

ORLAFOG – AN EXPERIENCE IN TEACHING, RESEARCH AND OUTREACH

ORLAFOG – UMA EXPERIÊNCIA DE ENSINO, PESQUISA E EXTENSÃO

ORLAFOG – UNA EXPERIENCIA EN DOCENCIA, INVESTIGACIÓN Y EXTENSIÓN



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ABSTRACT

The use of educational rockets as a pedagogical resource stands out as an effective strategy for scientific dissemination and for stimulating logical reasoning at different educational levels. This work shows how a project was able to spark the interest of students and teachers and generate learning from the construction and launch of experimental educational rockets, an activity that requires the application of the scientific method, aerodynamic and stability calculations, the choice of appropriate materials, and the organization of teamwork. The proposal brings young people closer to science in a playful and practical way, addressing the growing interest in the subject and the importance of integrating school, community, and scientific culture. The development of the activities took place through the offering of workshops, reception of students, and participation in dissemination events, with emphasis on the two editions of ORLAFOG (Rocket Olympics of the Lakes Region), organized by the IFRockets team, and made possible by approval in a CNPq call for proposals. The results obtained demonstrated a strong engagement of the participants, reflected in the formation of new rocket teams, increased participation in competitions, and the intensification of scientific reasoning in the classroom. Furthermore, there was significant participation from the school community of different institutions, including families, reinforcing the project's potential as a bridge between science and society. Thus, the experience proved that the use of didactic rockets goes beyond mere entertainment, establishing itself as a teaching tool capable of sparking vocations, consolidating interdisciplinary practices, and contributing to the dissemination of science.

Keywords: Experimental Rockets. Physics Teaching. University Extension. ORLAFOG.

RESUMO

A utilização de foguetes didáticos como recurso pedagógico se destaca como estratégia eficaz para a divulgação científica e para o estímulo ao raciocínio lógico em diferentes níveis de ensino. Este trabalho mostra como um projeto foi capaz de despertar o interesse dos

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estudantes e professores e gerar aprendizado a partir da construção lançamento de foguetes didáticos experimentais, atividade que exige a aplicação do método científico, cálculos de aerodinâmica e estabilidade, escolha de materiais adequados e organização do trabalho em equipe. A proposta aproxima os jovens da ciência de forma lúdica e prática, atendendo ao interesse crescente pela temática e à importância de integrar escola, comunidade e cultura científica. O desenvolvimento das atividades ocorreu por meio de oferta de oficinas, recepção de alunos e participação em eventos de divulgação, com destaque para as duas edições da ORLAFOG (Olimpíada da Região dos Lagos de Foguetes), organizada pela equipe IFRockets, e possibilitada por aprovação em edital do CNPq. Os resultados obtidos demonstraram um forte engajamento dos participantes, refletido na formação de novas equipes de foguetes, no aumento da participação em competições e na intensificação do raciocínio científico em sala de aula. Além disso, observou-se grande adesão da comunidade escolar de diferentes instituições, incluindo familiares, o que reforça o potencial do projeto como ponte entre ciência e sociedade. Dessa forma, a experiência comprovou que o uso de foguetes didáticos vai além do caráter lúdico, configurando-se como ferramenta de ensino capaz de despertar vocações, consolidar práticas interdisciplinares e contribuir para a difusão da ciência.

Palavras-chave: Foguetes Experimentais. Ensino de Física. Extensão Universitária. ORLAFOG.

RESUMEN

El uso de cohetes educativos como recurso pedagógico se destaca como una estrategia eficaz para la divulgación científica y la estimulación del razonamiento lógico en diferentes niveles educativos. Este trabajo muestra cómo un proyecto logró despertar el interés de estudiantes y docentes, generando aprendizaje a partir de la construcción y el lanzamiento de cohetes educativos experimentales, una actividad que requiere la aplicación del método científico, cálculos aerodinámicos y de estabilidad, la elección de materiales apropiados y la organización del trabajo en equipo. La propuesta acerca a los jóvenes a la ciencia de forma lúdica y práctica, abordando el creciente interés por la materia y la importancia de integrar la escuela, la comunidad y la cultura científica. El desarrollo de las actividades se llevó a cabo mediante talleres, la recepción de estudiantes y la participación en eventos de difusión, con especial énfasis en las dos ediciones de ORLAFOG (Olimpiadas de Cohetes de la Región de los Lagos), organizadas por el equipo IFRockets y posibilitadas por la aprobación en una convocatoria del CNPq. Los resultados obtenidos demostraron un fuerte compromiso de los participantes, reflejado en la formación de nuevos equipos de cohetes, una mayor participación en competiciones y la intensificación del razonamiento científico en el aula. Además, se contó con una importante participación de la comunidad escolar de diferentes instituciones, incluyendo familias, lo que reforzó el potencial del proyecto como puente entre la ciencia y la sociedad. De esta forma, la experiencia demostró que el uso de cohetes didácticos va más allá del mero entretenimiento, consolidándose como una herramienta didáctica capaz de despertar vocaciones, consolidar prácticas interdisciplinarias y contribuir a la difusión de la ciencia.

