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ORIGINAL

# Educational innovation for entrepreneurship in the university system Axis model applied in CUAltos

## Innovación educativa para el emprendimiento en el sistema universitario Modelo Axis aplicado en CUAltos

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## ABSTRACT

Academic entrepreneurship has established itself as a strategic pillar in higher education by promoting competencies focused on innovation, sustainability, and productive transformation. This article presents the experience of the Centro Universitario de los Altos in implementing a multi-axis model that combines different institutional components with the aim of strengthening the entrepreneurial ecosystem in the educational environment. The multi-axis model promotes interaction between the university, industry, and government and integrates socio-ecological, cultural, and digital factors that enable the development of a knowledge-based economy. Through this approach, students acquire essential entrepreneurial skills, digital competencies, and interdisciplinary skills necessary to succeed in a rapidly evolving market. The results underscore the effectiveness of this model in bridging the gap between academic knowledge and industry needs, ultimately fostering innovation and sustainable development.

**Keywords:** Academic Entrepreneurship; Innovation Ecosystem; Interdisciplinary Education; Digital Economy; Sustainability; Knowledge Transfer.

## RESUMEN

El emprendimiento académico se ha consolidado como un pilar estratégico en la educación superior al promover competencias centradas en la innovación, la sostenibilidad y la transformación productiva. Este artículo presenta la experiencia del Centro Universitario de los Altos en la implementación de un modelo multieje que combina diferentes componentes institucionales con el objetivo de fortalecer el ecosistema emprendedor en el entorno educativo. El modelo multieje promueve la interacción entre la universidad, la industria y el gobierno, e integra factores socioecológicos, culturales y digitales que permiten el desarrollo de una economía basada en el conocimiento. A través de este enfoque, los estudiantes adquieren habilidades emprendedoras esenciales, competencias digitales y habilidades interdisciplinarias necesarias para tener éxito en un mercado en rápida evolución. Los resultados subrayan la eficacia de este modelo para salvar la brecha entre el conocimiento académico y las necesidades de la industria, fomentando en última instancia la innovación y el desarrollo sostenible.

**Palabras clave:** Emprendimiento Académico; Ecosistema de Innovación; Educación Interdisciplinaria; Economía Numérica; Sostenibilidad; Transferencia de Conocimientos.

## INTRODUCTION

In today's highly competitive and constantly changing professional environment, students are trained with tools such as Canva templates and renowned business plans, which are relevant and essential. Each student represents their university in the workplace, thanks to the development of their faculty. When a graduate contributes positively to an organization, it not only boosts their own career but also strengthens the image of the university that trained them during their professional development by expanding institutional prestige. This effect can facilitate new job opportunities for future graduates. Conversely, if their performance is poor, employers are likely to choose to hire talent from other institutions, which indirectly affects the professional's reputation.

To ensure that CUAltos graduates adequately meet the demands of the professional environment, it is necessary to analyze the institution's functioning as an integrated system. This ecosystem involves authorities, professors, students, academic programs, and administrative processes, all interrelated and working toward a common purpose. Furthermore, CUAltos maintains active relationships with the productive and service sectors, as well as with different levels of government, which offer support and resources to strengthen educational and outreach activities.

The unique focus of the Los Altos University Center reflects its strategic role in the Southern Highlands region of Jalisco, with a strong presence in the area, characterized by dynamic economic activity in both the agro-industrial and commercial sectors. In addition to training competent professionals, the university has been able to connect with the needs of its surroundings, promoting projects that seek local and regional development. Its participation in entrepreneurship, social innovation, and collaboration programs with productive sectors has given it a prominent position as an institution that promotes talent and transformation in its immediate context.

CUAltos programs are structured to be developed in defined periods, comprised of a logical sequence of subjects. These programs meet the requirements established by educational authorities, ensuring that graduates obtain a formally recognized education. However, the introduction of new skills, such as entrepreneurship, or the updating of methodologies and technologies, can be hampered by the rigidity of the curriculum system, which hinders the rapid incorporation of new content.

The goal is for students, regardless of their discipline of origin, to develop skills that enable them to create value, propose solutions, manage projects, and lead their own initiatives. We seek to train professionals with the ability to innovate, adapt, and transform their environment. A vision of the student as a knowledge generator involves developing individuals capable of creating ideas, adapting knowledge, and proposing solutions based on what they have learned, integrating academic and practical aspects. A knowledge generator does not simply reproduce content; rather, they generate new ways of understanding and addressing the social, technological, or productive problems that arise in their daily lives.

This initiative, to promote academic entrepreneurship across all disciplines, inspires students, regardless of their fields of study, to acquire basic entrepreneurial skills, positioning themselves as generators of new knowledge and innovation, contributing to the prestige of their university, strengthening their professional identity, and generating a positive impact on the society around them.

### Theoretical framework

To ensure that every student at Altos University Center has the opportunity to become a knowledge generator—an entrepreneur—we seek to design dynamic entrepreneurial ecosystems where academic entrepreneurship is present. This entrepreneurial ecosystem is based on the role that digital technologies play in universities. As at other universities, it has been successfully integrated into more comprehensive frameworks, where, as Schepers et al.[1] put it, four main areas of specialization have been identified: digital technologies in entrepreneurship education, the framework for establishing spatial movement, digital technologies for opportunity discovery, and the development of entrepreneurial skills within the Altos University Center ecosystem.

This exercise clarifies how each part of the model relates to the dynamics previously analyzed, facilitating its evaluation and implementation in diverse university contexts. It also integrates operational definitions of key terms—such as academic entrepreneurship, spin-off, KTO, and digital economy—to ensure the text's comprehension by readers from different disciplines, thus ensuring clear and rigorous conceptual communication.

It is based on the relationship established between academic entrepreneurship and the digital age. The competencies required for university students are based on this[2], which is due to the role they play for university students as they become professionals.

This has generated increased interest among researchers in the impact of these technologies on future professionals, thus driving their development into educational platforms for entrepreneurship, business collaboration, and the companies that can emerge as a result of entrepreneurship.[3] This observation became even more relevant during the pandemic that affected the entire planet.

Furthermore, researchers have organized themselves into related groups that address models, tools,

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execution metrics, and the impact of digital technologies on entrepreneurial ecosystems, as Etzkowitz[4] points out. Therefore, the configuration of the entrepreneurial ecosystem in each higher education area must be based on factors such as the strength of the research and the environment where the university center is located. This will lead to a transformation of traditional university incubators and technology transfer offices, complementing them so that they can be driven by acceleration programs that verify that they adequately respond to the needs of companies.

Currently, the systematic integration of academic entrepreneurs into accelerators is still very limited, due to the need for a more in-depth analysis of their effectiveness in supporting early-stage projects. This phenomenon can be considered a deficiency in the oversight of academic entrepreneurship activities (including the role of university councils in supporting the development of business plans), as it has received little attention in research. Furthermore, as Guerrero et al.[5] point out, faculty mobility between universities and the location options of graduates when creating spin-off companies from academic entrepreneurship should be explored.

Therefore, it is necessary to generate more effective strategies at the university and government levels, which is why new theoretical perspectives should be explored in areas such as organizational behavior, human resource management, ethics, and social responsibility. Without forgetting that, according to authors such as Joo et al.[6], to promote academic entrepreneurship, it is necessary to investigate the influence of groupthink and other areas of research, such as human rights, intellectual property, incubators, business mobility, international entrepreneurship, and procedural justice.

Thus, authors such as Mardani et al.[7] consider that academic initiatives integrate a wide range of individuals, organizations, resources, norms and policies, including universities, colleges, government agencies, research institutes and financial markets, since the collective work they carry out can be facilitated by knowledge flows and technological development that will enable innovation in the market. For entrepreneurship in university-led innovation ecosystems, it is vital to monitor and analyze the structure and flows of the ecosystem in order to obtain more accurate information for decision-making.

It is important to emphasize that universities are not immune to social changes, the evolution of the digital economy, or the digital platforms that exist in the value chains of all sectors (including higher education). Therefore, innovation becomes essential for sustainable and socially relevant competitiveness. Furthermore, authors such as Navarro[8] have affirmed that entrepreneurship should be considered the notion of business with a social conscience in all educational programs, allowing for the creation of multidisciplinary teams based on entrepreneurship and innovation projects to create a better economy in the community, in addition to attracting better opportunities for graduates and students.

Likewise, the evolution brought about by the transformation of the digital economy has had a profound impact on social entrepreneurship. This is primarily due to the increasing availability of funding and support from philanthropic organizations, governments, and businesses. Therefore, social entrepreneurs have become influential players who address social issues to implement innovative solutions that benefit communities at large.

On the other hand, it is important to recognize that not all social entrepreneurial motivations and impacts have had the desired outcome. Therefore, it has been established that the digital economy offers new and different opportunities for social entrepreneurs, encouraging them to utilize unconventional strategies and leverage global networks for support. This entails challenges in attracting capital, developing sustainable revenue streams, and expanding their operations and impact. Therefore, it is notable, according to a study, that the current experimentation and diversity in the field of social entrepreneurship highlight the imperative to act collectively with excellent coordination and, above all, with a long-term vision to effectively address social challenges in the digital age.

It's also worth noting that digital platforms facilitate research collaboration with industry, patent applications, and the transformation of innovative ideas into startups. Furthermore, the accessibility and scalability offered by the digital economy allow academic entrepreneurs to reach a wider audience, attract investment, and accelerate the commercialization of their research. Therefore, navigating the complexity of the digital economy requires understanding the changing approaches and trends at each stage.

However, authors such as Walker et al.[9] have proposed that the adoption of cloud computing and other emerging technologies seeks to strengthen the capabilities of academic entrepreneurship, allowing it to acquire greater agility, efficiency, and global impact. Therefore, it has been established that when academic entrepreneurs recognize the relevance of the digital economy and keep up with this evolution, they improve productivity and create sustainable businesses that contribute to social and economic growth.

Therefore, a relationship has been established between the evolution of the digital economy and academic entrepreneurship, which highlights that financial support will be greater the higher the level of preparation. Promoting innovation and addressing new societal challenges through entrepreneurial initiatives derived from research. Therefore, Secundo et al.[10] affirm that, with the fusion of cutting-edge technologies and research-based solutions, academic entrepreneurship is well positioned to respond to the future business landscape, generating a positive impact on society and the economy.

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From the above, it follows that entrepreneurs in the ecosystem drive change and seize emerging opportunities, rendering the industry obsolete and simultaneously creating a new one, as has happened throughout history, especially in recent history, where there are numerous examples. Therefore, entrepreneurs are considered crucial as part of the dynamism of the innovation ecosystem, driving the creation of new companies and attracting stakeholders who support the establishment of the hub model.

It is essential to emphasize that the entrepreneurial spirit of the innovation ecosystem promoted by universities is vital for monitoring and analyzing the ecosystem's structure and flows, as they are the basis for decision-making. This is related to the fact that universities are part of social changes, as well as the evolution toward the digital economy and platforms, since, together, they have impacted numerous changes in value chains in general. For this reason, innovation becomes essential for universities to remain competitive, sustainable, and relevant to society.

Another objective of the university, according to Mthanti et al.[11], relates to its contribution to society, which is because as the university faces the challenges posed by the knowledge economy, globalization, financial crises and environmental problems, there is a greater need to broaden its traditional focus on teaching and research.

