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STARTUP EXPERIENCE INITIATIVE: A MODERN APPROACH TO INTEGRATING EDUCATION, RESEARCH, ENTREPRENEURSHIP, AND SOFT SKILLS TRAINING

André Bellin Mariano
Sustainable Energy Research and Development Center (NPDEAS)**,** Department of Electrical Engineering**,** - Federal University of Paraná **(UFPR)**, CP 19011, 81531-980 Curitiba, PR, Brazil**.**
e-mail:andrebmariano@gmail.com.

Flávio Júnior Santiago Silva
Ihana de Aguiar Severo
Erick Kollross
José Viriato Coelho Vargas
Sustainable Energy Research and Development Center (NPDEAS), Department of Mechanical Engineering, - Federal University of Paraná (UFPR), CP 19011, 81531-980 Curitiba, PR, Brazil.
e-mail: flaviojrsantiago@gmail.com, ihana.aguiar@gmail.com, erickollrosss@gmail.com, vargasjvcv3@gmail.com.

Abstract. *Educational institutions provide a space for knowledge, learning, and innovation through scientific research, in addition to providing a support structure for students, professors, and researchers to develop innovative work that promotes sustainability. Within this context are university extension projects, where the objective is to have a social impact on society with actions that can improve people's lives. Based on this, the Startup Experience Initiative aims to explore the contributions of research projects in creating startups as a model of academic entrepreneurship. This work discusses how the proposed methodology can be useful in the application of research knowledge in academic entrepreneurship, identifies the main contributions and challenges of the initiative in the university, and provides a model and guidelines for the implementation of the methodology in educational institutions, as well as involves the application of problem-based/project-based learning (PBL) teaching concepts and focus on the development of innovative entrepreneurship that relates to the productive sector and the local ecosystem (municipality and state). The project also includes university extension actions aimed at disseminating science, technology, and innovation to society, promoting science for all, where it is based on the integration of a) physical spaces for innovation; b) professional training (hard and soft skills); c) interdisciplinarity, and d) actions for entrepreneurship. The Startup Experience Initiative Methodology serves high school, undergraduate and graduate students from different areas of knowledge. Through the Startup Experience methodology, 76 startups were created, which went through the entire process from ideation to the creation of the Minimum Viable Product (MVP), through courses lasting 20, 45, 60, and 149 hours. More than 300 students from various undergraduate, specialization, master's, and doctoral courses were directly involved in this process. Some of the startups developed through this program are already operating in the market, demonstrating the effectiveness of the adopted educational approach and highlighting the importance of educational design as a tool to promote entrepreneurial education and the development of practical skills in an academic environment*.

Keywords: *Educational institutions, Startup Experience Initiative, Academic entrepreneurship, Innovation and Research projects.*

1. INTRODUCTION

In the realm of educational institutions, a profound commitment exists to foster knowledge, learning, and innovation through scientific research. These institutions not only serve as spaces for intellectual growth but also establish a support structure for students, professors, and researchers to embark on groundbreaking endeavors that promote sustainability. Among these endeavors are university extension projects, aimed at generating a positive social impact by implementing actions that enhance the lives of individuals and communities (Haan, 2019).

Within the ever-evolving landscape of education, university extension projects play a pivotal role in bridging the gap between academia and society. These initiatives serve as conduits for the application of theoretical knowledge and the practical implementation of innovative ideas. By engaging with communities and addressing their specific needs, extension projects strive to create tangible solutions that address societal challenges and contribute to sustainable development (Smith, 2022).

In the case of Brazil, although innovation and entrepreneurship education are already present in some disciplines and teaching courses, there is still a substantial distance between academia and the market (Dalmarco et al., 2018). One of the

major bottlenecks for those who want to transform a research result into technology or a business model is precisely the entrepreneurial culture. This is because just over 10% of Brazilian initial entrepreneurs indicate that their product, process and technology are new in the place where they operate. This reality of low competitiveness businesses in the country revisits the need to encourage knowledge-based entrepreneurship, which can be represented by multiple initiatives, including government support for the transfer of technology from universities to the market. This occurs in the context of academic entrepreneurship and Technology Based Companies (Fonseca and Nassif, 2019).

