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Review

A Learning-by-Doing Approach to Entrepreneurship Education: Evidence from a Short Intensive Online International Program

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Abstract: Entrepreneurship is considered a key driver for economic growth. Therefore, more and more studies are investigating the role and effectiveness of entrepreneurship education. In this context, the present study is aimed at investigating the effectiveness of entrepreneurship programs, with a learning-by-doing approach, on the entrepreneurial intention, entrepreneurial characteristics (entrepreneurial attitude, entrepreneurial self-efficacy, entrepreneurial mindset, core self-evaluation) and entrepreneurial skills (creativity, financial literacy, marshaling of resources, planning, teamwork). The study has analyzed a short intensive online entrepreneurship program, which adopts a learning-by-doing approach and targets students from different European technical universities, with different levels of education and different entrepreneurial backgrounds, giving them the opportunity to work on different types of projects. Pre- and post-course surveys were conducted in order to perform qualitative analyses on the effectiveness of the program. The results show that the entrepreneurial intention and perception of the entrepreneurial characteristics and skills of the students increased after participation in the program. In addition, our findings reveal that the program appears to be more effective for MSc students than for PhD ones and for students who had never attended any entrepreneurship program before, while there is no difference in the effectiveness of the program in terms of gender.

Keywords: entrepreneurship education; student entrepreneurship; learning-by-doing; entrepreneurial learning; entrepreneurial intention; entrepreneurial skills

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1. Introduction

It is widely recognized that entrepreneurship plays a key role in fostering economic growth and job creation (Thurik and Wennekers 2004). In such a context, both policy makers and academics have recognized the importance of more commitment to entrepreneurship, even at the university level, to spread knowledge and best practices (European Commission 2012). For example, in 2012, the European Commission pointed out the need for more commitment to entrepreneurship and especially to entrepreneurship education (European Commission 2012).

Universities are considered a privileged place for the creation of new innovative enterprises and the diffusion of entrepreneurial skills and knowledge (Cassia and Colombelli 2008; Carree et al. 2014; Ricci et al. 2019). Universities, which are primary sources of cutting-edge knowledge, in fact, play an important role in training individuals who are able to acquire, transform, and exploit such knowledge (Zahra and George 2002; Colombelli et al. 2021a). Such individuals are often students who are able to apply their knowledge to have an impact on society through the creation of new innovative enterprises or spread them by entering the labor market (Larsson et al. 2017; Wenninger 2018). Building on this, scholars are dedicating more and more attention to the creation of enterprises by university students (Bergmann et al. 2016; Minola et al. 2016; Chiarello et al. 2021).

Universities are paying attention to the creation of specific programs to increase awareness (Siegel and Wright 2015; Birtchnell et al. 2017), promote entrepreneurial propensity and mindsets among students and support the creation of new businesses (Hoppe 2015; Varano et al. 2018; Hahn et al. 2020). As a result, there has been an increase in the number of entrepreneurship programs offered to university students throughout the world (European Commission 2012; Ramos-Rodríguez et al. 2019).

From an academic perspective, understanding the effectiveness of these entrepreneurship programs is of paramount importance. In this direction, two strands related to entrepreneurship education can be identified in the literature. The first one focuses on the identification of the different approaches through which entrepreneurship education is taught (Vesper and Gartner 1997; Dana 2001; Matley 2006; McKeown et al. 2006). The second strand investigates the effectiveness of the different approaches (Charney and Libecap 2000; Henry 2004; Fayolle et al. 2006). Three main criteria have been identified to measure the effectiveness of entrepreneurial education programs and analyze in the empirical literature: the creation of a new enterprise (Charney and Libecap 2000; Rosa 2003; Henry 2004), academic performance (Hynes 1996; Vesper and Gartner 1997; Charney and Libecap 2000; Colombelli et al. 2021b) and psychological constructs (Peterman and Kennedy 2003; Rosa 2003; Veciana et al. 2005; Fayolle et al. 2006; Lee et al. 2006; Souitaris et al. 2007; Mwasalwiba 2010; Colombelli et al. 2022).

The findings of both streams reveal that the different approaches are all important and complementary (Dreisler et al. 2003; Pittaway and Cope 2007; Pittaway 2009). However, most studies state that more practice-oriented courses are more effective in improving an individual's entrepreneurial characteristics and skills than purely theoretical-oriented courses (Honig 2004; Rasmussen and Sørheim 2006; Pittaway and Cope 2007; Kassean et al. 2015). Furthermore, approaches focused on practical experience help to increase entrepreneurial intention (Kassean et al. 2015).