Therefore, according to a study, universities are expected to demonstrate a sense of responsibility and effective use of public funds through strategic management practices. This shift requires universities to transfer their knowledge to society, foster entrepreneurial skills, promote innovation, and contribute to social well-being and human capital formation. Through these activities, universities move away from the traditional "ivory tower" approach, addressing both societal needs and industrial objectives.

Another point worth highlighting is that the university's commitment to entrepreneurship is perceived as contrary to its own mission, values, and traditional academic culture, which can generate individual confrontations between academics. Therefore, it is essential to develop strategies to adapt entrepreneurship to any program offered at each university, which is comprised of different capabilities that must be fostered in students. As Burcharth et al.[12] point out, this is an extremely complex model to implement due to its constant evolution and must be oriented toward promoting the potential of entrepreneurship that drives regional development, since it involves establishing a favorable environment through the integration of innovation policies, public and private partnerships, as well as knowledge transfer.

The concept of the entrepreneurial university, according to Neves[13], originates in institutions such as MIT and Stanford University, as they are leaders in integrating commercially relevant applied research and transferring knowledge to industry, thanks to their corporate funding. However, European universities are embracing academic entrepreneurship, thanks to funding and intense competition, seeking to improve results and contribute to global development.

This is why, according to Ndou et al.[14], the entrepreneurial university is characterized by having established an internal system to market and commoditize its knowledge, doing so through technology transfer mechanisms such as incubators and science parks.

Therefore, five paths are identified for the entrepreneurial university: a) strengthening the governing core, b) expanding the development periphery, c) diversifying the financial base, d) strengthening the academic body, and e) integrating entrepreneurial culture. These involve strategic prioritization, acquiring financial resources, commercializing intellectual property, and collaborating with stakeholders for the development of regional innovation. Therefore, according to Mthanti et al.[11], an "entrepreneurial architecture" should be used that considers internal factors (structures, strategies, systems, leadership, and culture) and the decisive elements to shape university entrepreneurial agendas.

To transform a university into an entrepreneurial university, Burcharth et al.[12] established a series of stages: first, strategic priorities are established; then, financial resources are acquired; finally, academia actively commercializes intellectual property; and finally, stakeholders in regional innovation are engaged. These stages constitute the guidelines that a university seeking to become entrepreneurial should adopt.

Therefore, the adoption of an entrepreneurial culture in universities may not be universally accepted by academic staff: some traditionalists resist participating in entrepreneurial activities, while others engage in both scientific and entrepreneurial endeavors. Challenges therefore arise from potential conflicts between entrepreneurial imperatives and traditional academic values, in addition to constraints related to institutional norms, a lack of systemic coordination, poor entrepreneurial innovation environments, and insufficient attention to reputation and branding.

This is why it is sometimes not possible to establish a unified entrepreneurial culture supported by effective communication of academic staff initiatives. Therefore, Feola[15] established that Knowledge Transfer Offices (KTOs) or Technology Transfer Offices (TTOs) play an important role in managing knowledge transfer, commercialization, referrals, and promoting education and entrepreneurial culture. Knowledge transfer (KT) activities are vital for entrepreneurial universities as they enable the application of academic knowledge in commercial and community organizations for innovation and economic development. KT involves the

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commercialization of academic knowledge, patents, industry-university linkages, licensing agreements, and the creation of spin-off companies. Knowledge Transfer Offices (KTOs) have been introduced to effectively manage KT activities. They support the creation of spin-off companies, manage patents and licenses, and facilitate interactions between research units and companies.

According to the OECD (2015), there are various organizational models for technical cooperation organizations (KTOs) and decision-making tools that allow their activities to be aligned with university objectives. However, due to persistent gaps in research, more efficient strategies for designing and managing KTOs are needed.

According to Bikse et al.[16], the economic focus of patents and spin-offs should not overshadow the objectives and characteristics of universities. Therefore, collaboration between academia, policymakers, and industry is crucial for the impact of knowledge transfer activities, and their reach will be strengthened by developing comprehensive knowledge transfer approaches that encompass both economic and non-economic activities.

Universities play a fundamental role in promoting entrepreneurial education and culture. They offer interdisciplinary courses, practical applications, and vocational training to develop entrepreneurial skills. Therefore, a study has established that there are challenges in engaging academic and non-teaching staff in entrepreneurial activities, which requires their encouragement and support. Furthermore, industry, government, and local communities are important partners in entrepreneurship, and their participation is necessary to generate socioeconomic value.

Therefore, authors such as Mass et al.[17] make it clear that the provision of physical infrastructure and habitats for entrepreneurship, such as technology transfer offices, incubators, accelerators, science parks, and entrepreneurship centers, play an important role in promoting academic entrepreneurship. These resources are associated with stronger levels of academic entrepreneurship, as they can help spin-off companies overcome capital constraints. Furthermore, entrepreneurial incentives and development support within the academic context, including business guidance, mentoring, and access to adequate funding, are crucial for fostering entrepreneurial behavior among faculty. Likewise, organizational practices that facilitate academic entrepreneurship are necessary because marketing activities are not inherently natural for academics. Therefore, universities need to update their incentive frameworks, taking into account the high opportunity costs that faculty face when participating in new ventures. Furthermore, an institutional focus on entrepreneurship education is a potential driver of entrepreneurial behavior in academia. For the university to be entrepreneurial, it requires a group of actors from diverse backgrounds, including:

Academics (researchers, assistants, professors, and associate professors) who perform various functions related not only to research but also to the patent process and its commercialization, with specific research characteristics. They seek to extend this knowledge to their students, which motivates them to pursue academic endeavors under their own guidance, creating a strong partnership for future generations.

Students/graduates preparing for entrepreneurship participate in activities related to their group and individual preparation, where they are encouraged to develop their knowledge generation skills (which generally lead to entrepreneurship). In addition, opportunities to pursue and create businesses under student supervision are highlighted.

Universities/research institutions provide the infrastructure, resources, and support necessary for academic entrepreneurship. They are also responsible for fostering an environment conducive to innovation and knowledge transfer. They offer spaces, funding, mentorship, and opportunities for collaborative work. They have Technology Transfer Offices (TTOs) and innovation centers to facilitate the commercialization of research. Together with the support of companies, they create a more favorable environment for new professionals and network members.

Governments and politicians shape the academic entrepreneurship ecosystem by developing policies, programs, and funding initiatives. They offer grants, tax incentives, and regulatory frameworks to promote entrepreneurship in academia. They support knowledge exploitation, industrial collaboration, and the creation of new companies or spin-offs.

Industrial/Business Sector. Collaborates with academia, providing funding, resources, expertise, and practical applications for academic research. Participates in research collaborations, licensing agreements, joint ventures, or supports the commercialization of academic innovations.

Support organizations. Business incubators, entrepreneurship centers, venture capitalists, and others support academic entrepreneurship. They offer mentorship, funding, and guidance to academics interested in commercializing their ideas. Professional associations, networks, and industry groups offer networking opportunities and facilitate knowledge exchange.

Society/community. Act as potential clients or users of academic innovations. Provide feedback to the market, contributing to the social and economic impact of business activities.

## METHOD

Redesigning and updating the curricula and programs across all academic disciplines at the Los Altos

University Center represents a significant challenge, particularly ensuring that students acquire the necessary tools demanded by the industry while keeping up with technological advances. The rapid evolution of technology and industry standards makes it difficult to maintain a curriculum that consistently meets the needs of future graduates, which could put them at a disadvantage in the labor market.

To address this challenge, the proposed model is based on a structured scientific framework that integrates three main development axes: university, industry, and government. This triadic approach fosters a dynamic and synergistic ecosystem that enhances innovation and economic development (figure 1). The methodology follows a systematic process, leveraging qualitative and quantitative research techniques to analyze the interactions between these three pillars.

The model is based on the principle of structured interconnectivity, where each participant plays a crucial role in the generation, transfer, and commercialization of knowledge.[18] The university acts as the primary hub for research and innovation, industry provides practical applications and market insights, while government institutions establish policies and funding mechanisms to drive sustainable, knowledge-based economic growth. This approach ensures that curriculum development remains adaptable and responsive to changing social and technological demands.

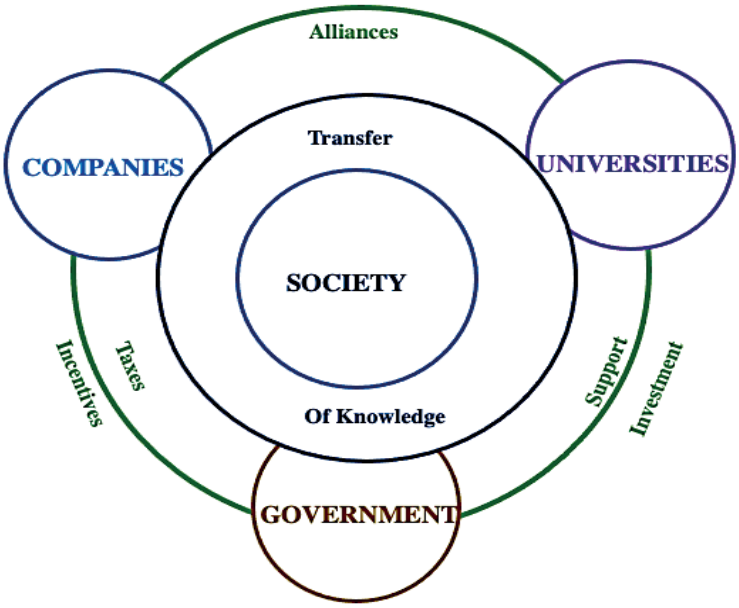


**Figure 1.** Three-axis model

The first axis (the university) occupies a fundamental position, as it is the main source of new knowledge and cutting-edge research. It is the origin of innovation and the promotion of innovative ideas and technologies through research. In addition to academic activities, it is actively involved in the business sector, promoting a culture of innovation and entrepreneurship in its academic communities.[19]

The second axis (industry), given that companies and businesses act as end users of academic research, drive the commercialization of innovative ideas and technologies. They offer a market-oriented perspective and identify potential opportunities for new products and services; above all, they provide researchers with invaluable information on their commercial viability. By creating alliances and collaborations with universities, industry bridges the gap between theory and practice and drives economic growth by commercializing research results.[20]

The third pillar (the government) plays a key role in funding research and providing financial resources to universities and research institutes. It also defines policies and regulations to foster innovation, entrepreneurship, and the smooth transfer of knowledge from academia to industry. These pillars create an ecosystem that fosters collaboration between universities and businesses, achieving this by providing the right environment for knowledge exchange and technology transfer.[21] Universities and industry interact dynamically and symbiotically, and their benefits are mutual, as academia provides a constant flow of research results, and industry offers real-world applications and funding opportunities. The government acts as a facilitator by supporting research through funding frameworks and policies to incentivize academic entrepreneurship and technology commercialization. This can be considered the foundation of the university-business-government circle, with the aim of promoting innovation and sustainable economic growth.[22]

However, for this research, authors such as Carayannis[23] have been taken into consideration, who has

proposed that, in order to have a sustainable model, the three-axis model must evolve, taking into account dimensions such as the society where the young student comes from and the environment where the company that aims to have a system in constant evolution, development and prosperity is located.

