
“F1® in Schools”: Unlocking STEM Potential from Youth and Teenage Period, for Society Development

“F1® in Schools”: despertando potencial STEM en los jóvenes, para el desarrollo de la sociedad

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Received: 11/11/2024 | Accepted: 14/3/2025

Abstract

The F1® in Schools project represents a pivotal platform that connects motor-sport with STEM education within primary and secondary schools. This research paper deepens in this relationship, and incorporates insights from diverse stakeholders, including students, public authorities, schools, industry partners, and top motor-sport community. The overarching objective is to define a pilot project to position F1® in Schools as a central component of a strategic initiative aimed at enhancing STEM profiles among secondary education students.

Keywords: F1® in schools, Madcup, motorsport, STEM, diversity.

Resumen

El Proyecto F1® in Schools representa una fantástica oportunidad para unir el deporte del motor con la denominada educación STEM en las escuelas de primaria y secundaria. En el presente trabajo de investigación se profundiza en esta relación, y se incorpora la visión y los intereses de los distintos grupos de interés o “stakeholders”, incluyendo entre otros a los propios estudiantes, las instituciones y autoridades públicas, los centros educativos, y las principales entidades relacionadas con el deporte del motor. El objetivo principal es la definición, tanto a nivel estratégico como operativo, de un proyecto piloto que posicione a F1® in Schools como el componente central de la estrategia para fomentar, detectar y potenciar perfiles STEM desde las primeras etapas educativas.

Palabras clave: F1® in schools, Madcup, deporte del motor, STEM, diversidad.

1. Introduction

At present, it is commonly accepted that so call STEM profiles (grouping Science, Technology, Engineering and Mathematics disciplines) are extremely important for society development, since they drive innovation and technological progress, contribute to economic growth by fostering entrepreneurship, ensure a capable workforce and address skill gaps in emerging industries, and play a critical role

in addressing current global challenges, always through research, innovation, and the application of scientific knowledge.

Although technology and innovation are nowadays, for some years now there is a trend among young people in secondary education to think that STEM related education and works are very difficult for them, and this especially noticeable within women, (Jenkins & Nelson, 2005).

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Then, the main goal of the educational project that is presented in this work, promoted by Madcup (Madcup, 2024) and uc3m, is to develop STEM competencies among our youth, through a competition linked to Formula 1[®], one of the most captivating sports, aiming to generate interest in various high-value professional disciplines for Spanish society. In order to do so, Madcup has recently signed an agreement with the NPO F1[®] in Schools that, having been launched in UK in 1999 in 8 schools, now it runs in more than 26000 schools in 51 countries worldwide (f1inschools, 2024).

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The evident growing demand for these kind of STEM profiles and professionals highlights the urgency of cultivating these profiles through clear, deliberate and structured procedures. While universities have traditionally been perceived as the primary arenas for developing STEM skills, this approach often overlooks the significant limitations derived from focusing exclusively on higher education. When the students enter university, their career trajectories are usually shaped by earlier educational experiences, social influences, or exposure to specific disciplines. As a result, efforts to develop STEM profiles solely at the university level may face considerable challenges, as foundational interests are typically established along secondary education or even earlier.

Research highlights that secondary education plays a critical role in fostering curiosity, problem-solving abilities, and analytical thinking, which are absolutely imperative to STEM fields. It is at high school when students are particularly receptive to exploration and experimentation, making it a good moment to introduce the principles and applications of STEM disciplines. Failure to engage students during this period risks limiting the talent detection in STEM professions, as many students may not even consider pursuing these areas. Moreover, societal stereotypes and perceived barriers related to gender or socio-economic background often begin to take hold during adolescence, further underscoring the necessity of early intervention. Gender perspective is especially relevant in STEM profiles. Even if there are some good recent research works like (Aragón et al., 2024) that point out the extremely good quality of women's leadership, even within traditionally sexist industrial sectors like automotive, our twenty first century society is still far from recovering this structural gap. And this is also the case within Motorsport where, despite the extremely demanding challenges, requirements and standards, there are still good examples of extremely well skilled and valued women engineers (Holman, 2018; Motorsport, 2019; Torres, 2024).