· In line with these arguments, this study falls into the second strand of the literature by considering a short intensive online entrepreneurship program, which adopts a learning-by-doing approach and targets students from different European technical universities, with different levels of education and different entrepreneurial backgrounds, giving them the opportunities to work on different types of projects. A psychological construct approach is adopted in the study to analyze the effectiveness of such a program on the entrepreneurial intention, entrepreneurial characteristics (entrepreneurial attitude, entrepreneurial self-efficacy, entrepreneurial mindset, core self-evaluation) and entrepreneurial skills (creativity, financial literacy, marshaling of resources, planning, teamwork). The high heterogeneity that characterizes this program has allowed us to study the impact of entrepreneurship education from different perspectives. The paper thus contributes to the literature in many different respects. First, compared to most studies on learning-by-doing programs that focus on students with a specific level of education (Nabi et al. 2017), the aim of the present study is to investigate the effectiveness of an entrepreneurial program that was offered to students with different levels of education, that is, students from master's degree programs and doctoral students. Moreover, the program was offered to students from different areas of engineering (mechanical engineering, management engineering, computer engineering, etc.) and from different European technical universities. Furthermore, the course involved both students who were participating for the first time and students who had already participated in other entrepreneurial courses that adopted a learning-by-doing approach. We found it was possible to measure the effectiveness of the course in relation to the entrepreneurial background of the students. Finally, the students had the opportunity to work on entrepreneurial projects that were based on patented technologies developed in the academic context or on projects proposed by other students.

Building on this, this study aims to address the following research question:

- Does participation in a short intensive online entrepreneurial program with a learning-by-doing approach increase the entrepreneurial intention, entrepreneurial characteristics (entrepreneurial attitude, entrepreneurial self-efficacy, entrepreneurial mindset,

core self-evaluation) and entrepreneurial skills (creativity, financial literacy, marshaling of resources, planning, teamwork) of the participating students?

Furthermore, four sub-questions were added to explore whether a differential impact of the entrepreneurial program can be found depending on specific characteristics of the participating students:

a. Is the effect of the entrepreneurial program on the participants' entrepreneurial intention, characteristics and skills affected by gender?
b. Is the effect of the entrepreneurial program on the participants' entrepreneurial intention, characteristics and skills affected by their educational level?
c. Is the effect of the entrepreneurial program on the participants' entrepreneurial intention, characteristics and skills affected by their entrepreneurial background?
d. Is the effect of the entrepreneurial program on the participants' entrepreneurial intention, characteristics and skills affected by the type of project?

In order to assess the effectiveness of the program, we collected data through a survey that was administered to students before and after attending the program. The survey allowed us to collect the students' perceptions in relation to entrepreneurial intention and a set of entrepreneurial characteristics and skills. An improvement in the students' entrepreneurial intention, characteristics and skills has been observed from the pre- to the post-course responses. However, different effects emerged when the sample was broken down by educational level and the attendance of other entrepreneurship courses.

2. Literature Review

Scholars are paying more and more attention to entrepreneurship education and to the approaches used to teach entrepreneurship, with the aim of understanding university mechanisms to facilitate student entrepreneurship (Wright et al. 2017). According to previous works, the approaches used in entrepreneurial education can be divided into four teaching models: "about", "for", "through" and "embedded" (Gibb 2002; Handscombe et al. 2007; Pittaway and Cope 2007; Pittaway 2009).

The "about" model uses a traditional teaching approach. Its purpose is to transfer entrepreneurial knowledge and increase student awareness through theorical lessons (Pittaway and Hannon 2008). The second model, "for", is aimed at allowing students to acquire key skills and competencies through their involvement in activities and projects (McMullan and Long 1987; Vesper and McMullen 1988; Solomon et al. 2002). This model includes several approaches, such as the experiential approach. The experiential approach is a typical example of the "for" type of model, the aim of which is to make people acquire skills in view of a future entrepreneurial experience through practices (Gibb 2002). The third model, "through", requires students to practice entrepreneurship under controlled conditions (Hills 1988; Truell et al. 1998). Finally, the "embedded" model involves the inclusion of entrepreneurial content in courses focused on other disciplines (Solomon et al. 2002; Kuratko 2005; Handscombe et al. 2007). Thus, it aims to increase the entrepreneurial awareness of students in a specific domain. Of the four models outlined in the literature, the two primarily practice-oriented models are the "for" model and the "through" model. The "for" model is, in particular, aimed at developing entrepreneurial behaviors, such as opportunity seeking, and at increasing entrepreneurial skills. The aim of the "through" model is to involve students in "real-world" activities so that they can identify with the role of the entrepreneur and gain entrepreneurial experience. These two models are slightly different, although they both focus on the same aspect, the acquisition of skills and experience.

