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ORIGINAL

Optimization of the Entrepreneurship Ecosystem: 5-Axis Model for Higher Education Systems; and the Higher Education Systems. Case Study for Center University of Los Altos

Optimización del Ecosistema de Emprendimiento: Modelo de 5 Ejes para los Sistemas de Educación Superior. Estudio de Caso Centro Universitario de los Altos

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ABSTRACT

Today in higher education there is a need for a higher quality preparation that adapts to the new educational philosophies, since the New Mexican School and the University Center of Los Altos (CUAltos) of the University of Guadalajara, have as an objective, to provide the conditions for the student of any area of knowledge to become a generator of new knowledge that lead to entrepreneurship. CUAltos has proposed a model based on five axes, the first one, the university, which is where plans, study programs, administrative policies, administrative, teaching and research personnel intervene, with the student as the main objective, the second axis, the industry, which is the key to the development of nations and demands highly qualified professionals, and the third axis, the government, which finances the public university, the government that funds the public university and develops policies that benefit productivity and national development, the fourth axis, the media responsible for promoting academic and cultural advances and technological innovation, and finally, socio-ecology that highlights the importance of the environment and its relationship with innovation in the knowledge economy. This model is considered essential to offer the best answers required by a society that is increasingly involved in improving the quality of life and care of the planet. This research adopts a mixed and transversal approach, based on surveys directed to students of different specialties that have been studied in the development of Entrepreneurship and Innovation projects. Likewise, it seeks to generate conditions that allow students, regardless of their area of knowledge, to become creators of new knowledge that drive the development of dynamic entrepreneurial ecosystems based on academic entrepreneurship.

Keywords: Axes; Entrepreneurship; Innovation; Model.

RESUMEN

Hoy en día en la educación superior existe la necesidad de una preparación de mayor calidad que se adapte a las nuevas filosofías educativas, ya que, la Nueva Escuela Mexicana y el Centro Universitario de los Altos (CUAltos) de la Universidad de Guadalajara, tienen como objetivo: el propiciar las condiciones para que el estudiante de cualquier área del conocimiento se convierta en un generador de nuevos conocimientos que desemboquen en emprendimientos junto a analizar una formación en diversas carreras y poder hacer una evaluación en la promoción en el emprendimiento. CUAltos ha propuesto un modelo basado en cinco ejes, el primero, la *universidad* que es en donde intervienen planes, programas de estudios, políticas administrativas,

personal administrativo, docente y de investigación, con el estudiante como objetivo principal de crear al profesionista idóneo para el mundo laboral, el segundo eje, *la industria* que es clave de desarrollo de las naciones y demanda de profesionales altamente calificados, el tercero, *el gobierno* que financia la universidad pública y desarrolla políticas que benefician la productividad y el desarrollo nacional, el cuarto eje, los *medios de comunicación* responsables de promocionar los avances académicos, culturales y la innovación tecnológica, y por último, la socio-ecología que resalta la importancia del medio ambiente y su relación con la innovación en la economía del conocimiento. Este modelo, se considera esencial para ofrecer la mejor de las respuestas que requiere la sociedad que está cada vez más involucrada en mejorar la calidad de vida y el cuidado del planeta. Esta investigación adopta un enfoque mixto y transversal, basados en encuestas dirigidas a estudiantes de distintas especialidades que se han cursado en el desarrollo de proyectos de Emprendimiento e Innovación. Asimismo, se busca general condiciones que permitan a los estudiantes, independientemente su área de conocimientos, convertirse en creadores de nuevos saberes que impulsen el desarrollo de ecosistemas empresariales dinámicos fundamentados en el espíritu empresarial académico.

Palabras clave: Ejes; Emprendimiento; Innovación; Modelo.

INTRODUCTION

Replacing study plans and programs is complicated due to the time and resources involved. However, CUAltos's educational offer must be kept up to date and include the use of cutting-edge technologies and tools demanded by companies, thus presenting a panorama that makes it possible to provide students with the knowledge that will enable them to respond to business demands (Hayter, 2022).

The philosophy of the new education system applied at the Centro Universitario de los Altos (CUAltos) coincides with that of the New Mexican School (NEM) (SEP, 2019), as both are aimed at providing students with the necessary skills to use cutting-edge tools, to generate new knowledge. This allows them to become a reference within the industry, thanks to which they will develop skills that favor their integral growth. In this way, graduates of any specialty will be valued in the business world, facilitating their insertion and acceptance by companies, thus opening doors for the following generations. Otherwise, if it does not meet these high standards, as it is a low-quality job, the employer will always be able to choose to hire a graduate from any other university.

For this reason, CUAltos has been working on integrating administrators, teachers, students, processes, plans, and study programs in activities linked to the productive and service sectors. Likewise, relations with the different levels of government have been included as part of the developed model and a predominant part of optimizing results, in addition to the communication platform of CUAltos itself, which is immersed in the sustainable management of environmental care and protection (García, López, and Martínez, 2020).

That is why the change in the teaching-learning model that stems from the NEM philosophy arrived at the university level three years ago and is now being incorporated. In this new model, elements such as transversality and the generation of knowledge coexist, and they have been taken up as part of the response provided by CUAltos to the demands of current and future society (Díaz-Barriga, 2019). For this reason, the quality of university education is based on the degree to which students are equipped with the latest knowledge and tools, leadership values, teamwork, honesty, and responsibility, in particular, with which graduates will meet business demands (Cruz, 2019).

Likewise, emphasis should be placed on the fact that the design of study plans and programs usually takes several years, so they are in force for at least a decade. At the same time, they allow for the consideration of new emerging technologies, which should be incorporated into educational models that impact education in general, that is, from preschool through all educational levels up to university level.

