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Study of the Entrepreneurial Attitudes of STEM Students

M. DOLORES LA RUBIA¹, CATALINA RUS-CASAS², SALVADOR BUENO-RODRÍGUEZ¹,
JUAN D. AGUILAR-PEÑA², AND DOLORES ELICHE-QUESADA¹

¹Department of Chemical, Environmental and Materials Engineering, University of Jaén at Las Lagunillas, 23071 Jaén, Spain

²Department of Electronic and Automatic Engineering, University of Jaén at Las Lagunillas, 23071 Jaén, Spain

Corresponding author: M. Dolores La Rubia (mdrubia@ujaen.es)

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ABSTRACT The Entrepreneurial Promotion Programs in Higher Education carry out training activities with the aim of promoting the entrepreneurial spirit among university students. These programs promote skills such as innovation and creativity which improve self-employment among young people, but do not usually modify the entrepreneurial attitude. This work presents the entrepreneurial profile of STEM (Science, Technology, Engineering and Mathematics) students at the University of Jaén (Spain). The study focuses on the results of the self-diagnostic survey of the Ministry of Industry, Trade and Tourism and the DG for Industry and Small and Medium-Sized Enterprise. The results have been analysed according to gender, age and Bachelor's Degree specialty. The Kaiser-Meyer-Olkin (KMO) test and the Pearson's correlation test was used for factor analysis and correlations. The results indicate that students have high entrepreneurial attitudes, although there are no significant differences in age and gender. On the other hand, statistically differences have been found based on the engineering expertise area. Students of the specialty in Industrial Electronics Engineering have higher attitudes regarding creativity and innovation that are key for entrepreneurship.

INDEX TERMS Entrepreneurial attitudes, STEM areas, students, higher education.

I. INTRODUCTION

The promotion and development of entrepreneurship education has been one of the key policy objectives of the European Union and the Member States for many years. The European Commission attaches great importance to the potential that young people have to launch and develop their own enterprises, thus becoming innovators. Entrepreneurship education is important not only to mold the mindset of young people but to provide the basic skills, knowledge and attitudes for the development of an entrepreneurial culture in Europe.

In this context, according to Welter and Lasch [1] there is a tendency to transfer business education to all educational levels. That is, outside of business school as an effective way to influence the entire university [2] and influence computer science, engineering, and life science students who are generally more likely to innovate [3]. The recommendations of the European Parliament in relation to adequately assessing youth entrepreneurship and education for entrepreneurship focus on the “development of

entrepreneurial skills at all levels of education” through “a systematic approach and the use of tools available”. In conclusion, as stated in the Commission Communication “A new concept of education: Investing in skills to achieve better socio-economic results” [4]. Therefore, current trends are committed to entrepreneurial education and training as a support for economic growth and business creation, considering “the reinforcement of innovation and creativity, including the entrepreneurial spirit, at all levels of education and the formation”.

Table 1, provides a summary of the main recommendations and proposals of the European Commission related to entrepreneurial education at different educational levels (Primary, Secondary School and University).

The first document for the promotion of an entrepreneurial culture in European Educational Systems is the European Charter for Small Enterprises, adopted by the European Council [5]. This document proposes as a line of action for the Member States the education and training to promote entrepreneurship. In this way, there is an agreement to undertake support actions in favour of small and medium-sized enterprises. The Entrepreneurship Action

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TABLE 1. Recommendations of the European commission.

Document	Year	Recommendations and proposals
European Charter for Small Enterprises. EU General Affairs Council. [5]	2000	Training in basic education and training.
European Forum training for Entrepreneurship. Digital Enterprise and Industry. European Commission. [6]	2000	Incorporate training in digital skills to promote entrepreneurship.
Enterprise and Industry. Industrial Policy communication. European Commission. [7]	2002-2021	Promote entrepreneurship in primary and secondary education Teachers training in entrepreneurship; cooperation between schools and universities. Agreement on the definition of entrepreneurship or “entrepreneurial spirit” in which education in entrepreneurial attitudes and capacities, which includes the development of certain personal qualities and does not focus directly on the creation of companies. They highlight the importance of teacher training and fostering learning through practice; creating a national or regional framework for entrepreneurship education and making political commitments.
Education and Training. European Commission. [8]	2003	Collaboration between university and business collaboration to increase opportunities and reduce rigidities in the labor market.
Promotion an enterprising mind-set though education and training. European Commission. [9]	2006	Incorporation of entrepreneurship training at all levels. At University level, integration of the entrepreneurial spirit as an important part of the study plan, distributed in different subjects and they even advise encouraging students to take entrepreneurship courses.
Oslo Agenda for Entrepreneurship Education in Europe European Commission. Recommendation on Key competences for permanent learning. [10]	2006	The importance of learning by doing and experiencing entrepreneurship in practice is highlighted, through projects and activities. In the university field, one more step is proposed, focused on generating business ideas, technology-based activities and innovation.
Small Business Act for Europe. European Commission [11]	2008	Training and promotion initiatives in the field of small companies, as an engine of economic growth.
High Level panel with representatives from Digital Cooperation of Educations and Industry/Economics of the Member States. European Commission. [12]	2009 -2020	Conclusions of the meetings of experts from different fields that propose training in entrepreneurship among other fields, trying to establish a roadmap for the EU countries. In 2020, entrepreneurship training has focused attention to achieve sustainable development goals.

Plan 2020, published in 2013 identified entrepreneurship education as an area in which an immediate intervention is required [13].

In May 2015, the European Entrepreneurship Education Network was created aiming to strengthen collaboration between authorities and experts at the European level,

in order to disseminate policies, measures and actions to support entrepreneurial education, as well as evaluating its impact [14]. Recent initiatives such as the European Entrepreneur Exchange Program-Erasmus for Young Entrepreneurs (www.erasmus-entrepreneurs.eu) or the collection of information for the preparation of the study

Education for Entrepreneurship in educational centers in Europe developed by the European Information Network on Education, EURYDICE [15], indicate that work is being done along this line.

In Spain, the national legislation on education [16] includes among its aims to ensure that students develop an entrepreneurial spirit. Law 14/2013, of September 27th, to support entrepreneurs and their internationalization [17] establishes the object, scope of application and the definition of an entrepreneur. It includes the idea of the entrepreneur and business culture as essential elements for the economic and social development of Spain. The entrepreneurial culture has been expressly introduced in some educational levels, but it is considered necessary to underline and expand this element, incorporating it as a specific objective at all educational stages.

