

University Support, Teaching Competencies and Entrepreneurial Competencies in Software Engineering and Graphic Design Students

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Abstract—The objective of this research was to evaluate how university support and teaching entrepreneurial competencies affect students' entrepreneurial competencies. As an empirical test, a sample of 201 software engineering and graphic design students from a university in Northwest Mexico was taken, where it was possible to corroborate three hypotheses. The results suggest that entrepreneurial competencies are influenced by external aspects, where the university can be understood as an open system, but also, as a part of a wider system within the triple helix. This shows that the joint work between the contextual and individual part can benefit the generation of innovation and development for society, especially in a country where there is a lack of R&D, although the practice of entrepreneurship is high. As a result, the university can play a relevant role when developing entrepreneurial competencies to train students to become entrepreneurs through innovation and technology.

Keywords—Entrepreneurial competencies, entrepreneurial university, university support, teaching competencies.

1 Introduction

Entrepreneurship and technology are two aspects that have gone hand in hand. From a theoretical approach, technology has played a relevant role in the understanding of entrepreneurial education. For example, bibliometrics show that technology stands out among the main topics in the understanding of entrepreneurial education (e.g. Fellnhöfer [1]; Kakouris and Georgiadis [2]), academic entrepreneurship (e.g. Skute [3]), and the literature on university-industry collaborations (e.g. Skute et al. [4]). Furthermore, an example of this is that both aspects – technology and entrepreneurship – were already considered jointly when approaching the case of innovation since the 1940s during the Schumpeter's work [5], author who is considered one of the precursors of the study of entrepreneurship; as well as the Drucker's management thought [6]. It is also important to note that articles relating entrepreneurship to technological aspects have been frequently published in recent years [7-8].

An emerging paradigm within this research field is the entrepreneurial university, which by combining teaching and research, aims to promote technological innovation [9]; additionally, it favors economic development, through its participation in the so-called triple helix (academy, industry and government relations) [10]. Under this perspective, the development of entrepreneurs plays a transcendental role, especially in certain regions of the world, as is the case of Latin America, where there are problems to be undertaken through technology. This is in spite of the fact that this region has the highest levels of TEA (Total Early-stage entrepreneurial Activity) since Mexico stands out by placing 17th in the world ranking, according to the Global Entrepreneurship Monitor [11]; however, it is important to point out that within the main weaknesses of this country, is the lack of R&D. For this reason, entrepreneurship in this location has been characterized by a lack of competitiveness [12-13] with technology and innovation being its main weaknesses [14].

This phenomenon can be understood from the contextual and individual part. On the one hand, from the first approach, the university is an important part of the triple helix [10], and can provide alternatives to counteract this problem; nevertheless, the university's participation in entrepreneurial development has been limited. An example of this, is that it has been oriented mainly towards the creation of incubators for external users [15]; in addition, certain weaknesses stand out, such as the lack of promotion of an entrepreneurial culture among students, the low use of science and technology platforms for innovation, and the development of entrepreneurial human capital [16].

From a structural and contextual point of view, it is important to understand that the university is a complex system [17], which is integrated by different elements (e.g. authorities, administrators, staff, researchers, professors and students) and aspects that integrate the university context, which can favor entrepreneurship [18]. In the case of student entrepreneurship, this can be explained through the influence of University Support [19] and Teaching Competencies [20-21]; the latter, considering that entrepreneurship can be taught [22].

On the other hand, from the individual point of view, it is necessary to understand that an entrepreneur is defined by what he or she does: create a business [23-24]; likewise, the university plays a very important role in the individual part of the entrepreneur [25, 9], where the formation of entrepreneurial skills and competencies stand out as essential to guarantee success [21, 26-28].

Finally, from the contextual point of view, it is imperative to consider that both the university and the scholar must develop different competencies in students [29], where entrepreneurial competences play an important role in generating value for society [21]; therefore, the following research question arises: how do university support and teaching competencies affect student's entrepreneurial competencies?