Similarly, it should be noted that the average number of subjects in a university degree course is 48 to 50, and they are placed in sequences that allow knowledge to be acquired structurally with the aim that the quality of the knowledge must be endorsed by the educational institution, through a study plan. However, one option that allows for the updating of all the curricula and syllabuses of the degrees offered at CUAltos is based on educational transversality, which can be achieved through the implementation of a subject that is common to all degrees (Planter, 2024) that allows the student to be encouraged to acquire knowledge and skills that will enable them to be a generator of new knowledge through entrepreneurship, which coincides with the philosophy of the NEM. Therefore, as part of the country's public education system, one of the objectives of CUAltos is to provide students with the opportunity to become generators of knowledge, that is, entrepreneurs, based on the idea of fostering dynamic entrepreneurial ecosystems based on academic entrepreneurship.

These ecosystems are based on digital technologies as part of the academic offer of CUAltos and their integration into the comprehensive frameworks of the teaching-learning processes (Schepers et al., 2020)

there; four areas are identified: digital technologies in business education, the framework for establishing spatial movement, digital technologies for the discovery of opportunities, and the creation of entrepreneurial skills. It begins by establishing a relationship between academic entrepreneurship and the digital age. Its basis lies in university students' skills (Ferreira et al., 2020) due to their role in turning university students into quality professionals. This relationship fosters more significant interest among researchers and the impact that emerging technologies have on the professional future so that their development is increased by using educational platforms for entrepreneurship, business collaboration, and companies, from which the entrepreneurship is derived (Zhang, 2023).

For this reason, the configuration of each university's business ecosystem is based on factors such as the strength of research and the environment in which the Centro Universitario de los Altos is located. For this reason, it is essential to transform the incubators. This phenomenon is considered deficient, which is exposed when the activities of academic entrepreneurship are supervised (including the role of university councils). For this reason, the mobility of faculty between universities and the options for graduate placement when starting companies derived from academic entrepreneurship must be explored (Hassan, 2020). In other words, it is necessary to generate more effective strategies at the university and government level, using theoretical perspectives in organizational behavior, human capital management, ethics, and social responsibility. To advance academic entrepreneurship, research is needed on the influence of group thinking on property rights, incubators, business mobility, international entrepreneurship, and procedural justice (Klyver, 2020).

It should be considered that academic entrepreneurship brings together a wide range of individuals, organizations, resources, rules and policies, universities, faculties, government agencies, research institutes, and financial markets since the collective work that is carried out facilitates the flow of knowledge, which is the basis of the technological development that makes market innovation possible (Fuster, 2020). The entrepreneurial spirit of the university-driven innovation ecosystem is vital for monitoring and analyzing the structure and flows of the ecosystem, as this will provide more accurate information for use in decision-making.

Therefore, it is necessary to emphasize that the university is not isolated from social changes, the economy's evolution, and digital platforms of value chains in all sectors (including higher education). Thus, innovation is essential for the university to remain competitive, sustainable, and relevant to society. For its part, entrepreneurship must be understood as an engine of economic growth and a generator of employment due to its contribution to innovation ecosystems' generation, development, and sustainability, supported by creating new companies and attracting organizations (Szerb, 2021). Technological evolution has led to the transformation of the digital economy, causing a very profound impact on social entrepreneurship. This is based on the growing availability of funding from philanthropic organizations, governments, and companies, with the social entrepreneur emerging as an influential actor who addresses social issues in the implementation of innovative solutions to help the community in general, but not all motivations and social entrepreneurs have managed to have the desired impact.

In the context of academic entrepreneurship, the evolution of the digital economy encourages collaboration and the exchange of knowledge and innovation. Digital platforms facilitate research collaboration with industry, patent applications, and the transformation of innovative ideas into start-ups. In addition, the accessibility and scalability of the digital economy allow academic entrepreneurs to reach larger audiences, attract investment, and accelerate the commercialization of their research, understanding that, in order to navigate the complexity of the digital economy, they must adapt to the changing focus and trends at each stage.

Cloud computing and emerging technologies should be adopted to improve academic entrepreneurship capabilities by acquiring greater agility, efficiency, and global impact (Szerb, 2021). This has resulted in the academic entrepreneur recognizing the relevance of the digital economy and keeping in step with its evolution, taking advantage of digital platforms and technologies to drive innovation, improve productivity, and create sustainable businesses that contribute to social and economic growth. The result of the relationship between the evolution of the digital economy and academic entrepreneurship is that the greater the economic support available, the greater the degree of preparation to drive innovation and address social challenges through entrepreneurial initiatives derived from research.

Hence, the possibility arises that the entrepreneur in the ecosystem will drive change and take advantage of the opportunities that arise from the company so that when one becomes obsolete, another new company can be created. The entrepreneur is a crucial part of the dynamism of the innovation ecosystem, as he encourages the creation of new companies and attracts various actors. Thus, the university, as a space for research, emerges as a key source for developing these entrepreneurial ecosystems, providing the security of protecting the results of its research and their transfer to the market, thus turning research into an institutional strategy.

Faced with the challenges of the knowledge economy, globalization, financial crises, and environmental problems, among other factors, the university must move from its traditional teaching approach to a participatory and research model to make a more significant contribution to society (Skute, 2019).

In addition, the university must demonstrate responsibility and efficiency in the administration of public

funds by making use of strategic management practices, which require the transfer of knowledge to society, the fostering of entrepreneurial skills, the promotion of innovation, and a contribution to social welfare and the training of human capital, helping to meet social needs and industrial objectives, thus moving away from the traditional approach. The university's commitment to entrepreneurship contradicts its mission, values, and traditional academic culture, which can lead to confrontation between academics. To this end, it is necessary to develop strategies that allow the adaptation of entrepreneurship in each degree program offered by the university, incorporating the skills that favor the student's integral development (Rippa, 2019).

The entrepreneurial university originates from MIT and Stanford University; this is clear from the fact that they are considered leaders in integrating applied research oriented towards commerce and the transfer of knowledge to industry, where most of their monetary funds come from. The European university adopted academic entrepreneurship in response to the increase in funding and competition, seeking to improve results and contribute to global development (Neves, 2020). In addition, it is characterized by establishing an internal system to commercialize and commodify its knowledge through technology transfer mechanisms such as incubators and science parks (Mathisen, 2022).