The selection of the five axes—university, industry, government, media/culture, and socioecological environment—is based on the need to approach academic entrepreneurship from a comprehensive and systemic perspective. The first three axes correspond to the triple helix model, widely recognized for its role in linking knowledge, production, and regulation. There are also two emerging axes: the media/culture axis, which highlights the role of communication in building an entrepreneurial culture, and the socioecological axis, which allows for consideration of the territorial, environmental, and community impact of entrepreneurship.

These axes are implemented at the Centro Universitario de los Altos through actions such as the inclusion of dissemination topics at the university level and the promotion of sustainable projects. This consolidates an academic entrepreneurship approach aligned with the challenges of local development and the digital economy. Considering a fourth axis (media and culture) is of utmost relevance due to the importance that communication, along with the creative industry, culture, values, and lifestyles, has in promoting knowledge of culture and values. This, along with the public reality presented through the media, influences the national innovation system. Therefore, the cultural dimension plays a fundamental role in promoting a knowledge-based economy, of interactions between universities, industry, government, and society in general.[18]

The fifth axis (socioecological) delves into the complexities of innovation ecosystems, which include society's natural environments, considered the driving force behind the production of new knowledge and innovation. Its role recognizes the importance of the environment in creating opportunities for the knowledge economy and, as societies and economies evolve, emphasizes the importance of socioecological factors that drive innovation and sustainable economic development.

According to Liyanage[24], by incorporating the socio-ecological environment as part of academic entrepreneurship, the evolution of innovation ecosystems deepens the understanding of the complex interdependencies and relationships between key actors, which allows us to recognize that sustainable economic growth and prosperity are the product of collaboration between the main actors, society and the environment. Now, according to Mass et al.[17], the role of this axis becomes a central point for the academic entrepreneur, since they acquire the ability to become more involved in environmental challenges (climate change, renewable resources), adopting ecological practices in addition to incorporating sustainable solutions in their initiatives.

Therefore, for the academic entrepreneur, the five-axis model, according to Barcellos-Paula et al.[25], defines the pathways that allow leveraging the natural environment to promote innovation and sustainable development, from which business strategies are derived aimed at creating environmentally friendly products and services to meet the growing demand for sustainable solutions. This aligns academic entrepreneurship with societal expectations and values, and positions companies for long-term success in an environmentally conscious market. Authors such as Taucean et al.[26] have established that key factors include a strong talent pool (with academic and business experience) capable of laying the foundations for generating and executing innovative ideas, highlighting that the venture capital community plays a crucial role in these ecosystems by providing funding to startups to scale and expand their businesses. Furthermore, supportive government policies are a very relevant aspect for the success of the entrepreneurial ecosystem, backed by tax exemptions, funding for research and development, but above all, by favorable regulations, especially in the initial stages.[27]

This is why leading startup ecosystems prioritize establishing strong networking opportunities, facilitating connections between startups, advisors, investors, and other resources.[22] With this network infrastructure, startups can gain valuable knowledge, obtain funding, and accelerate their growth. This is highly beneficial for universities, in their quest to increase academic entrepreneurship and adopt successful practices in these global startup ecosystems. By fostering a culture of strong innovation and entrepreneurship within academic communities, universities can stimulate the generation of innovative ideas, collaboration with industry partners, and the pursuit of technology transfer opportunities, with the aim of bridging the gap between theory and real-world applications.[6]

Authors such as Taucean et al.[26] propose that universities collaborate with the government by advocating for policies that encourage academic entrepreneurship, facilitate the commercialization of research results, provide networking opportunities for students, researchers, and graduates, and empower aspiring entrepreneurs to connect with advisors, investors, and potential collaborators.

Therefore, by implementing this methodology with the aim of promoting academic entrepreneurship and entrepreneurial culture, the Centro Universitario de los Altos is developing the following actions:

- Offer entrepreneurship programs (undergraduate and postgraduate): students are provided with specialized education and training in entrepreneurship, equipping the aspiring entrepreneur with the knowledge and skills to transform their ideas into viable businesses, as suggested by Ndou et al.[14].
- Establish business incubators and accelerators: they play a pivotal role in nurturing startups in

their early stages by providing them with capital, office space and mentoring, helping them overcome initial hurdles and putting them on the path to growth and success, as stated by Sarstedt et al.[28].

- Organize entrepreneurship events and competitions: these provide a platform for students to showcase their business ideas to potential investors and advisors, as they are considered opportunities to network and build valuable connections.[29]
- Cultivate strong graduate networks: strong graduate networks allow students to tap into pools of experienced professionals, advisors, and potential investors, thereby improving their chances of entrepreneurial success.[29]
- Promote innovation and creativity: an environment of innovation and creativity is fostered, emphasizing research and development activities that can lead to the creation of innovative companies and technologies.[10]

Despite the positive impact that the Altos University Center has on its participants (internal and external), some challenges remain to fully implement the reinforced three-axis model, among which the lack of resources stands out (which will never be sufficient for all the projects achieved), as well as the changes in economic support policies, which derive from changes in the government regime, although it is worth noting that there has been great progress in the participation of students, teachers, researchers, administrators, entrepreneurs of the region and municipal governments, mainly. Therefore, the following actions were carried out:

- Increase funding for entrepreneurship programs: search for new sources of funding to support the development and implementation of innovative projects.[30]
- Facilitate collaboration and networking opportunities: ensure that all faculty and researchers are supported to establish new supportive and collaborative relationships with other researchers, students, industry professionals, government agencies, and civil society with the goal of increasing knowledge sharing and technology transfer.[31]
- Entrepreneurship centers and incubators: promote the increase of new centers and incubators where mentoring, training, and access to resources are provided to help academic entrepreneurs in their initial journey.[32]
- Improve business education: promote the increase of students, professors and researchers participating in business advisory programs, as this facilitates business navigation, the acquisition of skills and knowledge by participants.[33]
- Streamline bureaucratic processes: simplify administrative procedures by reducing red tape to accelerate the transfer of knowledge and technology from academia to industry.[3]
- Foster a culture of innovation and risk-taking: instill an entrepreneurial mindset among students and teachers.[16]
- Promote alumni engagement: engage successful entrepreneurial graduates as mentors and investors to support the growth of academic entrepreneurship.[34]

Furthermore, the legal and regulatory framework governing the functioning of academic entrepreneurship has been considered, given its fundamental role in the landscape of innovation and business development. Regulations and laws are included that address provisions on genetic resources and their management, product labeling, including those intended for human consumption, as well as financing, marketing, patent rights, economic competition, data protection, commercial companies, financial transactions, taxes, and labor relations.

**The implementation of the strategic axis model at the Altos University Center**

The strategy used for its implementation, the first axis corresponds to the incorporation of work in a transversal manner, since all the careers offered by the Centro Universitario de los Altos had to have a common subject that had the objective of introducing and interesting the students (mainly), teachers, and researchers in entrepreneurship, so the subject had to be "Development of Entrepreneurship and Innovation Projects."

Therefore, business mentoring programs were created where students attended, witnessed, and participated in business mentoring sessions, thus expanding their knowledge as they gained responsibilities. The objectives of the knowledge competitions were expanded to include the participation of as many students as possible.

Event calendars were designed to engage researchers, professors, entrepreneurs, graduates, and members of various government agencies with presentations, talks, keynote addresses, and everything else that would enrich the knowledge of future professionals and foster an entrepreneurial spirit. Incubators and accelerators have also been implemented to support startups.

In the second axis, the entrepreneur was invited to participate as part of the entrepreneurship program, being invited to advise by researchers who, accompanied by their students, have the purpose of knowing their processes and proposing possible solutions to improve, substitute, replace or make it more efficient, in addition

to inviting them to make contributions to projects (ventures) for their company or those that could have the probability of being patented, developed, incubated, industrialized for purposes of economic benefit for all parties.

The third axis, the University Center of Los Altos, can be approached from two perspectives. The first, through the Legal Department of the University of Granada, carries out procedures and agreements with various authorities (State Government, local and federal Chamber of Deputies, among others) that contribute to strengthening the development of academic entrepreneurship, favoring those that are primarily the product of the student as the primary beneficiary, without forgetting researchers or student-entrepreneurs.

In the second of these, the University Center of Los Altos itself is responsible for establishing relationships with the municipal governments in its area of influence, as well as with organizations, civil groups, academic institutions in the region, among others, whose members are part of the same society. Therefore, their influence is necessary for the proper functioning of any relationship where there is an exchange of theoretical knowledge with real knowledge and the corresponding transfer of inputs that can be used by the consumer public.

The fourth pillar is the communications system of the Los Altos University Center, which is networked with the University of Granada itself and has its own radio and television systems. Not to mention that the local press and the internet have become the greatest allies of entrepreneurship, as the computer network provides access to the libraries of the university centers themselves, as well as to the virtual libraries of almost any university in the world. Through them, entrepreneurs can research their personal and business interests, what's happening in other places, climate change, environmental protection, and everything related to the laws that will enable or prevent their product from reaching those places without violating current environmental protection laws of all kinds.

The fifth axis, the Centro Universitario de los Altos, being part of a network of university centers of the University of Guadalajara (U de G), promotes the exchange of knowledge between researchers from different areas of knowledge, as well as agreements with other public and private higher education institutions, to enrich academic work with the purpose of having the largest number of them possible, either to be commercialized or as the basis for new companies, in general.

**Method for evaluating project results**

Having taught the course "Development of Entrepreneurship and Innovation Projects" on several occasions, it was deemed appropriate to evaluate the results obtained, as eight generations of future graduates will be able to demonstrate whether the activities were carried out appropriately.

Therefore, a survey was implemented for students who had already taken the course. The results will allow us to determine what needs to be adjusted, what can be improved, what will be maintained, and what isn't yielding the expected results. This table analyzes a qualitative survey in which students discussed their performance on the projects.

