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A framework explaining the entrepreneurial intentions of engineering students in public universities

Un modelo para explicar las intenciones de emprendimiento de los estudiantes de ingeniería en universidades públicas

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Abstract

This study explains the Entrepreneurial Intent (EI) of university students enrolled in engineering programs at the public university of the state of Guanajuato, Mexico, in terms of the three constructs of the Theory of Planned Behavior, formal (entrepreneurship education) and informal (the entrepreneurial demonstrated behavior of family and friends) institutional factors, and two individual traits (innovativeness and need of achievement). The conceptual model proposed also examines the role of entrepreneurship education in strengthening entrepreneurial self-efficacy. Survey data is analyzed using structural equation modeling. Findings indicate entrepreneurial attitudes have the

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most significant predictive ability on entrepreneurial intention over entrepreneurial education and the manifest entrepreneurial actions of close social groups that have only a moderate influence on EI. The analysis also confirms that entrepreneurship education enhances entrepreneurial self-efficacy. Based on these results, it is recommended that Engineering Schools devote more attention to experiential learning to create favorable entrepreneurial attitudes and develop students' entrepreneurial skills, particularly among those with a high need for achievement.

Keywords: Entrepreneurial intention; Entrepreneurship education; Theory of Planned Behavior; Self-efficacy; Institutional factors.

Resumen

Este estudio explica la Intención Emprendedora (IE) de estudiantes universitarios inscritos en los programas de ingeniería de la universidad pública del estado de Guanajuato, México, en términos de los tres constructos de la Teoría de Conducta Planeada, factores institucionales formales (educación en emprendimiento) e informales (conducta demostrada de emprendimiento de la familia y amigos), y dos características individuales (innovación y necesidad de logro). El modelo conceptual propuesto también examina el rol de la educación en emprendimiento en el fortalecimiento de la auto-eficacia en emprendimiento. Los datos de la encuesta se analizaron usando modelado de ecuaciones estructurales. Los resultados indican que las actitudes de emprendimiento tienen la mayor habilidad predictiva de la intención emprendedora, superior al efecto de la educación en emprendimiento y las acciones emprendedoras manifiestas de los grupos sociales cercanos cuya influencia en la IE es moderada. El análisis también confirma que la educación en emprendimiento aumenta la auto-eficacia emprendedora. Con base en estos resultados, se recomienda que las Escuelas de Ingeniería pongan más atención en el aprendizaje experiencial para crear actitudes de emprendimiento favorables y desarrollar las habilidades de emprendimiento de los estudiantes, particularmente las de aquellos con una alta necesidad de logro.

Palabras Clave: Intención emprendedora; Educación en emprendimiento; Teoría de la Conducta Planeada; Auto-eficacia; Factores institucionales.

1. Introduction

The expected loss of 41 million employees in Latin-American due to the COVID-19 pandemic (France 24, 2020) will severely affect some countries, including Mexico where more than 150 thousand small enterprises have closed (Institute of Geography and Statistics [INEGI], 2020). Fostering entrepreneurship and innovation in strategic economic sectors such as e-retailing and digital services is recognized as an option to reduce unemployment and contribute to the economic recuperation of the country (Popescu, Bostan, Robu, Maxim, and Diaconu, 2016; Ratten, 2020). Promoting and strengthening the entrepreneurial intent of students who have the individual characteristics associated with an entrepreneurship orientation is relevant to enhance their employability opportunities and consequently contribute to the regional innovation and economic systems (Ferreira, Raposo, Rodrigues, Dinis, and do Paco, 2012; Hammed and Irfan, 2019; Klofstena, Fayolleb, Guerrero, Mian, Urbano, and Wrightf, 2019; Popescu *et al.,* 2016; Santoso, 2017).

Entrepreneurial education has been traditionally provided in business schools, thus reducing students' opportunities from other schools and programs, particularly engineering students, to apply their technical knowledge to create new ventures. However, universities have tried to create an entrepreneurship environment in all areas of higher education (Center for Entrepreneurial Excellence, 2014) and promote the spillover and commercialization of products and technologies at all schools, including engineering.

This research aims to analyze the combined effect of a) the individual characteristics and b) institutional factors of the sociocultural context (Liñán and Chen, 2009) on the entrepreneurial intent of university students enrolled in the engineering program of a large Mexican public university.

2. Theoretical Framework

The institutional perspective of entrepre–neurship proposes that entrepreneurial behavior depends on the individuals' relations with the external environment (Schmutzler, Andonova, and Diaz-Serrano, 2019). The family support, the presence of universities that promote entrepreneurship, the availability of financial resources, and the socio-political and cultural environment are among these external factors (Baidi and Suyatno, 2018; Barbosa Da Silva, Gomes Costa, and Duarte Barros, 2015; Schmutzler *et al.,*

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2019). Of all these environmental factors, the acceptable attitudes and behaviors defined by the individual's immediate social groups (family, friends, peers, and professors) have been found to have a significant influence. Individuals may assume an entrepreneurship behavior if they perceive that their immediate social groups support, approve, and perform the behavior (Farooq, 2018; Meek, Pacheco, and York, 2010).

In particular, universities, through formal entrepreneurship and business courses, practice-oriented activities such as the development of prototypes, business projects, and creation of start-ups, and the active participation of students in university spin-offs and incubators, can contribute to developing the entrepreneurial skills and intentions of engineering students (Dao, 2018; Farooq, 2018; Ferreira *et al.,* 2012; Passaro, Quinto, and Thomas, 2018).

Extant research supports the conclusion that entrepreneurship education influences the entrepreneurial intent of university students (Henry and Lewis, 2018) and has a crucial role in the development of the technical, business management, and entrepreneurial skills of students (Almahry, Sarea, and Hamdan, 2018; Elmuti, Khoury, and Omran, 2012; Farooq, 2018; Leon, 2017). However, how universities can develop critical entrepreneurship capabilities, what is the influence of education on the success of new ventures, and what is the role of universities in supporting networking and providing an environmental endeavor are still questions that deserve further research (Davey, Hannon, and Penaluna, 2016). Despite the discussion about the role of universities in supporting entrepreneurship, a clear demand for more research regarding how entrepreneurship education contributes to increasing the students' awareness of the importance of having entrepreneurial competencies is recognized. Accordingly, the first research hypothesis is proposed:

H1: The development of practical business skills through experiential learning influences the entrepreneurial intentions of students enrolled in engineering programs.