Initiating STEM development in secondary education eases to extend beyond individual academic and professional success. Early exposure to STEM topics and concepts fosters a mindset of innovation and critical thinking

that allows the society development. For instance, programs such as robotics competitions, coding workshops, or interdisciplinary projects like F1 in Schools can create engaging pathways for students to develop technical skills while fostering creativity and collaboration. These initiatives not only socialize and normalize STEM subjects but also empower students by showing themselves their capabilities in solving real-world problems.

Furthermore, the integration of STEM principles into secondary curricula requires a holistic and inclusive approach. Teachers must be equipped with the necessary training and resources to inspire and guide students effectively. One of the best resources to challenge the students is the Flip Teaching approach. Normally oriented to university students (Cardós et al., 2024), it is absolutely valid and useful for secondary students, as projects like F1 in Schools clearly show.

While universities remain vital in refining and advancing STEM knowledge areas, the starting point for such profiles must be established much earlier in the educational journey, to ensure the pipeline of skilled professionals that society need, ready to detect and to solve the complex challenges of nowadays world.

It is for this reason that, although some other projects like Formula SAE or Formula Student have been implemented for some time now, they mainly boost vocations and skills at engineering level, and in university time (Davies, 2013).

On another note, it is also important to know that there are some important “structural” barriers for some groups, due to different reasons, that could impact the STEM career preparation. As (Turner et al., 2022) properly highlight, these are normally related to economic, discrimination or inequality reasons.

2. STEM and Society

2.1. STEM Impact on Economic Development

Science, Technology, Engineering and Mathematics (STEM) disciplines are remarkably important for technological development, as they allow to develop important skills for innovation and technological development, that are extremely important drivers for social and economic growth. And this is especially important in current times, as the gross domestic product (GDP) growths of the most developed countries are increasingly depending on technological aspects.

This relationship between the availability of well skilled STEM backgrounded professionals and economic development has been extensively analyzed by many researchers like (Kuschel et al., 2020; Wolter et al., 2019; Yordanova et al., 2020; Yurchenko & Semenikhina, 2023). However, from these research works it is also clearly deductible that

there is still a lot of work to do in order to maximize this extremely positive relationship between STEM knowledge and economic development, since key aspects like gender gap, sustainability, social differences, or a proper organization of the capacitation process along the different educational stages from primary to university are still far from being well defined.

Regarding sustainability, the integration of Sustainable Development Goals (SDGs) into engineering education represents a pivotal strategy for achieving the multifaceted global challenges of our society. Engineers play a critical role in the design, development, and implementation of innovative solutions that directly impact areas such as clean energy (SDG 7), sustainable infrastructure (SDG 9), and climate action (SDG 13). Moreover, by embedding the principles of ethics, sustainability and social responsibility within engineering curricula, educational institutions cultivate professionals capable of balancing technical innovation and societal well-being and development. Universities seem to be already aware of this need (Ramirez-Mendoza et al., 2020), as it is one of the best possibilities to implement the 2030 Agenda (Romero et al., 2020). This approach enables clear synergies among education and SDGs that have to be promoted (Trois et al., 2017). The core issue, however, is to be able to embed the SDGs philosophy into the real economy and industrial activities (Aragón et al., 2023), through the embedding as much tools as possible into the different educational programs (Sánchez-Carracedo et al., 2021). This alignment not only fosters the development of interdisciplinary skills, essential for achieving the SDGs, but also enhances engineers’ capacity to contribute meaningfully to global

sustainability transitions. However, when it comes to prepare future generations of engineers to act as catalysts for sustainable and equitable development worldwide, it is also crucial to start the awareness about these aspects at secondary educational stages.

This is the reason why, as part of the proposed general line of research, namely “Motorsport and Society”, the general framework of Figure 1 is proposed. As shown, the use of Project Based Learning (PBL) projects like F1 in Schools to engage the students on STEM disciplines is understood as essential, as it has already been highlighted by some authors like (Fernández-Martín et al., 2020; S. Han et al., 2015).