**Table 1.** "Evaluation Survey of Entrepreneurship and Innovation Development Projects" Likert scale indicator

| Dimensions | Description | Questions |
|---|---|---|
| Potential Knowledge (knowledge S) | Indicator used to represent the improvement, complementation and updating of learning | 1-5 |
| Execution Capacity (knowing how to do SH) | Knowledge is applied in processes to solve problems, find solutions and achieve established objectives. | 6-10 |
| Judgment Decision (knowing how to judge to decide SJD) | Processes for obtaining data and analyzing it to prioritize decision-making. | 11-15 |
| Entrepreneurial attitude (Knowledge to do ACHO) | Link the way initiative is demonstrated to establish creative and innovative proposals that focus on challenges to stimulate self-realization of professional potential. | 16-20 |

| Response options | | | | |
|---|---|---|---|---|
| 1.- Totally agree | 2.- I accept | 3.- Neither agree nor disagree | 4.- I do not accept | 5.- Totally disagree |

| | | | | | | |
|---|---|---|---|---|---|---|
| S1 | Were strategies incorporated to encourage the implementation of best learning practices? | 1 | 2 | 3 | 4 | 5 |
| S2 | Did your teachers or specialized advisors use complementary learning strategies to gain greater knowledge related to your entrepreneurial project? | 1 | 2 | 3 | 4 | 5 |
| S3 | Do you think you expanded your professional knowledge as a result of the dynamics carried out for the development of the entrepreneurial project? | 1 | 2 | 3 | 4 | 5 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| S4 | Did you find it stimulating to share knowledge with your colleagues in the entrepreneurial project? | 1 | 2 | 3 | 4 | 5 |
| S5 | Did you receive professional updates as complementary training applicable to the entrepreneurial project you developed? | 1 | 2 | 3 | 4 | 5 |
| SH 6 | Was the practical application of knowledge promoted during the stages of the entrepreneurial project? | 1 | 2 | 3 | 4 | 5 |
| SH 7 | Was guidance provided to resolve problems that arose during the development of the entrepreneurial project? | 1 | 2 | 3 | 4 | 5 |
| SH 8 | Was interdisciplinary and multidisciplinary teamwork promoted for the development of the entrepreneurial proposal? | 1 | 2 | 3 | 4 | 5 |
| SH 9 | Does the proposal focus on presenting results from a real-life entrepreneurial scenario? | 1 | 2 | 3 | 4 | 5 |
| SH 10 | Is there an incentive to add market-differentiating value to your business proposal? | 1 | 2 | 3 | 4 | 5 |
| SJD11 | Based on the data obtained, were you asked to analyze situations regarding the viability of the entrepreneurial project? | 1 | 2 | 3 | 4 | 5 |
| SJD12 | Were they asked to critically reflect on the strengths and weaknesses of their business proposal? | 1 | 2 | 3 | 4 | 5 |
| SJD13 | Were you able to develop a systemic (overall) view of the interrelationships and connections between the components of the entrepreneurial project? | 1 | 2 | 3 | 4 | 5 |
| SJD14 | Did the teachers define priorities to complete the proposal in a timely manner based on the analysis of the information from the entrepreneurial project? | 1 | 2 | 3 | 4 | 5 |
| SJD15 | Was alternatives analysis applied for decision-making? | 1 | 2 | 3 | 4 | 5 |
| ACHO 16 | Was your active participation encouraged in identifying opportunities for improvement during the development of the business proposal? | 1 | 2 | 3 | 4 | 5 |
| ACHO 17 | Was your active participation encouraged in identifying opportunities for improvement during the development of the business proposal? | 1 | 2 | 3 | 4 | 5 |
| ACHO 18 | Did your university advisors or business leaders in the region provide you with recommendations on tools that ensure better processes for the final product/service? | 1 | 2 | 3 | 4 | 5 |
| ACHO 19 | Does the selection of the entrepreneurial proposal arise from the analysis of better attention to market needs? | 1 | 2 | 3 | 4 | 5 |
| ACHO 20 | Does the business proposal involve creativity in its design and innovative processes for its development? | 1 | 2 | 3 | 4 | 5 |

The survey was answered by a total of 311 students from 13 of the 14 programs offered. This is due to the fact that the Pharmaceutical Chemist Biologist program began to be offered in 2023, and therefore, at the time of the survey, not a single student had taken it.

The course, designed for this purpose, is called “Development of Entrepreneurship and Innovation Projects” and is taught in the seventh semester of the program (although it is offered in master’s, diploma, and specialty programs, among others). For the present evaluation, greater emphasis has been placed on the degree programs offered.

The survey results are presented by specialty, as student participation varied. Medicine had 37 students, Administration 15, Veterinary Medicine 45, Nursing 10, International Business 25, Nutrition 18, Psychology 16, Law 10, Agroindustry 16, Computer Science 36, Livestock Systems 28, Public Accounting 28, and Dentistry 27, for a total of 311 students. Below are the graphs of the student responses. In them it can be observed that there is a tendency for the five modules in which the questions were grouped to have very few responses that represent “disagree” and “totally disagree”, which indicates that the work being done in this regard should focus on ensuring that each time there is a survey, a greater incidence of the responses “Totally agree” and

"Agree" is found, which will be reflected in the quality of the work being done.

As evidence of this, a greater number of students joined the sessions where advice was provided to entrepreneurs in the region, highlighting the fact that at the end, the student became the "advisor" of the entrepreneur (without forgetting that he was supervised at all times by the researcher), so for example, in the areas of medicine and nutrition (human and animal, as well as nursing) a very significant number of students were incorporated to participate with teachers to carry out real work with real patients, which was intended to make everything learned by the student real, since upon graduation they will have greater practicality and knowledge about their specialty.

In the engineering field, more students had the opportunity to participate in real-life projects developed by regional companies, where researchers from the Los Altos University Center provided advice. Similarly, in the law and psychology programs, a large number of students participate in solving real-life problems under the guidance of professors (professional researchers) who are working against the clock.

With respect to knowledge contests, there was a wide participation in local, regional and national contests where the results have been very flattering for the Centro Universitario de los Altos, since it distinguishes itself from the other university centers of the U of G network (Planter and in it you can see all the activity data (of all the activities that are carried out at the Centro Universitario de los Altos) with emphasis on those corresponding to certified careers, guided tours, contests, ventures (which translate into products, modifications to methods of systems that are currently part of regional companies) as well as development of ventures shown in contests against students from universities in other states, accelerators, national meetings, academic exchange days, student participation in CENEVAL exams (whose results by career, surprisingly, are occupied by students graduated from the same school), consultancies, agreements with educational and governmental institutions, which grows day by day, which is why the results of the surveys applied, through various institutional organizations that have the task of common to promote activities related to the development axes on which this research is based.

It should be noted that all current data from the Centro Universitario de los Altos are mentioned in detail in Planter ( n.d. ), since it is a concentrate of the work that is developed jointly by all the staff of the Centro Universitario de los Altos, with the objective of not stopping the process of appropriation of knowledge by the students, as well as in said report each and every one of the activities (in each of the axes) that have led to the status that it has are related, which has become an objective to overcome in each school period, so that the next one is conducive to surpassing the results that have been obtained and reported at the time.

This project analyzes the degree of influence achieved through the application of this core model from the student perspective. To this end, surveys were used to determine the level of satisfaction of all stakeholders predominantly involved in their academic preparation. The goal is to improve this model so that future generations of graduates are even better and, above all, become knowledge generators through entrepreneurship that allows them to expand their horizons and aspire to join large companies or own their own business, the result of an idea or venture. Therefore, to understand the role this model has played, the results of the surveys are presented below:

The survey presented was answered (randomly) by a total of 311 students, and its sample size is quite large (considering that they took the course "Development of Entrepreneurship and Innovation Projects"), with a total of 2000 students, so its results are considered valid. To understand the status of the development axes model used to promote entrepreneurship, the results obtained from administering the survey are used as a criterion to determine its performance, as can be seen below.

## RESULTS

To effectively evaluate the strategies that have influenced entrepreneurship development, a survey was developed based on an indicator known as the Likert scale (1-5). This method measures perceptions and levels of agreement in various social science and educational studies. Surveys are designed to provide clarity and precision, ensuring that responses are understandable and reflect the skills and knowledge being measured. The scale allowed students' opinions to be rated, from complete disagreement to complete agreement, thus facilitating the analysis of trends and patterns within the university community.

Ten students from the Law program responded (figure 2) and when using statistical techniques for verification (least squares), the trend shows that, in all surveys, regardless of the degree of the students, the responses of "Totally agree", "Agree" and "Neither agree nor disagree" have a greater incidence, which implies that the degree of satisfaction is not optimal, but it is a commitment that must be continued in continuous improvement.

In this and all subsequent figures, it can be observed that the last two columns are on the abscissa or "X" axis since it means that there were no students who selected them, but it does influence the shape that the curve takes, since it can also be observed that there is a greater preference in the column that represents the "Agree" option.

Fifteen students from the Administration program participated and the results obtained (figure 3) have a similar behavior to the previous one.

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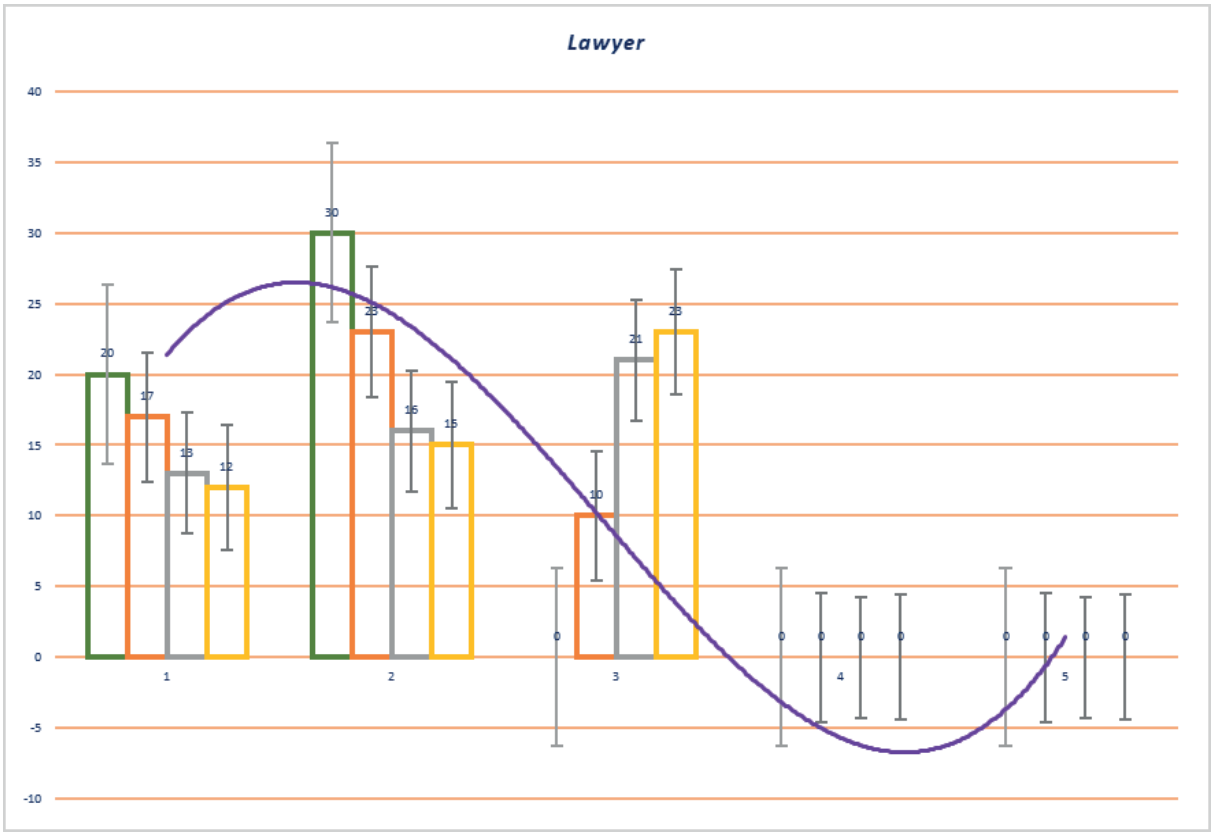