Another reference document is the guide “Entrepreneurship education in the Spanish education system” [18] an in-depth analysis of relevant data on policies, curriculum, outcomes and impact of entrepreneurship education. In addition, the document has valuable information on training and support measures for teachers and good practices in this field. This study focused on education encourages the identification of policies that lead to the creation of an entrepreneurship education ecosystem. Today’s universities also face the challenge of becoming more entrepreneurial and participating actively in solving social problems. They should not be mere viewers of change but be the main actors in this change, contributing through the generation of innovative ideas that drive economic and social development [19].

At regional level, in Andalusia (Spain), the Andalusia Entrepreneurship Foundation’s mission is to promote entrepreneurial initiative to contribute to the revitalization of the regional economy of Andalusia. For this, it develops programs that are effective and innovative instruments, which allow inculcating in young people entrepreneurship. Andalusia Entrepreneurship Foundation develops educational programs in collaboration with the Regional Board of Education and Andalusian Public Universities to activate the entrepreneurial action among the students through challenges to motivate and train future entrepreneurs [20].

At local level, the University of Jaén, in which this work is carried out, through its Operational Plan to Support the Transfer of Knowledge, Employability and Entrepreneurship, is developing practical actions that favour employability and entrepreneurship [21]. This Plan is also promoting the economic development of the environment and, consequently, the generation of qualified jobs. This purpose is a priority within its III Strategic Plan (PEUJA3-25): “Improving the employability of students by intensifying their contact with professional activity and the culture of entrepreneurship [22].

According to this background, it is necessary to promote entrepreneurial culture at all educational stages, with both students and teachers being the main actors. The latter should take on a leading role in fostering the entrepreneurial spirit of students, so that initiatives related to entrepreneurship can be

increased, seeking to provoke a proactive attitude in students with a view to their incorporation into the labour market. Therefore, the support and promotion of entrepreneurship in the university framework is a strategic action that is configured as a great opportunity to advance in the change of economic model, by allowing the development of a new, more innovative productive fabric, more intensive in the use of technologies and with a greater capacity to compete in international markets.

In this line, the authors of this work have carried out previous experiences within projects of the Entrepreneurial Promotion Programs (EPPs) that the university awarded on a competitive basis. In the case of engineering Degrees, where the promotion of entrepreneurial culture is a transversal competence, these projects are additional resources that reinforce the acquisition of Degree competences. These projects train students in entrepreneurship and develop more effectively the transversal competences associated with engineering degrees.

In previous works [23] face-to-face and online activities have been developed in the classroom, dynamized by social networks, which have influenced different aspects related to entrepreneurship training for engineering students. The analysis of the impact of these activities revealed that the perception of the environment and the motivation to undertake were greatly influenced. However, the personal requirements and self-efficacy, as the perception of the entrepreneurs’ confidence in themselves and in their own entrepreneurial abilities, were not modified.

In this sense, it is necessary to deepen the attitudes that are related to entrepreneurship. Students must know more about the entrepreneurial attitudes and identify them in themselves in order to increase their self-confidence. On the other hand, knowing the entrepreneurial attitudes of the students can be very useful to propose specific activities in the EPPs. Therefore, in this academic year the strategy was focused in analysing the entrepreneurial attitudes of STEM students using tools of self-diagnosis.

Next section reviews the attitudes in the literature.

A. CHARACTERISTICS OF ENTREPRENEURS IN THE LITERATURE

Entrepreneurial spirit is a concept that has been widely studied from different points of view. Traditionally, it was approached from a demographic perspective. Place of birth, gender, age, role models, educational level, and family background, among others, were considered to establish an entrepreneur profile [24]. Another widely used approach is that of personality traits. In this sense, certain authors support the belief that personality traits are important factors in determining whether a person will become an entrepreneur [25]–[29]. Both approaches, despite being successful for some researchers, are also highly criticized for being unsatisfactory in explaining business behaviour and performance. The association to an average personal profile of entrepreneurs is questionable

because entrepreneurs are a highly heterogeneous group of people [30]–[34].

Robinson *et al.* [34] incorporate a new approach accepting the opinion of Ajzen and Fishbein [35] that the attitude influences an individual’s evaluation. An attitude is, according to Robinson *et al.* [34], a predetermined propensity that responds generally positively or negatively to the object of the attitude. These authors also emphasize that an attitude can change over time. Therefore, business attitudes can be defined as predetermined but changing behavioural feelings and intentions that encompass creation and operation.

Krueger *et al.* [36] consider that the decision to become an entrepreneur is voluntary and conscious, so it is very important to understand how that decision is made and what factors affect. In this sense, entrepreneurial intention is perceived as a decisive antecedent of entrepreneurial behaviour [37], [38].



FIGURE 1. Attitudes of an entrepreneur in literature.

B. ATTITUDES OF AN ENTREPRENEUR

The entrepreneurial attitude represents the personal assessment, positive or negative, that individuals feel towards entrepreneurship [35]. The literature agrees on the classification of attitudes into different groups Figure 1, as shown in Table 2. The psychological profile of an entrepreneur, which encompasses the set of characteristics that define the entrepreneur’s personality and determine his or her behavior in specific situations, has always been considered to be the key factor for entrepreneurship. The decision to undertake certain activities, the determination needed to achieve goals or the ability to carry out a multitude of daily tasks, all involve the necessary leadership skills of the entrepreneur and can be related to personality characteristics.

However, the motivation is one of the factors that determine the attitude of the entrepreneur when starting a business. The main driver of motivation is achievement. Motivation in the life of an entrepreneur is vital, because without it there are no incentives, there is no winning spirit. Motivation is a psychological state produced when internal and external

TABLE 2. Attitudes.

	References
Psychological profile	[24]
Personality traits	[26-29]
Relationship between entrepreneurship and personality traits	[30-34]
Attitude, behavior and their variations over time	[34, 35]
Motivation	[36, 39]
Entrepreneurial intention	[37,38]
Leadership, attitude to change	[40]
Creativity and innovation	[41]

forces stimulate, direct or maintain behaviors to achieve a goal [39].

Motivation includes factors of different kinds to move us towards entrepreneurship, such as autonomy, independency, personal challenge or commitment, economic opportunity or need [30], [31].

