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Design and implementation of the methodology Project Based Learning (PBL). The MART case.

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MART (Málaga Racing Team), founded in 2016, is a multidisciplinary team composed of more than seventy students enrolled in eighteen bachelor's and two master's degrees at the University of Málaga. This team, organised in two main areas (technical and business), designs, develops and manufactures a vehicle that participates in Formula Student, a motor racing competition, between students from universities around the world, such as, Spain, Germany, The United States of America, Brazil, The Netherlands, China or Australia. To gain access to these competitions, students must pass very demanding exams that are simultaneously held between the participating universities.

This team develops a model based on active methodologies, such as Project Based Learning (PBL), an educational strategy of design and programming, that actively involves the student in a real, relevant and environmentally relevant situation. PBL implements a set of tasks based on the resolution of questions or problems (challenges), through a process of research or creation by students working relatively autonomously and with a high level of involvement and cooperation, culminating in a final product that is presented to others. Such methodologies are related to the way of working in the field of design, through projection and experimentation as techniques of analysis and progress in the development of a proposal.

The purpose of this paper is to define and develop the process followed by MART to design and implement the methodology PBL and to show, academically and professionally, the main achievements and results obtained by the team.

The methodology designed by MART involved several phases that guide students through the process of designing, planning and implementing the project. (1) *Initiation*. At the beginning of each academic year, the members of the team (teachers and students) make a presentation of the project in different centres of the University of Málaga. From that moment on, a process of recruitment, selection and integration of the new members who will form part of the team is carried out. The teachers may also identify the main objective of the project, and provide guidance and resources to help students get started. (2) *Research and planning*. Students engage in research to gather relevant information, for instance, they identify resources, interview experts and create a plan outlining the project's structure, timeline and required tasks. (3) *Design and development*. Students apply their knowledge and skills to design and start developing the project. Thus, members of the technical department create prototypes, models or other components required for the vehicle; while members of the business area, for example, design communication or sponsorship campaigns. They all collaborate to divide tasks and allocate responsibilities. (4) *Implementation*. Students put their plans into action and start manufacturing the vehicle. (5) *Testing and evaluation*. Once the vehicle is finished, students test its functionality and evaluate its effectiveness. This is the stage at which students ask for feedback from peers, teachers or even external stakeholders to improve their work further. (6) *Reflection and revision*. The members of the team reflect on their project experience and identify areas for improvement, what helps reinforce the learning experience. (7) *Presentation and sharing*. At the end of each academic year, the motor racing team presents the vehicle to an audience, which includes teachers, authorities, sponsors and family. This is the main event of the project and takes place in an emblematic place in the city of Málaga. (8) *Competition*. The last phase of the project coincides with the team's participation in Formula Student. During 2023, MART will compete at Montmeló (Formula Student Spain) and Hockenheim (Formula Student, Germany). In addition, the team is currently developing a new line of

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research related to the electric car and, also this season, will compete at motor racing level at Estoril (Formula Student, Portugal).

It is worth highlighting the scope and the contribution that this project makes in the pedagogical field and the value of the project pedagogies used. In this sense, the methodology designed and implemented by MART has contributed to the development, on the one hand, of the technical and business skills of the students involved in both areas, as well as of transversal skills, as the implementation of this methodology reinforces autonomy, critical spirit, collaboration and teamwork or communication skills, among the most significant ones. The project has also enabled students to acquire and/or improve skills related to employability, innovation and entrepreneurship.

Also of particular significance are the activities carried out by the members of the team in secondary schools with the aim of promoting vocations and the monthly activities they carry out in non-governmental organisations, with a double vision, to contribute to Málaga society and to strengthen team spirit.

Finally, the project has also contributed to obtaining academic results, as more than ten final degree and master's degree projects have been defended, several articles have been published in recognised indexed journals and papers related to the project have been presented at international congresses. In addition, over the last few years MART has achieved important results in Formula Student (Awards for the best spirit Formula Student Spain, 2019 and 2021; first position in the business plan test and third position in the endurance test in Formula Student Spain 2022; and two third positions in the acceleration and the endurance test in Formula Student Netherlands 2022), and important acknowledgments (Enterprise 4.0 Award from La Opinión de Málaga (2021); Talent Woman 2022 Award to the team leader; and Málaga Marketing Club Award for best product/service in 2022).

Keywords

Project based learning, education, MART (Málaga Racing Team)