As empirical evidence, the importance of developing entrepreneurial competencies in engineering students to promote innovation in Mexico is highlighted. This country has high levels of entrepreneurial activity worldwide, but also presents low levels in the area of R&D [11, 14]; moreover, it is not entirely clear how universities are influencing the education of future entrepreneurs in this country because, even though empirical evidence has increased (e.g. Gerrero, Urbano and Gajon [30]; Guerrero, Urbano, Cunningham and Gajon [31]; Guerrero, Urbano and Gajon [32]), more research is needed,

especially among the engineering students. Engineering students could contribute to transform Mexico from a country oriented towards service entrepreneurship to one based on technology and innovation.

As a result, it was decided to study a sample of students from a university in north-western Mexico. In order to contribute to regional development, this university has sought to implement a cross-cutting entrepreneurial education within its curriculum over the past few years [33-34]. Due to its geographic location, this institution serves over 17,000 undergraduate students [35], mostly from three states: Sonora, Sinaloa and Chihuahua. It is highlighted that its mission is focused on developing entrepreneurial competencies in its students [36].

The structure of the following document is articulated in the following way: in the first section, the theoretical framework of the study variables is presented (i.e. university context, as well as the entrepreneurial competencies of the professor and the student), to later formulate the hypotheses, through which a methodological design is developed. Finally, the results and conclusions are shown.

2 Theoretical Framework and Hypotheses

When looking more deeply into the theoretical orientations on the subject of entrepreneurship, it can be seen that there are two main areas. The first one is about the internal aspects of the person that allude to the individual factors (e.g. McClelland [37]; Islam [25]), where competencies play an important role (e.g. Arafeh [26]; Robles and Zárraga-Rodríguez [27]; Peltonen [21]; Rasmussen and Wright [18]); on the other hand, there are external aspects to the individual, also called environmental or contextual factors (e.g. Schumpeter [5]; Clarysse et al. [38]), where the university stands out [9-10], and the influence of the professor (e.g. Heinone and Hytti [20]; Peltonen [21]; Heinonen, and Akola [39]). These aspects constitute the study variables, which are described below.

2.1 Student's entrepreneurial competencies

Broadly speaking, the entrepreneurial competencies promote the development of capacities to create a company, the identification and creation of business opportunities, as well as the search for economic or social benefits, innovation, individual or collective work, and the combination of resources and talents [40]. According to Duarte and Ruiz [41], they also identify different aspects, such as: creativity, flexibility, risk, the need for achievement, discipline and dynamism. In this sense, these skills need to be understood under the competency model, which Tinoco [42] groups them into five dimensions.

A competence is defined as a set of skills that a person has developed to achieve a specific objective [43]. In fact, an entrepreneurial competence is formed by certain skills that allow an individual to create a successful business. Although, there is no fully accepted taxonomy of what these skills should be, some authors classify them into technical, business management, thinking and personal (e.g. Hatthakijphong and Ting [44]).

As for the latter, there are different models that explain them (e.g. McClelland [37]; Arafeh [26]; Robles and Zárraga-Rodríguez [27]; D'Este et al. [45]). For this research, and considering that it is a Latin American study, we took the model proposed by Tinoco [42], whose taxonomy is based on entrepreneurial competencies that have empirical evidence to support them: self-knowledge (e.g. Fernandez and Miñarro [46]), achievement motivation (e.g. Duarte and Ruiz [41]; McClelland [37]), vision (e.g. Chihsiang [47]; Carrera et al. [48]), planning (e.g. Chang and Chen [49]), and persuasion (e.g. Robles and Zárraga-Rodríguez [27]; Zampetakisa et al. [50]). It is important to note that some of these variables are within the models described.

The development of self-knowledge goes back to classical Greek philosophy, especially to Socrates [51], which allows the individual to have self-control in order to achieve personal goals [52]. In this sense, self-knowledge includes internal states and positive resources, which serve as emotional support and encourage entrepreneurial activity [46]. On the other hand, achievement motivation within entrepreneurial activity dates back to studies by McClelland [37], who found that self-employed people were attracted to achieving complex goals, especially generating their own business; an aspect that has been addressed by empirical studies (e.g. Duarte and Ruiz [41]). Another competence that defines the entrepreneur is vision, that is the ability to anticipate the future [48]. Planning, an aspect present in management since Fayol's work [53], allows the development of strategies for the success of a business [49]. Finally, persuasion permits the entrepreneur to influence others [50].