Energy and personal initiative are also key factors to carry out a business project. An entrepreneur must have a proactive attitude, a global view and clear grounds, which lead him/her to carry out a business project. Other personal qualities that an entrepreneur must have in order to carry out a project and create a company are initiative and organization of work and dedication to the business.

But the success of a business project depends not only on the products and/or services that the company offers, but also on the ability of its managers to understand the role of both the commercial organization and the relationship with their environment. It is important for the entrepreneur to examine the communication skills and commercial capacity, in order to establish links of affinity, correspondence, dealings or communication with other people.

On the other hand, the analysis capacity helps the entrepreneurs to approach the reality they are facing. The analysis of its elements and the construction of new knowledge will allow them to learn to develop in the business world, to plan their decisions and to achieve their objectives. It is necessary for the entrepreneurs to analyze their ability to evaluate and act before the circumstances or market in which their project is developed. In the ability to influence there are three elements. The first, awareness, is to understand that every action has an impact. Then, it is the capacity, conflict resolution and decision making, in terms of communication. Finally, the third is a commitment to your ideas, which involves making decisions that do not always like everyone and assuming and dealing with the consequences. Leaders are attributed so many qualities, which are sometimes difficult to identify with all of them. However, the ability to influence others is clearly a leadership skill.

Besides, the management of a business project also requires facing risk situations because decision-making and problem-solving lead to a multitude of situations that may involve risk. An entrepreneur must take risks, must have a

positive attitude towards contingencies and unforeseen events that may arise in the company.

Finally, creativity and innovation are essential for entrepreneurship. The ability to create new ideas based on concrete products or services is the starting point that the entrepreneur needs to start his or her project. In addition, research applied to design, production or marketing is a necessary component for a project to be successful. Creativity must be a basic process when starting the business plan and will help to differentiate it from the competition, it is the seed that can germinate into a product or service with a lot of added value that will reap great success and positioning in the market. Innovation is defined as “a process that involves the generation, adoption, implementation and incorporation of new ideas or practices within an organisation” [44]. According to The Organisation for Economic Co-operation and Development (OECD) and the European Commission, innovation means completing products and services by developing them technologically [45]. Innovation is traditionally linked to entrepreneurship [46]. Many researchers have emphasised the relevance of innovation for firms [47], [48]. From Gündoğdu [45] point of view, in the era of the advanced information and communication technologies, with the trend of globalisation, entrepreneurs and firms are forced to respond to customers and adapt to the environment more quickly. Innovation is an essential element for entrepreneurs to sustain their business [45].

Entrepreneurs should be in mind innovation issues because they have an interest in the organisation of a new business and is committed to its survival. By its nature, innovation is permeated with uncertainty and leads to risk as a driving or limiting factor in the analysis and decision making of the innovative agent. Decisions made under conditions of uncertainty tend to face higher risks that result in mistakes or failures. Although there is the possibility of reversing these processes, these risks can cause high losses to firms [49].

The above-mentioned papers show how important personal attitudes are in the entrepreneurial intention.

According to the background, most of the references related to the entrepreneurial attitude show three aspects: personality traits, motivation and creativity and innovation as key aspects in the entrepreneurial attitude.

The aim of this work is to analyse which aspects have a greater influence on the entrepreneurial attitudes of students of STEM areas of the University of Jaén.

II. METHODOLOGY

In this work, a self-diagnostic survey of entrepreneurial attitudes (Appendix A) was used out among 140 students of the Polytechnic School of Jaén (University of Jaén).

The Ministry of Industry, Trade and Tourism and the DG for Industry and Small and Medium-Sized Enterprises (DGIPYME) developed this survey, from a study involving 80 entrepreneurs with experience in business creation [50]. The survey is located in the DGIPYME web page and it is freely accessible. The questionnaire consists of 25

questions. Each question has three options and the student has to choose one of them. In order to be able to adapt the questionnaire to the statistical study, each answer was assigned a score of 1, 2 or 3, from least to greatest influence of the answer on the entrepreneurial intention/attitude. The authors of this study agreed the score of the answers.

The questionnaire analyses the attitudes related to seven main pillars of entrepreneurship. Most of them are related to the personality traits (personal energy, relational capacity, analysis capacity, psychological profile, risk tolerance), motivation, creativity and innovation. The personality traits include the Personal Energy and Initiative (G-ENERGY), where questions are proposed for the students to identify the personal qualities that incline them to create a business and their capacity to carry out the project. The Relational Capacity (G-REL) section includes questions related to the capacity to influence. In other words, the aim is to evaluate the qualities to establish links of affinity, correspondence, dealings or communication with other people.

With regard to the Analysis Capacity (G-ANALIT) section, the aim is to analyze the ability to examine, evaluate and act in the circumstances in which the project is developed. The attitude towards contingencies and unforeseen events that may arise in a company are assessed in the section called Risk tolerance (G-RISK), and to close the evaluation of personality traits related to entrepreneurship, questions about the leadership and attitude to change are encompassed in the Psychological Profile (G-PSYCO) section. The sixth section is Motivation and for this purpose, questions are posed to reflect on the reasons that encourage the entrepreneur to create a company and to manage it with interest and diligence. Finally, in the Creativity and Innovation section (G-INNOV), the students are asked to think about their capacity to identify and find new perspectives in their entrepreneurial attitude.

For the analysis of the data, a statistical study was carried out using IBM SPSS Statistics Version 25 and Microsoft Excel 2013. From the questionnaire, we studied which questions were grouped in a characteristic way. For this purpose, a factor analysis was applied to the students' answers in order to find groups of variables with common meaning (factors) and reduce the number of dimensions needed to explain the information. The Kaiser-Meyer-Olkin (KMO) test was used to establish whether the grouping of variables is adequate, defining a statistical level above 0.6 as acceptable, and the explained variance of each factor was used to measure the amount of information incorporated into each factor [51]. For each factor, descriptive statistics, the normality of the sample and the significant differences between variables according to gender, age and engineering field of expertise were also analyzed. In addition, bivariate correlations between the different groups of factors were established using Pearson's correlation test.

On the other hand, the parameter “Entrepreneurial Attitude” (EA), which encompasses the overall score of the answers of each student in the questionnaire, was calculated. The evolution of this parameter was analyzed according to

the gender, age and the Bachelor's Degree of the STEM area they are involved.