To achieve this, the university must follow a five-pronged approach: a) a strengthened management core, b) an expanded development periphery, c) a diversified funding base, d) a stimulated academic body, and e) an integrated business culture. These involve strategic prioritization, acquisition of financial resources, commercialization of intellectual property, and commitment to stakeholders to develop regional innovation. Therefore, when using an "entrepreneurial architecture," internal factors (structures, strategies, systems, leadership, and culture) and the decisive elements for forming university entrepreneurial agendas are considered (Cunningham, 2019).

Therefore, university entrepreneurial culture is only accepted by committed academic staff, as some traditionalists do not participate in entrepreneurial activities. From these challenges arise conflicts between commercial values and traditional academic values, where limitations related to institutional rules, lack of systemic coordination, environments of little or no entrepreneurial innovation, and insufficient attention to reputation and branding come together. It is difficult to establish a unified business culture based on the effective communication of academic staff initiatives. For this reason, Knowledge Transfer Offices (KTOs) are vital in managing knowledge transfer, commercialization, referrals, and promotion of education and business culture (Feola, 2021).

Knowledge transfer (KT) activities are vital for the entrepreneurial university, as they enable the application of academic knowledge in business and community organizations for innovation and economic development. KT involves commercializing academic knowledge, patents, industry-university links, licensing agreements, and business creation. KTOs aim to effectively manage KT activities, as they support the creation of spin-off companies, manage patents and licenses, and facilitate interactions between research units and companies (Belitski, 2019). Collaboration between academic policymakers and industries is crucial for KT activities to have a high impact, and their scope is strengthened by the development of comprehensive approaches to KT that encompass economic and non-economic activities.

The role of the entrepreneurial university is vital in promoting entrepreneurial education and culture since, through interdisciplinary courses, practical applications, and professional training for developing entrepreneurial skills, these objectives can be achieved. Some challenges involve teaching and non-teaching staff in entrepreneurship activities. They must be encouraged and supported since they interact with industry, government, and local communities, which act as partners in entrepreneurship. Their participation generates socio-economic value (Belitski, 2019). Providing physical infrastructure and habitats for entrepreneurship (technology transfer offices, incubators, accelerators, science parks, and entrepreneurship centers) is extremely important for promoting academic entrepreneurship (Mathisen, 2022). These resources are associated with the strongest levels of academic entrepreneurship.

Universities need to update their incentive frameworks, taking into account the high opportunity cost faced by teachers when participating in new companies, which means that an institutional focus on entrepreneurial education has the potential to boost entrepreneurial behavior (Barbini, 2021). To support the conversion of the university into an entrepreneurial one (Cunningham, 2019), it is necessary to integrate actors from diverse backgrounds, including decisively

Academics (researchers, assistants, professors, and associate professors) with roles in research, patenting, and commercialization possess characteristics specific to research (Wang, 2022). Students with an aptitude for entrepreneurship participate in group and individual activities. University/research institutions provide infrastructure, resources, and support for academic entrepreneurship and foster an environment of innovation and knowledge transfer. Government/politicians develop regulatory policies, funding, and tax incentive programs to benefit the entrepreneurial ecosystem that promotes academic business exchange, values knowledge, industrial collaboration, and the establishment of new companies and/or spin-offs (Gubbins, 2020). The industrial/business sector collaborates with academia, provides funding and expertise, applies academic

research products through agreements, promotes incubators, entrepreneurship centers, venture capital, and investments, mentors, funding, and guidance for commercializing ideas, and facilitates knowledge exchange. Society/community are customers or users of academic innovations. They provide feedback to the market, contributing to the social and economic impact of business activities (Hahn, 2020).

METHOD

Type of Study

The type of study carried out is focused on a mixed and cross-sectional analysis, for which surveys were used aimed at students of the specialties that have accredited the course in Development of Entrepreneurship and Innovation Projects to analyze the results obtained in the different degree courses where it is taught, to ascertain the impact achieved on the student and subsequently to make the necessary adjustments to influence the improvement of the results. In addition, the participating entrepreneur was interviewed about his perception of university, governmental, and environmental participation and the dissemination of these results. It is cross-disciplinary because it is based on the fact that CUAltos is only as strong as its weakest link; that is to say, the degree course with the least acceptable results should be taken as the starting point for the necessary adjustments.

Similarly, a (five-axis) model is structured that does not allow any of the actors who impact the quality or poverty of the education provided at CUAltos to be left out of the new teaching-learning model, which is of utmost importance for the university to substantially increase its acceptance as a quality institution that, because of its graduates, will be known wherever they go, since they will be the best ambassadors of the strict orientation they have to stand out for their proactive participation wherever they take part in the business transformation processes required by the regions where they are incorporated.

Perception of the model

To verify the results obtained, statistical techniques such as “least squares” were used to show the trend of the responses by degree course. The survey results are grouped by areas of affinity, as specialists in those areas designed the specific objectives of each specialization.

Instrumentation to Evaluate the Results of the Project

Once the subject “Development of Entrepreneurship and Innovation Projects” has been taught to several generations (eight) of students, it is necessary to evaluate the results obtained. For the evaluation, a survey was implemented aimed at students who had already taken the course since its results will allow any necessary adjustments to the course and any of the activities involved in the process.

Table 1. Survey dimensions

Dimensions	Description	Questions
Potential Knowledge (PK)	Indicator used to represent improvement, complementation and updating of learning	1-5
Ability to Execute (AE)	Knowledge is applied in processes for solving problems, searching for solutions and achieving established objectives.	6-10
Judgment Decision (JD)	Processes for obtaining data and analyzing it with the purpose of prioritizing decision making.	11-15
Entrepreneurial Attitude (EA)	Linking the way initiative is shown to establish creative and innovative proposals that are focused on challenges to stimulate the realization of professional potential.	16-20

