International Journal of Engineering Education Vol. 37, No. 4, pp. 1131–1143, 2021
Printed in Great Britain

0949-149X/91 $3.00+0.00

Investigating Factors That Impact the Development of Entrepreneurial Interest among Engineering Students*

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Entrepreneurship is a crucial skill in today's world, especially in the engineering and hi-tech industries, but engineering education is still lagging behind in finding ways to teach entrepreneurship. The purpose of this study is to clarify the factors that contribute to entrepreneurship tendencies among engineering students and to use them as an entrepreneurship predictor tool. We conducted research on 95 undergraduate engineering students, for which we used well-documented personality analysis and entrepreneurial questionnaires. In particular, we analyzed the relationship between personality profiling and entrepreneurial intention, and we examined entrepreneurship according to the types of goals that drive innovative behavior. We discovered four main factors that contribute to entrepreneurial behavior: motivation, control, innovative personality, and ability to get support. In addition, our findings indicate that while emotional intelligence contributes to the engineering students' entrepreneurial intention, students with an established perception of gender equality have higher entrepreneurship intention. This suggests that their entrepreneurial tendencies will benefit from an enhanced perception of gender equality. The importance of this study is that it points out the crucial impact of the perception of gender equality in the early stages of student development in the academic world. This pinpoints the effect of gender equality on entrepreneurial and innovation intention. Therefore, it is crucial to examine how gender equality and emotional intelligence can be incorporated into the curriculum of engineering studies. The challenges of teaching entrepreneurship in engineering education as well as the difficulties of involving women as entrepreneurs can both be solved by actions that foster entrepreneurship for women in the educational setting.

Keywords: entrepreneurship; gender differences; entrepreneurial intention; personality factors; engineering education

1. Introduction

Entrepreneurship is at the core of competitive and dynamic economies; and it is a valued factor in organizations, companies, and educational settings. Despite how commonplace this term is and how crucial it seems to be in today's world, it is still difficult to determine what defines and promotes entrepreneurship. Is it something that can be taught? Or is entrepreneurship determined by personality and character? How can individuals, companies, educational settings, and organizations cultivate this important skill?

As important as entrepreneurship is to certain industries, such as engineering and hi-tech, only recently has research been focused on the ability to teach entrepreneurship in an educational setting [1–5]. Teaching entrepreneurship in engineering education lags behind the demands of the industry. Studies have examined entrepreneurship by the type of goals that drive innovative behavior [6, 7], with evidence that entrepreneurial intention is a good indicator of future entrepreneurial action.

In particular, teaching entrepreneurship can have a significant impact by bridging the large gender gap in science, technology, engineering, and mathematics (STEM) [8]. Entrepreneurship can be an opportunity for women to overcome barriers and develop their potential after graduation from their engineering studies [9]. Entrepreneurship offers highly qualified women in engineering a chance to develop their careers as an option if they face difficulties when searching for their place in the job market [10].

This study extends the state of the art by looking at the association between personality factors and entrepreneurial intention among engineering students. Specifically, this paper has the following objectives:

(1) Examine the relationship between personality profiling and entrepreneurial intention.
(2) Discover which factors contribute to entrepreneurship tendencies among engineering students.
(3) Examine the relationship between gender equality perceptions and entrepreneurship tendencies among engineering students.

We conducted a study with 95 undergraduate engineering students. We used well-documented personality questionnaires to identify the students' entrepreneurial intention. Then, we analyzed the results to search for a connection between different personality features and entrepreneurial intention.

In the next section, we present background on entrepreneurship in general and entrepreneurship

* Accepted 19 March 2021.

education in engineering in particular. The third section describes the research. The results section analyzes students' answers to the entrepreneurial questionnaire, and in the final section, we discuss the results we obtained and the conclusions we draw from them.

2. Literature Review

2.1 Cultivating Entrepreneurship

In today's dynamic and competitive environment, understanding how to cultivate entrepreneurship is a major concern of many organizations, workplaces, and educational settings [1–5]. Entrepreneurship is needed to adapt to changing technologies and demands and to give oneself or one's company a lead over others [11]. Therefore, scientists and professionals seek to identify conditions that influence entrepreneurship. One critical factor is the type of goals that drive innovative behavior, particularly entrepreneurial intention [12].

Entrepreneurial intention refers to the intention of an individual to start a new business [13]. Entrepreneurial intention lies at the heart of entrepreneurship, since it activates the process of discovering, creating, and exploiting opportunities [14]. Recent empirical evidence confirms that entrepreneurial intention seems to be a good predictor of future startup behavior [6, 7, 15]. As such, entrepreneurial intention is one of the best measures of entrepreneurial potential, because it directly precedes the decision to start a business [13, 16, 17]. Because intention plays a crucial role as a preliminary stage in the entrepreneurial process, the literature on predictors of entrepreneurial intention continues to increase rapidly (e.g., [12, 18, 19]). Studies examining entrepreneurial intention in the educational entrepreneurial context have also been carried out. Those studies focus on variables that are likely to be related to the important variable of entrepreneurial intention [20–23]. Our study expands on this previous research by exploring the association between personality factors and entrepreneurial intention among engineering students.