In view of the facts presented so far, the authors leading this study started, implemented, and/or have actively participated in the "Startup Experience Methodology" (SEM), created in conjunction with researchers from Sustainable Energy Research and Development Center (NPDEAS), at the Federal University of Paraná (UFPR, Curitiba-PR, Brazil), which promotes the development of technologies that are directed towards society. This method was made official by the extension project "Science for All" (*Ciência para Todos*, in Portuguese) (Santos et al., 2021).

In brief, the SEM consists of the application of the teaching concepts of Problem/Project-Based Learning and focused on entrepreneurship with high school, undergraduate, and graduate students relating to the productive sector and local and regional innovation ecosystem (Santos et al., 2021).

1.1 Background

1.1.1 Startup: A review

In an objective and general way, a startup is a company born from an agile and lean business model, capable of generating value for society by solving an existing problem in the community. Therefore, it offers a scalable solution for the market and, for that, it uses technology as it is the primary tool (Abstartups, 2022). However, startups have a very competitive and uncertain evolution path, which is continuously faced, having to deal with several situations for which entrepreneurs in many cases are not prepared, such as patenting their idea, product, or service and creating workgroups according to the needs of the stages of your enterprise, and seek investment capital (Jesemann, 2019).

For a startup to be successful, it is necessary to know the life cycle of a startup, involves the following steps: i) the conception of the idea, identifying opportunities, and ways of solving the problem; ii) organization and preparation, which refers to the elaboration of the proof of concept (prototype), which will serve as a test for its technical and economic feasibility. At this stage, the business steps must be planned, involving the resources (human and financial) that will be needed, the operating model, the place to find investments, the tools to use, etc; iii) in the third stage, the work execution process begins, which is time to validate the product or service, understand if it really is market demand, and this product will be consumed by the target audience; and finally iv) to understand, according to the previous step, whether it is the growth or termination of the project (Feld, 2019). **Table 1** shows the four phases of the project management lifecycle.

Table 1: Typical project life cycle.

Stage	Description
1. Initiation	This stage involves identifying and defining the project's objectives, scope, and feasibility. Project stakeholders are identified, and initial planning takes place.
2. Planning	In this stage, detailed planning is done, including creating a project plan, defining project tasks, estimating resources and timelines, and developing a budget. Risk assessment and mitigation strategies are also established.
3. Execution	The execution stage involves implementing the project plan, assigning tasks to team members, and coordinating activities. Regular communication, monitoring, and tracking of progress occur to ensure tasks are completed as planned.
4. Monitoring and Control	During this stage, project performance is monitored, and deviations from the plan are identified. Necessary adjustments are made to keep the project on track, and risks are continuously managed.
5. Closure	The closure stage marks the completion of the project. Final deliverables are reviewed and handed over to the client or relevant stakeholders. Lessons learned are documented, and a project review is conducted to assess its success and identify areas for improvement.

Many of these startups, that are in the initial phase, start their trajectory without paying attention to the legal structure and other factors related to the activity carried out. In addition to the late search for regulation, as well as Brazilian laws themselves, which do not present norms for the singularities and complexity of startups (Marcon, 2021). However, there was a change after the federal government sanctioned complementary law No. 182, of June 1, 2021, which established fundamental definitions, principles, and guidelines for the legal framework for startups and innovative entrepreneurship (Complementary Law, 2021).

1.1.2 Entrepreneurship methods – Business models

The business environment is increasingly demanding and constantly changing, and in order to remain competitive in their markets, entrepreneurs seek news from innovative ideas to keep their loyal audience. Although the basic principles of entrepreneurship are the same, such as planning, opening and operating a business, the skills required may vary depending on the type of business (Smith, 2022).

Broadly speaking, entrepreneurship can be classified into four main models: (1) small businesses, (2) scalable startups, (3) large companies, and (4) social entrepreneurship (Lana, 2021). These models cover the fundamentals of starting a business and focus more on the company itself than on the qualities of an entrepreneur. Companies are constantly changing and increasingly competitive. This brings new opportunities to take risks and innovate, paving the way for new forms of entrepreneurship, such as startups.

Enterprise business models focus on three steps: (1) value creation, (2) value delivery, and (3) value capture (Johnson, 2023). The business model (BM) describes an organization's value logic toward the customer, that is, how it creates and captures customer value (Fielt et al., 2014). Interest in the study the BM has been growing since the 1990s, due to the increasing competitiveness of companies (Taran et al, 2015). The innovation of the business model (IBM) contributes to the competitiveness of companies is the creation and delivery of value, aiming to increase performance (Gassmann et al., 2017).