Parent's entrepreneurial status has also been suggested to determine entrepreneurial intention (Laspita, Breugst, Heblich, and Patzeltb, 2012). The exposure to entrepreneurial role models serves as a source of knowledge of potential success or failure factors and creates attitudes that make entrepreneurship a desirable career option (Schmutzler *et al.,* 2019). Lerchundi, Morales-Alonso, and Vargas (2014) analyze how self-employed parents transfer entrepreneurship knowledge and experiences, thus influencing engineering and architecture students' entrepreneurial intentions. Shirokova, Osiyevskyy, and Bogatyreva (2016) conclude that the intervention of family and universities enhances the positive relationship between entrepreneurial intentions and start-up activities. Saral and Alpakan (2019) compare the entrepreneurial intention of individuals of different ages, gender and with entrepreneurs in their families. Findings of the study indicate that individuals who have entrepreneurs among their close relatives (first-degree) have significantly higher entrepreneurial intentions than individuals without entrepreneurs in their families. Accordingly, the second research hypothesis is stated as follows:

H2: Manifest entrepreneurial actions (opening a new business, proposing new solutions to business problems, and finding new ways to increase the value of an existing business) of reference groups (family, friends, and peers) positively and significantly influence the entrepreneurial intentions of university students.

Laspita *et al.* (2012) state that two models have been extensively used to explain entrepreneurial intentions: Shapero's entrepreneurial event (SEE) and Ajzen's Theory of Planned Behavior (TPB). The TPB postulates that behaviors result from a rational thinking and deliberation process (Ajzen, 2002). Many studies contend entrepreneurial decision is the result of a cognitive process more than personality traits or demographics and have provided empirical support to the predictive power of the TPB in explaining entrepreneurial intentions in several contexts (Kautonen, Van Gelderen, and Fink, 2015; Munir, Jianfeng, and Ramzan 2019; Van Gelderen, Brand, van Praag, Bodewes, Poutsma, and van Gils 2008), including Latin America (Soria-Barreto, Honores-Marin, Gutiérrez-Zepeda, and Gutierrez-Rodríguez, 2017).

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Five constructs are considered in the TPB: attitudes, perceived behavioral control, subjective norms, behavioral intention, and actual behavior. The TPB proposes that the first three constructs are the direct antecedents of intention, leading to the actual behavior. Attitudes result from the individual's assessment of behavior outcomes and are influenced by social situations, personal experiences, and personal traits (Munir *et al.,* 2019). Subjective norms refer to the perceived social pressure to engage or not in a specific behavior. Subjective norm is determined by normative beliefs concerning the expectations of important referent groups such as family, friends, and peers. Finally, perceived behavioral control (PCB) relates to the individual's perceptions about his/her skills and ability to overcome the difficulties to perform the behavior. According to the TPB, intentions comprise the desirability or motivation to act and the feasibility to perform the behavior. The PCB construct stands for feasibility; meanwhile, subjective norms and attitudes towards entrepreneurship refer to the desirability part of the entrepreneurial intent (Sabah, 2016). The entrepreneurship literature concludes that the more favorable the attitude and subjective norm and a sufficient control over the behavior, the greater the intention to become an entrepreneur (Vamvaka, Stoforos, Palaskas, and Botsaris, 2020). Consequently, the following research hypotheses are formulated:

H3: Attitudes towards entrepreneurship positively and significantly influence the entrepreneurial intentions of university students enrolled in engineering programs.

H4: Subjective norms have a positive and significant influence on the entrepreneurial intentions of university students enrolled in engineering programs.

The Perceived Behavioral Control (PBC) has been conceptualized as a combination of Locus of Control (LC), that is, the belief one can control to some extent the events and outcomes in one's own life, and self-efficacy, which refers to the perceived ability to perform a behavior (Strauser, Ketz, and Keim, 2002; Van Gelderen *et al.,* 2008). Individuals with an internal LC have enduring confidence that their efforts, skills, and decisions will make things work out. Meanwhile, individuals with external LC believe external events are the key factors determining their actions' results. Thus LC implies a more general view than PCB. While LC and PBC are related to beliefs about controllability, the concept of self-efficacy describes the individual's perceptions of his/her ability to execute effective actions that will produce the desired outcomes (Bandura, 1997). Ajzen (2002) proposes a hierarchical model that considers self-efficacy and perceived controllability (LC) as two separate but interrelated components of PCB.

Extant research supports the effect of both concepts, LC and self-efficacy, on entrepreneurial intent and behavior. For example, Yan (2010) concludes that individuals with a strong internal locus of control perceive more desirability and feasibility from the same venture opportunity than individuals with an external locus of control. Atsan (2006) finds a positive relationship between internal LC and the entrepreneurial intent of Turkish students.

Wilson, Kickul, and Marino (2007) indicate that business self-efficacy significantly influences university students' self-employment intentions in the USA. More recently, Baidi and Suyatno (2018) and Santoso (2017) concluded that business self-efficacy positively influences the entrepreneurship intention of Indonesian students.

Based on these findings, the subsequent research hypotheses are proposed:

H5: Internal locus of control has a positive and significant influence on the entrepreneurial intentions of university students enrolled in engineering programs.

H6: Business self-efficacy perception has a positive and significant influence on the entrepreneurial intentions of university students enrolled in engineering programs.