**Figure 2.** Representation of the responses obtained from the Law degree

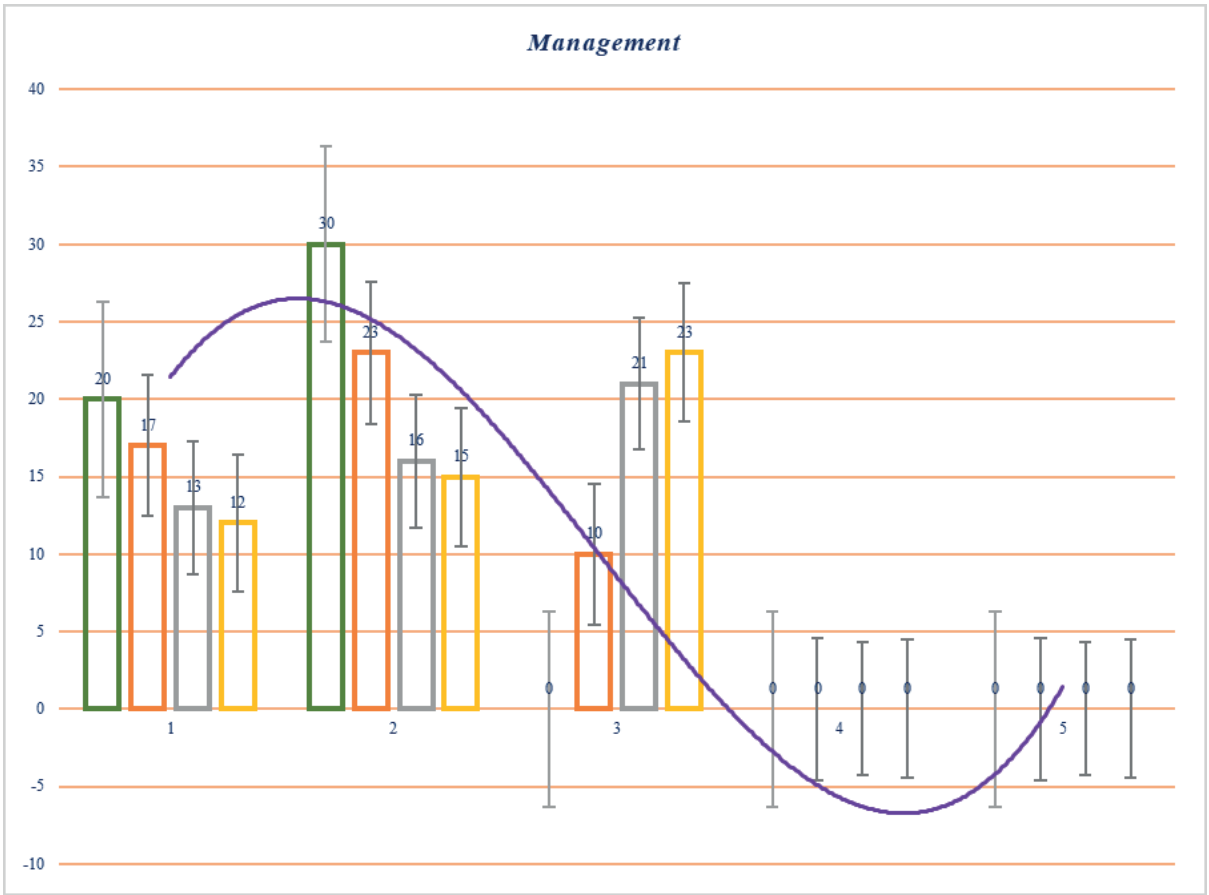


**Figure 3.** Representation of the responses obtained from the Administration degree

Ten students from the Nursing program participated and the results obtained (figure 4) have a similar behavior to the previous one.

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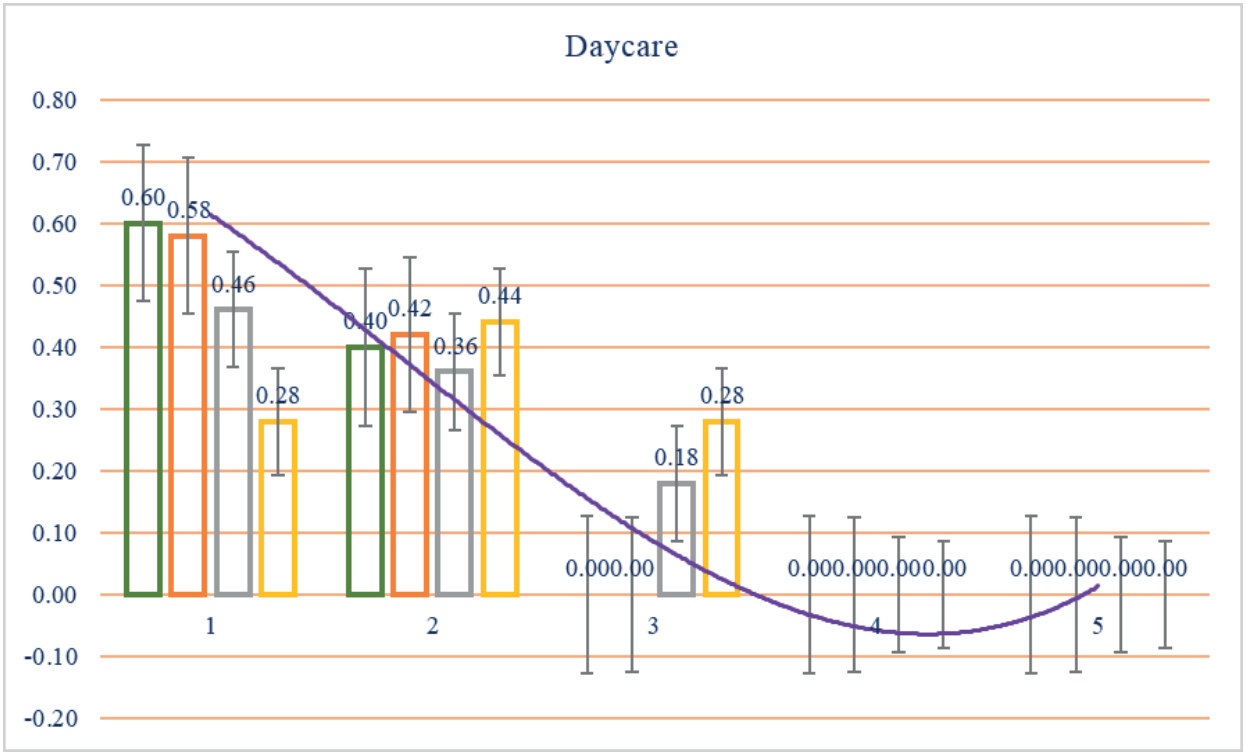


**Figure 4.** Representation of the responses obtained from the degree in Nutrition

Sixteen students from the Agroindustrial Engineering program participated and the results obtained (figure 5) have a similar behavior to the previous ones.

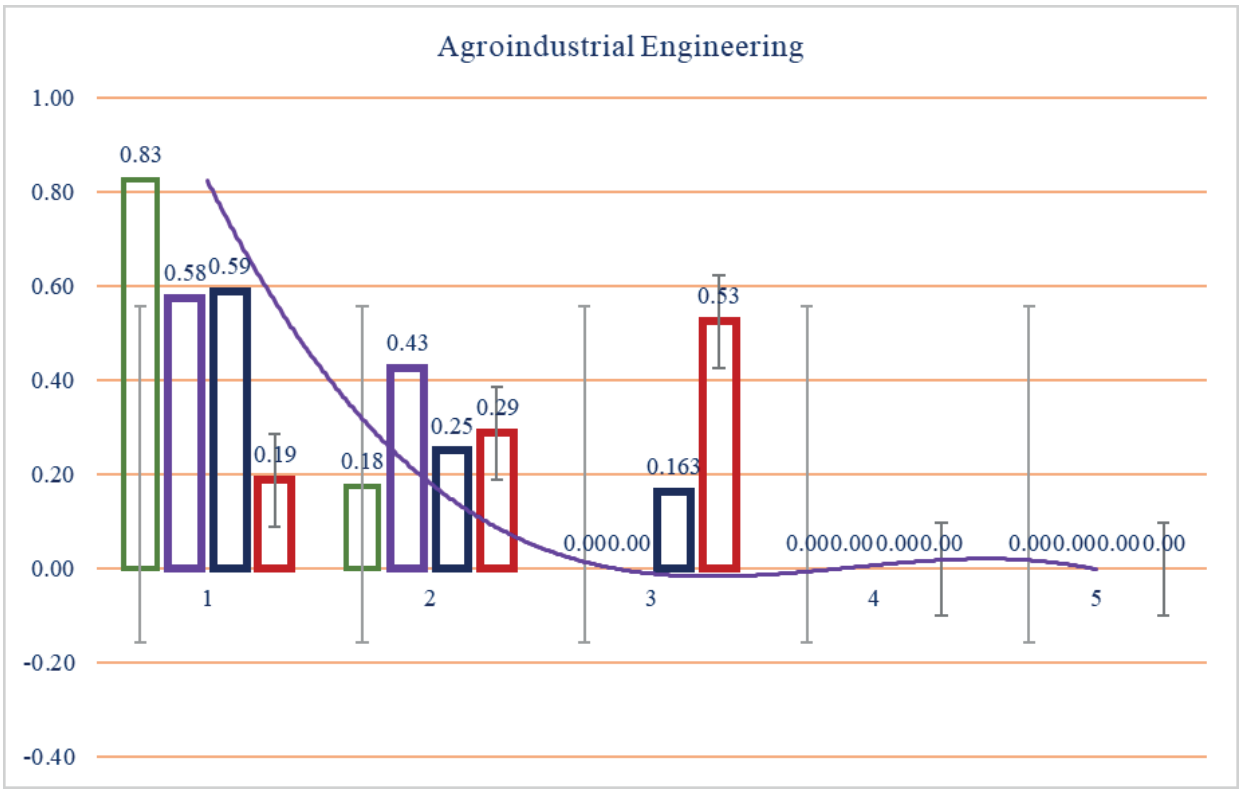


**Figure 5.** Representation of the responses obtained from the Agroindustrial Engineering degree

Thirty-six students from the Computer Engineering program participated, and the results obtained (figure 6) do not have a similar behavior to the previous ones, since at first glance one can see the trend curve that does not tend to the abscissa axis similar to the previous ones.

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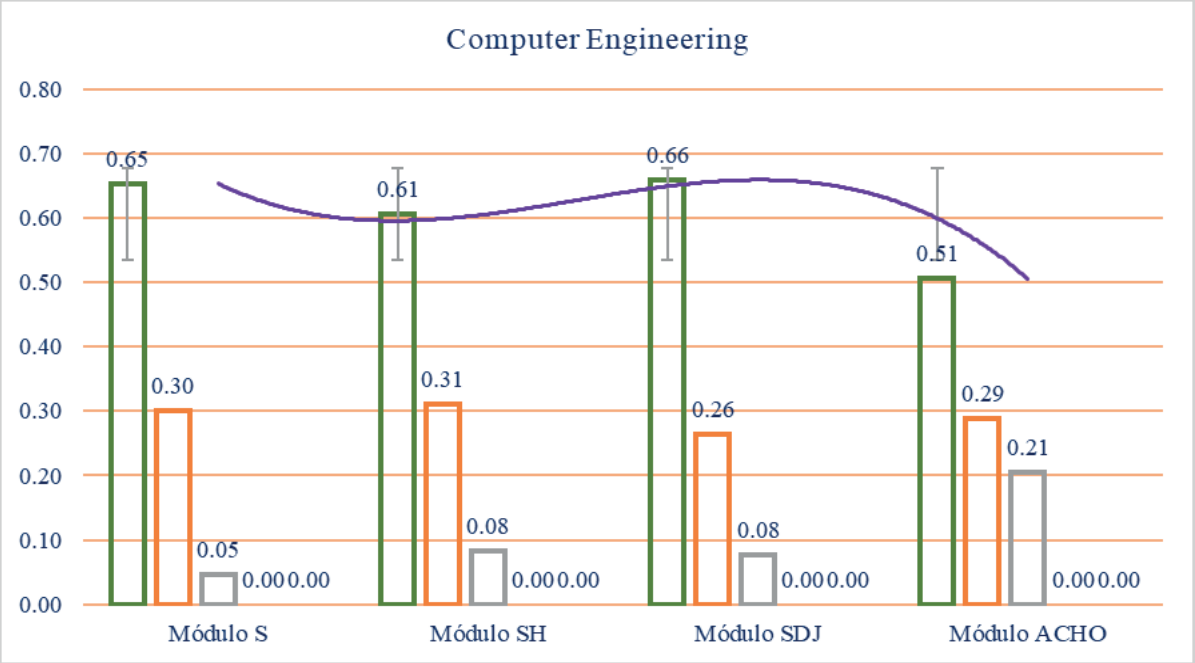


**Figure 6.** Representation of the responses obtained from the degree in Computer Engineering

In this representation, a different curve can be observed, which does not have a tendency to the abscissa, which is due to the fact that there were students who selected the lower options on the scale ("Disagree" and "Totally disagree"), for this reason an analysis must be made of what has not been done in that career, in order to be able to correct it quickly and thus the curve has a different behavior.