2.2 University entrepreneurial support

In recent years, the model of entrepreneurial university has gained importance [9], which aims to contribute the innovation and economic development [10]. For this reason, entrepreneurial universities play an important role through the production and dissemination of knowledge [30], as well as the generation of business incubators [31], which in general terms, they can impact on the development of future entrepreneurs. This has led to the emergence of different studies, which have put both scholars and students as the object of study. As for academics, Rasmussen and Jarl [54] found that the university context impacts on the entrepreneurial process, especially in the construction of capacities that facilitate entrepreneurship through a longitudinal study; in contrast, Rasmussen and Wright [18] addressed the literature that explained academic entrepreneurship and entrepreneurial competencies. In the Latin American context, Fischer et al. [55], studied faculty members from different Brazilian universities, where they found that many aspects of the university context do not promote academic entrepreneurship, which has prevented the adaptation of strategies that encourage this aspect within the region.

Although it is true that academic entrepreneurship can have an impact on the development of entrepreneurs, more studies are needed to be oriented towards students, especially in countries like Mexico, where university education is playing a very important role in the entrepreneurial ecosystem; however, there are aspects to be developed and improved such as association with other actors (e.g. industry), and the improvement of incubators [15]. It is important to note that the entrepreneurial university

is something recent in Mexico. It is true that most universities have entrepreneurial programs and generate a large number of entrepreneurial projects, many of which do not prosper and die due to lack of adequate follow-up [56]. Based on the above and in response to the research question, the following hypothesis is established:

H₁ = The greater the university support, the greater student's entrepreneurial competencies.

2.3 Entrepreneurial teaching competencies

Teaching activity needs changes in the objectives and expected results in order to bring universities towards the model of the entrepreneurial university. Changes are also required in their planning, teaching requirements and in the teaching-learning process, which must be closely linked to the business and professional environment. In the same way, graduates must be trained to be useful to society and companies in terms of their attitude and capacity for innovation and entrepreneurship, so they can impact and comply with their social responsibility to generate value in their regional economic environment.

Although, the study of entrepreneurial education has been increasing [1], the role of the professor has been little researched [20]. It is important to highlight that the professor, within the organizational structure of the entrepreneurial university, plays a relevant role in training entrepreneurs, but he or she must first develop certain competencies. Empirical evidence has shown that these competencies can be learned from professors (e.g. Peltonen [21]). In order to potentiate entrepreneurial teaching, a new way of thinking is required, as well as the promotion of new skills and behaviors [39], where both the professor and the student are involved.

With this in mind, it is important to consider that the influence of the professor on the student can be very broad, highlighting the teaching and behavior. From the first approach, the teacher's pedagogy should be oriented to encourage students to be part of an entrepreneurial process within the different disciplines they are studying, in order to provide the skills to generate a future business [20]. In the area of the teacher entrepreneurial behavioral, studies have found that this has an important influence on individuals, especially within the promotion of innovation (e.g. Adeyemo [57]), and the development of entrepreneurial competencies (e.g. Van Dam et al. [58]). Mexico has had problems in promoting innovative and technological entrepreneurship [11, 14], and that the studied university has modified its programs in recent years to orient them towards the promotion of entrepreneurship through a transversal program of entrepreneurial education [36] and where the professor should play a relevant role [33-34]. On account of this, the second hypothesis arises:

H₂ = The greater the entrepreneurial teaching competencies, the greater student's entrepreneurial competencies.

Finally, taking up all of the above, and with the intention of understanding the promotion of entrepreneurship, it is necessary to consider that the university is a complex system [17], where professors are integrated [18]. As a result, it seeks to know if both aspects influence the development of entrepreneurial skills of students. Since there is

not much empirical evidence on how both aspects influence the formation of entrepreneurial competencies, more studies are needed to explain how these external aspects - university and teaching- can have a positive or negative impact on the individual, especially in aspects as personal as self-knowledge, achievement motivation, planning, vision and persuasion [42]. These are aspects that demonstrate that psychology plays a transcendental role in order to understand the entrepreneur [59]. Taking into account what defines an entrepreneur is his or her capacity to generate a new company [23], it is necessary to go further in order to improve the understanding of his or her actions, which will make it possible to develop an effective pedagogy that will have an impact on the training of entrepreneurs within the university; therefore, this is how the last hypothesis is developed:

H₃= The university support and entrepreneurial teaching competencies influence on student's entrepreneurial competencies.