Zhao, Seibert, and Hills (2005) find that self-efficacy mediates the effect of entrepreneurship education on entrepreneurial intention because education provides the opportunity to practice with new ventures, thus increasing students' confidence in becoming successful entrepreneurs. Meanwhile, Pittaway, and Cope (2006) acknowledge that

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entrepreneurship education at the graduate level may influence students' entrepreneurial intent and perceptions to become effective entrepreneurs. Oyugi (2015) study the relationship between entrepreneurship education and entrepreneurial intention among university students in Uganda. The study concludes that self-efficacy mediates the relationship between the two constructs; entrepreneurship education was found necessary but not sufficient to develop entrepreneurial intentions unless entrepreneurial self-efficacy is improved through education. Shinnar, Hsu, and Powell (2014) also explore the contribution of entrepreneurship education in strengthening entrepreneurial self-efficacy and entrepreneurial intentions among women and men. Findings indicate that entrepreneurship education significantly increases entrepreneurial self-efficacy among men. Accordingly, the following hypothesis results:

H7: The development of practical business skills through experiential learning influences the entrepreneurial intentions of students enrolled in engineering programs through the mediation of self-efficacy.

Several studies have looked to enhance the predictive power of the TPB on entrepreneurial intention by considering additional variables (Munir *et al.,* 2019; Roy, Akhtar, and Das, 2017). This work adds to the TPB two individual traits recognized as distinctive of entrepreneurs: the need for achievement and personal innovativeness (Kerr, Kerr, and Xu, 2017). Need for achievement denotes the satisfaction and wellbeing felt by an individual when he/she achieves a goal through his/her efforts. Popescu *et al.* (2016) find a positive relationship between the need for achievement and the entrepreneurial intentions of Romanian undergraduate and master students. Meanwhile, Baidi and Suyatno (2018) conclude that the need for achievement adds to entrepreneurial education by reinforcing students' entrepreneurial intention in business schools.

Sun, Ni, Teh, and Lo (2020) investigate the interdependence among four entrepreneurial characteristics (need for achievement, locus of control, risk-taking propensity, and creativity) and their effect on the entrepreneurial intention of engineering students. Findings indicate that the need for achievement indirectly affects the entrepreneurial intention through the mediation of risk-taking and creativity. It implies that the need for achievement motivates individuals to take more risks and embrace innovative ideas. Fazlurrahman (2020) compared the effect that the need for achievement, locus of control, and instrumental readiness (access to capital and information and social networking) has on the entrepreneurship intention of engineering and business students. The three variables have a significant direct influence on the entrepreneurial intent of business students but not for engineering students. These contradictory results call for additional research in other contexts and with larger samples. Therefore, the following hypothesis is stated:

H8: The need for achievement has a positive and significant influence on the entrepreneurial intentions of university students enrolled in engineering programs.

Ferreira *et al.* (2012) and Atsan (2006) describe innovativeness as the creativity and disposition of an individual to create new concepts and state-of-the-art technologies to develop prototypes that can be commercialized. While creativity is broadly defined as innovative thinking that is contextual, intuitive, and expensive (Barnard and Herbst, 2018), innovation is more oriented to the systematic search for opportunities to turn an invention into a marketable product. Mueller and Thomas (2000) state that successful entrepreneurs innovate in products, services, and methods to open new markets or reorganize organizations. Robinson and Stubberud (2014) compared the entrepreneurial intent of university students before and after a two-week entrepreneurship course in a Nordic university. Innovation ratings did not significantly change after the course in the low intent group but increased among the students with high entrepreneurial intentions. This result suggests that students with high entrepreneurial intentions were more prone to increase their innovativeness because they recognize innovativeness supports their entrepreneurial intent. Law and Breznik (2017) show that the innovativeness

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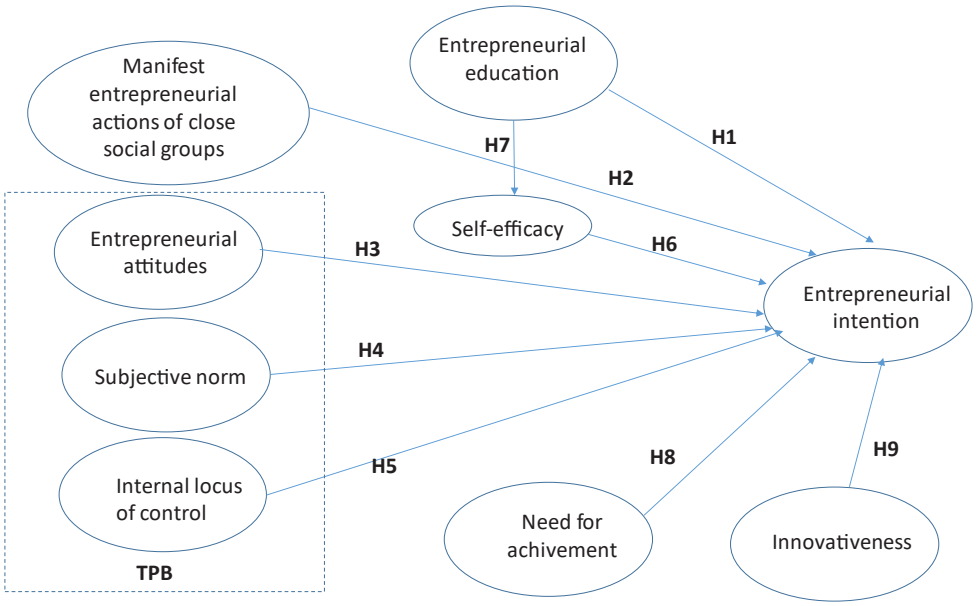
Figure 1. The theoretical model of entrepreneurial intentions



Source: Authors' own elaboration.

of engineering students affects their entrepreneurial intentions, especially among male students. Moreover, innovativeness was significantly correlated to self-efficacy and entrepreneurial attitudes, thus reinforcing the entrepreneurial intent. Then, the final research hypothesis follows:

H9: Innovativeness has a positive and significant influence on the entrepreneurial intentions of university students.

All research hypotheses are integrated into the conceptual model of Figure 1.

3. Methodology

This research uses a quantitative approach to evaluate the model of Figure 1 empirically. The variance-based structural equation modeling method of partial least squares (PLS-SEM) was used to analyze a survey applied to undergraduate and graduate students of the University of Guanajuato (UG) located in the central part of Mexico. The UG is a major Mexican public university with four campuses located in the state's main cities. All campuses offer different engineering careers; mechanical engineering, information technology and computing, and electrical engineering are the principal ones.