Thirty-six students participated in the Livestock Systems Engineering program (figure 7). It is worth noting that the Altos University Center is located in a predominantly agricultural region. Therefore, the identified companies are related to agricultural activities and their derivatives.

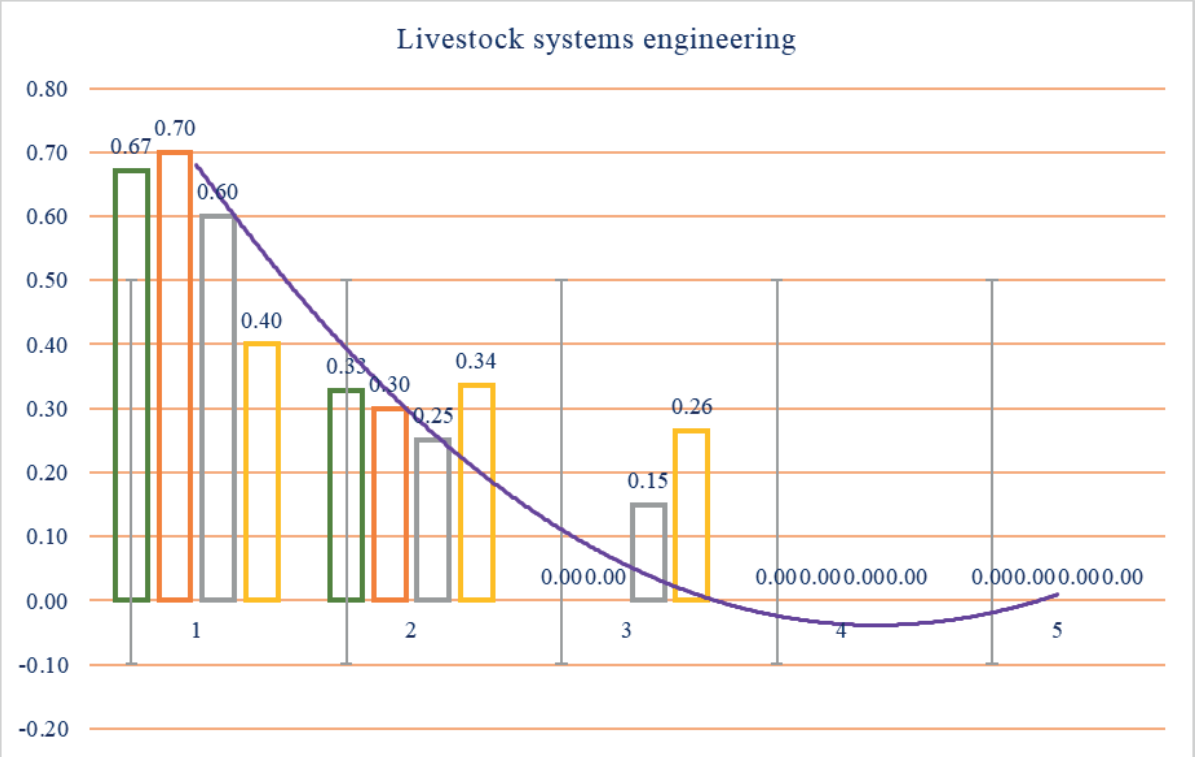


**Figure 7.** Representation of the responses obtained from Livestock Systems Engineering

Visually, it can be observed that the efforts and activities related to this career have had better acceptance among students, since the vast majority, represented in the column closest to the orders ("Totally agree"), was

the one that obtained a greater number of selections, which means that there is still much work to be done so that the third column of the abscissa ("Neither agree nor disagree") can have a tendency to be so and be greater than that of "Totally agree".

Thirty-seven students participated in the Medicine program (figure 8), and the results obtained show that a large number of students perceive that the Centro Universitario de los Altos has a lot of work to do.

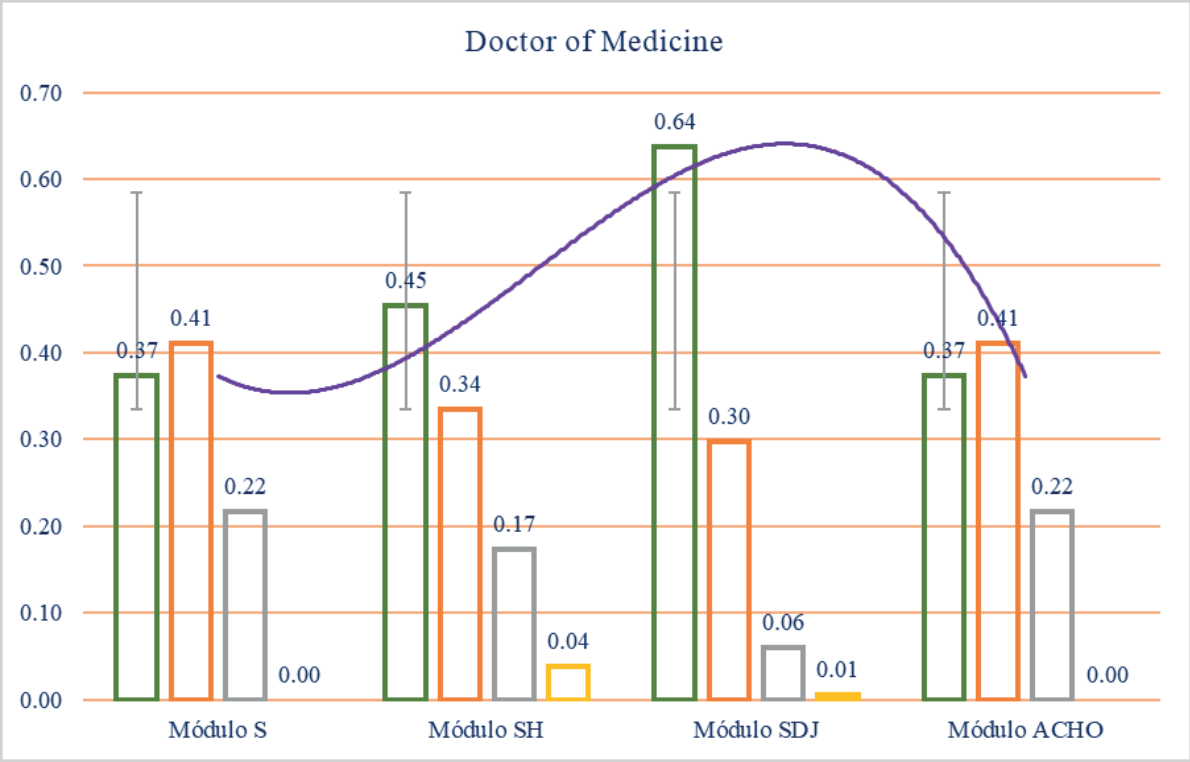


**Figure 8.** Representation of the responses obtained from the Medicine degree

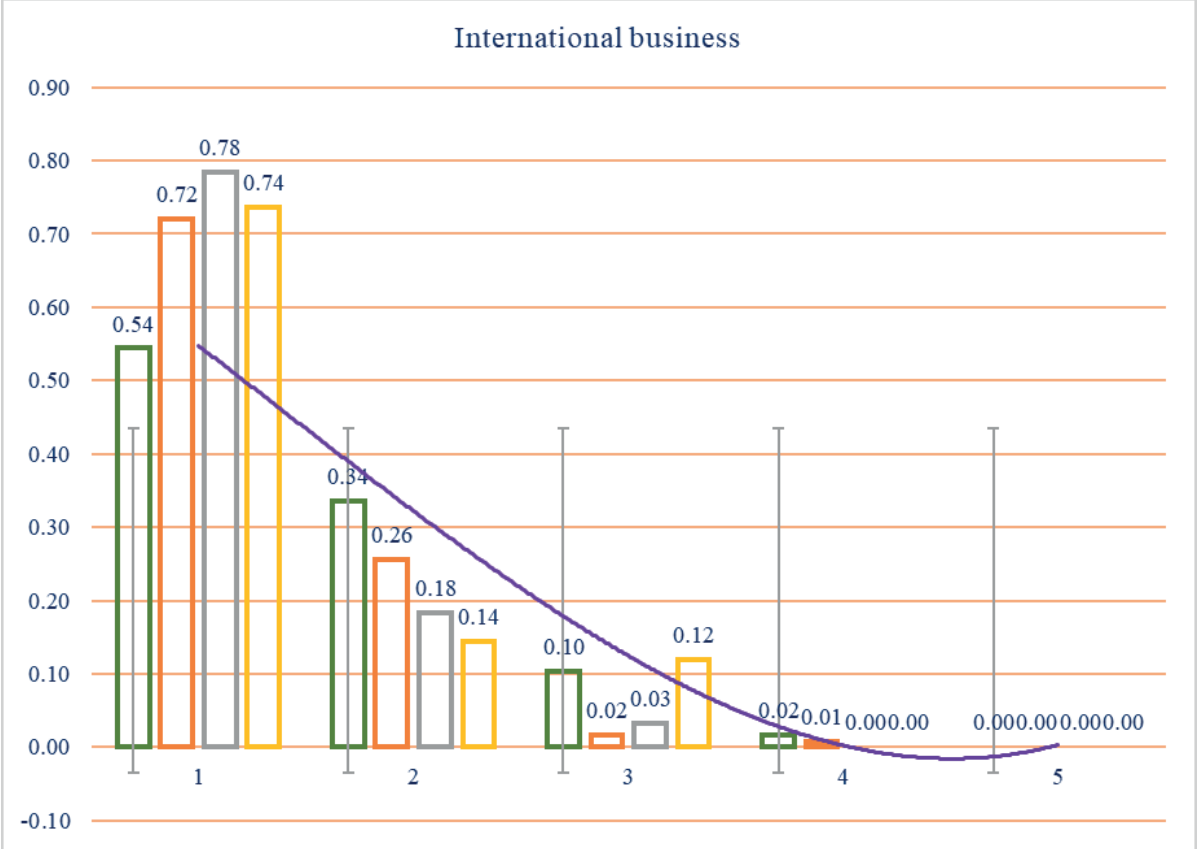


**Figure 9.** Representation of the responses obtained from the International Business degree

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The statistical test shows that a large number of medical students most frequently selected the responses "Neither agree nor disagree," "Disagree," and "Strongly disagree," which is highly worrying, as these are considered flaws in the actions and activities designed for students in this specialty.