III. RESULTS AND DISCUSSION

A. SAMPLE DATA CHARACTERISTICS

The study has 140 students of three STEM areas (Chemistry, Industrial Electronic and Mechanical Engineering) from the University of Jaén. Of the total, 71.63% were men and 28.36% women. The age distribution was 31.9% between 18 and 20 years old, 36.8% between 21 and 23 years old, 12.3% between 24 and 26 years old and 19% between 27-30 years old. Table 3 shows the courses and the number of students involved in this study.

TABLE 3. Courses and students involved.

Bachelor's Degree	Course	Students (%)
Bachelor's Degree in Chemistry	Materials Science	9.21
Bachelor's Degree in Industrial Electronic Engineering	Electronic Instrumentation	7.09
	Materials Science and Engineering	27.64
	Fundamentals in Photovoltaic Solar Energy	4.95
Bachelor's Degree in Mechanical Engineering	Materials Science and Engineering	22.05
	Materials Technology	24.82
	Topography and Construction Materials	4.25

B. SAMPLE DATA CHARACTERISTICS

The questionnaire and students' answers were analysed to find groups of variables with common meaning (factors) and to reduce the number of dimensions necessary to explain the information. In this case, it was considered that all the variables were independents. The Kaiser–Meyer–Olkin (KMO) test was used to establish whether the grouping of variables was adequate, defining a statistical level greater than 0.6 as acceptable. The explained variance of each factor was used to measure the amount of information that was incorporated to each factor [51]. Table 4, shows the descriptive statistics of the questionnaire variables and the variables of each factor, which correspond to each of the questionnaire questions (Appendix A). The number of factors considered was 12.

The Autonomy factor encompasses aspects related to the need of the entrepreneur to seek freedom in a business project, which it is not found working for someone else. Money factor encompasses the motivation to earn money and the need for money to undertake. Initiative factor encompasses initiative, decision-making and aspects related to dedication to the business and the influence of luck. The Commitment factor considers the commitment to the project and the fulfillment of objectives as means to achieve the proposed achievements. Interpersonal skills factor encompasses communication skills

and the importance of the commercial function. Planning and quality factor encompasses the aspects related to the company organization. In addition, it includes the concept of product quality that must be monitored throughout its life, from its creation until it reaches the customer. Market factor addresses the importance of the market and customers, as well as the ability to adapt to the environment, from a commercial point of view. Risk is related to tolerance to risk, its management and the search for solutions to problems. Leadership, establishes the importance of being a leader, of being able to influence others, as well as being a perfectionist, maintaining a desire for perfection. Attitude to change and external recognition factor includes restlessness, curiosity and the ability to seek new opportunities. In addition, the search for customer satisfaction and evaluation. Finally, the Creativity and Innovation factors analyze the ability to create new ideas based on specific products or services as the starting point that the entrepreneur needs to start his project.

A second grouping was carried out considering blocks of factors (similar to the survey sections), as shown in the diagram in Figure 1. This new grouping was used for the discussion of the results.

Once the factors and the way in which they are grouped have been established, the Entrepreneurial Attitude (EA) has been defined as the sum of the mean scores of each factor, which has been expressed out of 100.

Next, it was analysed whether there are significant differences in the values obtained in the grouped factors and in the Entrepreneurial Attitude, according to gender, age and Bachelor's Degree. For this, the normality of the sample was analysed using the One-Sample Kolmogorov-Smirnov Test and Shapiro-Wilk test, obtaining that the sample does not follow a normal distribution. Therefore, to compare the means of each group of factors, the non-parametric Kruskal-Wallis test was used, establishing a significance level of 0.05.

The following tables and figures show the results of the G-factors and the entrepreneurial attitude by gender, age and field of expertise of the Bachelor's Degree. The results are over 100, for a better visualization. Three levels were considered: 0-25 low, 26-50 medium, 51-75 high and 75-100 very high. The significance is greater than 0.05 in all cases, so there are no statistically significant differences by gender and age. However, some differences in scores are going to compare with literature.

Regarding the results by gender (Table 5 and Figure 2), both men and women obtain very high scores in all the blocks, except in the G-REL and G-ENERGY, which their score is high.

Table 5, shows that women have higher score in the entrepreneurial attitude than men. This could indicate that women have greater confidence in their own skills and knowledge to undertake, having a greater self-perception of their capacity for initiative and leadership. There are studies that try to find out who is more entrepreneurial, women or men. These studies seem to indicate that the entrepreneurial spirit is greater in men than in women [38], [52]–[56].

TABLE 4. Descriptive statistics and factors obtained from the variables of the Questionnaire.

Questions	Descriptive Statistics		Factors	Groups of factors
	Mean	Deviation		
1	2.47	0.071	Autonomy	Motivation (G-MOTIV)
2	2.06	0.047	Money	
3	2.32	0.079		
4	2.19	0.044	Initiative	Personal energy and initiative (G-ENERGY)
5	2.19	0.071		
6	2.17	0.039	Commitment	
7	2.24	0.069		
8	2.30	0.058	Interpersonal skills	Relational capacity (G-REL)
9	2.19	0.064		
10	2.16	0.080		Planning and quality
11	2.61	0.043		
12	2.59	0.049	Market	
13	2.34	0.066		
14	2.61	0.043	Risk tolerance	Propension to risk (G-RISK)
15	2.24	0.043		
16	2.65	0.061	Leadership	Psychological profile (G-PSYCO)
17	2.51	0.042		
18	2.29	0.064	Attitude to change and external recognition	
19	2.38	0.053		
20	2.06	0.056	Creativity	Creativity and innovation (G-INNOV)
21	2.57	0.067		
22	2.25	0.064	Innovation	
23	1.92	0.073		
24	2.60	0.046		
25	2.53	0.059		

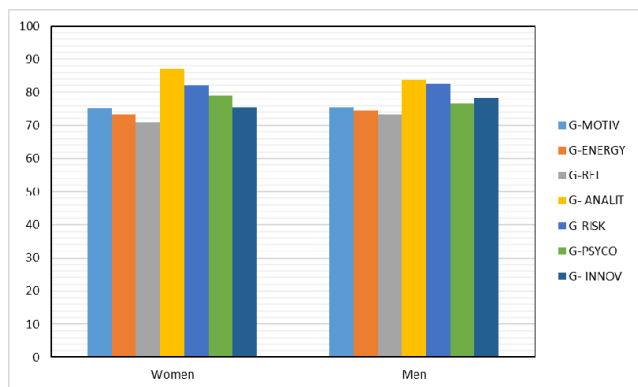


FIGURE 2. Factors by gender.