The UG has developed an entrepreneurship program (Vinculación, Innovación, Desarrollo y Aplicación del Conocimiento, VIDA) to facilitate the transfer of knowledge, innovation, and technology via the development of products and services aimed to satisfy the local market and industry (Pérez-Zavala, Molina-Sánchez, Schmitt, and López-Salazar, 2019). VIDA organizes seminars and workshops, supported by the faculty and research centers, to promote the students' entrepreneurship spirit, get patents and seed capital. UG students enrolled at all schools are encouraged to participate in the program, but assistance is voluntary.

3.1. Sampling plan

The target population was defined as "students enrolled in the UG Engineering School". Two of the authors and close colleagues invited students to answer the survey at the beginning of the 2019 fall semester. After two months of promotion (September and October 2019), 369 (41%) of the students enrolled in the UG Engineering School responded to the survey. Nonresponse

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bias was assessed by comparing the mean of each response between the first pool of students (207) versus the last pool (162) of respondents. Most of the respondents (90%) were undergraduate students; both genders were fairly represented (54% men and 46% women), mostly (70%) aged between 18 and 25 years old. All responses were saved in an Excel file and analyzed by using PLS-SEM. This methodology was selected because it is a non-parametric approach with a predictive focus and requires relatively small sample sizes (Hair, Hult, Ringle, and Sarstedt, 2017).

3.2. Design of the measurement instrument

The study uses scales from prior published research (Tsai, Chang, and Pen, 2016). All items are on a Likert scale ranging from 1 = total disagreement to 5 = total agreement. The first section of the instrument assessed the constructs of the TPB, namely, *subjective norms* (3 items), *attitudes* (8 items), and *intentions* (7 items). *Internal locus of control* was measured with the 8-item Rotter I-E Scale applied by Mueller and Thomas (2000).

Self-efficacy was assessed using the entrepreneurial-specific scale developed and validated by Schjoedt and Craig (2017). Two items were added based on the premise that entrepreneurship can be "taught" at universities by executing experiential learning activities related to business management, particularly planning. *Need for achievement* (5 items) was measured by adapting the scales proposed by Atsan (2006) and Zeffane (2013). *Innovativeness* was assessed with a simplified 4-item scale that merged creativity items (Popescu *et al.,* 2016) and items of the Jackson Personality Inventory (Atsan, 2006).

The *entrepreneurship education* construct (Barbosa da Silva *et al.,* 2015) comprised ten items related to management competencies, creative problem solving, leadership, and skills to deal with uncertainty. Finally, the *entrepreneurial actions of close social groups* were assessed by asking participants if their parents, friends, or university fellows act as entrepreneurs (e.g., open a business). Responses were registered as three binary variables (1 = yes and 0 = no) that were added to obtain an ordinal scale ranging from 0 to 3.

4. Results

Exploratory Factor Analysis (EFA) analysis was used to purify and revise the scales. The eight-factor structure of the measurement instrument was verified (eigenvalues greater than one, scree-plot cut-off at eight, and 58.9% of the variance explained). Ten items poorly correlated with other items were eliminated (communalities < 0.5 and inter-item correlations < 0.3). Five of the eliminated items were related to creative problem solving, leadership, and management of uncertainty. The elimination of these items suggests students view these abilities as "non-teachable." Four items initially comprising the locus of control scale were reassigned because they correlated highly with the self-efficacy construct. The re-assignation is theoretically supported because of the inter-correlation between the two constructs.

Confirmatory Factor Analysis (CFA) using Smart PLS 3 software was performed to validate the scales. All items had highly significant standardized factor loadings above 0.7 (90%), providing evidence of convergent validity. The scales' validity, uni-dimensionality, and reliability using Cronbach's alpha, Average Variance Extracted (AVE), and Composite Reliability (CR) was adequate for all variables, with Cronbach's alphas all above 0.7, CR's above 0.5, and AVE's over 0.5 (Hair *et al.,* 2017).

Discriminant validity was evaluated by two procedures, the Fornell and Larcker and the heterotrait-heteromethod (HTMT) criteria (Hair *et al.,* 2017). All AVE's were greater than the squared correlation between the nine factors, and the upper limit of none of the confidence intervals (full bootstrapping with n = 5000) exceeded the 0.9 thresholds, thus supporting discriminant validity).

A PLS-SEM model was used to test hypotheses H1-H9. The incremental fit index was 0.905, the determination coefficient R^2 = 0.636 indicates that the model explains a moderate amount of the variance of entrepreneurial intention. The predictive

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Table 1. Path coefficients for the entrepreneurial intention model

Hypotheses	Path	Standardized Coefficient β	T-Value	P-Value	Cohen's test A	Decision
H1	Entrepreneurial education → Entrepreneurial Intention	0,150**	2,567	0,010	0,027	Supported Weak effect
H2	Entrepreneurial actions of close groups → Entrepreneurial Intention	0,077 a	1,938	0,051	0,015	Supported Moderate effect
H3	Entrepreneurial Attitudes → Entrepreneurial Intention	0,451**	7,315	0,000	0,224	Strongly supported Large effect
H4	Subjective Norms → Entrepreneurial Intention	-0,034 ns	0,596	0,552	0,002	Unsupported
H5	Internal locus of Control → Entrepreneurial Intention	0,184**	2,960	0,002	0,038	Supported Weak effect
H6	Self Efficacy → Entrepreneurial Intention	0,111 b	1,792	0,073	0,014	Weakly supported Small effect
H7	Entrepreneurial education → Self Efficacy	0,387**	6,608	0,000	0,176	Strongly supported Moderate effect
H8	Need for Achievement → Entrepreneurial Intention	0,216**	2,632	0,008	0,048	Supported Small effect
H9	Innovativeness → Entrepreneurial Intention	0,034 ns	0,577	0,564	0,001	Unsupported

Cohen's test: 0,02 small effect, 0,15 moderate effect, and 0,35 a large effect of constructs. Significant at the 11% level.

Source: Own elaboration based on the analytical results.

relevance test $Q^2 = 0.373 > 0$ indicates the model reasonably predicts a planned missed part of the data, supporting its predictive validity (Hair *et al.,* 2017; Hooper, Coughlan, and Mullen, 2008). Full bootstrapping (n = 5000) was used to test the path coefficients are not zero. Cohen's test was also computed to assess the extent to which each construct explains the entrepreneurial intention. Table 1 summarizes the results.