Palabras clave: Cohetes Experimentales. Enseñanza de la Física. Extensión Universitaria. ORLAFOG.

1 INTRODUCTION

Taking place at the Fluminense Federal Institute *Cabo Frio campus*, the *IFRockets project* articulates knowledge at a theoretical and practical level, presenting scientific processes to society, seeking to facilitate the process of transforming wise knowledge into taught knowledge. In this way, it provides inclusion in access to knowledge, ensuring new possibilities and opportunities for the popularization of Science. The team is composed of higher education students and technical high school students and has as one of the principles the strengthening of interdisciplinarity inside and outside the team. The project promotes knowledge exchanges from various areas, being an alternative for cooperative work in search of an improved development of activities, from team management to the application of technical knowledge presented in the classrooms. In the community, it plays an important role in extension, in scientific dissemination for students and teachers in the context of continuing education.

According to the National Plan for Space Activities 2022-2031 (PNAE 2022-2031), in its Strategic Objective for Space 05 (OEE.5), part of the strategy is "to foster the development of scientific, technological and innovation skills for the space sector":

Technical training, higher education and postgraduate courses - specialization, master's and doctorate - are the instruments for the materialization of this potential. The space production chain is of high added value, which catalyzes the generation of income and the economic development of the country. However, success in this market depends on professionals qualified to deal with the specificities of this niche. Thus, the continuous promotion of professional training and academic training becomes a priority agenda for the growth of space activities in Brazil. (GOV.BR - 2022)

The alignment of the *IFRockets project* in relation to national demands is verified, adding value of innovation and entrepreneurship to this work, which also corroborates with the PNAE: "Also, the availability of labor needs to be in the set of factors to be considered. In this aspect, the identification of thematic groups capable of promoting scientific and technological development in the country becomes essential". The project works by developing mastery of technology and disseminating the need, justified by a set of factors, for social and financial investment in this area that becomes comprehensive and strategic for the national economy. In addition, the activities developed arise from the legal requirement of the curricularization of extension in higher education courses presented in CNES/CES resolution No. 7, of December 18, 2018, which says in its article 3:

Art. 3 Extension in Brazilian Higher Education is the activity that is integrated into the curricular matrix and the organization of research, constituting an interdisciplinary,

political, educational, cultural, scientific, and technological process, which promotes the transformative interaction between higher education institutions and other sectors of society, through the production and application of knowledge. in permanent articulation with teaching and research. (MEC-2019)

Therefore, it is noted that the academic group *IF Rockets* has the potential to articulate Teaching, Research and Extension which, according to the objectives of the Federal Institute of Education, Science and Technology of Rio de Janeiro, guarantees "a continuous and permanent dialogue between the local community and the curricular project of the courses involved". The project has reached elementary school students with a more playful presentation proposal and teachers from municipal and state schools, offering technical training and exchanging experiences of teaching strategies in the areas of Science and Mathematics.

2 PROJECT AND TEACHING-LEARNING

Active learning methods make students participate in the teaching-learning process in a collaborative way, being the protagonists in the production of knowledge. The project does not advocate any specific method, but, in fact, some methods can be used as a reference for the development of learning, as presented below. The project enables challenges scaled by levels, respecting the previous knowledge of the participants and the teacher acts as a mediator in new discoveries, provides inclusion and learning of different subjects.