Therefore, a study must be conducted into the reasons that led the student to select these responses, in order to rethink, modify, remove, or add strategies to improve participation in the activities that have been designed, but, above all, to ensure that they are reflected in increased results related to entrepreneurship in that particular area.

Twenty-five students participated in the International Business program (figure 9), and the results obtained show that there is a large number of students whose perception is reflected in entrepreneurship and all the activities related to it, and have been very influential in it.

The statistical test shows that a large number of students are highly satisfied with everything that, as part of the core model, has been integrated into their teaching-learning activities aimed at promoting entrepreneurship. However, the work done with the specialty in general should not be neglected; on the contrary, we must continue to improve and innovate in the activities that have the greatest impact on the knowledge acquired by students.

In the Nutrition program, 18 students participated (figure 10), and the results obtained demonstrate that there is a large number of students whose perception is reflected in entrepreneurship and all the activities related to it, and have been very influential in it.

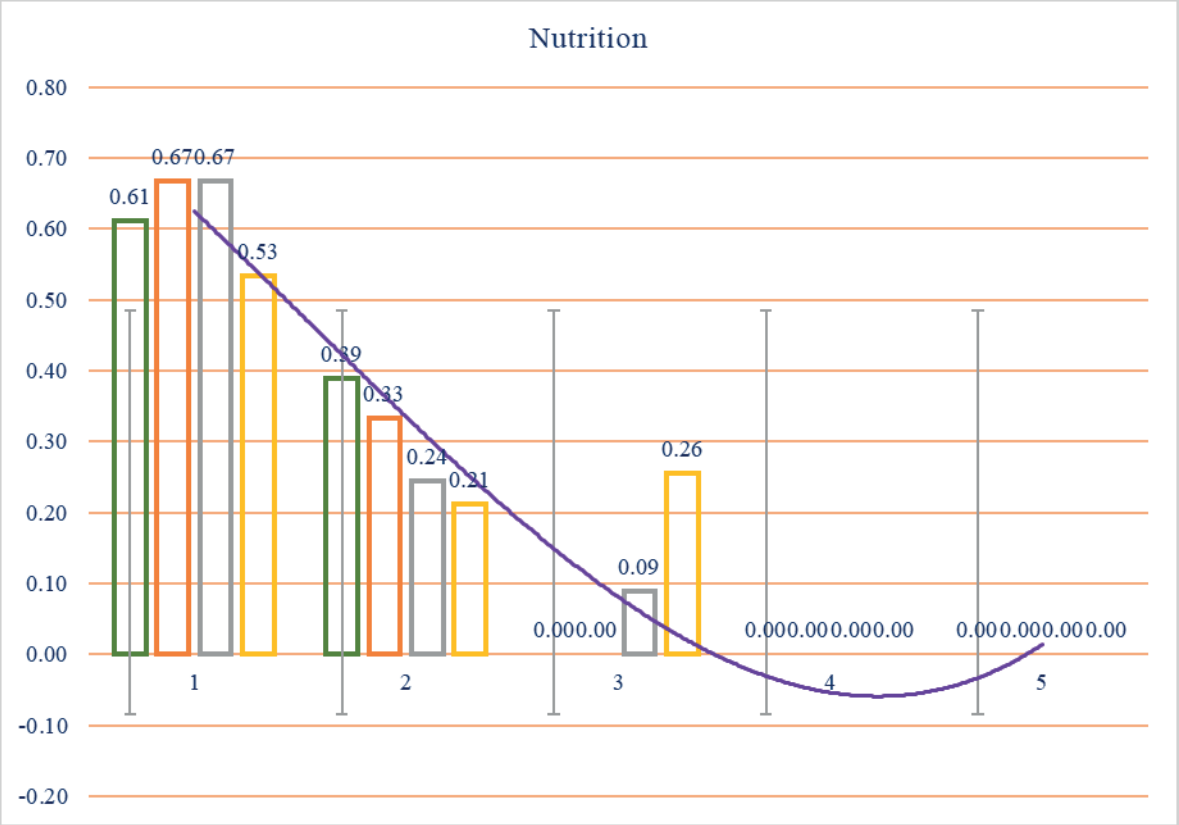


**Figure 10.** Representation of the responses obtained from the degree in Nutrition

The statistical test shows that a large number of students are highly satisfied with everything that, as part of the core model, has been integrated into their teaching-learning activities aimed at promoting entrepreneurship.

In the Veterinary Medicine program, 45 students participated (figure 11), and the results obtained show that there is a large number of students whose perception is reflected in entrepreneurship and all the activities related to it, and have been very influential in it.

The statistical test shows that a large number of students do not have a high level of satisfaction, so the work that must be done to change these perceptions must be very careful and extensive, but above all, when applied, great care must be taken to ensure that its results modify the entrepreneurship rates in this particular area.

In the Psychology degree, 16 students participated (figure 12), and the results obtained show that there is a large number of students whose perception is reflected in entrepreneurship and all related activities, therefore, they have not had the necessary elements to participate in them.

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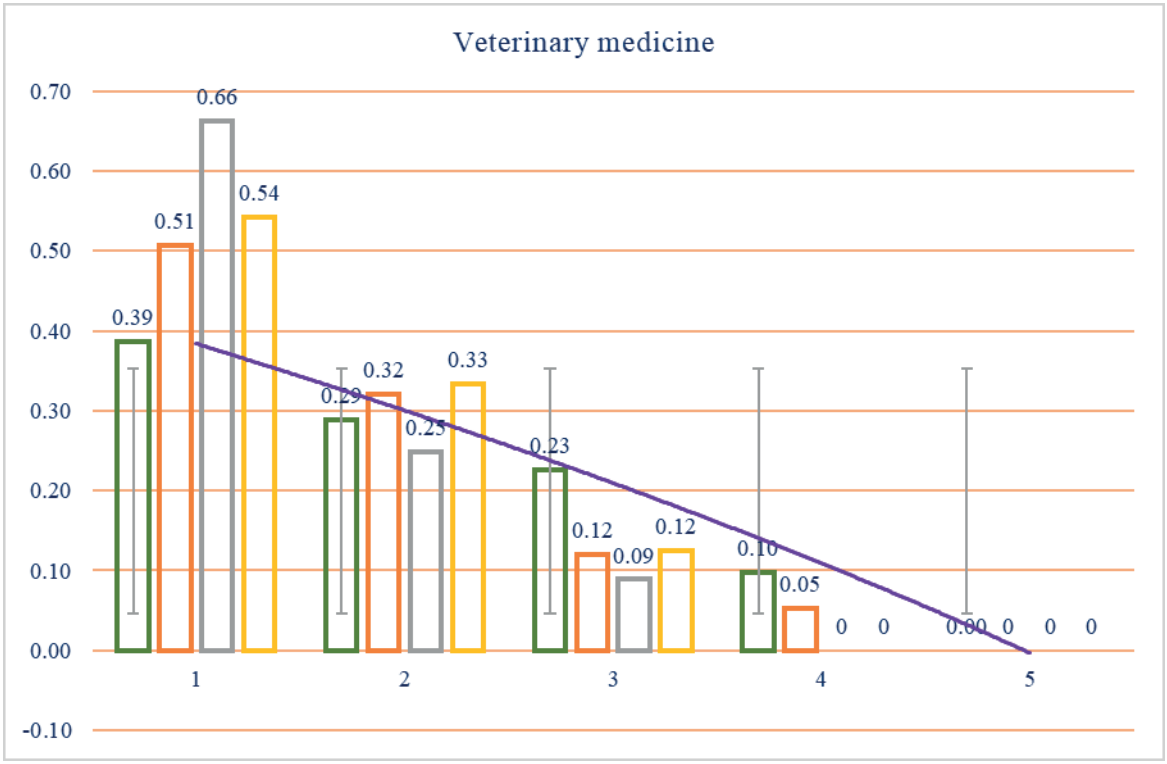


**Figure 11.** Representation of the responses obtained from the degree in Veterinary Medicine

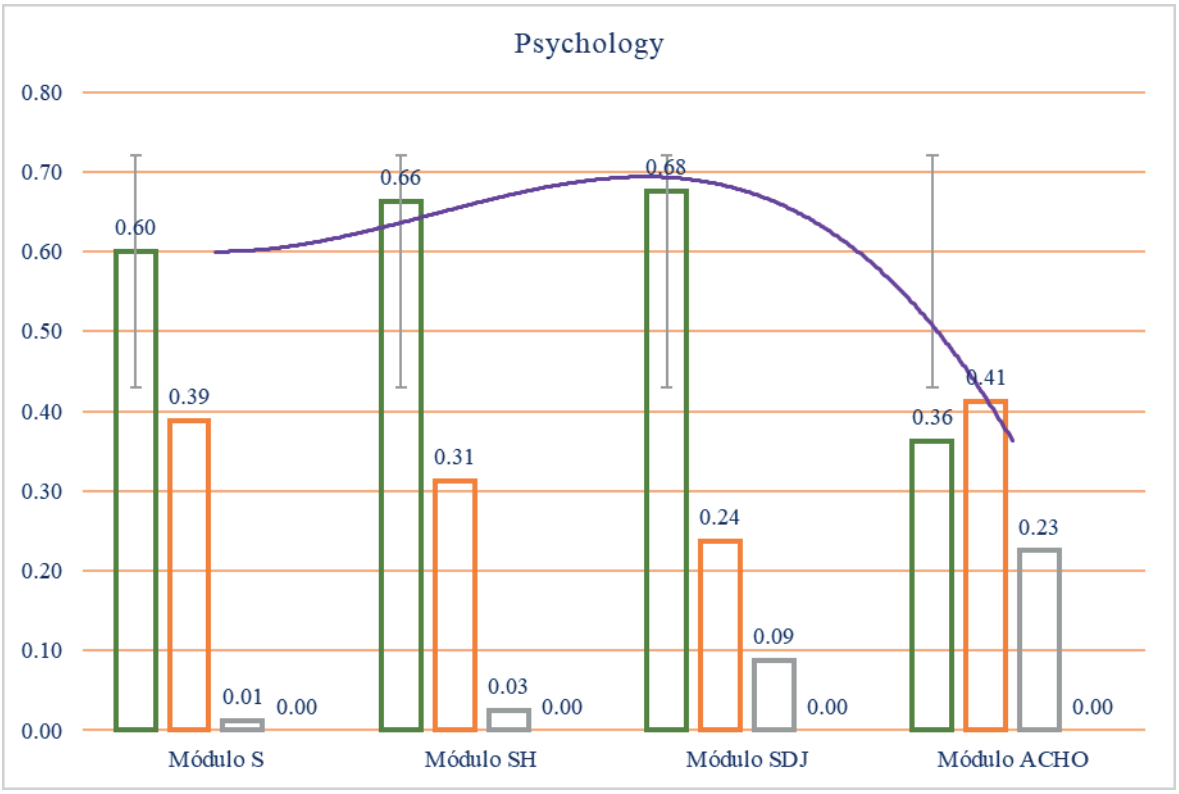


**Figure 12.** Representation of the responses obtained from the Psychology degree

The statistical test shows that a large number of students perceive that the applied model does not meet their expectations, as the shape of the curve indicates that they believe more conditions should exist to allow them to contribute to the number of entrepreneurships in their area. Therefore, a significant effort is required to improve all the conditions that will allow us to modify the results obtained to date in this particular area.