5. Discussion

All significant path coefficients were positive as expected. Results confirm two of the TPB constructs, attitudes and internal locus of control, strongly and weakly predict the entrepreneurial intention of engineering students. Law and Breznik (2017) also reported that attitudes strongly contribute to the entrepreneurial intention of engineering students in Hong Kong. Regarding the influence of the interpersonal context on entrepreneurship intentions, entrepreneurial education has a significant but weak effect. The effect of social norms on entrepreneurial intention was non-significant, meaning getting the approval and meeting the expectations of family, friends, and university peers and professors do not predict the interest in being an entrepreneur. In contrast, the demonstrated entrepreneurial actions of close social groups are relevant in explaining entrepreneurial intentions. This result agrees with previous research that argues social norms maybe only relevant for societies with a particular profile (Lee-Ross, 2017).

Cohen's test confirms that favorable entrepreneurial attitudes are the best predictor of entrepreneurship intentions. However, entrepreneurial education and the entrepreneurial behavior of close social groups are also meaningful predictors. This finding suggests engineering schools

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can generate and reinforce positive entrepreneurial attitudes by providing meaningful entrepreneurial experiences such as interaction with family-business owners and local entrepreneurs who can share their experiences and contribute to vicarious learning (Roy *et al.,* 2017). Results also indicate that the university can increase students' self-confidence to become an entrepreneur, for example, by integrating interdisciplinary teams to launch and manage a new business (Din, Anuar, and Usman, 2016; Wilson *et al.,* 2007). Although the influence of self-efficacy on entrepreneurial intention was relatively small, extant research supports its relevance in predicting entrepreneurial behavior (Pihie and Bagheri, 2013; Udayanan, 2019). A possible explanation of the low predictive ability of this construct on the entrepreneurial intent of participants is that self-efficacy levels were low (Average = 2,756, SD = 0,713).

Only one of the two individual traits, the need for achievement, significantly predicts entrepreneurial intention. As concluded by previous research, a strong need for achievement is required for entrepreneurial persistence (Wu, Matthews, and Dagher, 2007). Again, universities can increase entrepreneurship intent by designing experiential learning activities aimed at practicing business skills as part of technology innovation courses and promoting alliances with local companies that satisfy the business goals of interested students. Regarding innovativeness, the non-significance of this individual trait may be attributed to the proposed direct relation. For example, Bellò, Mattana, and Loi (2018) found that the relationship between creativity and entrepreneurial intentions is moderated by self-efficacy and the influence of social groups. Therefore, an indirect effect of innovativeness on entrepreneurial intention deserves further study.

6. Conclusions and future work

This study extends the TPB by considering how the immediate social context and two personal traits influence the entrepreneurial intent of university students enrolled in engineering programs. Analytical results conclude that the TPB constructs, particularly favorable positive entrepreneurial attitudes and, to a lower extent, the internal locus of control, are predictors of entrepreneurial intentions. Entrepreneurship education, mainly based on experiential learning, is also significant and positively related to the engineering students' intentions to become entrepreneurs. Nevertheless, what engineering students acknowledge as entrepreneurial education is mainly related to business knowledge, while entrepreneurial abilities such as creative thinking, leadership, and networking seem to be associated with the passion for merchandising innovations and creating a profitable new venture (Saif and Ghania, 2020).

Kirby, Guerrero, and Urbano (2011) define entrepreneurial universities as revolutionary institutions focused on innovation, the development of an entrepreneurial culture that seeks to involve faculty in creating start-ups based on their research, and become incubators of new business. This concept is critical to encouraging entrepreneurship at all levels and particularly relevant in developing favorable attitudes towards entrepreneurship by highlighting its importance to foster regional innovation, technology development, and economic growth (Pugh, Lamine, Jack, and Hamilton, 2018). This concept has important implications for universities that would need to revise the structure, content, and experiences of their entrepreneurship programs to make them attractive to engineering students who have the knowledge and competencies to open digital businesses and introduce new technologies in existing businesses to increase their international competitiveness, particularly after the shutdowns and restricted activity imposed by the COVID-19 pandemic (Muzychenko, 2008).

Digitalization and servitization registered positive trends that the COVID-19 pandemic has accelerated. Engineering students can contribute to the digital transformation of business, predominantly medium-sized enterprises, if universities foster their entrepreneurial intent, emphasize obtaining patents, and establish links with external stakeholders who may provide experience and venture capital.

Extensions to this research are directly derived from its limitations. First, the

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current results are based on a non-random sample of students enrolled in a single public university. The selection of probabilistic samples from randomly selected universities that offer entrepreneurship programs with different characteristics (formal courses only, entrepreneurship programs based on experiential learning, joint entrepreneurship programs with private enterprises, and tutoring with entrepreneurs) will allow confirming the influence of individual traits and factors of the interpersonal context on EI, and the identification of the characteristics of the most successful entrepreneurship program. Exploring the effect of entrepreneurship education on the entrepreneurial intent and creation of new ventures among students of several schools (business, engineering, health, social sciences, for example) is the second extension of this work.

Third, the study proposed a conceptual model with mainly direct effects, except by the moderator effect of self-efficacy on the relationship between entrepreneurship education and entrepreneurial intention. New research, including moderation effects and interrelationships between the TPB constructs, entrepreneurship education, and individual traits, would provide new insights into how education contributes to select entrepreneurship as a career. Future research can also consider the influence of additional personal traits and skills such as entrepreneurial passion, creativity, interpersonal relationship abilities, and analytical and logical skills on entrepreneurial intent (Cristina, 2016). Comparing how individual traits and entrepreneurial skills differ across groups with different profiles (e.g., gender, age, and employment status) is another relevant extension to the present research (Kallas and Parts, 2020; Saral and Alpkan, 2019).

The fifth extension of this research is to consider the effect of macro institutional factors such as the socio-cultural, political, technological, and economic conditions that influence the entrepreneurial activity of individuals, support/inhibit the creation of new business, and encourage competitiveness and innovation. Finally, conducting a cross-cultural study that considers that personal traits such as innovativeness, risk-taking, and self-employment interest, among other variables, may depend on the cultural context is another topic for future research.