Table 2. Survey and response scale

Dimension	Question	Scale				
CP1	Were there strategies that promoted better learning practices?	1	2	3	4	5
CP2	Did the teacher use complementary learning strategies to encourage the appropriation of knowledge related to your entrepreneurship?	1	2	3	4	5
CP3	Based on the dynamics used in the entrepreneurship project, do you consider that your professional knowledge was expanded?	1	2	3	4	5
CP4	Was there an incentive to share knowledge among the members of your entrepreneurship team?	1	2	3	4	5
CP5	Was there complementary training that could be applied to your entrepreneurship?	1	2	3	4	5
HE6	During the stages of the entrepreneurship project, was the application of the knowledge acquired promoted?	1	2	3	4	5
HE7	During the entrepreneurship project, was advice available to solve the problems that arose?	1	2	3	4	5

HE8	During the development of the proposal, were you given advice on working in inter- and multidisciplinary teams?	1	2	3	4	5
HE9	During the development of the proposal, were you advised on how to present the results in a real-life scenario?	1	2	3	4	5
HE10	For your entrepreneurial proposal, were you encouraged to add value that would make a difference with respect to existing products/services?	1	2	3	4	5
JD11	Once the results of the entrepreneurial activity were obtained, was the feasibility of the entrepreneurial project analyzed?	1	2	3	4	5
JD12	Once the proposal was finished, was a SWOT analysis carried out?	1	2	3	4	5
JD13	During the entrepreneurship project, did you manage to develop a systemic vision of the set of interrelations and connections of its components?	1	2	3	4	5
JD14	Based on the analysis of the information in the entrepreneurship proposal, were you able to define the priorities so that they could be completed in a timely manner?	1	2	3	4	5
JD15	In decision-making, was an analysis of alternatives applied?	1	2	3	4	5
AEE16	During the development of the entrepreneurship proposal, were you encouraged to get actively involved in identifying opportunities for improvement?	1	2	3	4	5
AEE17	During the development of the entrepreneurship proposal, did you address any experience that contributes to achieving your professional goals?	1	2	3	4	5
AEE18	Did the university advisors and/or entrepreneurs in the region provide you with recommendations on the use of tools that can ensure better processes to improve your entrepreneurship?	1	2	3	4	5
AEE19	Did your entrepreneurial proposal arise as a result of an analysis that aims to improve the needs of a market sector?	1	2	3	4	5
AEE20	Does your entrepreneurial proposal involve creativity in its design/innovative processes for its development?	1	2	3	4	5
	Response options					
1.-Totally agree	2.- Agreed	3.- Neither agree nor disagree	4.- I disagree	5 Strongly disagree		

The survey was posted on the CUAltos computer network for five days. The school services department sent an email to students who had previously taken the course to participate. Three hundred eleven students answered it out of a total of 2000 who had taken it and come from 13 of the 14-degree courses on offer, which is because the degree in Chemistry, Pharmacy, and Biology only began to be offered in 2023, so when the survey was applied, no student from that degree course had taken it.

The subject, "Development of Entrepreneurship and Innovation Projects," is taught in the seventh semester of the studied degree. Student participation ranged from a maximum of 45 in veterinary science to a minimum of 10 in nursing.

Development

The legal and regulatory framework that governs the functioning of the field of academic entrepreneurship, and because its role is fundamental in innovation and business development, including regulations and laws with provisions on genetic resources and their management, product labeling, including those for human consumption, financing programs, commercialization, patent rights, economic competition, data protection, commercial companies, financial operations, taxes, and labor relations, it is considered that they may not be up to date with current circumstances. Yet, their use is essential for the CUAltos to function and improve in the search for increased research and academic entrepreneurshTaking into account that the curricula of the CUAltos cannot be changed, to implement the five-axis model has been implemented in the following way:The first axis (university) incorporates transversality in CUAltos's degrees. A common subject (Development of Entrepreneurship and Innovation Projects) was implemented to introduce and interest students, teachers, and researchers in entrepreneurship.From this inclusion, the aim is to derive consultancy programs for entrepreneurs where the student attends, participates in, and contributes to these sessions, thus expanding the student's knowledge and acquiring the responsibilities inherent to the new knowledge. For this reason, the objectives of the knowledge competitions constantly held at CUAltos were expanded, as this is how we seek to have the greatest possible participation of students from all areas of knowledge.Calendars of events were designed so that researchers, teachers, businesspeople, graduates, and members of different government bodies could participate in exhibitions, talks, lectures, and everything else that would enrich the knowledge of the future professional by developing the entrepreneurial spirit in the student. Many incubators and accelerators have been implemented to support emerging ventures.

In the second axis (industry/business), entrepreneurs were invited to join the entrepreneurship program, hosting advisory sessions with the researcher (accompanied by students) to get to know and analyze their processes to propose possible solutions for the improvement, substitution, or replacement of these processes

(to make them more efficient). In addition, the entrepreneur is invited to contribute to projects (ventures) for his company or those that may be considered with a high probability of being patented, developed, incubated, or industrialized for economic benefit for all parties.

CUAltos focuses on the third axis (government) from two perspectives. The first of these is through the Legal Department of the University of Guadalajara, which is responsible for acting as a conduit for carrying out, before different authorities (State Government, local and federal Chamber of Deputies, among others), the procedures and agreements required to strengthen the development of academic entrepreneurship, favoring the student as the primary beneficiary, without forgetting the researcher and the entrepreneur-student.

The second perspective is the sole responsibility of CUAltos, as it is in charge of establishing relations with the municipal governments of the Los Altos region (which is its area of direct influence), as well as with organizations, civil groups, academic institutions (public and private), among others, which is because they are all part of the same society and their influence is required for the proper functioning of any relationship where an exchange of knowledge and the possible transfer of consumables destined for a segment of the consumer is possible.

The fourth axis (communication and culture) is based on the CUAltos' communication system, which forms part of the mass communication network (television and radio) of the University of Guadalajara (U de G) itself, as it has its own radio and television programming, as well as a magazine that is circulated throughout all the centers that make up the network of university centers of the U de G. To this communication system we must add the local press (written and radio), as well as the internet. Together, they become the best ally for publicizing the enterprise, to which we must add the computer network, which allows access to virtual libraries of almost any university in the international university circuit.

In this way, entrepreneurs can research their personal and entrepreneurial interests and what is happening in other places, including everything related to climate change, environmental protection, and enabling legislation, so that the product of an entrepreneurial venture can reach any place without breaking any current laws and contribute to environmental improvement.