Despite the contribution of previous studies to the understanding of the mental processes that enable entrepreneurship, those studies pay relatively little attention to the role of the entrepreneur's personality and emotional skills in the initiation of new ventures [24–27]. In addition, they seem to do little justice to the often-noted problem of gender bias within the entrepreneurial educational process, a bias that might stifle otherwise valid entrepreneurial intention [9, 28, 29]. The entrepreneurial event model [30] and the theory of planned behavior [13, 16] have directed most empirical research explaining the formation and cultivation of entrepreneurial intention. These cognitive frameworks perceive entrepreneurial intention as a specific kind of planned behavior; therefore, they focus on the entrepreneur's assumptions and beliefs regarding new venture formation. Indeed, recent studies have demonstrated a positive association between emotional intelligence and entrepreneurial intention (e.g., [31]). Positive associations were also found between positive personality traits, such as a proactive personality and self-efficacy, and entrepreneurial intention (e.g., [32]). Yet, surprisingly, the role of subjective norms in the formation and cultivation of entrepreneurial intention, as well as cultural factors such as gender disparities and bias, has received comparatively little consideration. Subjective norms may be especially important for entrepreneurs among engineering students where gender equality is an issue. Although the female entrepreneur has been more present in the past decade, a trend observed in countries of various cultural systems [8, 28], literature reviews have noted many foundational problems that are yet to be solved in those countries [29]. According to Smith and Gayles [29], women remain vastly underrepresented in engineering fields. The problem has been formulated in terms of reduced social capital: in some fields, women simply have reduced social capital, which in turn isolates them from having an influencing community that gain benefits as well [33]. Although such issues are part of a larger cultural framework that is resilient to change, many studies have noted the important role of entrepreneurship education in shaping new generations that break away from the framework in question [33, 34]. Indeed, some of the factors that reinforce the large gender gap in STEM disciplines are not explicit rules and some are not even conscious [8]. Despite these difficulties, it is generally agreed that education can play an important role in addressing these structural disparities [35]. For example, Strachan et al. [8] concluded that it is essential to provide educational and workplace environments that are welcoming and value each one of us, and indeed, together with the realization of one's own bias, this is an important catalyst for change.

2.2 Entrepreneurship Education in Engineering

Previous studies have focused on pedagogy methodologies and personality factors that will encourage students' intention to become entrepreneurs (e.g., [36–38]) and enhance their skills as professional engineers [39]. However, teaching entrepreneurship in engineering courses has not bridged the

gender gap highlighted by recent reports from industry. A recent UNESCO report on the situation of women in STEM disciplines has noted this gender gap, particularly at higher levels of education, such as master's, PhD, and postdoctoral studies [40]. Similarly, a 2017 study from the National Science Foundation in the United States revealed that women constitute only 20% of students graduating with a bachelor's degree in engineering [29]. With research that focuses on teaching entrepreneurship to future engineers being relatively recent, the time is ripe to understand which student factors influence successful entrepreneurship teaching so that those factors are found or fostered in women. Thus, the challenges of teaching entrepreneurship in engineering education [41–43], as well as the difficulties of involving women as entrepreneurs [33, 40], can be overcome by actions that foster entrepreneurship for women in the educational setting. For this purpose, we take a closer look at several such actions that have been discussed in literature. Although these papers are not explicitly directed towards encouraging women participation in engineering, we believe that these factors can be applied *mutatis mutandis* to target the specific subgroup of female students.

Rideout and Gray [44] and Kleine et al. [45] looked at what science and technology engineering program coordinators face when they aim to bring entrepreneurship into their curriculum and transition from passive to action-based learning. They suggested that in order to promote entrepreneurial activities in engineering, pedagogies should encourage interactive learning, active involvement of students, and self-directed learning. This action-based training should stress learning outcomes in external contexts found in the non-academic world. This, they suggested, requires a supportive and collaborative environment, where interactions with other stakeholders (business, teachers, mentors) activated in various contexts help the students transition after studies.

One can look at entrepreneurship education as consisting of three constituent parts: knowledge or learning; facilities or networking; and entrepreneurial intention or attitudes [45, 46]. From this point of view, how to teach entrepreneurial intention to engineering and science students seems to be the most difficult aspect to put into pedagogical practice.

As Besterfield-Sacre et al. [47] found, while faculty members were aware that values and attitudes needed to be taught in addition to skills, and faculty members felt confident about teaching both, there was less clarity about the methods for instilling entrepreneurial attitudes and values. In an early study on teaching entrepreneurship to engineering students, Souitaris, Zerbinati, and Al-Laham [22] found that students who were part of an entrepreneurship program increased their subjective norms and intention toward self-employment, in contrast to students who did not attend such a program. However, at the end of the program, there was no indication that these students actually transferred their intention into action. The researchers found that inspiration, and not learning or resource-utilization, was the cause that increased the subjective norms and intention toward self-employment of the students.