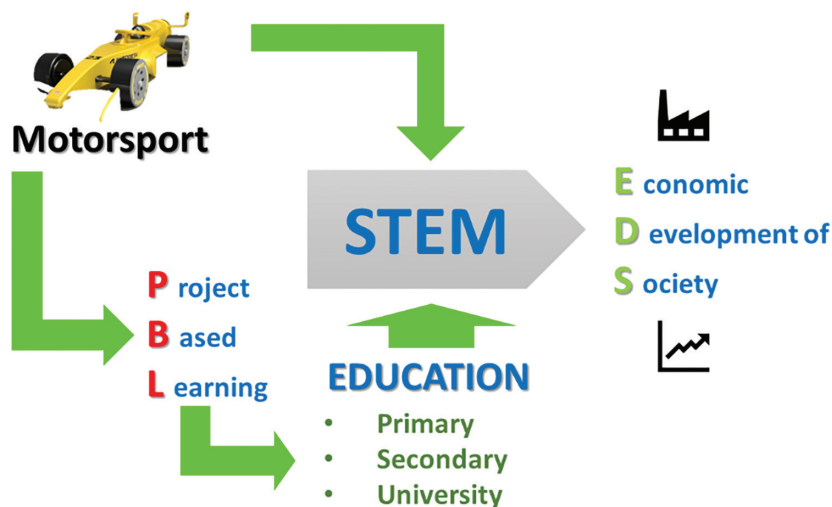
2.2. Skills Development through STEM

There are many research jobs on the analysis of the different factors that condition the cross disciplinary skills of the students (Wheeler et al., 2023), about the reasons why the students choose their future majors, and consequently they steer their future professional careers (Wang, 2013), and the effect of STEM education on academic and future professional achievements (Taşdemir, 2022).

Most of the main conclusions of these research works match with what has been deduced from the analysis of the collected data from the students that have participated in F1 in Schools program this year, being the main conclusions the followings:

- Students’ choice of future academic orientation seems to be influenced by their teachers, by their classroom situation (group integration, etc.), and the social demographic situation.

Figure 1. As part of the research line “Motorsport and Society”, the utilization of Project Based Learning Projects as F1 in Schools is understood as critical to boost the closeness and affinity of the students, mainly in early ages. Besides, the main way to develop STEM skills in students is along the different education stages, and Motorsport in general, and Formula 1 in particular, are extremely valuable environments to capture the students’ attention.



Source: own elaboration.

- There seem to be a clear relationship between the academic achievement of the students, and their background on STEM knowledge.
- In most of the cases, a positive correlation between STEM background and self-efficacy or overcome expectancy can be settled (Han et al., 2021).

2.3. Motorsport and STEM

Among the different sectors of industrial activity, it is commonly accepted that automotive sector is one of the most demanding from a global perspective, since every single aspect of the industrial operations, from strategy definition to aftersales service and recycling, going through all the intermediate steps like design, manufacturing, cost optimization, marketing, distribution, data and information management or supply chain management.

And within the automotive sector, Motorsport is absolutely the real spearhead from the point of view of competitiveness, technological requirements, innovation, and minimum reaction times. As a consequence, and as it has already been highlighted by some authors like (Hylton, 2010), and freely reported by the students involved in F1 in schools project.

At this point, it is extremely important to highlight that, as shown in Figure 2, educational programs like F1 in Schools are not only interesting from the engineering and STEM related knowledge point of view, but also from the organizational engineering point of view, to the point of having the collaboration of an institution like the Project Management Institute (Erina Wan Zul, 2024),

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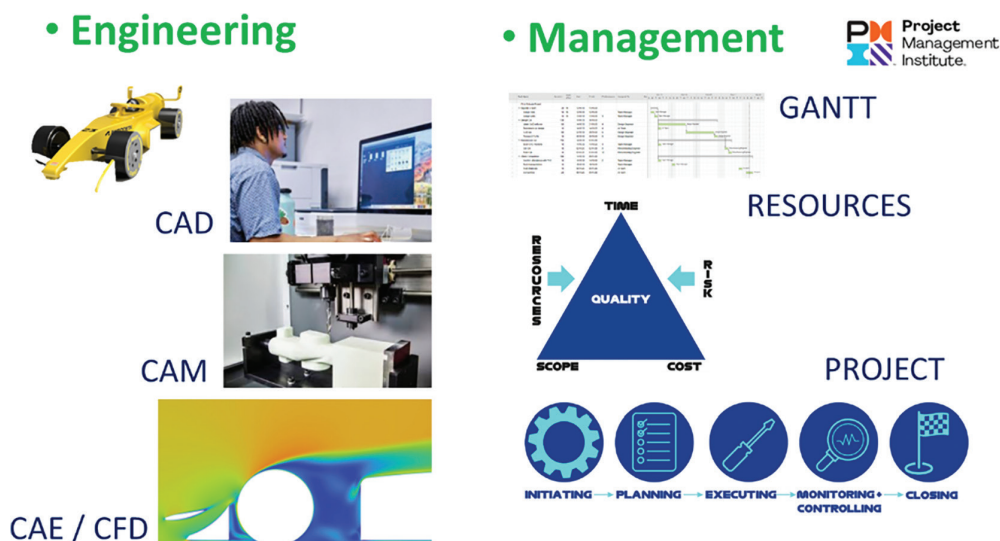
When it comes to provide a good education to future professionals, managers, leaders, or simply good citizens, it becomes quite clear the imperative to provide a broad education. As (Beyers, 2009) states, it is important to provide the students with enough skills for their future life and contribution to society, including from the ability to survive, to the capacity of understanding the current global world, but also going through enough knowledge, the capacity of accessing valid and true information, and sufficient training about evaluation and decision making.

