, C., et al. (eds.) Proceedings of the 7th International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM 2019), León (Spain) October 2019). ACM International Conference Proceeding Series (ICPS), New York, NY, USA, pp. 232–239. ACM (2019). https://doi.org/10.1145/3362789.3362902
15. González Rogado, A.B., García-Holgado, A., García-Peñalvo, F.J.: Mentoring for future female engineers: pilot at the Higher Polytechnic School of Zamora. In: García-Holgado, A., García-Peñalvo, F.J., González González, C.S., et al. (eds.) XI International Conference on Virtual Campus (JICV), USA. IEEE (2021). https://doi.org/10.1109/JICV53222.2021.9600410
16. Zabaniotou, A.: Towards gender equality in Mediterranean Engineering Schools through networking, collaborative learning, synergies and commitment to SDGs. Global Transitions **2**, 4–15 (2020). https://doi.org/10.1016/j.glt.2019.12.001
17. García-Peñalvo, F.J., Bello, A., Domínguez, A., et al.: Gender balance actions, policies and strategies for STEM: results from a World Café Conversation. Educ. Knowl. Soc. **20**, 15, 31 (2019). https://doi.org/10.14201/eks2019_20_a31
18. González-González, C.S., García-Holgado, A., García-Peñalvo, F.J.: Strategies to introduce gender perspective in engineering studies: a proposal based on self-diagnosis. In: 2020 IEEE Global Engineering Education Conference (EDUCON), (27–30 April 2020, Porto, Portugal), USA, pp. 1884–1890. IEEE (2020). https://doi.org/10.1109/EDUCON45650.2020.9125289
19. García-Holgado, A., Mena, J., González, C.S., et al.: Perspectiva de Género en Ingeniería Informática: Cuestionario GENCE, University of Salamanca, Salamanca, Spain, Technical report GRIAL-TR-2019-001 (2019). https://doi.org/10.5281/zenodo.2550690
20. Höhne, E., Zander, L.: Belonging uncertainty as predictor of dropout intentions among first-semester students of the computer sciences. Zeitschrift für Erziehungswissenschaft **22**(5), 1099–1119 (2019). https://doi.org/10.1007/s11618-019-00907-y

21. Salazar-Fernández, J.P., Sepúlveda, M., Muñoz-Gama, J.: Influence of student diversity on educational trajectories in engineering high-failure rate courses that lead to late dropout. In: 2019 IEEE Global Engineering Education Conference (EDUCON), pp. 607–616. IEEE (2019). https://doi.org/10.1109/EDUCON.2019.8725143
22. Matusovich, H.M., Streveler, R.A., Miller, R.L.: Why do students choose engineering? A qualitative, longitudinal investigation of students' motivational values. J. Eng. Educ. **99**(4), 289–303 (2010). https://doi.org/10.1002/j.2168-9830.2010.tb01064.x
23. French, B.F., Immekus, J.C., Oakes, W.C.: An examination of indicators of engineering students' success and persistence. J. Eng. Educ. **94**(4), 419–425 (2005). https://doi.org/10.1002/j.2168-9830.2005.tb00869
24. García-Holgado, A., González-González, C.S., Peixoto, A.: A comparative study on the support in engineering courses: a case study in Brazil and Spain. IEEE Access **8**, 125179–125190 (2020). https://doi.org/10.1109/ACCESS.2020.3007711
25. de las Cuevas, P., García-Arenas, M., Rico, N.: Why Not STEM? A study case on the influence of gender factors on students' higher education choice. Mathematics **10**(2), 239 (2022). https://doi.org/10.3390/math10020239