In contrast, Maresch et al. [48] found that teaching entrepreneurial intention to science and engineering students had little effect on their outlook as future entrepreneurs, compared to business students. They suggested that subjective norms among the students' peer group may cause them to view entrepreneurship in negative terms, as opposed to traditional paths for science and engineering students. By conducting a meta-analytic review of research on teaching entrepreneurship to engineering students, Bae et al. [49] found that there was only a small positive relationship with entrepreneurial intention. They found that entrepreneurship education was a more effective pedagogical tool for enhancing engineering students' entrepreneurial intention than traditional business education. However, entrepreneurship education was not significantly associated with the entrepreneurial intention of students after completing a program. In fact, the entrepreneurial intention of students upon entering a program might have more impact on outcome than what is taught in the program. This suggests that teaching methods in entrepreneurship have to be adapted to engineering students.

This adaptation will also need to take into consideration the specific conditions faced by women in engineering (and STEM fields more generally). Research has shown that while female engineering students start their college program with the same level of motivation as male students, they face marginalization, isolation, and stereotyping [29], circumstances that tend to aggravate over time. In addition, favoritism and differential treatment from professors and peers also affect the experiences of young women in engineering programs and influence their performance [29]. By taking into consideration such specific cultural factors, one can increase the efficiency of applying the insights mentioned above from the studies of Besterfield-Sacre et al. [47], Maresch et al. [48], and others. Without this adaptation to cultural context, an improvement of educational programs in engineering might only perpetrate already-existing gender disparities.

Table 1. Descriptive statistics for students' background characteristics

		Frequency	%
Gender	Male	81	85.3
	Female	14	14.7
Study major	Industrial engineering and management		27.12
	Mechanical engineering		70.00
	Software engineering		26.50
Age (years)			
Mean	27.12		
SD	2.90		
Lower	21		
Upper	42		

3. Research Description

3.1 Rationale and Questions

This research focused on identifying the factors that influence entrepreneurial behavior and tendencies. Our research questions were the following:

(1) What are the important personal factors in developing an entrepreneurial intention among engineering students?
(2) How do gender and gender equality affect entrepreneurial behavior and tendency among engineering students?
(3) How can we encourage entrepreneurial intention through engineering studies?

3.2 Participants

The study was conducted with 95 students from different departments in an engineering college in our country. The students were from the Software Department, the Mechanical Engineering Department, and the Industrial Engineering and Management Department. All of the students were in their fourth and final year of their engineering studies. Of the 95 students, 14 (15%) were women and the rest (85%) were men (Table 1).

3.3 Course Details

The course Basic Concepts in Entrepreneurship is taught in all the departments on campus. It is based on the book Introduction to Entrepreneurship by Kuratko [50]. The details of the course syllabus are given in Table 2.

Table 2. Details of the Basic Concepts in Entrepreneurship course syllabus

Type of course	Elective / required
Level of course	First degree / second degree
Year of study	Third / fourth
Mode of delivery	Project oriented
Semester	A
Prerequisites	None
Credit	3
Co-requisites	None
European Credit Transfer System (ECTS) credit points	4.5

3.3.1 Course Objectives

This course will focus on a basic understanding of the terminology and principles guiding the entrepreneurial world. It will deal with the differences between entrepreneurship and intrapreneurship (entrepreneurship within existing organizations) while reviewing theoretical and practical aspects, all considering examples from Israeli and global markets.

3.3.2 Learning Outcomes

Upon successful completion of the course the students will be able to:

(1) Successfully build a viable business model and use practical knowledge in building a bottom-up startup;
(2) Access various funding sources; and
(3) Develop business strategies and use analytical tools for startup development.

3.3.3 Teaching Method

The course was taught using the project-oriented (PO) approach. The PO approach involves active learning based on an applied project, which accompanies the students' learning of theoretical materials. The approach is similar to problem-based learning, product-based learning, and project-based learning. It replaces the teacher-centered (frontal) learning method with the modern approach of self-learning using the methods and at the times the students prefer [51]. The unique format of the course is based on the assumption that self-practice will enrich the students' knowledge and motivation, although it requires more intensive work from the students and from the course staff. The approach enables students to apply their knowledge and turn it into an engineering solution at every stage of their studies. The project ideas are sometimes applicable

in industry and companies in the economy. Other project ideas are a result of the innovative and entrepreneurial spirit of the students or their lectures. Many of the projects are social projects for the needs of the community. Usually, the project is done in a team or a small group and under the guidance of the course staff. Assessment in the PO approach is challenging since it needs to focus on the objectives that PO fosters in conjunction with the educational course objectives [52]. The assessment of the end project is certainly important, but it is also important to focus on assessments of each of the project stages, which enables the meaningful learning that happens throughout the project [53].

3.3.4 Planned Learning Activities

The course includes three weekly frontal academic lecture hours and one practical training hour. The frontal lectures are also accompanied by guest lectures delivered by leading experts. During the lectures, students dedicate some time to working on their project. In addition, they perform case study analysis of successful and failed businesses and carry out practical simulations of entrepreneurial work. At the end of the course, students take part in a hackathon and present their work for evaluation.

3.3.5 Assessment Methods and Criteria

The students' projects were assessed as shown in Table 3.

4. Research Tools And Methods

We used well-documented questionnaires to measure several personality characteristics: entrepreneurial intention, emotional intelligence, self-esteem, and gender perceptions (Fig. 1).