Being these aspects important in general, they become absolutely key when speaking about STEM profiles. It is also interesting what (Chien & Chu, 2018), among others highlight in their work when evolving from STEM to STEAM concept, incorporating the “A” for Arts, as one of the important drivers to develop creativity in students. It is also important to call attention to the fact that it is convenient to start detecting and developing STEM vocations in educational stages prior to university, since some extremely good potentialities could be lost. And this is specially the case in Spain, which education system does not ease to change the path once the university has been started, and particularly in women.

It is for this reason that, although some other projects like Formula SAE or Formula Student have been implemented for some time now, they mainly boost vocations and skills at engineering level, and in university time (Davies, 2013).

The intersection of entrepreneurship and STEM profiles represents a dynamic synergy that drives innovation,

Figure 2. Motorsport provides the perfect environment for the students to develop their soft and hard skills though F1 in Schools project. The involvement and commitment of organizations like PMI allow the students to boost their organizational skills to a nearly professional level, from very early ages.



Source: own elaboration.

economic growth and, consequently, societal advancement. There is strong research backed consensus about the fact that STEM professionals possess the technical expertise and analytical skills to solve complex challenges. In turn, entrepreneurship provides a platform for STEM individuals to translate their knowledge into practical applications, boosting the development and application of disruptive technologies and innovative business models. This relationship is particularly significant in the context of emerging industrial sectors like clean energy, biotechnology, artificial intelligence, and additive manufacturing, where entrepreneurial initiatives led by STEM professionals have redefined market landscapes.

When analyzing the main reasons why the majority of the start-ups do not last too much time in the market, a good analysis can be found in (Zapata-Molina et al., 2022), where it is clearly stated that some of the most important factors to overcome the current situation of large failure rates like risk management or business management could be easily learned, from early stages, in an attractive and pleasant way, with programs like F1 in Schools. By integrating entrepreneurial training into STEM education, institutions can empower students to not only excel in technical domains but also to develop soft skills like leadership, creativity, and strategic thinking necessary to launch and sustain transformative ventures.

On another note, it is also important to know that there are some important "structural" barriers for some groups, due to different reasons, that could impact the STEM career preparation. As (Turner et al., 2022) properly highlight, these are normally related to economic, discrimination or inequality reasons.

4. Pilot Project Approach

In Spain, according to (Ministerio de Educación y Formación Profesional, 2023), there are currently more than 468000 secondary school teachers (around 54% on public centres, and the rest on private and charter ones), teaching a total of 2,08 million students. And these figures give a clear idea of the potential for influence and change of any initiative to be implemented at that educational stage. Nonetheless, and mostly because of the enormous size of the affected group, it is extremely important to define what kind of actions to implement, focused on what groups, and in which order.

With this objective, several working groups have been created along the first quarter of 2024, integrating all the involved stakeholders. The general framework is shown at Figure 3, and their main conclusions can be summarized in:

- It is important to involve all the stakeholders with ability to influence the whole project with their positive advice. This project has to be mid to long term oriented, so it is extremely important to learn from the pilot as much

as possible, to improve efficiency and results in future phases.