2.1 PROJECT-BASED LEARNING (ABP)

The whole approach during the process of building the rockets seeks to pass on responsibilities to the student and that success will depend on their dedication and commitment. It is always reinforced that success, in this case, will not mean victory over competitors and that the important thing is to evolve with your project. In this context, Bender (2014), in his studies on this methodology in modern education, says:

PBL can be defined as the use of authentic and realistic projects, based on a highly motivating and engaging question, task or problem, to teach academic content to students in the context of cooperative work for problem solving. [...] Students' inquiry is deeply integrated into project-based learning, and because they generally have some discretion regarding their group's project and the methods to be used to develop them, they tend to have a much greater motivation to work diligently on problem-solving (BENDER, 2014, p. 15).

Thus, the rocket construction project fully connects with this methodology and presents all the criteria for the development of solid and non-mechanical learning.

2.2 MAKER CULTURE

Maker Culture is a movement that gained strength in Brazil from 2010 and has a line of action along the lines of "hands-on" or "do it yourself". Nowadays, a good number of schools have received the Makers or LabMakers spaces with equipment and tools for services such as laser cutting, modeling and 3D printing. These spaces stimulate creativity and enable the construction and innovation of parts for the rockets. In addition, authors such as Duque (2023), argue that:

Maker culture can be a valuable tool for specialized educational care, since it is based on the idea that everyone can learn and create, regardless of their abilities and limitations. Through maker culture, students with educational needs can explore different approaches to learning, experiment with new forms of communication and expression, and work on projects that are experimenting for them. (DUKE, p. 155)

Students participating in the project can choose a subsystem of the project. They can work in the development of parts for aerodynamics, recovery and avionics (electronic sensors and parachutes), they can develop propulsion systems, develop launch bases, can articulate the team's marketing by recording and publishing activities on social networks or can be responsible for scheduling visits and external events (extension).

2.3 MULTIDISCIPLINARITY AND STEAM EDUCATION

The project presents demand in several disciplinary areas and demonstrates potential for practical application of many theories of Physics (all dynamics for rocket flight), Chemistry (physical-chemical reactions for propulsion), Biology (environmental preservation issues and Astrobiology), Engineering (design of parts and study of materials), Electronics (use of sensors) and can also be support for discussions in Geography (geopolitics and geolocation), History (cold war), Informatics (modeling software), among other possibilities, so the multidisciplinary characteristic of the project is very clear.

One of the pedagogical approaches that we have defined as a basis for developing multidisciplinary is the STEAM methodology, which stands for *Science, Technology, Engineering, Arts and Mathematics*, respectively. The methodology allows for active, dynamic, and creative learning, as indicated by MAIA (2021)

STEAM Education is not characterized as a teaching methodology, but a pedagogical approach that is linked to different proposals for active learning. As Riley (2020, p.1) emphasizes: it is about "(...) an approach to learning that uses Science, Technology, Engineering, Arts and Mathematics as access points to guide student inquiry, dialogue and critical thinking". By exploring skills such as problem-solving, creativity, and collaboration, models of active methodologies such as Problem-Based Learning or

Project-Based Learning (PBL) align with the way the approach is developed. Thus, STEAM Education favors creative and hands-on learning (maker), which provides students with opportunities to learn through the development of projects, with their peers, with engagement and experimentation (RESNICK, 2014). This conception is in line with what Blikstein, Valente and Moura (2020) highlight and call STEM-amplified or STEM-rich. (MAIA, 2021, p. 71)

3 METHODOLOGY

The project execution methodology consists of the development of integration work and deepening of content for the students who are part of the project at the IFF *Campus* Cabo Frio. Another aspect of the methodology is the strong performance in extension activities, through visits to basic education schools, predominantly public schools, in addition to participation in educational events and scientific dissemination for the community in general, such as fairs, festivals and actions of the Science Caravan program – IFF Cabo Frio.

In the internal activities, the members of the project, organized into subsystems, develop and design components of the experimental rockets developed by the team. In addition, several types of rockets are also produced, from the most playful levels that aim not only at scientific learning, but also at motor-cognitive stimulation - to more elaborate levels, promoting logical thinking and the scientific method. This practice allows the student to take an applied and in-depth look at the contents studied, in a multidisciplinary way, with a view to the operation of different areas of knowledge. The students who are part of the project are from various courses at the institution and participate in the subsystems they choose, being encouraged to make periodic exchanges even though they know that integration happens all the time.