Table 3. Distribution of marks for students' projects

Assignments	50% (25% for work in pairs and 25% for a personal 15-minute presentation)
Hackathon	50% (investor presentation in a group of up to 3 students)

Entrepreneurial intention was measured using the Entrepreneurial Intention Questionnaire (EIQ) of Liñán and Chen [54]. The EIQ contains 7-point Likert-scale items, with response options ranging from 1 (total disagreement) to 7 (total agreement). Sample items are "I am ready to do anything to be an entrepreneur" and "My professional goal is to become an entrepreneur."

Emotional intelligence was measured using the Wong and Law Emotional Intelligence Scale (WLEIS) [55], based on the four-dimensional definition of emotional intelligence introduced by Davies et al. [56]. WLEIS consists of the following four subscales: self-emotions appraisal, regulation of emotion, use of emotion, others' emotions appraisal. WLEIS uses a 5-point Likert-type scale, with response options ranging from 1 (totally disagree) to 5 (totally agree). Sample items for the various scales include these: "I really understand what I feel" (self-emotions appraisal); "I can always calm down quickly when I am very angry" (regulation of emotion); "I would always encourage myself to try my best" (use of emotion to facilitate performance); and "I have a good understanding of the emotions of people around me" (others' emotions appraisal).

Self-esteem was measured using Rosenberg's [57] scale. Items 2, 5, 6, 8, and 9 in our questionnaire (Table 4) are reverse scored: strongly disagree, 1 point; disagree, 2 points; agree, 3 points; and strongly agree, 4 points. Higher scores indicate higher self-esteem.

Gender perceptions were measured using the Greene et al. [58] questionnaire. The Gender Perceptions Questionnaire contains 5-point Likert-scale items, with response options ranging from 1 (total disagreement) to 5 (total agreement). Sample items

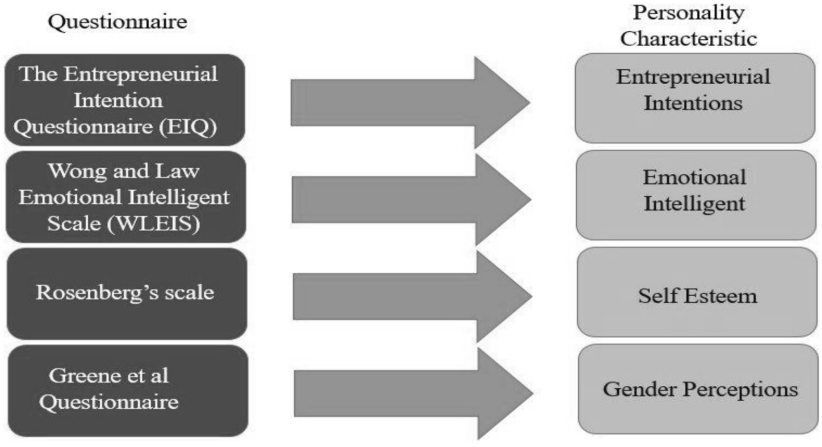

Fig. 1. Questionnaires used for analysis of personality characteristics.

Table 4. Exploratory factoring results for entrepreneurial behavior

		Factor 1	Factor 2	Factor 3	Factor 4
#		Motivation	Control	Innovative Personality	Getting Support
2	My professional goal is to be an entrepreneur.	1.03	–0.05	–0.06	–0.14
6	I find a career as an entrepreneur appealing.	0.88	–0.10	0.11	0.02
13	I am prepared to do anything to be an entrepreneur.	0.87	0.16	–0.06	–0.06
8	Among various options, I would rather be an entrepreneur.	0.85	0.03	–0.12	0.09
4	I am determined to create a business venture in the future.	0.84	–0.08	0.16	0.02
9	Being an entrepreneur would give me great satisfaction.	0.81	0.07	–0.08	0.14
1	I am ready to do anything to be an entrepreneur.	0.76	0.00	0.11	0.01
5	Being an entrepreneur implies more advantages than disadvantages to me.	0.66	0.18	–0.10	–0.12
3	I will make every effort to start and run my own business.	0.47	0.26	0.17	–0.04
7	If I had the opportunity and resources, I'd like to start a business.	0.42	0.11	0.36	0.09
10	To start a business and keep it working would be easy for me.	0.07	0.76	–0.10	–0.02
12	I would have complete control over the situation if I start and run a business.	0.15	0.72	–0.27	0.21
15	If I wanted to, I could easily start and run a business.	0.06	0.69	–0.04	0.14
14	I know all about the necessary practical details needed to start a business.	–0.19	0.69	0.24	0.05
11	I am able to control the creation process of a new business.	0.09	0.64	–0.02	0.19
24	I am preparing a plan and schedule for embedding new ideas.	0.01	0.61	0.47	–0.28
16	If I tried to start a business, I would have a high chance of being successful.	0.12	0.46	0.11	0.22
22	I am promoting and supporting idea development for others.	–0.23	0.01	0.85	0.25
21	I am creating creative ideas.	0.09	–0.12	0.81	0.13
23	I research and save money needed to implement new ideas.	0.06	0.36	0.68	–0.28
20	I am looking for new technologies, processes, techniques and /or product ideas.	0.33	–0.28	0.62	0.23
18	My immediate family would confirm the decision to start a business.	0.03	0.06	0.01	0.84
19	My colleague will approve the decision to start a business.	–0.01	0.08	0.06	0.83
17	My friend would agree with the decision to start a business.	–0.13	0.16	0.20	0.70
	Eigenvalue	12.34	1.83	1.35	1.18
	Explained variance	51.4	7.61	5.64	4.93

Note: Shaded cells indicate high factor loadings.

are "Girls need to accept that they will get married and raise children and not think about career development" and "Women and men should have the same chance of doing the same work."