According to Slywotzky (1995) and Osterwalder et al (2002), a BM is a conceptual tool that contains several interrelated elements that allow explaining the logic of a business of a given company. BM depends on how the company selects its type of customers, defines its product and its differentiating characteristics.

This theory was rewriting by adding pillars that are formed by four essential questions, "What?"; "Who?"; "How?"; and "How much?". These questions are fundamental for the realization of a BM, considering that it is important to understand what is offered to the client, who is the target audience, how the tasks proposed for the client can be performed and how much can be earned in the transactions made by the company (Osterwalder et al., 2002). Startups are an example of opportunity entrepreneurship. These are small companies, usually technology-based, that offer a reproducible and scalable service, such as the methodology that integrates other agile management and business development methodologies, such as Scrum, Design Sprint, Lean Startup, Design thinking and Extreme programing methodology, as detailed below (Chart 1).

Chart 1: Business development methodologies.

Methodology	Concept	Key Activities
Scrum	Agile framework	• Daily Standups: Daily progress meetings; • Sprint Planning: Planning the work for each sprint; • Iterative and incremental development of products/services.
Design Sprint	Rapid innovation and design process	• Define the challenge or problem to solve; • Generate ideas and solutions; • Rapid prototyping and testing.
Lean Startup	Learning and validation-based approach	• Build a Minimum Viable Product (MVP); • Measure and learn based on results; • Rapid iterations and adaptation.
Design Thinking	User-centered and creative approach	• Empathize with users and understand their needs; • Define the problem and establish a focus; • Ideate solutions and generate prototypes;
Extreme Programming	Agile software development approach	• Pair Programming: Collaborative development in pairs; • Continuous testing and refactoring; • Frequent delivery and close collaboration with the client.

1.1.3 Teaching, Research, and Extension at the University

In Brazil, there is a demand to implement the curricularization of extension activities. According to the National Council of Education resolution CNE/CES No. 7/2018, it establishes the Guidelines for Extension in Brazilian Higher Education and regulates the provisions of Goal 12.7 of Law No. 13,005, dated June 25, 2014. The mentioned goal states: 12.7) ensure, at least, 10% (ten percent) of the total required curricular credits for undergraduate programs be dedicated to university extension programs and projects, prioritizing actions in areas of significant social relevance.

At UFPR (Federal University of Paraná), there is the Integrated Week of Teaching, Research, and Extension (SIEPE), which integrates Teaching, Research, and Extension with the purpose of promoting and stimulating interaction among faculty, undergraduate and graduate students, technical education, high school education, technical staff, and the general community. During SIEPE, knowledge and experiences are shared through reflection on various topics across different areas, facilitated by projects supervised by UFPR faculty and developed in teaching, research, and extension activities.

2. METHODOLOGY

2.1 The Startup Experience Initiative – SEM

The SEM was initially established in mid-2008 and made official by the "Science for All" project (*Ciência para Todos*, in Portuguese) in august 2016, at the Sustainable Energy Research and Development Center (NPDEAS), group led by the authors of this work. The methodology consists of applying the teaching concepts of problem/project-based learning (PBL) and focused on the development of innovative entrepreneurship, relating to the productive sector and local ecosystem (city and state).

Regarding Science for All, the project involves university extension actions aimed at disseminating science, technology, and innovation to society (http://cienciaufpr.blogspot.com/). Already NPDEAS, it consists of a Research and Development (R&D) group, which began its activities in 2008 at the Federal University of Paraná (UFPR), aiming to develop and apply solutions on an engineering scale of renewable energy (Costa et al., 2022; Dias et al., 2023), wastewater treatment (Miyawaki et al., 2021), microalgae-based processes and products(Dzuman et al., 2022; Severo et al., 2021), and engineering design (Vargas et al., 2014) for the industry, in addition to research with national and international partnerships (http://npdeas.blogspot.com/).

In this line of action, the integration between the SEM initiative, extension project, and R&D group forms a technological package that directly and indirectly influences society. Through the development of startups that create mobile applications and other products and services, this package facilitates the daily lives of the population and improves their quality of life. The implementation and results achieved from this package have a significant impact on society.

Additionally, the Startup Experience Initiative is based on the integration of physical spaces designed for innovation, professional training (technical and behavioral skills), interdisciplinary actions, and entrepreneurship, as described in Figure 3.