The fifth axis (socio-ecology), CUAltos, as part of the network of university centers of the University of Guadalajara, has policies for the exchange of knowledge and researchers from different areas of expertise, agreements with national and international (public and private) higher education institutions, through which it is possible to enrich academic entrepreneurship based on the protection of the environment (with ventures that do not harm it) and that contribute to reversing, as far as possible, climate change through the generation of derivatives of the entrepreneurship that make it posible.

RESULTS

Development of the Five-Axis Model

The model that has been implemented to manage the educational quality offered by CUAltos optimally was developed based on five axes (figure 1) that serve as a dynamic basis for development between (a) university, (b) business, (c) government, (d) media and culture (d) socio-ecology. It fosters innovation, economic development, and sustainability. It is based on the evolution and improvement of Cai's (2021)28 three-axis model, as it has a clear tendency to be a sustainable entrepreneurship model for generating knowledge and marketing products and services

In figure 1, we can see the cohesion of the elements that make up each axis of the model because if that cohesion is broken in any of its links, there is an imbalance. Its results would be disastrous, and the benefits to society in general would be incalculable, resulting in a decline in the quality demanded by society. It is a model aimed at raising the quality of public university education; the members of each axe must participate proactively so that it has a beneficial impact on society, where university, business, government, environment, and the media are a vital part of it. Its fruits are reflected in the students, who will make them known through their actions.

The first axis (university) is cutting-edge knowledge and research, which are the source of innovation and foster innovative ideas and technologies. The second axis (industry) is the end user of academic research and drives the commercialization of creative ideas and technologies. It is a market-oriented perspective; it identifies opportunities for new products and services, and it provides feedback to the researcher on commercial viability, so its basis is alliances and collaborations that reduce the theory-practice gap and stimulate the economic growth of the commercialization of research products (Awasthy, 2020).

The third axis (government) finances research and provides financial resources to universities and institutes. It formulates policies and regulations encouraging innovation, entrepreneurship, and knowledge transfer from academia to industry (Storz, 2020).

The fourth axis (media and culture) is how research in the creative industry, culture, values, and lifestyles are disseminated, knowledge of culture and values attached to public reality is enhanced, and the innovation system is influenced. The cultural dissemination of the knowledge economy and interactions between

universities, industry, government, and society means a dimension outside parameters (Cai, 2022).

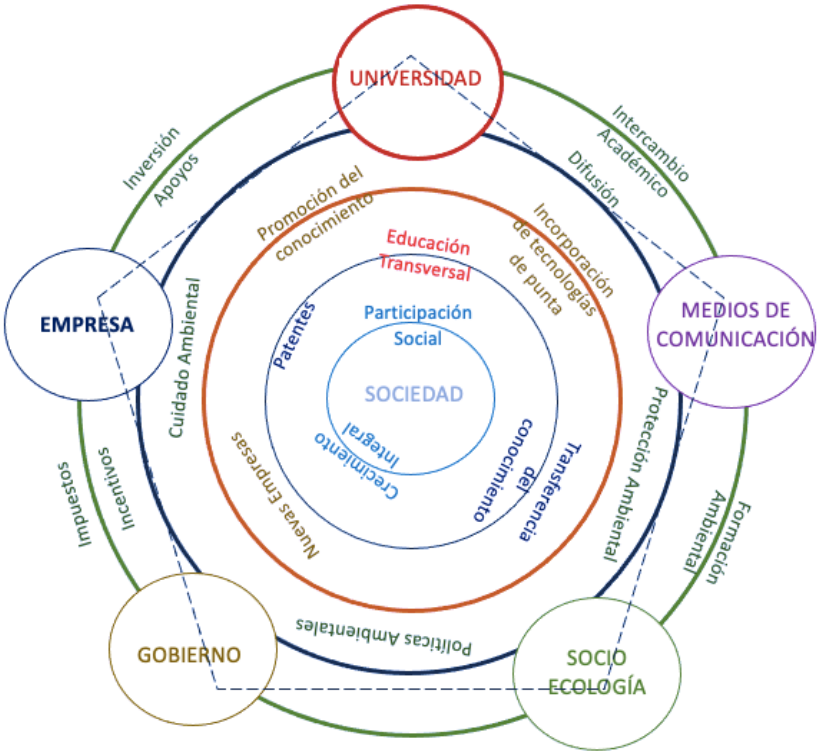

Figure 1. Five-axis model

The fifth axis (socioecology) delves into the complexity of innovation ecosystems, including the "natural environments of society" as the driving force behind the production of knowledge and innovation. It recognizes the importance of the environment in the knowledge economy and the evolution of societies and economies where socio-ecological factors are emphasized in innovation and sustainable economic development (Mineiro, 2021).

University and industry interact for mutual benefit, with academia providing a flow of research results and industry offering applications and funding opportunities. The government supports research with funding and guidelines, encouraging entrepreneurship in academia and the sale of technology. For this reason, it is considered key to the dynamics between universities, companies, the state itself, the press, and the social environment. The present research proposes that a sustainable model is based on a five-axis model, where society is the student's origin and the environment is the company's home, which needs a constantly updated system (Carayannis, 2022).

By incorporating the socio-ecological environment into academic entrepreneurship, as innovation ecosystems evolve, the interdependencies and relationships between stakeholders can be understood, thus identifying that sustainable economic growth and prosperity are the product of collaboration between all actors (Liyanage, 2022). The role of this axis is the core of the academic entrepreneur, acquiring the ability to get involved in environmental challenges (climate change, non-renewable resources) by adopting more ecological practices and incorporating sustainable solutions into entrepreneurship (Stam, 2021).

The academic entrepreneur in the five-axis model has the means to take advantage of the natural environment to foster innovation and sustainable development, hence the commercial strategies aimed at creating environmentally friendly products and services. Aligning academic entrepreneurship with social expectations and values positions the company for long-term success in the environmentally conscious market (Barcellos-Paula et al., 2021).