5. Results

Data for this study were drawn from a survey among 95 students at a college of engineering; of these, 81 (85%) were men and 14 (15%) were women. Almost 70% of the respondents were studying mechanical engineering, another 26.5% were studying software engineering, and the rest were studying industrial engineering and management. The average age was 27.12 years, with SD = 2.90, ranging from 21 to 42 years (see Table 1).

We used several statistical tools in several steps to analyze the results (Fig. 2). At first we used exploratory factor analysis (the principal axis factoring extraction method and the Promax rotation technique) to identify possible dimensions across items of the entrepreneurial questionnaire [59]. This analysis yielded four distinct dimensions: (1) motivation; (2) control; (3) innovative personality; and (4) getting support; see Table 4 for factor loadings. The internal consistencies of these four dimensions, respectively, were 0.96, 0.90, 0.87, and 0.90, which were considered high.

We also developed several predictors (Table 5) for these entrepreneurial behavior dimensions, which showed reasonable to high internal consistency, in parentheses: self-esteem (0.70); feeling (0.87); perception of equality across genders (0.77); and optimism (0.74).

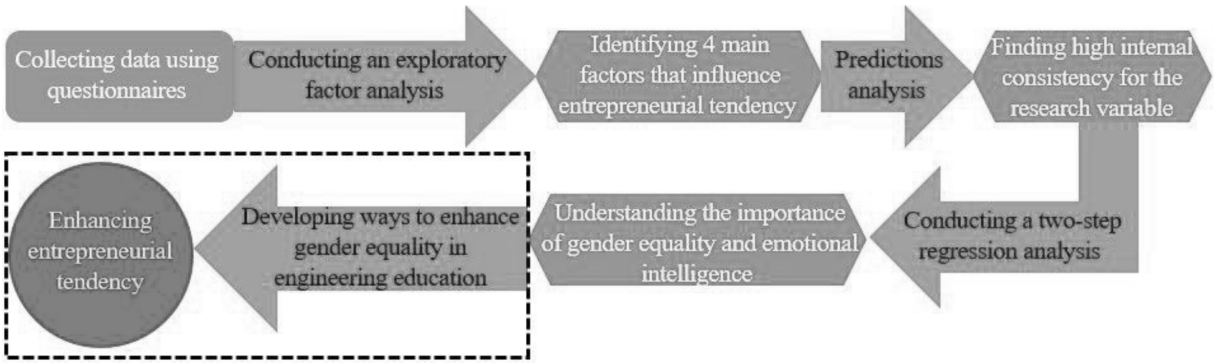

Fig. 2. Research and methodologic flow. The activities inside the dashed rectangle are intended for future work.

Table 5. Means, standard deviations, and reliabilities for all research variables

	Items (*N*)	Reliability	Mean	SD	Range
Independent variables					
Self-esteem	10	0.70	3.92	0.48	2.70–4.60
Feeling	16	0.87	3.90	0.51	2.87–5.00
Gender equality	8	0.77	4.01	0.69	2.75–5.00
Optimism	6	0.74	3.77	0.68	1.67–5.00
Dependent variables					
Total initiative	24	0.96	4.12	1.18	1.08–7.00
Motivation	10	0.96	4.15	1.46	1.00–7.00
Control	7	0.90	3.63	1.27	1.00–7.00
Innovative personality	4	0.87	4.65	1.43	1.00–7.00
Getting support	3	0.90	4.44	0.50	1.00–7.00

Table 6. Regression model results for the effect of personal characteristics on entrepreneurial behavior

	Entrepreneurial Total	Motivation	Control	Innovative Personality	Getting Support
Step 1: Main effect					
Gender	–0.28**	–0.31**	–0.10	–0.19	–0.31**
Self-esteem	–0.19*	–0.16	–0.21*	–0.16	–0.07
Feelings	0.38***	0.33**	0.41***	0.36***	0.08
Gender equality	0.31**	0.33**	0.11	0.26*	0.30**
Optimism	0.01	–0.01	0.06	–0.07	0.06
$F(5,89)$	8.24***	7.40***	4.85**	5.45***	3.26**
R^2	0.32***	0.29***	0.21**	0.24***	0.16**
Step 2: Interactions					
Self-esteem × feeling	–0.001	0.04	–0.06	0.08	–0.12
Self-esteem × gender equality	0.09	0.06	0.19	–0.06	0.06
Self-esteem × optimism	–0.08	–0.10	–0.12	0.09	–0.01
Feelings × gender equality	0.19∼	0.17	0.20*	0.23*	–0.05
Feelings × optimism	0.05	–0.05	0.10	0.07	0.17
Gender equality × optimism	0.03	0.01	0.11	–0.07	0.03
$F(11,83)$	4.48***	3.66***	3.77***	3.53***	1.67
R^2	0.37***	0.33***	0.33***	0.32***	0.18

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. Standardized coefficients are presented.