Several studies in the literature have shown that models that adopt a practice-oriented approach are more effective than theoretical models. According to Rae and Carswell (2000), entrepreneurship programs that adopt a learning-by-doing approach are more effective in improving the development of the entrepreneurial skills of students.

Specific measurement criteria are used to define the effectiveness of Entrepreneurship Education programs. The most widely used criterion in the literature involves investigating

the number of students who start an enterprise after participating in an entrepreneurship program. Several studies agree on how entrepreneurship courses are closely related to the formation of new enterprises (Charney and Libecap 2000; Rosa 2003; Henry 2004; Lyons and Zhang 2018). The second criterion generally adopted by researchers is related to the academic performance of students. According to several researchers, the evaluations obtained in university exams and the final graduation mark are useful criteria to immediately assess the effects generated by participation in an entrepreneurship course (Hynes 1996; Vesper and Gartner 1997; Charney and Libecap 2000). The third criterion involves psychological constructs. Thus, to evaluate the effectiveness of an entrepreneurship program, it is possible to analyze the changes in the psychological constructs of students, such as entrepreneurial intention, entrepreneurial characteristics, and entrepreneurial skills (Peterman and Kennedy 2003; Rosa 2003; Veciana et al. 2005; Fayolle et al. 2006; Lee et al. 2006; Souitaris et al. 2007; Colombelli et al. 2022).

The empirical literature has provided evidence on the different models and their effectiveness. For example, Barr et al. (2009) analyzed a practice-oriented course based on "for" and "through" models. Barr and colleagues, through their experience of over ten years of TEC—an entrepreneurship course for students and researchers—identified the main characteristics that should be present in an entrepreneurship course that adopts a learning-by-doing approach. They identified four elements: reality, intensity, interdisciplinarity and interactivity. The program analyzed by Barr et al. (2009) was offered to master's degree, PhD and MBA students from different universities. These students were offered a two-semester course during which they worked on technologies from either the university technology transfer office or from the R&D departments of various companies. The main objective of the TEC program is to increase students' skills in technological entrepreneurship. The results of the study conducted by Barr et al. show that the program enabled students to acquire the necessary skills to recognize and understand entrepreneurial market opportunities.

Thursby et al. (2009) showed, in their study, that the multidisciplinary nature of a team is a key element for entrepreneurship programs that adopt a learning-by-doing approach. Thursby et al. (2009) conducted a study on an entrepreneurship program that had the aim to transfer a multidisciplinary perspective. According to Thursby and colleagues, such a perspective is necessary to succeed in innovation-related careers and to transfer the results of academic research to the market. The program was offered to PhD students in science and engineering, to law students and to MBA students. They conducted analyses, through a pre- and post-course survey, to assess the effectiveness of this program. The results of the analyses show an improvement in the students' ability to identify the market viability of a technology, identify the resources needed to succeed in a particular industry, identify business opportunities and assess the opportunities and threats of the competitive environment.

The studies by Barr et al. (2009) and Thursby et al. (2009) are literature examples that demonstrate that entrepreneurship education programs which adopt a learning-by-doing approach are effective in improving the entrepreneurial characteristics and skills of students and in encouraging the start of an entrepreneurial career. There are several studies in the literature that demonstrate how such programs generate a positive effect on entrepreneurial intention (Souitaris et al. 2007; Athayde 2009; Sánchez 2011, 2013; Martin et al. 2013; Walter et al. 2013; Bae et al. 2014; Zhang et al. 2014; Gielnik et al. 2015; Shahab et al. 2019), entrepreneurial characteristics (Fayolle et al. 2006; Souitaris et al. 2007; Wilson et al. 2007; Sánchez 2011; Fayolle and Gailly 2015; Duval-Couetil et al. 2021) and entrepreneurial skills (Wilson et al. 2007; Athayde 2009; Morris et al. 2013; Sánchez 2013; Duval-Couetil 2013; Shahab et al. 2019).

However, it is necessary to draw attention to the characteristics of the entrepreneurship programs analyzed in the literature. Despite the studies by Barr et al. (2009) and Thursby et al. (2009), the literature review by Nabi et al. (2017) showed that most of the analyzed courses were designed for students of a specific educational level (BSc, MSc, PhD, etc.) and students from a specific field of study, generally related to management and business. As also shown by the studies of Barr et al. (2009) and Thursby et al. (2009), such programs may last several months, sometimes even more than one academic semester. Moreover, such programs may involve entrepreneurial projects of the same type, such as projects based on a technology developed in the academic field, in the same program.