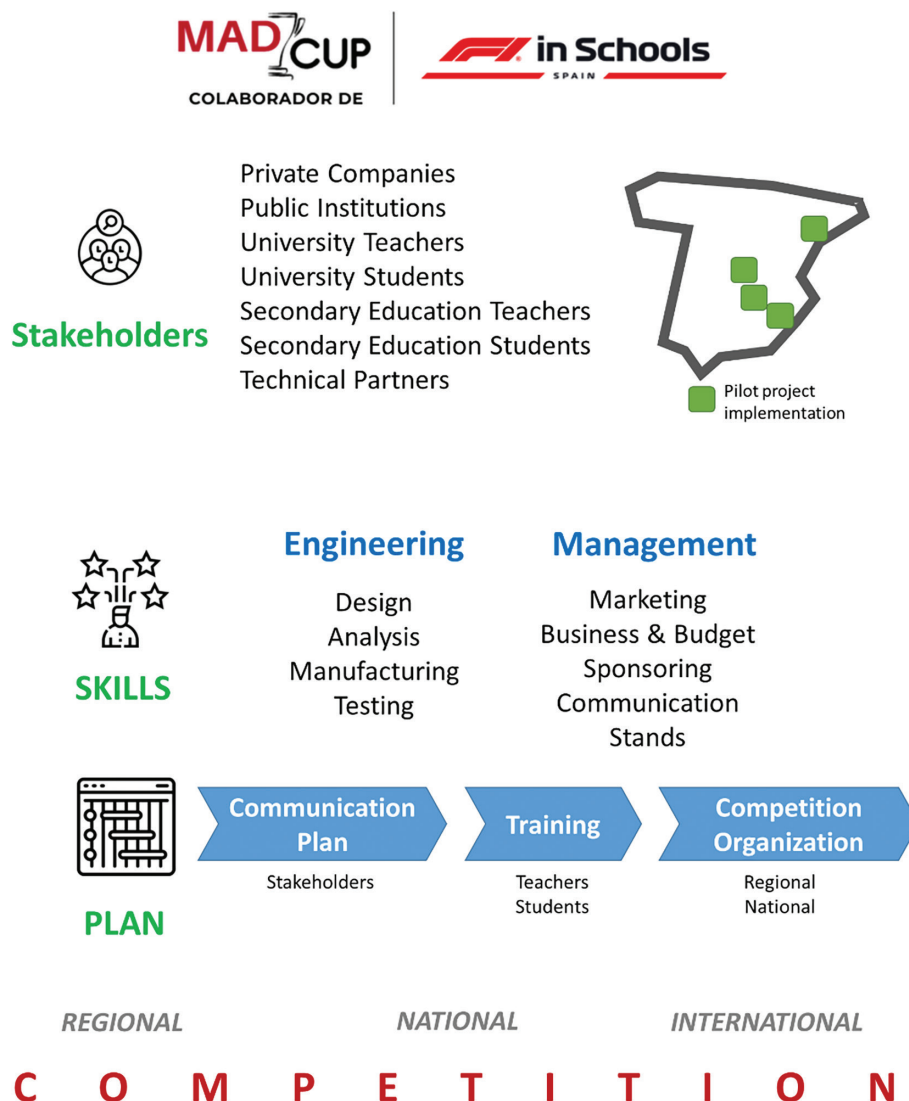
- Taking into consideration the number of secondary centers and students, it is obvious that the project must be divided into phases, so the pilot phase must be focused on those regions with the potential to provide the best strategic and operative feed-back, like it is the case of Madrid, Cataluña, Valencia and Castilla la Mancha.
- The fact of capturing the synergies of Madcup as experienced organizer of similar challenges for football and basketball sports, is an extremely positive point for the long-term project.
- The initial research gaps that have been found to be important for the project objectives are mainly to analyze and quantify the real impact for society, and try to optimize the implemented actions in order to increase the STEM vocations among students. There are some related investigations like (Abu Mansor & Harun, 2017; Gai, 2021) but most of them are purely related to engineering skills and knowledge.
- There should be a deeper exploration of the drivers of the F1® case studies, (f1inschools, 2024), to identify the best practices that are applicable to secondary education students to boost their professional careers.