3 Research Methodology

3.1 Sampling

A convenience sample of 201 graphic design ($n = 149$) and software engineering ($n = 52$) students from a university in Northwest Mexico was obtained. It should be noted that 23.4% of the sample were entrepreneurs (See Table 1).

Table 1. Sample Characterization

Characteristics	<i>n</i>	%
Gender		
Female	105	52.2
Male	96	47.8
Educational Program		
Graphic Design	149	74.1
Software Engineering	52	25.9
Semester		
First	40	19.9
Second	4	2.0
Third	24	11.9
Fourth	1	0.5
Fifth	65	32.3
Sixth	3	1.5
Seventh	27	13.4
Eighth	37	18.4
Are you currently an entrepreneur?		
Yes	47	23.4
No	154	76.6

3.2 Instrument

The questionnaire was composed of three sections to measure students' perceptions. In the first one, *the professor's competencies* were evaluated in order to develop the entrepreneurial intention in the students. In this case, four items based on competency model for high education (knowing, being and doing) [29] were used, which were adapted to the topic of study (entrepreneurship). The items were the following: "My professors encourage me to create my own company"; "My professors train me to be an entrepreneur"; "The personality of my professors motivates me to create my own company"; "The experience of my professors motivates me to create my own company". Originally, the questionnaire was composed of seven items, but after the validity analysis (content, construct and convergence), it was modified. It should be noted that, as concerns content validity, a pilot test was applied. Regarding *University support*, an adaptation to Spanish of the Lüthje and Franke subscale [19] was used. Finally, for the *student's entrepreneurial competencies*, an adaptation of the indicators proposed by Tinoco [42] was used, which was composed of 12 items, and is integrated by five dimensions: self-knowledge (2 items), vision (2 items), achievement motivation (2 items), planning (3 items) and persuasion (3 items). The three sections were measured using the Likert-5 scale with values from 1 (*strongly disagree*) to 5 (*strongly agree*) (See Table 2).

3.3 Validity and reliability

To validate the measuring instruments, construct validity and convergent validity were measured. Regarding the entrepreneurial competencies, Principal component analysis with Varimax rotation was performed, where the five dimensions explained 72.73% of the variance. It has to be emphasized that favorable results were obtained for the Keiser-Meyer-Olkin test ($KMO = .890$; $X^2 = .824.45$; $df = 66$; $p = .000$). In addition, high values of the Average Variance Extracted (AVE) were found for all variable dimensions, which, according to Hair et al. [60], they should be greater than .50, showing that the indicators have favorable levels of construct and convergent validity. The construct validity refers to the degree that an instrument measures a dimension [43, 61], and is based on convergent validity, which it is understood as the degree the instrument measures a single feature of the variable [62]. The same happened in the case of University Support and Entrepreneurial Teaching Competencies, which are unidimensional variables. Regarding reliability, Composite Reliability was tested. The results were satisfactory because they were higher than .70 (See Table 2).

Table 2. Validity and Reliability

Variable	Items	AVE	Composite Reliability
Entrepreneurial Teaching Competencies	4	.670	.889
University Support	3	.518	.763
Self-knowledge	2	.552	.702
Vision	2	.599	.749
Achievement Motivation	2	.563	.721
Planning	3	.572	.800
Persuasion	3	.524	.764

3.4 Research process

After having obtained the approval of the authorities from a university in Northwest Mexico, the questionnaire was applied through self-administration. A total of 320 questionnaires were obtained; however, some of them that had missing data and others that reflected inconsistencies (e.g. social desirability) were eliminated. The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 21 software. As a way to test the study hypotheses, correlation and multiple regression were also performed. In the case of the latter, the Variance Inflation Factor (VIF) was analyzed to evaluate problems of collinearity, where values of less than 1.40 were obtained in all models, which, according to Hair et al. [60], is adequate since these values are less than 10.