The studies of Langowitz and Morgan [56] and Langowitz and Minniti [57] also show that women entrepreneurs are perceived as less valid in relation to men.

These studies suggest that whereas men tend to undertake due to factors related to opportunity, financing or the desire to eliminate professional frustration, women do so due to a precarious work situation or difficulties in accessing a job. In Spain, data provided by the GEM Spain 2019-2020 report [59] indicates that women score lower in the perceptions associated with entrepreneurial behaviour and higher in the perception of fear of failure, which inhibits entrepreneurial

TABLE 5. Data disaggregated by gender and Kruskal-Wallis test.

	Women	Men	Kruskal-Wallis H	df	Asymp. Sig.
G-MOTIV	75.21	75.41	0.000	1	0.996
G-ENERGY	73.29	74.51	0.382	1	0.537
G-REL	70.94	73.37	0.330	1	0.565
G-ANALIT	86.97	83.66	3.097	1	0.078
G-RISK	82.05	82.46	0.034	1	0.854
G-PSICO	79.06	76.71	1.573	1	0.210
G-INNOV	75.64	78.35	2.509	1	0.113
EA	77.78	76.07	0.184	1	0.668

behaviour. This is responsible for the gender gap that continues to exist. However, the gap between men and women when it comes to entrepreneurship has decreased continuously since 2013 [57].

However, women who study engineering may have a greater entrepreneurial attitude, as indicated by previous studies that identify significant differences in women's entrepreneurship based on educational level [60], [61].

On the other hand, women stand out in the analysis factor (G-ANALIT) and in the psychological profile (G-PSYCO). Women in this group are more organized, they seem to know clearly that if they are going to start a business they have to analyse the market in a more detailed way to be close to their customers, and know what their needs are. Women seem to

have a greater capacity to meet and listen to customers. They can maintain a more active attitude of continuous search, of association of ideas, which allow changing their aspirations into specific products and markets.

Regarding the psychological profile, women are perfectionist and are more concerned that both the entrepreneur and the customers must be satisfied with the result. Women maintain a perfectionist attitude largely that gradually improves results. This fact results in increased confidence regarding their potential capabilities. Regarding leadership, future engineers are considered to have greater leadership capacity. A leader is a person with the ability to influence people, get the best out of each person, involve them in the performance of the project and combine interests and objectives of the group with those of the project, which undoubtedly facilitates the implementation of a business project.

TABLE 6. Data disaggregated by age and Kruskal-Wallis test.

	18-20	21-23	24-26	27-30	Kruskal-Wallis H	df	Asymp. Sig.
G-MOTIV	78.37	74.03	73.33	70.83	5.211	3	0.157
G-ENERGY	73.72	75.42	71.67	73.96	1.708	3	0.635
G-REL	69.87	74.44	71.67	79.17	1.890	3	0.596
G-ANALIT	83.01	85.14	86.25	86.46	2.879	3	0.411
G-RISK	79.91	84.63	81.11	86.11	5.510	3	0.138
G-PSICO	78.21	75.14	81.25	80.21	3.913	3	0.271
G-INNOV	76.76	78.61	74.17	84.38	5.444	3	0.142
EA	77.49	77.98	79.96	79.75	2.372	3	0.499

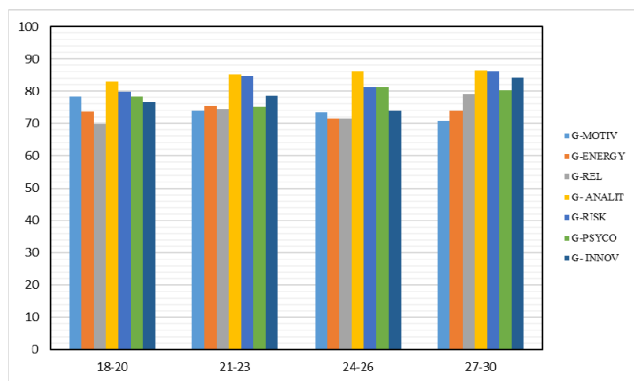


FIGURE 3. Factors by age.

Information regarding age is shown in Table 6 and Figure 3. The entrepreneurial attitude increases as the age of students increases. Age can be decisive for undertaking, but this study group is under 30 years of age and many of them may have not yet considered their labour market insertion. Young people tend to have fewer resources and experience, but they also have fewer responsibilities and family burdens that limit their risk tolerance. In addition, they have a better knowledge of the latest technologies and greater energy, analytical skills and enthusiasm when starting a business.

The analysis of the students by age groups indicates that as the age increases the students are more likely to consider entrepreneurship as a job option.

In Spain, in 2019, the Spanish population groups with the lowest level of participation in entrepreneurial initiatives were people aged 18 to 24 years (4.9% of the total) and people aged 55 to 64 years (4.2% of the total). People aged 25 to 34 and 35 to 44 years are those who have traditionally shown a greater propensity to undertake over time [59].

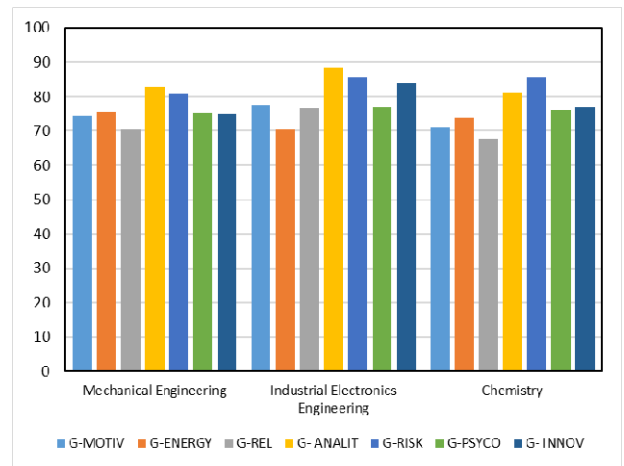


FIGURE 4. Factors by bachelor's degree.

Considering the Bachelor's Degree, Table 7 and Figure 4 show that the students have high or very high scores. Students of the Industrial Electronic Engineering stand out with a very high value of entrepreneurial attitude and stand out in all the blocks except G-ENERGY. In addition, G-INNOV has a significance less than 0.05, so there are statistically significant differences by field of expertise.