7. Conflict of interest

The authors declare no conflict of interest.

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9. References

Ajzen, I. (2002). Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. *Journal of Applied Social Psychology, 32*(4), 665-683. https://doi.org/10.1111/j.1559-1816.2002.tb00236.x

Almahry, F. F., Sarea, A. M., & Hamdan, A. M. (2018). A Review Paper on Entrepreneurship Education and Entrepreneurs' Skills. *Journal of Entrepreneurship Education*, *21*(2S), 1-7. https://goo.su/8sKJ

Atsan, Y. G. N. (2006). Entrepreneurial characteristics amongst university students. *Education + Training*, *48*(1), 25-38. http://dx.doi.org/10.1108/03090599410068024

Baidi & Suyatno. (2018). Effect of entrepreneurship education, selfefficacy and need for achievement toward students' entrepreneurship intention: case study, in F. I. Sukarta, Indonesia. *Journal of Entrepreneurship Education*, *21*(2), 1-16. https://www.abacademies.org/articles/Effect-of-entrepreneurship-education-1528-2651-21-2-161.pdf

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W. H. Freeman Co.

Barbosa Da Silva, G., Gomes Costa, H., & Duarte de Barros, M. (2015). Entrepreneurship in engineering education: a literature review. *International Journal of Engineering Education*, *31*(6-A), 1701-1710. https://bit.ly/3GuVbYT

Barnard, B. & Herbst, D. (2018). Entrepreneurship, innovation, and creativity: the creative process of entrepreneurs and innovators. https://goo.su/8sKe

Bellò, B., Mattana, V., & Loi, M. (2018). The power of peers. A new look at the impact of creativity, social context, and self-efficacy

https://doi.org/10.25100/cdea.v37i71.10736

on entrepreneurial intentions. *International Journal of Entrepreneurial Behavior & Research*, *24*(1), 214-233. https://doi.org/10.1108/IJEBR-07-2016-0205

Center for Entrepreneurial Excellence George Washington University. (2014). *The National Survey of Entrepreneurship Education. An Overview of 2012-2014 Survey Data*. The George Washington University. http://www.nationalsurvey.org/files/2014KauffmanReport_Clean.pdf

Cristina, M. D. (2016). Promoting technological entrepreneurship through sustainable engineering education. *Procedia Technology*, *22*, 1129-1134. https://doi.org/10.1016/j.protcy.2016.01.159

Dao, C. T. H. (2018). A proposal for improving entrepreneurship education for engineering students in Vietnam. *Review of Integrative Business and Economics Research*, *7*(3), 2414-6722. GMP Press and Printing. http://buscompress.com/uploads/3/4/9/8/34980536/riber_7-s3_02k18-137_12-19.pdf

Davey, T., Hannon, P., & Penaluna, A. (2016). Entrepreneurship education and the role of universities in entrepreneurship: Introduction to the special issue. *Industry and Higher Education*, *30*(3), 171-182. https://doi.org/10.1177/0950422216656699

Din, B. H., Anuar, A. R., & Usman, M. (2016). The effectiveness of the entrepreneurship education program in upgrading entrepreneurial skills among public university students. *Procedia Social and Behavioral Sciences*, *224*, 117-123. https://doi.org/10.1016/j.sbspro.2016.05.413

Elmuti, D., Khoury, G., & Omran, O. (2012). Does entrepreneurship education have a role in developing entrepreneurial skills and ventures' effectiveness? *Journal of Entrepreneurship Education*, *15*, 83-98. https://goo.su/8sKD

Farooq, S. M. (2018). Modelling the significance of social support and entrepreneurial skills for determining entrepreneurial behavior of individuals. A structural equation modelling approach. *World Journal of Entrepreneurship, Management and Sustainable Development*, *14*(3), 242-266. https://doi.org/10.1108/WJEMSD-12-2017-0096

Fazlurrahman, H. (2020). Measuring entrepreneurship intention with need for achievement, locus of control, self-efficacy, and readiness instrument: business and engineering student in Indonesia. *International Journal of Management, Innovation & Entrepreneurial Research*, *6*(1), 7-14. https://doi.org/10.18510/ijmier.2020.6127

Ferreira, J. J., Raposo, M. L., Rodrigues, R. G., Dinis, A., & do Paco, A. (2012). A model of entrepreneurial intention, An application of the psychological and behavioral approaches. *Journal of Small Business and Enterprise Development*, *19*(3), 424-440. https://doi.org/10.1108/14626001211250144

France 24. (July 2, 2020). *OIT: América Latina es la región con más empleos perdidos por cuenta de la pandemia.* https://www.france24.com/es/20200701-oit-latinoamerica-desempleo-economia-pandemia-covid19

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A primer on partial least squares structural equation modeling (PLS-SEM)* (2nd ed.). SAGE Publications. https://lccn.loc.gov/2016050545

Hammed, I. & Irfan, Z. (2019). Entrepreneurship education: A review of challenges, characteristics, and opportunities. *Entrepreneurship Education, 2,* 135-148. https://doi.org/10.1007/s41959-019-00018-z

Henry, C. & Lewis, K. (2018). A review of entrepreneurship education research: Exploring the contribution of the Education + Training special issues, *Education + Training*, *60*(3), 263-286. https://doi.org/10.1108/ET-12-2017-0189

Hooper, D., Coughlan, J., & Mullen, M. R. (2008). Structural Equation Modelling: Guidelines for determining model fit. *The Electronic Journal of Business Research Methods*, *6*(1), 53-60. http://mural.maynoothuniversity.ie/6596/1/JC-Structural-Equation.pdf

Kallas, E. & Parts, E. (2020). F*rom entrepreneurial intention to enterprise creation: the case of Estonia.* https://doi.org/10.1108/JEEE-07-2020-0235

Kautonen, T., Van Gelderen, M., & Fink, M. (2015). Robustness of the theory of planned behavior in predicting entrepreneurial intentions and actions. *Entrepreneurship Theory and Practice*, *39*(3), 655-674. https://doi.org/10.1111/etap.12056