4 Results and Discussion

The presentation of the results is based on structured assumptions. Firstly, with respect to H_1 and H_2 in Table 3, it can be seen that both Entrepreneurial Teaching Competencies and University Support are positively associated with the student's entrepreneurial competencies. The results of the correlation can be interpreted from different perspectives: a) the findings reflected that the contextual part has been positively and significantly associated with the individual part in the studied university; b) this is in line with empirical evidence that has been found that, in terms of entrepreneurship formation, the university has a relevant impact [9-10], as well as the behavior and teachings of the professor [20-21, 39]; c) this reflects the relevance to evaluate the third hypothesis.

Table 3. Correlation of variables

Variables	1	2	3	4	5	6	7
1. Entrepreneurial teaching competencies	1						
2. University Support	.441**	1					
3. Self-knowledge	.194**	.113	1				
4. Vision	.322**	.157*	.485**	1			
5. Achievement motivation	.314**	.195**	.457**	.641**	1		
6. Planning	.246**	.194**	.416**	.517**	.598**	1	
7. Persuasion	.313**	.058	.367**	.543**	.544**	.520**	1

** $p \leq 0.01$ (2-tailed); * $p \leq 0,05$ (2-tailed)

For H_3 , five multiple regressions were performed. Three models and control variables were used (i.e., entrepreneur status and program) and had a significant impact on vision (Table 5). The results are reported in Tables 4 to 8. With respect of the self-knowledge variable, it is understood as an internal state that allows to have a domain on itself [46], in order to achieve personal goals [52], and it was found that it was influenced only by University Support ($\beta = .204$; $p \leq .05$; Adjusted $R^2 = 3.4\%$). Considering that this competence is very important for the development of the human part of the entrepreneur, it could be significantly enhanced through the entrepreneurial behavior of the professor, and it can impact in a favorable way on the organizational structure and on the students [63]. Regarding the context, different academics have emphasized the need to promote self-knowledge in Mexican culture [64-67]. This seems to be another opportunity area for the university in this country.

Table 4. Linear Regression: Self-Knowledge as dependent variable

Variables	Model 1	Model 2	Model 3
<i>Control Variables</i>			
Entrepreneur Status	-.95 (.130)	-.108 (.131)	-.115 (.129)
Program	.036 (.126)	.020 (.126)	.080 (.132)
Entrepreneurial Teaching Competencies		.125 (.084)	.027* (.095)
University Support			.204* (.083)
R^2	.009	.024	.054
Adjusted R^2	-.001	.009	.034
F	.875	3.029	6.202*

** $p < .01$; (standard error)

Conversely, considering that the future entrepreneur requires cultivating the capacity to anticipate the future, Tables 5 and 7 show that both vision and planning were impacted by the two independent variables, with Adjusted R^2 of 15.9% and 5.7%, respectively. Then, the empirical evidence shows that such competencies, besides being an important part of the individual character of the entrepreneur, are also developed within the transversal program proposed by the studied university [33]. This reflects the fact that software engineering and design students feel supported, both by the university and

professors, in developing their vision, that is, in anticipating the future [48], as well as in their planning capacity, which is indispensable for decision-making [49]. From a cultural approach, these aspects require attention, especially in Mexico, a country whose culture has been characterized by a short-term orientation [68].

Table 5. Linear Regression: Vision as dependent variable

Variables	Model 1	Model 2	Model 3
<i>Control Variables</i>			
Entrepreneur Status	-.234*** (.118)	-.257*** (.116)	-.268*** (.112)
Program	-.079 (.114)	-.106 (.112)	-.017 (.115)
Entrepreneurial Teaching Competencies		.209** (.075)	.065 (.083)
University Support			.299*** (.072)
R ²	.069	.111	.176
Adjusted R ²	.060	.098	.159
F	7.379***	9.334**	15.370***

***p* < .01; (standard error)

The achievement motivation, a variable with much empirical evidence within the entrepreneurial behavior (e.g. Duarte and Ruiz [41]), is understood as the need to meet difficult goals [37]. The results showed that independent variables impacted on this entrepreneurial competition. The interpretation of this result requires the understanding of contextual analysis due to the existence of contradictory data. From a cultural point of view [68], the Mexican culture has been characterized by a low tolerance for frustration, but this country has presented a high level of TEA [11], unlike first world countries. It may be possible to combine these perspectives to develop the training of entrepreneurs, when adapting the entrepreneurial university model to the reality of Mexico.