The extension subsystem is the one that brings demands from external events where the team makes exhibitions, demonstration launches, participates and organizes competitions. In the years 2024 and 2025, the team was responsible for the Olympics of the Rocket Lakes Region, an event that had the support of city halls, teacher training and training workshops and distributed approximately one thousand awards. The event is developed during the year with dissemination, meetings with city halls, visits to schools, offering workshops in teacher training meetings and the culmination takes place at the end of the year with the award ceremony, where the entire process is valued by delivering medals to students and teachers, respecting the classification of the measurements of the launches, but distributing medals and certificates to all participants. Later we will talk a little more about the impact of this event.

3.1 DIDACTIC ROCKETS

Rockets are transport vehicles that work by propulsion. This propulsion can be a mass of gas or liquid expelled from the back of the rocket or by transferring energy in some other way.

To have good rockets, two points deserve attention: the body, divided into a hood, fins and payload compartment; and the base, which guides and stabilizes the rocket during initial propulsion, a phase of more turbulence. The most interesting thing is that all levels of rockets, in varying dimensions, always have these parts that are fundamental for the rocket to have a stable flight.

Figure 1



Source: A.I.-generated (<https://g.co/gemini/share/3de5212af2f5>).

For the development of this extension work, rockets were selected that were easy to assemble, but that scaled levels of technical difficulty and that increasingly offered possibilities for personal adjustments that could improve the performance of the rocket. The activities developed have always had a bias of competition and exchange. All teams seek improvements and innovations, but always sharing results with those who are interested, building an environment of mutual growth. Below, we describe the rocket models used for the presentations and competitions.

3.1.1 Shock rocket (collision)

Figure 1

Rocket with pogo stick, barbecue stick and pen tube



Source: prepared by the authors.

This rocket is our first to be presented, made of very accessible material, with a very low cost and very playful. It is assembled with a "pogo stick" ball and a barbecue stick for the launch base and the rocket body made with a school marker tube and pieces of plastic in the shape of a hood. Its launch can be done in any space and just hold the stick vertically and abandon the set. When the ball collides with the ground, there is a transfer of energy from the ball to the rocket, which launches it in the opposite direction of the fall, that is, upwards. In this throw, the launcher needs to use the pincer grip with his fingers and concentrate so as not to create turbulence when leaving the system. With it it is possible to work on concentration, development or maintenance of fine motor coordination, being an excellent activity for children in the early years and the elderly.

Figure 2

Shock rocket launch (collision)



Source: Prepared by the authors.

3.1.2 Paper and compressed air rocket (blowing)

Figure 3

Blow rocket construction



Source: Prepared by the authors.

Figure 4

Blow rocket presentation



Source: Prepared by the authors.

This rocket presents, at a very safe level, the opportunity for the student to seek techniques and/or innovations to improve the result of the launch of their rocket and already brings them the awareness of launch control. Initially, this model can be assembled based on a pet bottle with a piece of pipe attached and the rocket made of sulfite paper. However, they usually soon realize that they can achieve a higher propulsion speed if they change the pet bottle base for a base made of pipe and "PVC" connections, as illustrated in the following images.

3.1.3 Pet Bottle and Compressed Air Rocket

The PET bottle and compressed air rocket offers many possibilities for improvement and already provides more sophisticated challenges that require participants to study some theory, define processes to reduce risks and damage. This rocket cannot be launched and worked without a safety *checklist*. The base of this rocket already needs to have a depressurization valve, launch lock and guarantee of a safe distance for launch. In this type

of rockets, elementary school children already have direct contact with more specific content, such as Newton's Laws and Aerodynamics concepts - and this happens in a light and natural way.

Figure 5

Rocket pet bottle with its PVC base



Source: Prepared by the authors.

3.1.4 Rocket with propulsion through the reaction of vinegar and bicarbonate

Figure 6

Rocket participating in ORLAFOG 2025 at the Campos Novos farm – Cabo Frio RJ



Source: Prepared by the authors. Photographer: @eu_jotage.

Figure 7

Rocket propulsion in competition ORLAFOG 2025



Source: Prepared by the authors. Photographer: @eu_jotage.