Kirby, D. A., Guerrero, M., & Urbano, D. (2011). Making Universities More Entrepreneurial: Development of a Model. *Canadian Journal of Administrative Sciences*, *28*(3), 302-316. https://doi.org/10.1002/cjas.220

Klofstena, M., Fayolleb, A., Guerrero, M., Mian, S., Urbano, D., & Wrightf, M. (2019). The

https://doi.org/10.25100/cdea.v37i71.10736

entrepreneurial university as driver for economic growth and social change - Key strategic challenges. *Technological Forecasting and Social Change*, *141*, 149-158. https://goo.su/8sKg

Kerr, S. P., Kerr, W. R., & Xu, T. (2017). *Personality traits of entrepreneurs: A review of recent literature* (Working Paper 18-047). Harvard Business School. https://goo.su/8SKK

Laspita, S., Breugst, N., Heblich, H., &, Patzeltb, H. (2012). Intergenerational transmission of entrepreneurial intentions. *Journal of Business Venturing*, *27*(4), 414-435. https://doi.org/10.1016/j.jbusvent.2011.11.006

Law, M. Y. & Breznik, K. (2017). Impacts of innovativeness and attitude on entrepreneurial intention: among engineering and non-engineering students. *International Journal of Technology and Design Education*, *27*, 683-700. https://doi.org/10.1007/s10798-016-9373-0

Lee-Ross, D. (2017). An examination of the entrepreneurial intent of MBA students in Australia using the entrepreneurial intention questionnaire. *Journal of Management Development*, *36*(9), 1180-1190. https://doi.org/10.1108/JMD-10-2016-0200

Leon, D. R. (2017). Developing entrepreneurial skills. An educational and intercultural perspective. *Journal of Entrepreneurship, Management and Innovation*, *14*(4), 97-121. https://doi.org/10.7341/20171346

Lerchundi, I. P., Morales-Alonso, G., & Vargas, A. M. (2014). *Does family matter? A study of parents' influence on the entrepreneurial intention of technical degrees students in Spain.* https://oa.upm.es/36927/1/INVE_MEM_2014_196852.pdf

Liñán, F. & Chen, Y. W. (2009). Development and cross-cultural application of a specific instrument to measure entrepreneurial intentions. *Entrepreneurship Theory and Practice*, *5*, 593-617. https://doi.org/10.1111/j.1540-6520.2009.00318.x

Meek, W. R., Pacheco, D. F., & York, J. G. (2010). The impact of social norms on entrepreneurial action: evidence from the environmental entrepreneurship context. *Journal of Business Venturing*, *25*(5), 493-509. https://doi.org/10.1016/j.jbusvent.2009.09.007

Mueller, S. A. & Thomas, A. (2000). Case for comparative entrepreneurship: assessing the relevance of culture. *Journal of International Business Studies, 31*, 287-301. https://doi.org/10.1057/palgrave.jibs.8490906

Munir, H., Jianfeng, C., & Ramzan, S. (2019). Personality traits and theory of planned behavior comparison of entrepreneurial intentions between an emerging economy and a developing country. *International Journal of Entrepreneurial Behavior & Research*, *25*(3), 554-580. https://doi.org/10.1108/IJEBR-05-2018-0336

Muzychenko, O. (2008). Cross-cultural entrepreneurial competence in identifying international business opportunities. *European Management Journal*, *26*(6), 366-377. https://doi.org/10.1016/j.emj.2008.09.002

National Institute of Statistics and Geography [INEGI] (2020). *Encuesta sobre el Impacto Económico Generado por COVID-19 en las Empresas (ECOVID-IE) 2020.* https://www.inegi.org.mx/programas/ecovidie/2020/

Oyugi, L. (2015). The Mediating Effect of Self-Efficacy on the Relationship Between Entrepreneurship Education and Entrepreneurial Intentions of University students. *Journal of Entrepreneurship Management and Innovation*, *11*(2), 31-56. https://doi.org/10.7341/20151122

Passaro, R., Quinto, I., & Thomas, A. (2018). The impact of higher education on entrepreneurial intention and human capital. *Journal of Intellectual Capital*, *19*(4), 1469-1930. https://doi.org/10.1108/JIC-04-2017-0056

Pérez-Zavala, M. G., Molina-Sanchez, R., Schmitt, C., y López-Salazar, A. (2019). Emprendimiento en dos universidades públicas: Universidad de Guanajuato, México y Université de Lorraine, France. *Dans Projectics*, *2*(23), 99-116. https://www.cairn.info/revue-projectique-2019-2-page-99.htm

Pihie, Z. A. L., & Bagheri, A. (2013). Self-Efficacy and Entrepreneurial Intention: The Mediation Effect of Self-Regulation. *Vocations and Learning*, *6*, 385-401. https://doi.org/10.1007/s12186-013-9101-9

Pittaway, L., & Cope, J. (2006). *Entrepreneurship Education: A Systematic Review of the Evidence* (Working Paper 002/2006). National Council for Graduate Entrepreneurship. http://citeseerx.ist.psu.edu/viewdoc/load?doi=10.1.1.473.4972&rep=rep1&type=pdf

Pugh, R., Lamine, W., Jack, S., & Hamilton, E. (2018). The entrepreneurial university and the region: what role for entrepreneurship departments? *European Planning Studies*, *26*(9), 1835-1855. https://doi.org/10.1080/09654313.2018.1447551

https://doi.org/10.25100/cdea.v37i71.10736

Popescu, C. C., Bostan, I., Robu, A. M., Maxim, A., & Diaconu, L. (2016). An analysis of the determinants of entrepreneurial intentions among students: A Romanian case study. *Sustainability, 8*, 771-793. https://doi.org/10.3390/su8080771

Ratten, V. (2020). Coronavirus (covid-19) and entrepreneurship: changing life and work landscape. *Journal of Small Business & Entrepreneurship*, *32*(5), 503-516. https://doi.org/10.1080/08276331.2020.1790167

Robinson, S. & Stubberud, H. A. (2014). Elements of entrepreneurial orientation and their relationship to entrepreneurial intent. *Journal of Entrepreneurship Education*, *17*(2), 1-11. https://www.abacademies.org/articles/jeevol1722014.pdf