The SEM can influence society directly or indirectly through innovative technologies, ranging from creating new products or services to improving existing ones. This allows high school students to participate in startup development teams, alongside undergraduate students who can enhance their scientific research or identify problems in society that their degree can solve. Postgraduate students (Master's and PhD) can use their research to turn it into possible businesses that generate value for society. This is possible through integration within the university itself, which can provide infrastructure and direct participation with technicians and other professors who can assist in the creation of innovative or existing ideas.

2.2 Startup Experience Initiative application

The SEM application consists of the implementation of innovative solutions during a few hours or weeks of immersion in the development and improvement of new or existing ideas with practical and viable solutions for the community in general.

The implementation stages of the methodology are depicted. First, students are separated into groups, where each team must start their research on existing problems in society through data collection, analysis, and survey of "pains" (problems already identified) as an evaluation of these problems and in-depth interviews, which will later have to be resolved. The topics involve issues related to accessibility, urban mobility, biomedical engineering, smart cities, smart home, agribusiness, biotechnology, renewable energy, industry 4.0, digital agribusiness, ergonomics, among others. These axes must be viable and feasible to generate value in society

Regarding team formation, all group members are assigned roles related to the startup ecosystem, in which case each member takes responsibility for their position, and thus a better division of activities for the development of the proposed solution. With this, the positions of executive director, operational director, financial sector, human resources, product technology, marketing, and dissemination, among other functions can be created according to the specifics of each project as shown in Figure 1.

Figure 1: Division of roles for each team member

After the division of all positions among team members, the SEM methodology presents a set of several tools according to the innovation ecosystem, which are methods used and validated by various unicorn startups (startups with a market value above 1 billion dollars), that were essential to put the business idea into practice, through exploration, whether by conducting interviews or listening directly to their potential customer, so that it is possible to identify and validate the real need of their future customer.

Validate the proposal for a product or service solution through the Minimum Viable Product (MVP). Then, structure a business model, identify initial strategies, and participate in innovation events with pitches to expose your product or service to potential sales or investors. The main tools used by this methodology are presented in the following sections.

According to some investors, the main success factors of a startup are: team, market and product. Because a team needs to have the specialized competence to perform the activities effectively, that is, it is necessary to be familiar with the chosen topic. The team needs to be resilient or flexible to any changes/activities during the ideation journey as well as having good communication skills (Feld, 2019).

To create a product or service, the startups need to understand what the customer's needs are and how the competitors operating in the market where startups want to have market share, seeking differentials, attractive alternatives for future customers, and also verifying the cost of manufacturing and selling to the final consumer. It must be performed always complying with government laws according to the product or service developed.

As an example, follows an application of the methodology already validated for a period of 10 weeks, where the activities of each team/startup go through four phases, from the beginning of the project, the organization, execution until a possible presentation of a MVP. In addition, content on the impact and culture of a solution in a society, the life cycle of a project/startup, the phases of this project, such as the ideation phases, and future perspectives are studied. **Table 3** shows a schedule of activities during the 10-week period, or, depending on the need and availability of each class, this schedule is changed.

Table 2: Activities developed during the 10 weeks.

PERÍOD	DESCRIPTION OF ACTIVITIES
1º Week	All members are divided into teams, in which research begins to find opportunities/problems existing in society.
2º Week	Every team will have a Control Panel to manage all steps of creation of the Startup and manage all collaborators.
3º Week	Definition of the final theme and beginning of the project's ideation and structuring.
4º Week	Each team has a schedule of activities to be completed in the last 6 weeks, such as designing the flowchart of the product or service to be delivered by startup.

5º Week	The Startup must develop an action plan and a portfolio in advance, even if it is a draft for presenting the idea in digital channels.
6º Week	After planning actions, it is proposed for each team to create profiles on digital platforms to publicize the startup, how to present the company's mission, vision and values.
7º Week	With the activities carried out in recent weeks, each team has the ability to present preliminary results.
8º Week	Presentation of intermediate results and final portfolio.
9º Week	Presentation of the final results obtained by each team, how to present the MVP.
10º Week	Preparation of pitches – quick videos for dissemination in media channels or even for participation in events.

After defining the chosen theme and the theoretically found solution, each team focuses on performing all activities, among those in progress, an important one is associated with defining the name of the Startup, creating the logo, also defining the mission, vision and values of the company. Thus, with the objective of disclosing and prospecting future investors, as well as encouraging other students to be interested in entrepreneurship.