Rocket also made of pet bottle, with a base structure equal to that already worked in the final years of Elementary School, but this type of rocket is indicated and worked only with High School students. Controlling the launch is more difficult, because the previous rocket, with compressed air, was pressurized by an air pump and now the students need to set up a procedure in which vinegar and bicarbonate come into contact only inside the rocket with it already locked at the base. There is a need to determine the right amounts of vinegar and bicarbonate so that enough gases are generated to culminate in a satisfactory internal pressure for the rocket to reach the greatest possible distance. Aerodynamics are key and they can already use simulators to design their rockets. They are already encouraged to use 3D modeling and printing to build their rockets and other improvements can be made, following some safety standards, such as, for example, the prohibition of using metal in the body of the rocket.

3.1.5 Paper rocket with solid propulsion

This rocket transitions from basic to college level. On this rocket, several tests are already necessary before launch. This rocket has a paper body, but it already begins the studies of electronics and recovery for the rockets launched. The students, in addition to having to design an engine, usually mixing potassium nitrate-based fertilizer with sugar, already receive the difficult challenges of attaching parachutes and sensors to the rockets, distributing the mass and taking care not to lose the stability of their rocket.

Figure 8

Solid propulsion rocket launch



Source: Prepared by the authors.

Figure 9

Paper rockets and solid propulsion at their launch bases



Source: Prepared by the authors.

3.1.6 University Rockets

These rockets have several categories according to the intended apogee, among them, 500 meters, 1 kilometer, 3 kilometers. For this, it is necessary to size the engine, do burn-in tests and static tests. For all university categories, sensors such as an altimeter, and a recovery system with parachutes and, if possible, GPS are mandatory. In fact, university rockets enable a lot of practical application of the knowledge presented in the classroom of various courses: Mathematics, Physics, Engineering, Chemistry, Biology, mainly.

Currently the team is working on the design and testing of the Genesis rocket, its aerodynamics are being prepared for 500m and 1km apogee flights, for this two engines are being sized to have the necessary thrust without failure or explosion. For everything to go well, several static burning tests are being carried out to determine the impulse generated, associated with the thermal resistance of the materials. In parallel, all avionics and recovery systems are being prepared. Only after these tests can the rocket actually be launched. It is a process of a lot of disciplined work, but very rich. In the three years of development of the team, higher education students have already produced research presented at the National Congress of Mechanical Engineering (CONEM – 2024) on the treatment of fin materials, Course Completion Work (TCC) research of the bachelor's degree course in Mechanical Engineering on hydraulic machine for propellant compaction and sizing and virtual simulation of rocket engines and a TCC of the Physics Degree course on student learning regular classes through the application of the project to the 1st year of High School.

Figure 11

Genesis rocket projected by the team to an apogee of 1km



Source: Prepared by the authors.

3.2 EXTENSION ACTIVITIES

In activities outside the Institute, the project serves, in particular, the seven municipalities of the Lakes Region, but also the other neighboring cities. The Project team has participated in educational events. The extension actions also have rocket development workshops, working as a mini-course, in order to include the community in general in the production of rockets. The project has been in contact with partner schools, city halls in the region, secretariats and education coordinators, with a view to the extension work together with public agencies, which enabled the planning of the Olympics of the Rocket Lakes Region (ORLAFOG), organized and carried out by the *IF Rockets project*, with support from the Institution and CNPq/MCTI, through approval in a public call, in an action to popularize Science.

3.2.1 ORLAFOG in Numbers

The activities developed in educational and scientific dissemination events demonstrated a strong demand for interest from young people in the development of rockets, a fact clearly perceived in the testimonies, in interactions in digital communication vehicles, such as Instagram (@ifrocketscf), and in the great interaction of the public with the project's activities. The Rocket Lakes Region Olympics (ORLAFOG) had its first edition in October 2024, on the 17th and 25th.

Two moments of the ORLAFOG Teachers' Meeting were planned and implemented, an event that aimed to train, qualify and support the faculty responsible for coordinating the participating teams. At first, we had the participation of 40 teachers working in State Schools. In the second moment, we were with 80 teachers from the municipal network. Everyone was able to participate in Modeling, 3D Printing and Rocket Workshop training and discuss new active teaching-learning approaches through the didactic rocket project. There were

moments of great interaction and exchanges that resulted in 72 teams of students enrolled for ORLAFOG.

The Olympiad took place on a farm provided with the support of the city of Armação de Búzios RJ and the participants were able to experience all the emotion of competing and see the result of the work developed in their schools. There were schools representing 14 municipalities in the state of Rio de Janeiro and the award was a moment of great celebration for everyone.