The promotion of the entrepreneurship is not a competence of the Bachelor's Degree in Chemistry. This can be seen because these students have the lowest score in the entrepreneurial attitude. As for the rest of the factors, chemistry students have the lowest values in motivation and relationship skills. On the other hand, the entrepreneurial attitude score is higher in the engineering students. Similar competences are developed in the two Engineering Degrees, so this difference in innovation and creativity skills can be due to the methodologies used in the Industrial Electronic Degree.

After a study of the teaching guides of the subjects of the three degrees, it was detected that in the case of electronic specific subjects, the practical training and the collaborative work are very common methodologies used. In addition, they have important role in the course considering the evaluation criteria. A most practical training, oriented towards finding solutions, is closely related to creativity and innovation. These methodologies improve the exchange of ideas and a critical spirit. In addition, the training they receive allows them to have more skills in new technologies and digital entrepreneurship, which favors considering entrepreneurship as career opportunity.

The Degree in Industrial Electronics Engineering at the University of Jaén has been evaluated by external organizations and has readapted its methodologies according

TABLE 7. Data disaggregated by bachelor's degree and Kruskal-Wallis test.

	Bachelor's Degree in Mechanical Engineering	Bachelor's Degree in Industrial Electronics Engineering	Bachelor's Degree in Chemistry	Kruskal-Wallis H	df	Asymp. Sig.
G-MOTIV	74.21	77.50	70.83	1.525	2	0.467
G-ENERGY	75.61	70.28	73.81	0.805	2	0.669
G-REL	70.50	76.67	67.86	0.917	2	0.632
G-ANALIT	82.83	88.33	80.95	1.606	2	0.448
G-RISK	80.69	85.74	85.71	3.748	2	0.153
G-PSICO	75.36	76.81	76.19	0.149	2	0.928
G-INNOV	74.96	83.75	76.79	7.794	2	0.020*
EA	76.43	78.71	75.89	2.804	2	0.246

* Correlation is significant at the 0.05 level

TABLE 8. Pearson's correlations between groups of factors.

		G-MOTIV	G-ENERGY	G-REL	G-RISK	G-INNOV
G-MOTIV	Pearson's Coefficient	1	-0.096	0.022	0.185*	-0.003
	Sig. (2-tailed)		0.258	0.800	0.028	0.971
G-ENERGY	Pearson's Coefficient	0.096	1	0.205*	-0.013	0.145
	Sig. (2-tailed)	0.258		0.015	0.875	0.086
G-REL	Pearson's Coefficient	0.022	0.205*	1	-0.010	0.189*
	Sig. (2-tailed)	0.800	0.015		0.904	0.025
G-RISK	Pearson's Coefficient	0.185*	-0.013	-0.010	1	0.039
	Sig. (2-tailed)	0.028	0.875	0.904		0.646
G-INNOV	Pearson's Coefficient	-0.003	0.145	0.189*	0.039	1
	Sig. (2-tailed)	0.971	0.086	0.025	0.646	

* Correlation is significant at the 0.05 level (2-tailed)

to the needs of the environment and the feedback of the agents which participated in the evaluation. In that sense, entrepreneurship in areas related to this specialty is a reality. In the Entrepreneurship Spanish Map 2020 [62], one of the greatest demands of Start-ups is technological support. In addition, three of the top ten sectors where entrepreneurship is highlighting in Spain are closely related to electronics and technology, as is the case with FinTech solutions, Software Development and Clean and Green Tech.

C. CORRELATION BETWEEN THE FACTORS

Possible relationships between groups of factors have been evaluated. To do this, Pearson's linear correlation method (bivariate correlations) has been used to verify that there are relationships between the factors. Table 8 shows the values of the Pearson correlation coefficients.

Only the relationships between G-MOT vs G-RISK, G-ENERGY vs G-REL and G-REL vs G-INNOV, which are shown in the Table 8, are statistically significant.

It is appreciated that the relationship between the groups of factors is positive. This indicates that when one of the

factors increases, so does the other. However, as the Pearson coefficient values are less than 0.3, the correlation is low.

1) MOTICATION (G-MOTIV) VS PROPENSION TO RISK (G-RISK)

These two variables were identified as associated with the entrepreneurial attitude in several studies with students in the bibliography.

The motivation to undertake, either by the desire to shape an idea, by the search for autonomy, recognition from others or for money [43], [55], make people more likely to face risks, based on the certainty that who does not risk does not get. In addition, it is motivation that drives us to seek solutions to problems, to have an active attitude and to take problems as challenges [62]–[66]. The most important thing for entrepreneurs is that they like what they do, what is above money and the recognition of others. Motivation favors assuming the risks associated with business activity. Therefore, risk is an element that is present in decisions and must be controlled as much as possible and minimized as far as possible. The greater the commitment to a project, the more work will be done and this will be done with

analytical criteria, measuring risk. This attitude allows to face the unexpected in a positive way.

2) ENERGY (G-ENERGY) VS RELATIONAL CAPACITY (G-REL)

Personal initiative, confidence, extroversion, and enthusiasm are characteristics that are linked to the theories of entrepreneurship [67]. The outgoing persons tends to be cheerful with people, to participate in organized groups and to act with enthusiasm in incentives. These characteristics help to interact with the environment. Studies such as that of Loveland et al. [68], state that an extroverted person reacts quickly, tends to welcome changes and adapts more quickly to them. Entrepreneurship requires that social interaction, a characteristic that arises in extroverts. In their study, the authors analysed the extroversion personality trait in relation to the entrepreneurial status of entrepreneurs and managers, not finding a positive relationship of this trait in both groups [67]. On the other hand, Brice [69] argues that the entrepreneur must be a sociable, enthusiastic person with the ability to develop external communication networks that are necessary in a company.

Studies with students [70] show positive relationships between extroversion and an entrepreneurial attitude.

3) RELATIONAL CAPACITY (G-REL) VS CREATIVITY AND INNOVATION (G-INNOV)

This relationship may be because people, who show intuition and creativity in their responses to their problems, tend to evolve easily in the business environment and therefore they feel a greater attraction for the entrepreneurship as professional option [70]. In addition, the interaction with the environment favors the entrepreneur to know the needs that exist and be able to seek creative and innovative solutions.

IV. CONCLUSION

The university is a fundamental axis for the development of ideas within society. These ideas are a strategy to obtain an entrepreneurial attitude in the development of our environment. Universities must train, analyze and encourage students to generate creativity and innovation that will later become a key element for the economic growth of the society in which they live.

