

# Research and development of an creative instrument to allure students towards Engineering

Paulo Silva  
CIETI - Centre of Innovation on  
Engineering and Industrial Technology  
IPP-ISEP, School of Engineering,  
Porto, Portugal  
0000-0002-9879-8414

Anabela Silva Conde  
Ordem dos Engenheiros Região Norte  
Porto, Portugal  
anabelasilvaconde@oern.pt

Alicia García-Holgado  
GRIAL Research Group, Instituto  
Universitario de Ciencias de la  
Educación  
Universidad de Salamanca  
Salamanca, Spain  
0000-0001-9663-1103

Bento Aires  
Ordem dos Engenheiros Região Norte  
Porto, Portugal  
bmaires@oern.pt

Carlos Felgueiras  
CIETI - Centre of Innovation on  
Engineering and Industrial Technology  
IPP-ISEP, School of Engineering,  
Porto, Portugal  
0000-0002-4202-5551

**Abstract**— The quality of education is a key factor in the training of responsible, competent, multidisciplinary, and highly trained professionals. It is imperative to develop modern solutions that respond to the Sustainable Development Goals. These new solutions are increasingly complex and multidisciplinary, requiring more professionals in the STEAM areas, and in particular from engineering. Paradoxically, it is exactly in this context that there is a reduction in students choosing engineering as a future professional career, a situation that is not compatible with actual real needs. It is therefore necessary (i) to understand the origin of this phenomenon and (ii) to stimulate programs that tend to attract the attention of students to the areas of engineering, particularly in the pre-university phase, that is, in secondary education. One of these programs is *Há Engenharia em Mim*® (There is Engineering in Me) and is being coordinated by the National Association of Engineers of Portugal, *Ordem dos Engenheiros*. Through this creative tool, curiosity, sagacity, astuteness and attractiveness towards Engineering are stimulated in a simplified and captivating way, meaning that the widespread implementation of this program can mitigate or reverse the trend of students moving away from choosing careers in Engineering. The present work approaches this program and presents some results.

**Keywords**—Education, Engineering, innovation, creativity

## I. INTRODUCTION (HEADING 1)

The 21st Century brings many challenges to society, forcing professionals to adapt to the demands of the job market, providing themselves with technical and practical knowledge and multidisciplinary vocations. Marked by rapid development in technology, this century requires companies to follow the evolution of technology in order to guarantee a response to current challenges. “No factor is more critical in underpinning the continuing health and vitality of any national economy than a strong supply of graduate engineers equipped with the understanding, attitudes and abilities necessary to apply their skills in business and other environments”. This quotation [1] from UK Royal Academy of Engineering provides the adequate context to the perspective of what we are going to report in this paper.

Amongst the greatest challenges we face in Portuguese education today are the innovation of teaching methodologies, the ability to attract and motivate students towards exact scientific areas and the guarantee of a quality education system. Yet at this time when society's need for engineering

talent is huge, and when society is increasingly interested in how they can help to save the planet and create innovative solutions, we are failing to persuade them that engineering careers are exciting, having the lowest number of students enrolled for the first time in Higher Education in courses related to Engineering[2].

One of the problems base that is possible to verify in modern school is lack of strong inter-disciplinary connections, since it cannot use received knowledge neither in current situations and day-to-day practices, nor in other curricular units[3]. It appears that it is insufficient to captivate students in problem-based learning exercises that only add knowledge in 'science' without its practical application in real situations, making the expressed need to experiment evident. Experience in the 'practice of engineering' should be obtained through judicious, rigorous, challenging, and complex experiential learning processes that apply engineering theory to scenarios requiring design resolution [4].

## II. THE RELEVANCE OF DEVELOPING TOOLS IN EDUCATION INNOVATION

The need for digital transition, new technologies and the demand for increasingly multidisciplinary professionals shape the needs of the labor market, resulting in an adaptation of the educational system without compromising the quality of education. STEM learning combined with new approaches demonstrates the effectiveness in developing students' creative thinking abilities, as they experience practical activities combined with repetitive solving steps such as preparation, exploration and verification [5]. In this aspect, it is essential that the educational system is revolutionized to meet the needs of students. In this context, the organization of STEM programs and school education initiatives plays an important role, improving students' overall performance in the area of exact sciences, such as science and mathematics, and increasing students' opportunities for STEM-related careers [6].