Our hypothesis-testing approach was two-step regression analysis, in which main effects of background and personal indicators were entered first, and a set of interaction effects between research predictors was tested in the second step. For those significant interactions, we show simple slopes and predicted values for high and low levels of the moderators [60]. Results are shown in Table 6.

Although women accounted for only 15% of our study, we found that they showed less motivation (β

= –0.31, $p < 0.01$) and received less support (β = –0.31, $p < 0.01$), which led to a lower level of entrepreneurial behavior overall (β = –0.28, $p < 0.01$). Respondents with higher self-esteem were associated with lower overall entrepreneurial behavior (β = –0.19, $p < 0.05$) and control (β = –0.21, $p < 0.05$), but feelings showed the opposite effect across all first four entrepreneurial behavior measurements (overall: β = 0.38, $p < 0.001$; motivation: β = 0.33, $p < 0.01$; control: β = 0.41, $p < 0.001$; entrepreneurial behavior: β = 0.36, $p < 0.001$). Another positive predictor was gender equality (overall: β = 0.31, $p < 0.01$; motivation: β = 0.33, $p < 0.01$; innovative personality: β = 0.26, $p < 0.05$; receiving support: β = 0.30, $p < 0.01$). Put differently, higher perceptions of gender equality were associated with higher overall entrepreneurial behavior, higher motivation, higher innovative personality, and higher received support and vice versa. In contrast, optimism was not found to affect entrepreneurial behavior.

Next, we ran the model with interaction effects and found three significant interactions ($p < 0.10$). The interaction between gender equality and feelings showed an effect on innovation control (Fig. 3), innovative personality (Fig. 4), and the overall entrepreneurial measurement (Fig. 5).

For each interaction effect, as no direction was predefined, we tested the sources both ways. For the assessment of the interaction sources, we used the PROCESS procedure (model 1), by Hayes [61]. Fig. 3a shows a positive association between feelings and innovation control when perceptions of gender equality were high (b = 1.42, $p < 0.001$), but the association was insignificant when these perceptions were low. If we take the perception of

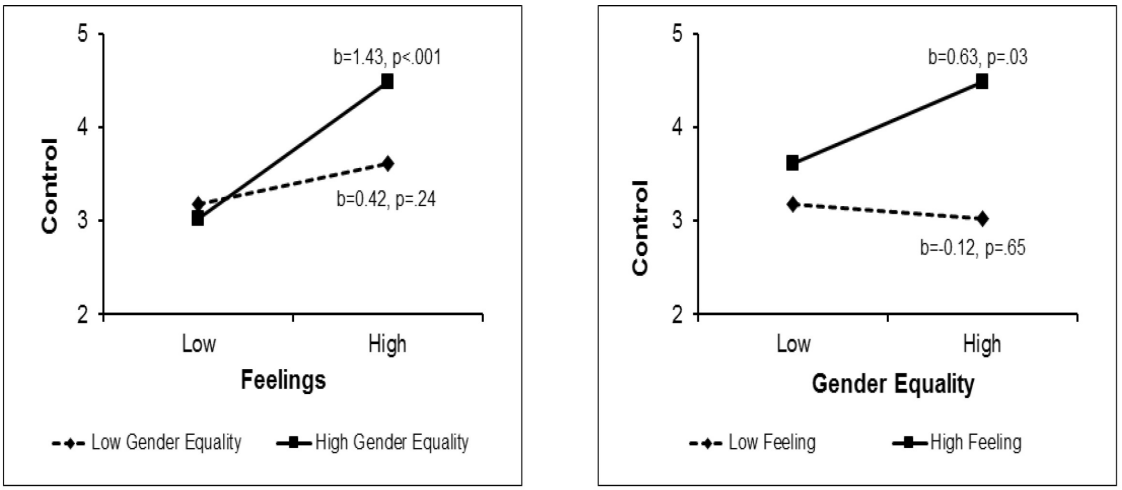

Fig. 3. Interaction between control and feelings (a) and gender equality (b).