Table 6. Linear Regression: Achievement motivation as dependent variable

Variables	Model 1	Model 2	Model 3
<i>Control Variables</i>			
Entrepreneur Status	-.099 (.117)	-.124 (.115)	-.134* (.112)
Program	-.054 (.113)	-.083 (.111)	.00 (.114)
Entrepreneurial Teaching Competencies		.225** (.074)	.090 (.083)
Perceived university Support			.280*** (.071)
R ²	.015	.064	.120
Adjusted R ²	.005	.049	.102
F	1.512	10.239**	12.581***

***p* < .01; (standard error).

Table 7. Linear Regression: Planning as dependent variable

Variables	Model 1	Model 2	Model 3
<i>Control Variables</i>			
Entrepreneur Status	-.045 (.127)	-.069 (.125)	-.075 (.124)
Program	-.049 (.123)	-.077 (.121)	-.021 (.127)
Entrepreneurial teaching competencies		.215** (.081)	.124 (.092)
University Support			.1289* (.079)
R ²	.005	.050	.076
Adjusted R ²	-.005	.036	.057
F	.543	9.260**	5.479*

** $p < .01$; (standard error)

Finally, Table 8 shows the findings that persuasion was only positively affected by the University Support ($\beta = .363$; Adjusted R² = 9.7%; $F = 21.006$; $p \leq .001$). This reflects that there is still work to be done in terms of developing the entrepreneurial behavior of the professors, so they can develop their teaching competencies [29], and actively participate in the teaching-learning process to form entrepreneurs who generate value for society [21].

Table 8. Linear Regression: Persuasion as dependent variable

Variables	Model 1	Model 2	Model 3
<i>Control Variables</i>			
Entrepreneur Status	-.073 (.136)	-.082 (.136)	-.095 (.130)
Program	-.075 (.121)	-.085 (.132)	.023 (.133)
Entrepreneurial Teaching Competencies		.082 (.088)	-.093 (.096)
University Support			.363*** (.083)
R ²	.013	.020	.115
Adjusted R ²	.003	.005	.097
F	1.335	1.307	21.006***

** $p < .01$; (standard error)

5 Conclusion

It is true that concepts like entrepreneurship and technological development were already present since Schumpeter's creative destruction [5], and currently the study on these aspects has been vast (e.g. Ferreira et al. [7]; Montiel et al. [8]); however, it has been difficult to promote R&D for many regions, such as Latin America, especially in Mexico, a country that requires a plan to generate innovative entrepreneurs [11]. For

this reason, Latin American countries have sought to strengthen entrepreneurship education programs [14], especially within technology-related fields.

For this reason, the objective of this research was to evaluate whether the University Support and Teaching competencies affect the entrepreneurial competencies in software engineering and graphic design students. Through the sample of 201 students from a university in Northwest Mexico, it was possible to corroborate the three hypotheses raised. The results suggest that entrepreneurial training depends on both external aspects (university and teaching) and internal aspects (entrepreneurial competencies), where the university is seen as an open system [17], but also as a part of a wider system such as the triple helix, which shows that the joint work of academia, industry and government relations can generate innovation and development for society [10].

While the results shown cannot be generalized due to the type of used sampling (non-probabilistic) -which is the main limitation of the study- through this research, it is proposed that the university in the region should adapt principles and experiences from the entrepreneurial university model [9-10] to its own reality, where financial and human resources are not optimal for training entrepreneurs. In this investigation, it could be observed that the efforts made by the university have favorably impacted on the development of entrepreneurial competencies of students. In this sense, for future research, it would be convenient to follow up on the present investigation; likewise, to involve other variables that could help to understand the emerging concept of the entrepreneurial university in the Mexican context within the technology and engineering field. Thus, the relevance of the traditional teaching method should be thoroughly reviewed in order to improve university entrepreneurial education [69-72].

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