Perception of the Model

From the responses received, it should be noted that if the first column is the highest, more students agree with the knowledge, activities, and products they have created. In the case that the column with the most support is the second, this suggests that the students are satisfied with the knowledge and activities they receive. If the third column is in the highest position, the students are neutral to the entrepreneurship model. If it is the fourth, the model offers few benefits for their academic development. If the last column is the highest, nothing that has been incorporated will motivate the students to become generators of knowledge.

Suppose the fourth or fifth column is mastered. This case requires the support of other experts in these areas, who are in networks of university centers of the U of G, as well as specialists from local companies and private and national educational institutions. The areas are presented below, organized by affinity of knowledge, since they involve teachers and researchers in administration, medicine, and engineering.

As with the modules for common subjects, they are grouped by affinity. The first group consists of degrees in Law (10 participants), Business Administration (15 participants), International Business (25 participants), and Public Accounting (28 participants). The latter degree is selected for graphic representation because it has the highest number of participants (figure 2(a)).

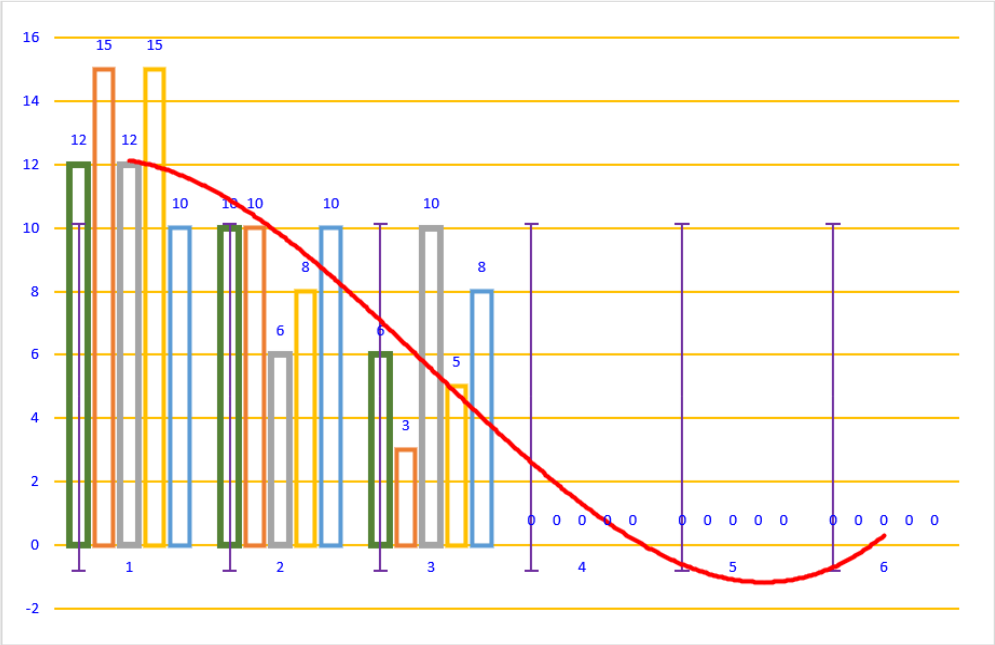

Figure 2 (a). Accounting

The next group consists of Nursing (10 participation), Medicine (37 participation), Nutrition (10 participation), Veterinary Science (45 participation), and Dentistry (37 participation). From this group, the graphic representations of the participation in Medicine (figure 2(b)) and Veterinary Medicine (figure 2(c)) were selected.