## III. METHODOLOGY

In the earlier school years, it is possible to verify that throughout their academic career, reluctance and compassionate distance from exact curricular subjects, such as mathematics, physics and chemistry are clearly evident. The question becomes more pressing when it comes to their

motivation and propensity to pursue this academic path as their own choice, over a longer period, later mirrored in a professional life. In order to understand and change this paradigm, the *Ordem dos Engenheiros* created an Engineering Discovery activity that aims to (re)discover in teenagers the stimulus and practical sense for the exact sciences, namely engineering, in a playful-pedagogical 'hands on' approach, based on a STEAM (Science, Technology, Engineering, Arts and Maths) learning tool. With this new creative tool, based on Scratch software, it is proposed practicing critical thinking, analyzing data and developing prototypes that solve complex problems relevant to the real world.

Through careful experimentation, the purpose is to make teenagers aware of all the specialties that make up engineering and how they are reproduced in society and in our daily lives, allowing them to study mathematics, physics, computer science, electronics, and robotics, not forgetting social and organizational skills. The belief is that learning is compatible and exciting while playing as shown in figure 1.



Fig. 1. Example of an activity from the *Há Engenharia em Mim*® program

Stimulating creativity and curiosity through simple but fundamental engineering processes, gaining not only students' interest and motivation for the exact sciences, but also developing and broadening their knowledge, with a view to observing, participating, and contributing in a proactive way to the issues of everyday life and coexistence. At the end, we'll be able to affirm: *há Engenharia em Mim* (there is engineering in me). And in you?

The implementation of this activity aims to build confidence, motivation and improve school success, as well preparing students for an increasingly challenging and complex future, requiring investment in hands-on teaching-learning models. It should be noted that it is important to recognize the role of science, technology and engineering for the SDGs, since these are the bases that support progress, anticipate the future consequences, and which pave the way for crucial aspects such as the digital transition, sustainability transformations and responses to important agreements such as the green deal [7].

#### IV. EXPECTED RESULTS

After implementing and using the creative tool *Há Engenharia em Mim*®, and despite the time set for executing the challenge having ended, it is possible to verify that students are motivated, curious, and challenged to improve their prototype, achieving better and more efficient results. It

is expected and believable that these activities will awaken within students the perception of continuous improvement in results, the importance of ingenuity in solving tasks and the development of vocations in Engineering. The implementation and use of an assessment tool will be important to verify the effect this program has on students in the short, medium, and long term[8].

#### V. CONCLUSIONS

The development and implementation of creative programs and tools are highly efficient in enticing, captivating and promoting skills and qualities in adolescent students, as it motivates them to continually improve solutions, the sense of facing challenges and not being afraid of failure. Stimulating vocations in certain scientific areas promotes rapprochement and willingness to pursue professional careers within these scientific areas, which could solve current labor market problems and improve the sustainability of the current system.

#### ACKNOWLEDGMENT

This research work is conducted under the University of Salamanca PhD Programme on Education in the Knowledge Society scope (<http://knowledgesociety.usal.es>).

This work was financially supported by Base Funding – UIDB/04730/2020 of Center for Innovation in Engineering and Industrial Technology, Portugal, CIETI – funded by national funds through the FCT/MCTES (PIDDAC), Portugal;

#### REFERENCES

- [1] T. R. A. of Engineering, "Educating Engineers for the 21st Century," United Kingdom, 2007.
- [2] DGEEC, "Inscritos no Ensino Superior - Ano letivo 2022 / 2023," 2023. [Online]. Available: <https://www.dgeec.mec.pt/np4/EstatVagasInsc/>.
- [3] V. Mayorova, D. Grishko, and V. Leonov, "New educational tools to encourage high-school students' activity in STEM," *Adv. Sp. Res.*, vol. 61, no. 1, pp. 457–465, 2017, doi: 10.1016/j.asr.2017.07.037.
- [4] I. De Vere, "Developing creative engineers: a design approach to engineering education," 2015, no. September 2009.
- [5] D. Sastradika and D. Defrianti, "Development of creative thinking skills through STEM-based instruction in senior high school student," *J. Phys. Conf. Ser.*, no. 6th International Conference on Mathematics, Science, and Education, 2020, doi: 10.1088/1742-6596/1567/4/042043.
- [6] R. M. Othman, O., Iksan, Z. H., & Yasin, "Creative Teaching STEM Module: High School Students' Perception," *Eur. J. Educ. Res.*, vol. 11, no. 4, pp. 2127–2137, 2022, doi: <https://doi.org/10.12973/eurjer.11.4.2127>.
- [7] U. Nations, S. and Educational, and C. Organization, *Engineering for Sustainable Development*. United Nations Educational, Scientific and Cultural Organization, 2021.
- [8] M. Koufis, "Systematic Review of STEM Attitude Measures," 2021.