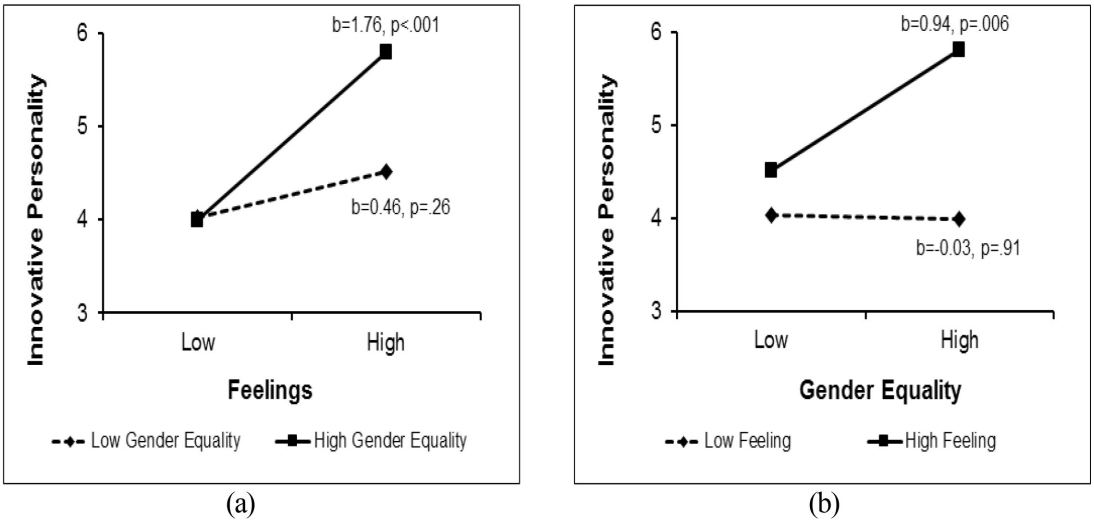

Fig. 4. Interaction between innovative personality and feelings (a) and gender equality (b).

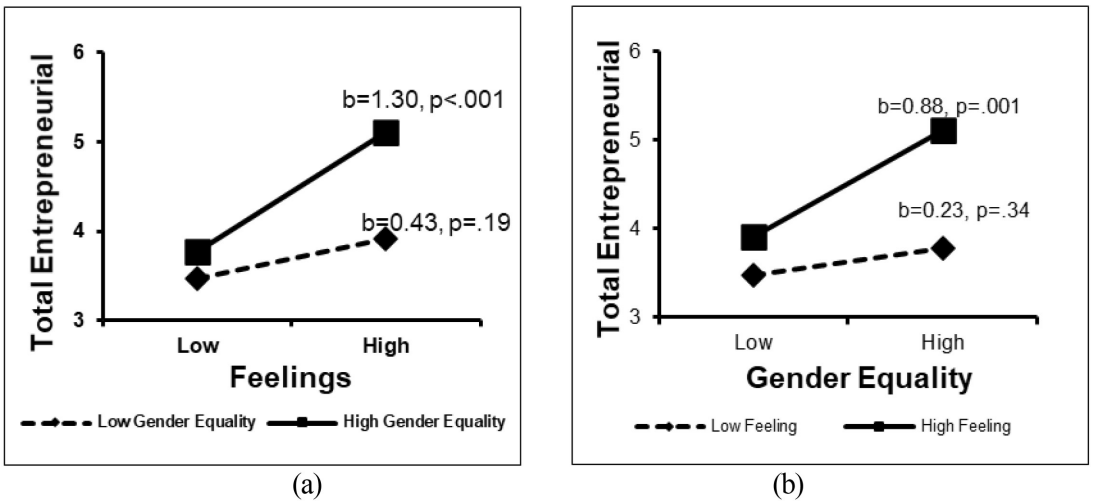

Fig. 5. Interaction between total entrepreneurial behavior and feelings (a) and gender equality (b).

gender equality as the independent variable (see Fig. 3b) when feelings were at higher levels, perceptions were positively associated with control (b = 0.63, $p < 0.05$).

A similar pattern of interaction effect was found for innovative personality (Fig. 4). For higher feelings, perceptions showed a positive effect on innovative personality (b = 1.76, $p < 0.001$), and when feelings were high, the perceptions had a positive effect on innovative personality (b = 0.94, $p < 0.01$). Overall, the feeling effect was positive given high gender-equality perceptions (b = 1.30, $p < 0.001$).

Similarly, when feelings were taken as a moderating effect, perceptions showed a positive association with total entrepreneurial behavior if levels of feelings were high (b = 0.88, $p < 0.01$), but not when they were low (Fig. 5).

6. Discussion

Teaching entrepreneurship in engineering education has to move forward to catch the pace of development in the industry and to fulfill industry demand. Since in engineering studies the focus is on technology and science curriculum content and methodology, a significant shift has to be made in order to teach entrepreneurship effectively.

In our research, we analyzed personality factors in engineering students that may affect their intention to become entrepreneurs and evaluated and documented these factors for an entrepreneurship predictor tool. This research was conducted using an entrepreneurial questionnaire. The statements in the questionnaire were divided into four categories: (1) self-esteem; (2) feelings; (3) perceptions of gender equality; and (4) optimism. Each of those categories was examined in light of the students' entrepreneurial tendency.

While analyzing the entrepreneurial behavior exploratory questions, we discovered that entrepreneurial behavior can actually be divided into main factors that influence the total entrepreneurial behavior of the student. An exploratory statistical analysis classified the questionnaire items into four dimensions, which each represent a factor. We named those factors on the basis of the content of the items they included: (a) motivation, (b) control, (c) innovative personality, and (d) getting support.

Several conclusions that arise from the analysis appear in Table 6. It seems that the student's gender is significantly statistically connected to the student's total entrepreneurial behavior. Moreover, it seems that the student's motivation and support level were also significantly connected with the student's gender. This implies that men tend to have higher motivation levels and more support from their environment to follow entrepreneurial tendencies.

In contrast, there was no significant connection between innovative personality and the student's gender. The same can be said about the control factor. The men in our study did not tend to be more innovative or feel more in control than the women.