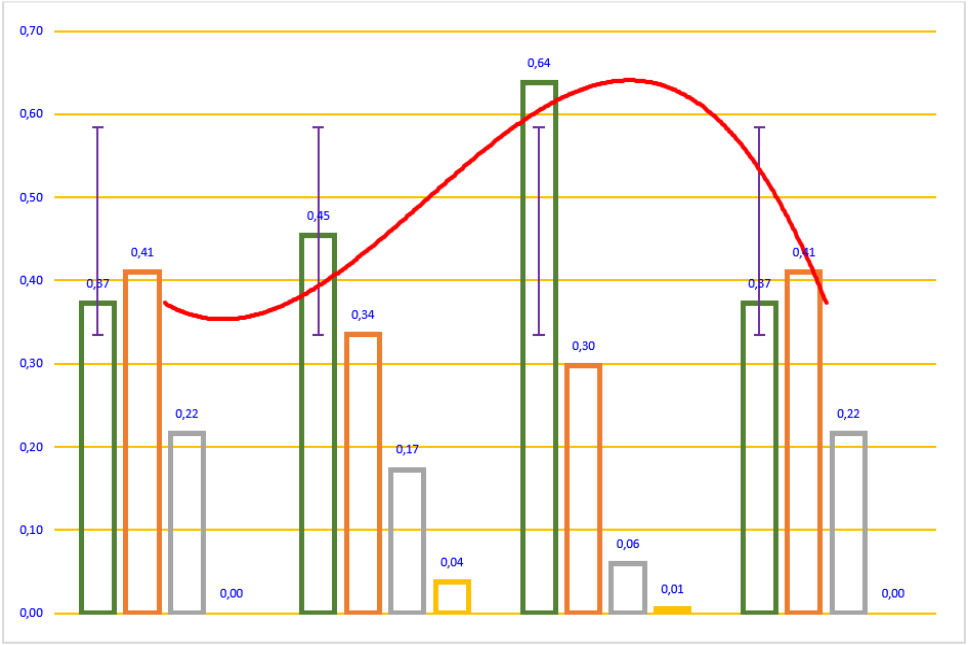

Figure 2 (b). Medicine

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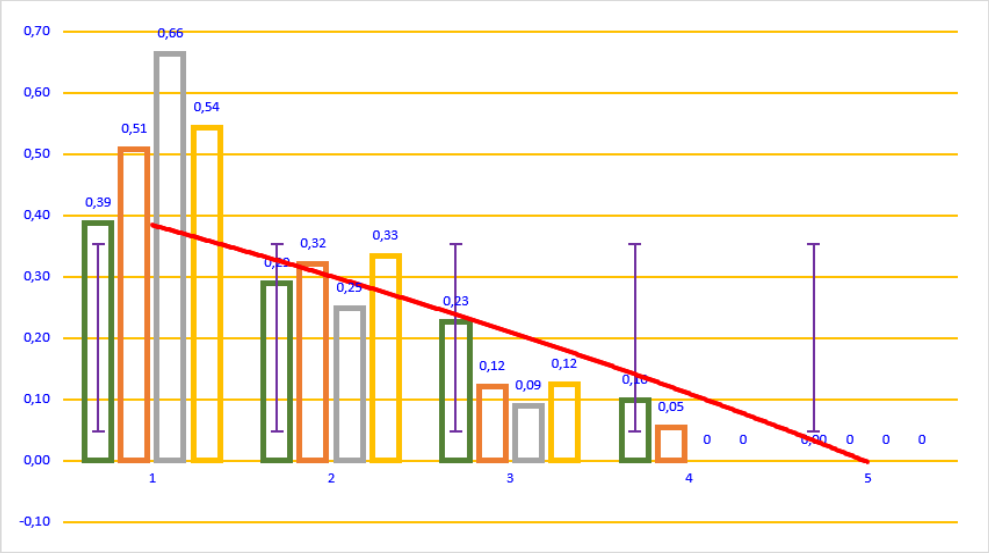

Figure 2 (c). Medicine and Veterinary Science

Figure 2 (d). Livestock Systems

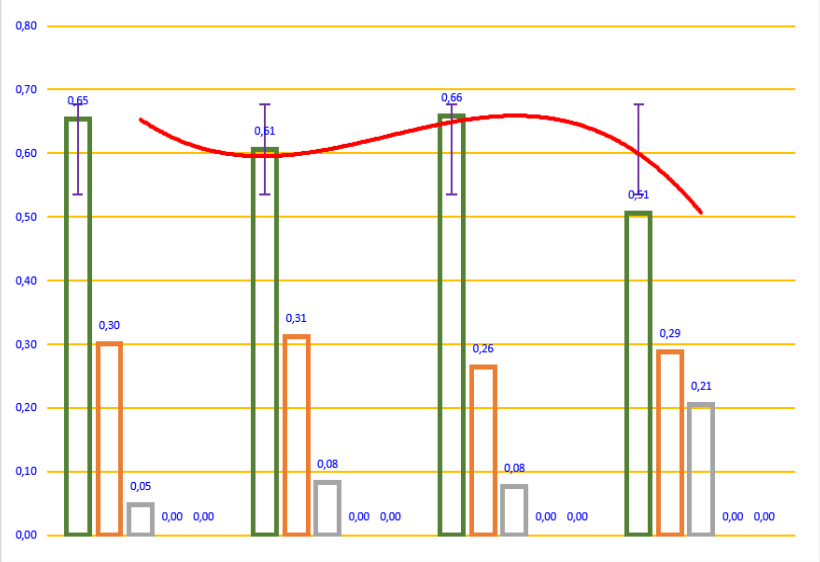

Figure 2 (e). Computing

https://doi.org/10.56294/mw2025677

The last module corresponds to engineering degrees, and their participation was as follows: Agro-industry (16 participations), Livestock Systems (36 participations), and Computing (32 participations). From these, the degrees of Livestock Systems (figure 2(d)) and Computing (figure 2(e)) were selected to show the results of the choices made.

The vertical axis shows the percentage of students who chose the same option. On the other hand, the horizontal axis shows the selected question modules, which means that this axis includes the answer modules, which should be interpreted as follows: in the first module, the answers appear on social dimensions such as potential knowledge, ability to execute, decision judgment and the attitude of the entrepreneurial spirit. On the horizontal axis, the answers are grouped according to the available options: "strongly agree," "agree," "neither agree nor disagree," "disagree," and "strongly disagree," according to the answers in previous modules. It is better understood if we visually observe that the columns closest to the origin (on the x-y axes) indicate dissatisfaction in some specialties, and it is necessary to take strict measures to solve this problem. On the other hand, if the majority of the responses are not concentrated in columns of "totally agree," actions must be implemented to improve the students' perception of entrepreneurship-related activities.

Project Results

An analysis of the responses found that, in the five modules of questions, very few responses correspond to the options "disagree" and "strongly disagree." This indicates that the work being carried out, although it can be considered good, requires better work so that when the next survey is carried out, a greater trend and higher values can be obtained in the "Strongly agree" and "Agree" responses.

These results may be because the number of students participating in the advisory sessions given to entrepreneurs in the region continues to increase, where it is noteworthy that at the end of these advisory sessions, there were students who became "advisors" of the entrepreneur, in the areas related to medicine (midwife, veterinarian, nursing, nutrition, psychology), a very significant number of students participated with the teachers to carry out fieldwork with real patients so that when they graduate, they have greater practicality and knowledge about their specialty.

In engineering, a greater number of students are involved in real projects developed for regional companies. Contacts were established through the teachers who provided advice and, in some cases, by the student who made the contact. Similarly, in the law degree, a large number of students participate in solving real problems supervised by teachers who are practicing their profession.

Participation in the various knowledge competitions was very high, and the results obtained are very flattering for CUAltos in general, as it stands out in the network of university centers of the U de G. (Planter, 2024). In addition, emphasis is placed on the results in certified careers, guided tours, competitions, and entrepreneurship (which translate into product modifications to systems methods that are currently part of regional companies) and are shown in competitions in which students from universities in other states participate, accelerators, national meetings, academic exchange sessions, student participation in CENEVAL exams (with surprising results by career), consultancies, agreements with educational and governmental institutions.

The present project analyzes the five-axis model's degree of influence and penetration. The shape of the red curve indicates the behavior of the selection of answers in general. When it presents the shape of Figure 2(a) or Figure 2(d), a series of actions must be implemented that promote a greater understanding and application of the entrepreneurship model so that many answers are in the first column regardless of the module. Otherwise, it is in the form that Figure 2(d) and Figure 2(e) take, as it indicates that a different approach is required to support entrepreneurship in these degree programs. Hence, the origin of the failures has to be analyzed to implement the measures that will allow these deviations to be corrected.