Twenty-eight students participated in the Public Accounting program (figure 13), and the results obtained demonstrate that a large number of students, whose perception is reflected in entrepreneurship and all the activities related to it, have not yet had the necessary elements to participate in them.

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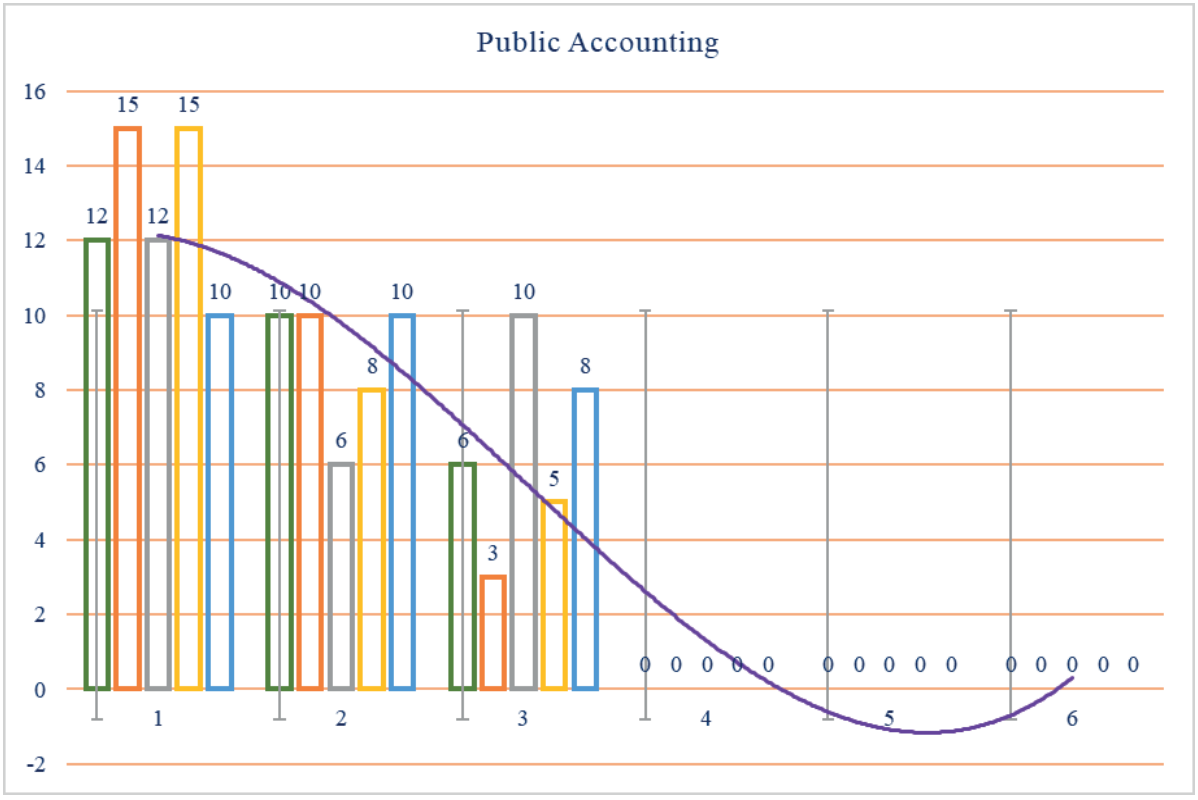


**Figure 13.** Representation of the responses obtained from the Public Accounting career

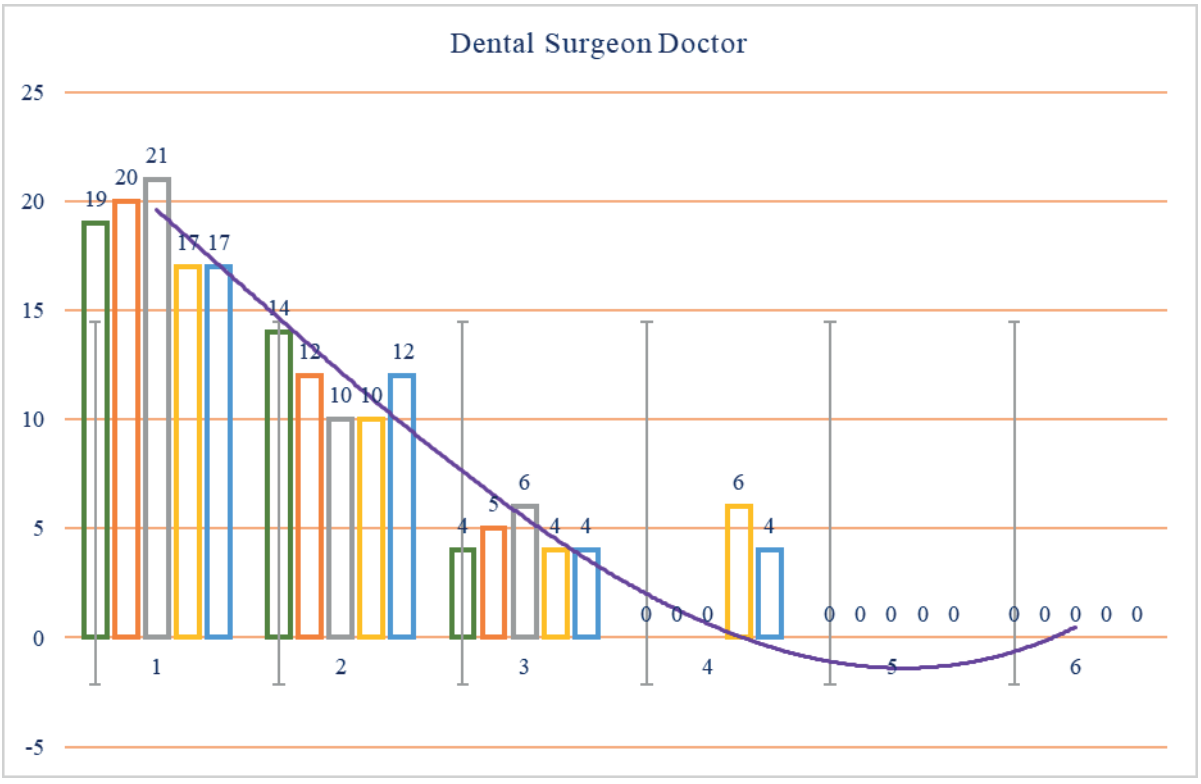


**Figure 14.** Representation of the responses obtained from the Dentistry career

The statistical test shows that a large number of students perceive that the model being implemented still lacks all the elements that could fully satisfy their expectations, since the first two columns should accommodate a greater number of students who see entrepreneurship as an opportunity for faster growth.

In the Dentistry program, 37 students participated (figure 14), and the results show that a large number of students' perceptions are reflected in entrepreneurship and all related activities. However, they still have some problems that need to be addressed.

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The statistical test shows that a large number of students perceive that the model being implemented requires more attractive elements to increase the number of startups, which can be reflected in a greater number of students who have the capacity to generate new knowledge.

## DISCUSSION

The initiatives implemented at the Los Altos University Center have been geared toward consolidating an academic ecosystem that fosters the development of a broader group of professionals capable of generating, transferring, and applying knowledge with an innovative and entrepreneurial approach. This focus is reflected in the active participation of students and faculty in business projects and their involvement in the productive sector.[35,36,37,38]

The multi-pronged intervention model adopted emphasizes the importance of contributions from both internal stakeholders (students, teachers, researchers) and external stakeholders (business, government institutions, and social organizations). This collaborative approach reinforces the notion that continuous improvement is an essential component for strengthening and sustaining the educational model.[39,40]

However, it is essential to maintain ongoing evaluation of the implemented actions in order to analyze, modify, and adapt them to changing environments and new knowledge demands. This ongoing process of critical review ensures that students and faculty remain active within a dynamic learning ecosystem focused on innovation, entrepreneurship, and academic excellence.[41]

## CONCLUSIONS

Achieving different and improved results requires a shift in approach. In this study, the implementation of a five-axis model was intended to function as a cohesive framework. However, the survey results indicate that further refinement is required to fully align student perceptions with the intended objectives. Despite notable progress, there remains a gap in encouraging students to actively participate in knowledge creation within their respective field or collaborate with colleagues from the Altos University Center, other university centers within the U of G network, higher education institutions, industry partners, and government entities at various levels.

Therefore, the work carried out serves as a foundation for a step toward a more comprehensive and impactful initiative. The ongoing efforts aim to generate greater benefits for a broader audience, ensuring that the progress made within this structure contributes to a culture of innovation and interdisciplinary collaboration. To expand the academic entrepreneurship model to other institutions or regions, it is important to follow a series of practical measures to ensure its adaptation and sustainability. First, there is a need to promote the inclusion of entrepreneurship in university curricula and integrate subjects that address local problems and promote solutions from student perspectives. At the same time, it is crucial to strengthen university incubators, adapt them to the production realities of each region, and promote their coordination with stakeholders in the ecosystem.

Another crucial step is to forge strategic partnerships with local and regional governments to facilitate funding, technical support, and legitimization of the projects developed. Similarly, the power of local media and cultural networks should be harnessed to share success stories, foster an entrepreneurial culture, and connect with diverse communities.

Finally, the inclusion of a socio-ecological approach allows entrepreneurship to focus on sustainable models where initiatives seek not only economic profitability but also positive social and environmental impacts. This comprehensive approach promotes the model's reproducibility in different contexts, respects their specificities, and strengthens regional innovation ecosystems.

### Future work

The analysis of the results found in the survey responses is considered the starting point for correcting, expanding, removing, and adapting actions and activities that each participant must carry out in the teaching-learning process, which aims to turn the student into a generator of new knowledge, which is reflected in ventures that range from modifying something that already exists to the generation of new companies that are a product of that venture.

Only in this way will it be possible to encourage students to become the focus of the needs of the entrepreneurship-based educational model and, to achieve this, apply the axes model to the design and implementation of activities. Feedback, in the context of discussion and conclusions, defines the analysis of the survey results as a fundamental starting point for redesigning, strengthening, or adapting the actions and activities carried out by the stakeholders in the teaching-learning process.

This allows pedagogical practices to be oriented toward a clear objective: for students to become active generators of knowledge, which is reflected in entrepreneurial initiatives, which can range from the improvement of new processes or existing products to the creation of companies. This approach reinforces the need to place the student at the center of the entrepreneurial education model, supported by the structured

application of the core model for the design and implementation of training activities. In this context, lines of research are proposed that will focus on the effectiveness of the model in different academic contexts, the relationship between entrepreneurial experience and the generation of significant knowledge, as well as the impact of these practices on changing the graduate's professional profile. These guidelines would contribute to the validation, scaling, and enrichment of the model and ensure its relevance in different educational contexts.

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## CONFLICT OF INTEREST

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