The self-esteem category was found to have a significant negative connection with total entrepreneurial behavior and the control dimension. These connections are surprising, since it is believed that people with low self-esteem will feel less in control of the situations in their life and will hesitate to take risks that are a must in the entrepreneurial world. However, the results suggest exactly the opposite scenario. It might be that people will a low sense of self-esteem feel they have less to lose, hence their higher tendency toward entrepreneurial intention. These data need to be further explored.

The feeling category refers to emotional intelli-

gence, that is, the ability of people to understand their own feelings and those of others. Therefore, it is not surprising that we found a positive, statistically significant connection between the feeling category and the motivation, control, and innovative personality dimensions, as well as total entrepreneurial behavior.

Surprisingly, the optimism category has no significant connection with the other dimensions. It seems that, in contrast to popular opinion, optimistic people do not tend to be more motivated or to feel more in control. Also, they do not tend to get more support from the environment or have a higher tendency toward innovative or entrepreneurial behavior.

Another result emerging from analyzing the research data is that the interaction between gender equality and feeling has a positive connection to total entrepreneurial behavior and a significant, positive connection to control and innovative personality. This result can also be seen in Figs. 3 and 4.

It is interesting that the number of female students who chose to take the course was much lower than the number of male students (as can be seen in Table 1). While we fear this might have influenced the results, it could not be avoided. As seen in this study, women had lower levels of support and lower motivation, which drove them away from entrepreneurial behavior and studies.

We believe that the most interesting and prominence finding of this research is that students with a high perception of gender equality had greater motivation and a high innovation tendency. Those students also received support from their social environment.

The correlation between gender equality and innovation has been observed in other studies as well. Research indicates that when gender equality is practiced and promoted as an important aspect of a company's culture, innovation increases in that company. A survey done by Accenture concerning the relationship between gender equality and innovation in the workplace involving over 18,000 employees in 27 countries revealed a significant correlation between gender equality and innovation. According to the data collected in the survey, "innovation is six times higher at organizations with the most equal workplace cultures compared to those organizations with the least equal ones" [62]. Rating high in elements such as diverse leadership teams, paternity and maternity leave policies, and transparency concerning equal pay, companies viewed as promoting gender equality create an environment in which employees feel they have the freedom to innovate.

In the results of the analysis of entrepreneurial intention and the perception of gender inequality, we suspect the latter may reflect the inequality of gender representation in engineering studies programs. There is a gender gap in STEM, with a low number of women enrolled in those programs and even lower numbers of graduates [63]. The higher education institutions must be the promoter of strategies and mechanisms to reduce this gender gap. Engineering studies programs must implement gender equality action plans based on their gender equality situation. Education programs, specifically STEM programs, should approach conceptual mismatches between gender or sex and change its foundations to guarantee equal education for any person by limiting the influence of social stereotypes and dominant culture [9].

Current entrepreneurship programs have to be adapted to engineering students and today's advanced teaching methodologies in engineering. Therefore, it is crucial to examine how gender equality and emotional intelligence can be incorporated into the curriculum of engineering studies. One solution can be the use of varied learning environments and activities that can have a positive influence on student's perceptions of gender equality. One such environment is the PO approach [51, 53], which involves active learning based on an applied project. The approach enables students to transform their accumulated knowledge into an engineering solution. The PO approach provides a learning environment that challenges students to be actively involved in the learning process. This active and experiential learning approach encouraged our students to think and do research, which increased their enjoyment and motivation. The course included various learning activities, such as personal projects, case study analysis, and a hackathon. All those activities are done in small groups. All in all, the activities improved students' self-esteem and helped them develop their emotional intelligence. If the groups are assembled correctly, this can greatly enhance gender equality.

Such a curriculum will enable effective entrepreneurship education in engineering. This, in turn, will potentially have a broader effect on entrepreneurship tendencies, the economy, and society.

7. Conclusions, Limitations, and Future Works

The importance of this study is that it points out the crucial impact of the perception of gender equality in early stages of student development in the academic world and in higher education. This pinpoints the effect of gender equality on entrepreneurial and innovation intention.

This study adds another layer of knowledge to

previous studies that have demonstrated the role that personality traits and emotional skills play as antecedents in predicting entrepreneurial intention. However, in the current study, we examined for the first time the role of dispositional optimism, emotional intelligence, self-esteem, and gender perceptions as predictors of entrepreneurial intention among engineering students.

As our findings significantly demonstrate the importance of gender perception to the entrepreneurial intention, one can assume that pedagogical programs that contain an aspect of gender equality will have a great impact on entrepreneurial education in later stages of the academic program, as well as on student entrepreneurial performance in the future.

A major strength of the current study lies in its focus on well-validated measures of personality characteristics, perceptions, and entrepreneurial intention. However, the generalizability of its findings may be limited due to its cross-sectional nature and its use of a survey methodology, rather than measurement of actual behavior. In addition, the research was done on engineering students, and as in most engineering studies, the majority of the participants were men. Therefore, future research should be in the format of longitudinal studies and further analyze different contexts, and the male versus female ratio in terms of environmental, organizational, and family traditions, and their impact on entrepreneurial intention and the relative contribution of the personality characteristics.

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