Roy, R., Akhtar, N., & Das, F. (2017). Entrepreneurial intention among science & technology students in India: extending the theory of planned behavior. *International Entrepreneurship Management Journal, 13*, 1013-1041. https://doi.org/10.22610/jebs.v6i9.531

Sabah, S. (2016). Entrepreneurial intention: theory of planned behaviour and the moderation effect of start-up experience. In M. Franco (Ed.), *Entrepreneurship Practice-Oriented Perspective.* https://goo.su/8skv

Saif, A. & Ghaia, U. (2020). Need for achievement as a predictor of entrepreneurial behavior: the mediating role of entrepreneurial passion for founding and entrepreneurial interest. *International Review of Management and Marketing*, *10*(1), 40-53. https://doi.org/10.32479/irmm.8949

Saral, H. C. & Alpakan, L. (2019). differences in entrepreneurial intention and characteristics according to demographics and other factors. *The European Proceedings of Social & Behavioural Sciences*, 364-376. https://dx.doi.org/10.15405/epsbs.2019.01.02.32

Santoso, S. (2017). Influence of entrepreneurship education, gender, and parent background to relationship between self-efficacy and entrepreneurship intention. *International Journal of Information, Business and Management*, *9*(3), 264-275. http://ijibm.site666.com/IJIBM_Vol9No3_Aug2017.pdf#page=253-

Schjoedt, L., & Craig, J. B. (2017). Development and validation of a unidimensional domain-specific entrepreneurial self-efficacy scale. *International Journal of Entrepreneurial Behavior & Research*, *23*(1), 98-113. https://doi.org/10.1108/IJEBR-11-2015-0251

Schmutzler, J., Andonova, V., & Diaz-Serrano, L. (2019). How context shapes entrepreneurial self-efficacy as a driver of entrepreneurial intentions: A multilevel approach. *Entrepreneurship Theory and Practice*, *53*(5), 880-920. https://doi.org/10.1177/1042258717753142

Shirokova, G. Osiyevskyy, O., & Bogatyreva, K. (2016). Exploring the intention-behavior link in student entrepreneurship: Moderating effects of individual and environmental characteristic. *European Management Journal*, *34*, 386-399. https://doi.org/10.1016/j.emj.2015.12.007

Shinnar, R. S., Hsu, D. K., & Powell, B. C. (2014). Self-efficacy, entrepreneurial intentions, and gender: Assessing the impact of entrepreneurship education longitudinally. The International *Journal of Management Education*, *12*(3), 561-570. https://doi.org/10.1016/j.ijme.2014.09.005

Soria-Barreto, K., Honores-Marin, G., Gutiérrez-Zepeda, P., & Gutiérrez-Rodríguez, J. (2017). Prior exposure and educational environment towards entrepreneurial intention. *Journal of Technology Management and Innovation*, *12*(2), 45-58. http://dx.doi.org/10.4067/S0718-27242017000200006

Strauser, D. R., Ketz, K., & Keim, J. (2002). The relationship between self-efficacy, locus of control, and work personality. *Journal of Rehabilitation*, *68*(1), 20-26. https://experts.illinois.edu/en/publications/the-relationship-between-self-efficacy-locus-of-control-and-work-

Sun, H., Ni, W., Teh, P. L., & Lo, C. (2020). The systematic impact of personal characteristics on entrepreneurial intentions of engineering students. *Frontiers in Psychology*, *11*, 1072. https://doi.org/10.3389/fpsyg.2020.01072

Tsai, K. H., Chang, H. C., & Peng, C. Y. (2016). Extending the link between entrepreneurial self-efficacy and intention: a moderated mediation model. *International Entrepreneurship Management Journal*, *12*, 445-463. https://doi.org/10.1007/s11365-014-0351-2

Udayanan, P. (2019). The role of self-efficacy and entrepreneurial self-efficacy on the entrepreneurial intentions of graduate students: a study among Omani graduates. *Entrepreneurial Business and Economics Review*, *7*(4), 7-20. https://doi.org/10.15678/EBER.2019.070401

Vamvaka, V., Stoforos, C., Palaskas, T., & Botsaris, C. (2020). Attitude toward entrepreneurship, perceived behavioral control, and

https://doi.org/10.25100/cdea.v37i71.10736

entrepreneurial intention: dimensionality, structural relationships, and gender differences. *Journal of Innovation and Entrepreneurship*, *9*(5). https://doi.org/10.1186/s13731-020-0112-0

Van Gelderen, M., Brand, M., van Praag, M., Bodewes, W., Poutsma, E., & van Gils, A. (2008). Explaining entrepreneurial intentions by means of the theory of planned behaviour. *Career Development International*, *13*(6), 538-559. https://doi.org/10.1108/13620430810901688

Wilson, F., Kickul, J., & Marlino, D. (2007). Gender, entrepreneurial self-efficacy, and entrepreneurial career intentions: implications for entrepreneurship education. *Entrepreneurship Theory and Practice*, *31*(3), 387-406. https://doi.org/10.1111/j.1540-6520.2007.00179.x

Wu, S., Matthews, & Dagher, G. K. (2007). Need for achievement, business goals, and entrepreneurial persistence. *Management Research News*, *30*(12), 928-941. https://doi.org/10.1108/01409170710833358

Yan, J. (2010). The impact of entrepreneurial personality traits on perception of new venture opportunity. *New England Journal of Entrepreneurship*, Fall, 21-35. https://digitalcommons.sacredheart.edu/neje/vol13/iss2/4

Zeffane, R. (2013). Need for achievement, personality and entrepreneurial potential: a study of young adults in the United Arab Emirates. *Journal of Enterprising Culture*, *21*(1), 75-105. https://doi.org/10.1142/S0218495813500040

Zhao, H. Seibert, S. E., & Hills, G. E. (2005). The mediating role of self-efficacy in the development of entrepreneurial intentions. *Journal of Applied Psychology*, *90*(6), 1265-1272. https://doi.apa.org/doi/10.1037/0021-9010.90.6.1265

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https://doi.org/10.25100/cdea.v37i71.10736