Figure 12

ORLAFOG 2024 competition - Búzios RJ



Source: Prepared by the authors.

Figure 10

ORLAFOG 2024 Award Ceremony, in the IFF Cabo Frio RJ campus auditorium



Source: Prepared by the authors.

In 2025, the organizing team focused on publicizing and encouraging municipalities that had not yet participated, while still supporting schools that were excited to improve their participation. On average, the participating schools increased their participation and new schools came to participate and develop projects in their schools. A great example was the municipality of Cabo Frio, which had 5 teams in the first edition and in the 2025 edition, it increased to 66 registered teams, such was the repercussion within schools and the education network. At the end of registration, a total of 212 registered teams were reached, representing 19 municipalities in the state.

The ORLAFOG event in these two editions moved approximately 200 teachers, with more than 1000 students participating, with approximately 80% of the participants being first-time in didactic rocket competitions. It provided an opportunity for interaction between society and undergraduates, offering practical experience both in the area of the degree and in the area of engineering.

Figure 11

Teacher and students from the public school system of Búzios RJ in action at ORLAFOG 2025



Source: Prepared by the authors. Photographer: @eu_jotage.

Figure 12

ORLAFOG 2025 award ceremony, in the auditorium of the IFF campus Cabo Frio RJ



Source: Prepared by the authors. Photographer: @eu_jotage.

4 RESULTS AND DISCUSSIONS

In fact, developing the didactic rocket activity proved to be a multidisciplinary tool of great scope and impact. The activity offers the possibility of working at various levels of difficulty and discussing various subjects in various areas of knowledge. The activity provides the student with protagonism and engagement, and places the teacher in a situation of mediator of knowledge, with students being the main actors in the process.

Figure 13

Competitor interaction with his fans - ORLAFOG 2025



Source: Prepared by the authors. Photographer: @eu_jotage.

At first, the teacher thinks he cannot handle the activity. They are afraid of the school calendar of their schools, imagine difficulties with the number of students and show concern about the safety and commitment of students. In the training meetings, however, we explained that the organization and the idea of orderly procedures, with a weekly *check-list*, does not allow any lack of control of the activities. Of course, some teams may not finish the process and not all students may want to launch their rockets, the minority, but even these students get involved studying theory, helping the teams in their class and cheering.

We have always defended the idea that the project is not just to launch rockets, but to provide an experience of coexistence, project management, teamwork that develops skills for modern life. The fact is that the teacher needs to build knowledge in agreement and together with the student. The result is always the embrace, on the one hand, the happiness of the success achieved by the effort and dedication of your student or the reception for an unexpected result. On the other hand, the student's hug of gratitude for the support, for the opportunity to be living a very learning and pleasurable activity.

Figure 14

Teacher-student interaction at ORLAFOG 2025



Source: Prepared by the authors. Photographer: @eu_jotage.

For university extension students, it is a unique opportunity to apply technical knowledge, work in project management, sharing experiences with their peers, add autonomy to their training, enable their condition to deal with others, experience an activity that often requires leadership and problem solving.

Figure 15

Undergraduate students working in the organization of ORLAFOG 2025



Source: Prepared by the authors. Photographer: @eu_jotage.

5 CONCLUSIONS

The project, started in 2022, today has volunteers, and its organizational structure is composed of the Coordinating Professor, CEO, subsystem managers and its members. This organization promotes a greater direction of activities and focus on the development of each sector. Although it is separated into subsystems (avionics, recovery, propulsion, marketing, extension), there is an exchange of knowledge, ideal for team integration. In addition to the partnerships formed during the construction and execution of the project (schools, city halls, integrated projects of the institution, partner events) and the help of the Institute's employees, there is also an exchange with other more experienced experimental rocket teams. This collaborative environment contributes to an exchange of experiences from different perspectives, from the "school floor", making the participating public know everything from playful rockets made with very simple materials to university rockets. In the context of teaching, the project works on the fundamentals of Project-Based Teaching, the *STEAM* approach, the *Maker Culture*, based on the principle of having the student as the protagonist, with the application of active learning methods and presenting various levels of participation, facilitating school inclusion respecting the previous knowledge and the level of initial knowledge of each student. The project presents an excellent and viable tool for university courses to implement as an extension curriculum option, currently required by the MEC and contributes to the national plans for the development of activities in the aerospace sector.

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