In the final phase, each team must be able to present a possible MVP, even if it is just a prototype in the testing phases. In addition, each startup creates short videos, called Pitch, for quick presentations at innovation events. Finally, through the methodology, the macro trends directed to the quality of life, health and well-being of the population are presented.

3. RESULTS AND DISCUSSUS

3.1 Startups

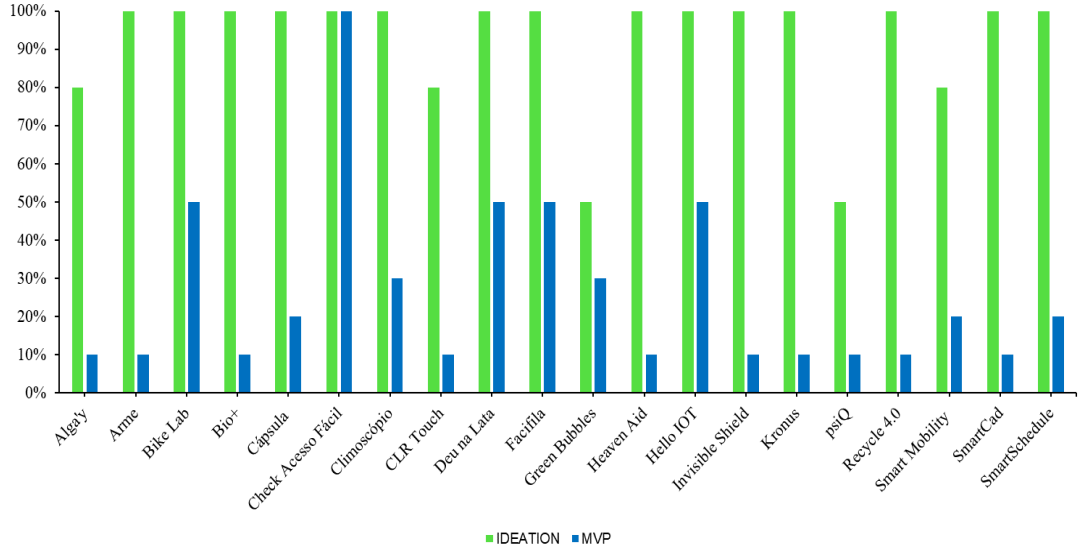
Figure 3 shows 20 startups developed through the implementation of the SEM, of which 17 managed to develop 100% of the ideation phase, that is, the main idea is defined according to the tools that were used in Table 2. Of these startups, one managed to prepare 100% of its MVP, which was Check: Acesso Fácil (Check: Easy Acess), which is based on a digital control system for managing access to UFPR's physical spaces, mainly including research laboratories. With this, it is possible to monitor the inflows, outflows and possible cases of contamination by COVID-19 or users who present symptoms (Santos, 2021).

Another startup that managed to prepare 50% of it is MVP is the “Bike Lab”, which uses portable equipment digitally linked to a cell phone application to collect data on pollution emitted by vehicles into the environment and control the behavior of bicycles in traffic and the health of cyclists. The startup “Green Bubbles”, which uses microalgae immobilization technology to remove pollutant compounds, also is another example (Silva, 2021). The other startups managed to deliver 10% of their prototypes.

And after this period, students may decide to continue executing the idea or abort it. In addition to these startups, there are “Hello IoT”(https://www.helloiot.com.br/), which is based on Internet of Things and engineering, and is already on the market; and the startup “*Castor Mecânico*”(Mechanical Beaver: https://www.youtube.com/@castormecanico), a spin-off, which promotes video classes using 3D modeling software. In this way, the application of the SEM methodology becomes useful for the development and improvement of ideas, such as planning, executing, and ultimately delivering an MVP to the market.

Following the ideation phase and the presentation of a product or service to society, startups are guided by UFPR's innovation agency. This agency is responsible for the dissemination and identification of potential investors interested in supporting these startups in transferring their technology to the community. It plays a crucial role in connecting these innovative ventures with the resources and funding required to actualize their ideas and ultimately benefit society at large. Through this collaboration, the university's innovation ecosystem works in concert with startups to bridge the gap between academia and the practical application of cutting-edge technologies.

Figure 2: Startups developed through SEM



3.2 Selected startups

The implementation of the methodology, several of the startups developed both through the Science for All extension project and the project management discipline at UFPR, created solutions to real business problems, and participated in innovation events, hackathons, pitches, such as some were also selected to receive investment from the state government and angel investors, and others were invited to become a startups accelerator (incubator). These startups are described below.