This work shows the concern of a group of teachers to identify a tool to evaluate the entrepreneurial attitude of students taking Degrees in the STEM area. The tool used is a questionnaire designed for this purpose. The statistical analysis of the answers yields interesting results, in which a series of factors are proposed, such as motivation, personality traits and creativity and innovation.

Considering gender, it is observed that, in these group, women have higher entrepreneurial attitude. The questionnaire shows two qualities such as the capacity for analysis and psychology traits that can make women decide to undertake to be successful in their projects. These attitudes are essential

to make a project viable and therefore can make a business idea successful.

As regard of age, data obtained are similar to those published in other works, although the fact that students over 24 years of age have characteristics that will favor entrepreneurship, such as factors: G-REL, G-ANALIT, G-RISK, G-PSICO. These factors contribute to an EA score close to 80 points in this age group.

Finally, it stands out that the students of the Bachelor's Degree in Industrial Electronic Engineering with an EA score of 2.28 points above those with Degrees in Mechanical Engineering and 2.82 points above those with Degree in Chemistry. Skills associated with the training received in this Degree in which the students calculate, design, simulate and build projects in which they use up-to-date and rapidly evolving technology that may be the reason for their great capacity for innovation and creativity.

The results obtained in this work will help to evaluate, in future works, how the values of these factors can be modified with training and experiences that allow educational institutions to contribute to promoting entrepreneurship in an optional way.

APPENDIX A
AUTONOMY

Q1. From the point of view of motivation, indicate the answer that best suits your personal position.

I would like to be my own boss	<input type="checkbox"/>
I don't want work discipline to be imposed on me by another	<input type="checkbox"/>
I don't like working for others	<input type="checkbox"/>

Q2. What is your view about the time you should dedicate to your company?

Total dedication	<input type="checkbox"/>
I don't mind working more, when necessary	<input type="checkbox"/>
Work has its hours	<input type="checkbox"/>

APPENDIX B
MONEY

Q3. To what extent is economic motivation important for you?

It is important	<input type="checkbox"/>
Money is not something that worries me	<input type="checkbox"/>
If I create a company, it is to earn a lot of money	<input type="checkbox"/>

Q4. Do you believe that having your own money for your company is important?

Money is necessary but not critical	<input type="checkbox"/>
Having money is not important	<input type="checkbox"/>
Money is very important	<input type="checkbox"/>

**APPENDIX C
INITIATIVE**

Q5. Facing the new project: which of these statements could you make yours?

I have great adaptability	<input type="checkbox"/>
I improvise a lot	<input type="checkbox"/>
I am systematic and organized	<input type="checkbox"/>

Q6. How do you think luck can affect your business?

I think that luck exists	<input type="checkbox"/>
Sometimes a stroke of luck is necessary	<input type="checkbox"/>
Without luck, nothing can be done	<input type="checkbox"/>

**APPENDIX D
COMMITMENT**

Q7. Facing the problems raised by the management of your own company: which of these answers seem the most suitable for you?

It is a personal challenge	<input type="checkbox"/>
I will be able to get ahead	<input type="checkbox"/>
Difficulties are overcome with the support of your environment	<input type="checkbox"/>

Q8. With which of the following definitions do you feel most identified?

I like to organize new projects	<input type="checkbox"/>
I have initiative when necessary	<input type="checkbox"/>
I don't like to undertake new projects	<input type="checkbox"/>

**APPENDIX E
INTERPERSONAL SKILLS**

Q9. In the face of your ability to relate and social influence: with which of these statements do you agree?

I convey my ideas well	<input type="checkbox"/>
I adapt my opinions to the circumstances	<input type="checkbox"/>
The product is the important thing	<input type="checkbox"/>

Q10. As to the commercial function: with which response do you feel most identified?

A good commercial organization is essential	<input type="checkbox"/>
It depends on the product that is sold	<input type="checkbox"/>
The important thing is to have a good product or service	<input type="checkbox"/>

**APPENDIX F
PLANNING AND QUALITY**

Q11. With which of the following opinions about the business world do you feel closer?

I find everything that happens around me interesting	<input type="checkbox"/>
Knowledge does not take place	<input type="checkbox"/>
I already have great knowledge of the business world	<input type="checkbox"/>

Q12. Do you consider necessary to define goals to put an idea into practice?

You need to plan the project	<input type="checkbox"/>
It is necessary to set objectives	<input type="checkbox"/>
The important thing is to sell	<input type="checkbox"/>

**APPENDIX G
MARKET**

Q13. Which statements of the following do you consider essential to start your business?

Define who will be my clients	<input type="checkbox"/>
Have money and an interesting product	<input type="checkbox"/>
Work hard	<input type="checkbox"/>

Q14. If you have to serve an order to a customer but at that time you cannot do it in an optimal way: what decision would you make?

The important thing is that the customer is satisfied.	<input type="checkbox"/>
The order would not be served until everything was correct.	<input type="checkbox"/>
I would serve the order in any circumstance	<input type="checkbox"/>

**APPENDIX H
RISK TOLERANCE**

Q15. To what extent do you consider you have to take risk when making decisions?

Decision making always carries risk	<input type="checkbox"/>
I need to know the risk and know if I can face it	<input type="checkbox"/>
I prefer not to risk it	<input type="checkbox"/>

Q16. How would you be affected the everyday problems faced by the company?

They don't scare me and I like to solve them.	<input type="checkbox"/>
I analyze them and seek advice when necessary.	<input type="checkbox"/>
I am looking for someone to advise me and solve them	<input type="checkbox"/>

Q17. In the face of impossible risks, how do you evaluate these situations?

Sometimes it is convenient to seek external advice.	<input type="checkbox"/>
Intuition and experience allow you to weigh the risk	<input type="checkbox"/>
I try to identify all the risks and do not decide until I study the alternatives.	<input type="checkbox"/>

**APPENDIX I
LEADERSHIP**

Q18. In situations in which several tasks have to be developed simultaneously, when would you give by finished a task?

I am satisfied with obtaining a satisfactory result.	<input type="checkbox"/>
You have to work until you get a perfect result.	<input type="checkbox"/>
Strive to achieve the best possible result.	<input type="checkbox"/>

Q19. Do you consider that it is necessary to have leadership skills to direct a business?