DISCUSSION

The work that has been carried out at CUAltos has been aimed at having a more significant number of professionals who can be considered "knowledge generators," which can be seen reflected in the type of participation they have in the ventures since the axis model that has been used aims to show that the work carried out by each participant (both internal and external to CUAltos) is of vital importance for continuous improvement of conditions. However, it is necessary to continue analyzing, modifying, and adapting the activities considered conducive to the continuous improvement of all participating in the university professional education model.

Analysis of the Model Government policies, such as tax exemptions, research and development funding, and favorable regulations, are very relevant to the successful entrepreneurship ecosystem, especially in the initial stages (Ziakis, 2022).

With this network infrastructure, the new company can obtain valuable knowledge, secure funding, and accelerate its growth. This benefits the university, which seeks to increase its academic entrepreneurship and adopt successful practices in these global startup ecosystems. This encourages the university to collaborate

with the government in the search for policies that incentivize academic entrepreneurship, facilitate the commercialization of research results, foster networking opportunities for students, researchers, and graduates, and train aspiring entrepreneurs to connect with advisors, investors, and potential collaborators (Taucean et al., 2019).

In implementing this methodology to foster academic entrepreneurship and entrepreneurial culture, CUAltos has implemented the following actions:

- Cultivating strong networks of graduates: This allows students to take advantage of groups of experienced professionals, advisors, and potential investors to improve their chances of business success (Bititci et al., 2019).
- Establishing business incubators and accelerators: their fundamental role in promoting start-ups in their initial stages, providing capital, office space, and mentoring.
- Fostering innovation and creativity: emphasis is placed on research and development activities that create innovative companies and technologies (Secundo et al., 2016).
- Offering entrepreneurship programs (undergraduate and postgraduate): providing students with specialized education in entrepreneurship, equipping aspiring entrepreneurs with the knowledge and skills to transform their ideas into viable businesses (Ndou et al., 2018).
- Organizing entrepreneurship events and competitions: a platform for students to showcase their business ideas to potential investors and advisors, which are opportunities to network and build connections (Alexander & Evgeniy, 2014).

Despite the positive impact that CUAltos has on participants in entrepreneurship ecosystems (internal and external), challenges remain in the implementation of the five-axis model; since the economic resources to support the projects that arise will never be sufficient, changes in economic support policies are derived from the regimes that govern, and there are gradual advances in increasing the participation of students, teachers, researchers, administrators, business people from the region and municipal, state and federal governments.

To achieve the progress made so far, the following actions are being taken:

- Streamlining bureaucratic processes: simplifying administrative procedures by eliminating bureaucratic steps to accelerate the transfer of knowledge and technologies from academia to industry (Hausberg, 2020).
- Increasing funding for entrepreneurship programs: Seeking new sources of funding for developing and implementing innovative projects (Sánchez-Barrioluenfo & Benneworth, 2019).
- Foster a culture of innovation and risk-taking by instilling an entrepreneurial mindset in students and teachers (Nájera-Sánchez, 2023).
- Generate more entrepreneurship centers and incubators: Increase the number of entrepreneurship centers and incubators, increase the number of tutorials and improvement programs, and provide access to more resources to help academic entrepreneurs, mainly in their initial stages (Kalar & Antoncic, 2015).
- More opportunities for collaboration and networking: encourage teachers to establish new relationships of support and collaboration with researchers, students, industry professionals, government agencies, and civil society to increase knowledge exchange and technology transfer (Ye, 2020).
- Continuously improve business education: Improve business education programs to increase the number of students, teachers, and researchers enrolled in advisory programs that facilitate business navigation and the acquisition of skills and knowledge (Pratono & Mahmood, 2015).
- Promote more significant participation of graduates: Involve as many entrepreneurial graduates as possible to act as mentors and investors, supporting the growth of academic entrepreneurship (Fuster, 2020)

CONCLUSION

The educational model at CUAltos has been reformulated with a five-pronged approach, anticipating the implementation of the new Mexican school at the higher level. This strategy has made it possible to increase the number of students generating new knowledge, which is reflected in patents and the strengthening of the entrepreneurial ecosystem. To guarantee the quality and competitiveness of education, an attempt has been made to accredit all the academic programs consolidated at the Centro Universitario de los Altos as an institution with regional, national, and international appeal.

As part of this transformation, a subject common to all specialties was implemented to enable students to develop skills that can generate knowledge and its application in entrepreneurship with the potential to become businesses. In order to evaluate the impact of this strategy, a survey was administered to the students, the results of which allowed for an analysis of their perception of the activities integrated into the new educational model. The findings indicated that, although progress has been made, it is necessary to deepen the analysis and improve what entrepreneurship requires. Adaptation to this new approach in a way that attempts to adapt

to change promotes in students an understanding of their role as generators of knowledge and their ability to adapt in a professional environment. This project meant a far-reaching educational transformation whose benefits will impact students, teachers, and industries, contributing to a change in the country's mentality and educational models

Perspectives

The NEM philosophy is currently being applied in the third grade of secondary school, so the CUAltos has been constantly preparing in the characteristics of this philosophy since from August 2025, these students will arrive at upper secondary schools, and several of them are part of the U de G education system, which is why the teaching and administrative staff must be prepared to become involved in the activities that form part of this new educational model.

In undergraduate and postgraduate courses, the courses will have to be taught by CUAltos staff (teaching and administrative) since it will be a very valuable opportunity that should be taken advantage of to extend the cross-curricular education that forms part of the policies of the NEM models and of CUAltos itself, so that, in this way, during their time at the institution, students acquire the cutting-edge tools that will enable them to obtain the highest quality of education, which is reflected in the appropriation of the knowledge they receive and, by adding it to the new knowledge they acquire, they generate their knowledge, which will be reflected in a more significant number of patents for the University of Girona.

This is because, when they become professionals, the company they start or join will be able to benefit directly from the results of the application of the knowledge possessed by the new professional.

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