4.1. Preliminary results

After posing a questionnaire to all the students attending the Spanish national final of F1 in Schools, and even being clear that for the time being the number of answers (N=21) does not allow to generalize the conclusions from a statistical point of view, some important aspects can be obtained:

- An important effort must be made in communication, since one third of the students knew about F1 in schools through social networks, and the remaining two thirds through their friends or colleagues. But none of them new about this opportunity through institutional channels as educational centres, etc.
- Even in a so called "developed" country like Spain, girls' representation was slightly over 40%, so under represented.
- Most of the students reported that the effort to learn about CAE (Computer Assisted Engineering) and CAM (Computer Assisted Manufacturing) was very high, while to learn about the other areas like CAD (Computer Assisted Design), aerodynamics, or communication skills had been much close to what they expected.
- Slightly over 90% of the students valued the contribution of F1 in School project to their future professional and personal development as high or extremely high.
- When asked about open testimonials about the real reason why they had decided to enter F1 in Schools

Figure 3. Global framework of the proposed pilot project to boost STEM profiles among secondary school students. Main objectives and strategic axes must arise from the involved stakeholders, and the different actions must be implemented at both strategic and operational levels. Taking into account the potential scope of the project, given the high number of students and schools involved, the efficiency of its implementation is absolutely critical.



competition, slightly over 70% of their comments included F1 term, being some of them: “I really like F1”, “I am interested in STEM projects and the use of CAD programs”, or “My interest in F1 and my hope to become an F1 engineer”.

4.2. The students goal. 2024 World Finals

The main goal of every single team competing in F1 in Schools is to reach the World Finals (F1 in, 2024), after having qualified within their respective countries. Quite recently, two Spanish teams (Velotech, 2024; Xispa, 2024) qualified for the World Finals. Events like this F1 in Schools Aramco World Finals offer young students a unique, multidisciplinary learning experience that extends beyond

traditional classroom education. Participants engage with core STEM principles in an extremely international and demanding environment. In addition to technical skills, students develop critical soft skills, including teamwork, project management, and effective communication, as they collaborate on designing, testing, and presenting their projects. The competition also fosters entrepreneurial thinking, as students must secure sponsorships, manage budgets, and market their teams. Furthermore, the event emphasizes the importance of innovation, problem-solving, and resilience, enabling students to adapt to unforeseen challenges in a high-pressure environment. Creativity, work capacity and technical capabilities are really impressive, and this can be easily seen at the teams’ pit displays (figure 4).

Figure 4. Example of the pit display of one participant team (from Greece), showing a wind tunnel, a four axle CNC machine and a computer simulator, all designed, manufactured and operated by secondary students.



Figure 5. Having the opportunity to enter a real F1 Grand Prix, meet top drivers, and see real F1 cars up close while being able to discuss with top engineers is really a dream for the secondary students.



Reaching the World Finals represents for all the participants the best possible reward to their dedication, hard work, and creativity. It provides an unparalleled opportunity to compete on a global stage, connect with peers and industry leaders, and gain international recognition for

their efforts. Beyond the competition itself, attending the event inspires students to envision themselves as future engineers, innovators, and entrepreneurs, and allow them to get in contact with the real pinnacle of motorsport: the F1 (figure 5).

5. Conclusions

The main influences between STEM profiles and society development are based on innovation and technological advancement, economic growth and competitiveness, and addressing global challenges.

F1[®] in Schools project represents a transformative educational experience that could transcend conventional boundaries. By intertwining motorsport with STEM education, F1[®] in Schools can definitely help to make it flourish a new generation of STEM enthusiasts, particularly among women, while nurturing essential life skills and fostering positive values. This initiative underscores the importance of collaboration among stakeholders in shaping the future of STEM education and workforce development.

As the pilot project that is presented in this research work continues to evolve, its impact on multidisciplinary learning, gender diversity in STEM, and the cultivation of critical skills will remain unparalleled.

By leveraging innovative approaches and strategic partnerships, F1[®] in Schools, together with the research team, and the key involved stakeholders, will certainly serve as a blueprint for educational initiatives in Spain, driving excellence, inclusivity, and innovation in STEM education.

Funding

This work has been supported by the Madrid Government (Comunidad de Madrid-Spain) under the Multiannual Agreement with UC3M in the line of Excellence of University Professors (EPUC3M20), and in the context of the V PRICIT (Regional Program of Research and Technological Innovation).

This research work has been partially supported by MAD-CUP S.L., as part of the Research and Investigation Project 2024 / 00255 / 001 of UC3M Universitas XXI Portal.

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