Having leadership skills seems essential to me	<input type="checkbox"/>
I can balance leadership skills with my professional skills	<input type="checkbox"/>
Work is fundamental	<input type="checkbox"/>

**APPENDIX J
ATTITUDE TO CHANGE AND EXTERNAL RECOGNITION**

Q20. What is your attitude towards unexpected and frequent changes in your daily workplace?

I like the changes	<input type="checkbox"/>
I don't like changes	<input type="checkbox"/>
I try to avoid them, although if they do occur, I prioritize and resolve them.	<input type="checkbox"/>

Q21. Before the satisfaction of having successful with a solution that I consider adequate

I do not share it with others.	<input type="checkbox"/>
I like to be recognized when the opportunity arises.	<input type="checkbox"/>
I seek recognition from others.	<input type="checkbox"/>

**APPENDIX K
CREATIVITY**

Q22. Do you consider that you have an idea that will allow you to set up a business?

I think I have an idea	<input type="checkbox"/>
The market is what really matters	<input type="checkbox"/>
I consider that the idea is the beginning of the path of undertaking	<input type="checkbox"/>

Q23. Will you set up your company because you are convinced that you have a product or service that you can sell successfully?

I think I have an idea	<input type="checkbox"/>
The market is what really matters	<input type="checkbox"/>
I consider that the idea is the beginning of the path of undertaking	<input type="checkbox"/>

**APPENDIX L
INNOVATION**

Q24. Do you think research is important for your future business?

I think researching is an investment worth making.	<input type="checkbox"/>
It can provide differential added value.	<input type="checkbox"/>
You just have to improve what is already invented.	<input type="checkbox"/>

Q25. Have you ever wondered if you are innovative and how this can help you succeed in your new business?

What is innovative is understanding that knowledge makes us competitive	<input type="checkbox"/>
Other more advanced markets have to be adapted	<input type="checkbox"/>
What you need to know is how to access the market	<input type="checkbox"/>

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SALVADOR BUENO-RODRÍGUEZ received the Ph.D. degree from the Institute of Ceramic and Glass (ICV-CSIC), Spain, in 2005.

He was trained in the colloidal processing and mechanical characterization of ceramics at ICV-CSIC. Next, the Researcher completed a post-doctoral stay with the Istituto di Scienza e Tecnologia dei Materiali Ceramici (ISTEC-CNR), Italy, from 2006 to 2007. The research topic comprised the design of materials with application in industrial processes that involve erosion, wear, and impact. Therefore, he developed the skills necessary to combine processing, mechanical testing procedures, and microstructural characterization of ceramic materials. He has coordinated the Materials Department and the Research and Development Laboratory, Fundación Innovarcilla (Ceramics Technical Centre of Andalusia), from 2007 to 2019. The main research lines of this Department has taken into account the new challenges for the materials industry, such as production of high-quality and more efficient materials along with environmentally friendly processing methods capable of increasing the product life cycle and reducing energy consumption and pollution. In particular, he has been a main Researcher of regional projects Kerameco, Efiwall, and CirculaRCD, that have involved different aspects related to the sustainability of construction materials, such as waste recovery, and life cycle analysis or alkaline activation (geopolymerization) of construction and demolition waste.



JUAN D. AGUILAR-PEÑA was born in Jaén, Spain, in 1959. He received the Technical Industrial Engineer degree in electronic engineering from the University of Granada, Spain, in 2002, and the Ph.D. degree from the University of Jaén, Spain, in 2011. He was the Director of the Department of Electronic and Automatic Engineering, from 1993 to 1998. He is currently a Professor with the Electronic Technology Area, Electronic and Automatic Department, University of Jaén.

He participated in teaching innovation projects of engineering students. His research interests include electronic engineering education, computer science education, system photovoltaics education, blended teaching of photovoltaic systems, technologies applied to electronics teaching, and teaching power electronics. He is currently a Founding Member and the President of TAEE: "Technology, Learning and Teaching of Electronics," Higher Education Teachers Association. He received the Industrial Technical Award by the General Council of Colleges of Industrial Technical Engineers of Spain (COGITI), in 1987, and the Second Prize in the CITA'98 I Contest Iberoamerican. He was awarded with the 2016 TAEE "Tomás Pollán Award for Multidisciplinary Merit."



DOLORES ELICHE-QUESADA was born in Torredelcampo, Jaén, Spain, in 1976. She received the Chemical Engineering degree from the University of Granada, Spain, in 2000, and the Ph.D. degree in science from Malaga University, Spain, in 2004.

From 2005 to 2006, she was a Research Projects Researcher in the framework of the I3P project in chemical technology research programs of the MEC with the Institute of Catalysis and Petrochemistry (CSIC), Madrid, Spain. From 2006 to 2011, she was an Assistant Professor with the Chemical, Environmental and Material Engineering Department, University of Jaén, Spain. In 2012, she was an Associate Professor in material sciences. She participated in teaching innovation projects and the promotion of entrepreneurship of engineering students. She is the author of more than 70 articles in international journals and more than 125 international conferences. Her research interests include materials science and technology, and in particular the development of new sustainable materials through the recovery of industrial waste and biomass for the construction sector. She is currently an Associate Editor of the journal *Materials*.

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M. DOLORES LA RUBIA received the degree in chemical sciences from the University of Jaén, Spain, the master's degree in science and technology of polymers from UNED, Spain, and the Ph.D. degree in chemical sciences from the University of Jaén, in 2005. She is currently a Professor with the University of Jaen, where she develops research on advanced materials and bioprocesses. She has coordinated several projects of entrepreneurial promotion in higher education and

research projects about plastic injection mold design and technology and new products design. She is also a main Researcher of the European project LIFE-COMPOLIVE, which is developing new biocomposites for industrial applications.



CATALINA RUS-CASAS received the degree in electronic engineering from the University of Granada and the Ph.D. degree in engineering from the University of Jaén. She is currently a Tenured Professor with the Electronic and Automatic Engineering Department, where she lectures graduate and postgraduate degrees. She has obtained an excellent evaluation through the docencia program. Her training and research experience is reflected in her contributions toward university education in

over 35 publications in international journals, international conferences, and education texts. Moreover, she has done the coordination, the evaluation, and the participation in 15 of educational innovation projects. She participated in the promotion of entrepreneurship of engineering students. Her research interests include study and monitoring of photovoltaic systems, system monitoring via the Internet of Things, and energy generation via self-consumption photovoltaic systems. She received the First Prize in the 2014/2015 Academic Year awarded to the Project for the Promotion of Entrepreneurial Culture at the University of Jaén.