1) Bio +: Startup developed for real-time monitoring of microorganism cultures on a variable scale through an Internet of Things (IoT) device, with the objective of automating data collection, making them available to the final consumer, in addition to enabling the simultaneous monitoring of the process with just a single device. The Bio+ was one of the startups selected from several at a local event to receive financial investment.

2) Arme: The solution developed by the startup proposes the use of X-ray images, musculature, internal organs and infrared imaging as a didactic means for teaching human anatomy and disease diagnosis by interpreting three-dimensionally processed images using an application phone with augmented reality tools. As a result, the startup was among the top 100 most promising startups of the Paraná State Government to receive investment.

3) Hello IoT and engineering: This is a company that has been in the market for over three years, providing proprietary and on-demand solutions in the Internet of Things (IoT) and Industry 4.0. It achieved first place in the Hackathon of the Innovation Week at a local event, attributed to its product being already on the market, solving industry-related problems.

4) Check: accesso fácil (Check: Easy Acess): Mobile application developed for managing access control to UFPR environments and tracking possible cases of COVID-19. The startup was developed on demand by the Information and Communication Technology Agency of the Federal University of Paraná.

5) Psiq: Mobile application created for organizing clinics, automatic graphical generation of results, storage and categorization of data in the field of psychology. Startup participated in the innovation arena, which was invited to receive an investment to develop its technology.

6) Deu na lata: The startup's objective is to improve the logistics of the garbage collection system, thereby reducing energy, operating and pollutant emission costs through a cell phone application and smart device. The startup was invited to join a startup accelerator.

7) Facifila: Startup developed to manage queues on demand at the Hospital das Clínicas Complex of the Federal University of Paraná.

8) Capsula: It is an automated booth for pro-diagnosis of cancer imaging through more accurate exams than the traditional one, being non-invasive, non-radioactive and without the use of employees. The startup won 1st place on the Pitch Day Promoted by the Institute of Applied Technological Solutions at UFPR, in Curitiba-PR, Brazil.

9) Trajeto livre: This startup has developed a mobility assistance device for the visually impaired, aiming to enhance their mobility autonomy. The device is reliable and cost-effective, identifying obstacles that may not be detected by a standard mobility cane. It has been recognized as the best final project by the Regional Council of Engineering and Agronomy of the State of Paraná, and has received coverage in multiple local television programs.

In addition to the aforementioned startups, the SEM methodology has also been applied in major innovation events, including lectures, workshops, mentor training, as well as an academy of entrepreneurial methods for directors and CEOs of large companies, all with the aim of addressing societal demands or problems. Currently, the methodology is expanding throughout the state of Paraná, Brazil, through a new partnership with the Federal Technological University of Paraná (UTFPR) for the implementation of the SEM method in the city of Palotina, Paraná, Brazil.

4. CONCLUSION

This article presents the implementation of the Startup Experience initiative for undergraduate students, specifically in the Electrical Engineering course and the university extension project "Science for All" at NPDEAS, Federal University of Paraná. Through the utilization of innovative methods from the innovation ecosystem, the initiative aims to provide students with a practical and enriching experience.

The primary objective of implementing the Startup Experience methodology is the transfer of developed or enhanced technology over the course of a semester, focusing on addressing existing societal problems. This implementation can also be carried out within a 10-week period, as exemplified in one of the cases presented in this article. However, the Startup Experience methodology can be adapted according to the context of the course, project, researchers, professors, and others.

The main focus of applying this methodology is to enable students to develop new skills and be able to apply them outside the university environment. Among these skills, soft skills such as teamwork, people management, communication, planning, organization, empathy, ethics, leadership, conflict resolution, flexibility, marketing knowledge, and even fostering an interest in entrepreneurship and networking, stand out.

By participating in the Startup Experience initiative, students have the opportunity to experience an entrepreneurial environment where they are challenged to apply the knowledge acquired in the classroom. Additionally, the initiative seeks to stimulate students' creative and innovative thinking, preparing them for the challenges of the job market and fostering an entrepreneurial culture. With this innovative approach, the Startup Experience initiative aims to promote a more integrated education, where theory meets practice, and provide students with a comprehensive education focused on the application of knowledge and the development of essential skills for the current business world.

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