It appears that some aspects of the effectiveness of entrepreneurship programs that adopt a learning-by-doing approach are still under-explored. It could be interesting to investigate the effectiveness of such programs by involving students who have different levels of education. A second interesting aspect concerns the type of entrepreneurial project on which students work during these programs. It could be useful to investigate the effectiveness of such projects by including ones with different characteristics within the same program, e.g., projects based on technology developed in academia and projects proposed by students. A third element that could influence the effect of learning-by-doing programs on the entrepreneurial characteristics of students concerns the duration of these programs. Although the effectiveness of long-term programs has already been analyzed, to our best knowledge, the positive effect of intensive, short-term programs has yet to be proved. A fourth characteristic concerns the way in which the activities were carried out. In fact, all the activities of the program analyzed were carried out online, whereas in general a mode that allows activities to be carried out in person is preferred for such programs. Finally, an aspect that could further influence the impact of such programs is the entrepreneurial background of the students. It could be useful to understand whether the learning-by-doing approach is effective for students who have previous experience in such programs or for students who are participating for the first time.

The study presented in this article is aimed at investigating these under-researched aspects. Consequently, it focuses on the effectiveness of a learning-by-doing entrepreneurship program on the entrepreneurial intention, entrepreneurial characteristics (entrepreneurial attitude, entrepreneurial self-efficacy, entrepreneurial mindset, core self-evaluation) and entrepreneurial skills (creativity, financial literacy, marshaling of resources, planning, teamwork) of students. We have measured this effectiveness in relation to the level of education (MSc or PhD), the level of the entrepreneurial background, gender, and the type of entrepreneurial project on which the students have worked (patented technology or idea proposed by the students).

3. Methodology

3.1. Program Description

The program considered in this study is CAST, i.e., an entrepreneurship school for start-up creation organized by the Entrepreneurship and Innovation Center (EIC) of the Politecnico di Torino. CAST is a short intensive online entrepreneurship program that adopts a learning-by-doing approach. CAST targets students from different European technical universities, with different levels of education and different entrepreneurial backgrounds, giving them the opportunity to work on different types of projects. CAST is a program in which the participants have the opportunity to attend lectures and workshops on how to turn an idea into a profitable business. The main goal of the program is to involve students in the development of an entrepreneurial project by providing them with theoretical content and giving them the opportunity to work with a practice-oriented approach.

The course is offered to students enrolled in master's degrees and doctoral courses from the partner universities of Unite!,[1] a network that includes seven European technical universities: the Politecnico di Torino, the Technical University of Darmstadt, Aalto University, Grenoble INP Graduate school of Engineering and Management, KTH Royal Institute of Technology, Universidade de Lisboa and Universitat Politècnica de Catalunya.

The students who participated in the first edition had the opportunity to work on entrepreneurial projects based on technologies patented by the Politecnico di Torino or on entrepreneurial ideas proposed by other students. Specifically, the students worked on 4 patented technologies from Politecnico di Torino and 2 business ideas presented by students.

A total of 39 students were assigned to a specific project, on the basis of their preferences and skills, to form 6 teams of 6 or 7 people each. Moreover, the gender, background level and educational level of the members were taken into account in the creation of the teams. In this way, it was possible to organize multidisciplinary and highly motivated teams to tackle the course. As far as patented technologies are concerned, one or two inventors were involved in the teamwork, due to their profound knowledge of the technology, thus facilitating the transfer of know-how to the other members of the team. Similarly, the founders of the two entrepreneurial ideas proposed by students were involved in the teamwork. In addition to the features described so far, a final one deserves special mention: the participants were selected considering both students with previous experience in entrepreneurship programs that had adopted a practice-oriented approach and students involved in a program of this type for the first time.

In short, with respect to the previous courses on entrepreneurship education and learning-by-doing approaches (Barr et al. 2009; Thursby et al. 2009), the CAST program presents certain features that make it unique and interesting for potential research developments in the field of entrepreneurship education. The features that distinguish the program under investigation concern the following characteristics:

1. Duration: The program lasts a few weeks;
2. Intensity: All the activities are carried out day-by-day by the participants, in a short amount of days;
3. Online: Activities are carried out remotely;
4. Academic background: Students from different areas of engineering are involved;
5. University: The participants come from European technical universities belonging to the Unite! network;
6. Education level: The program involves both Master's and PhD students;
7. Support offered by Inventors and Founders: The inventors of technologies and founders of entrepreneurial ideas are involved in the development of the projects;
8. Entrepreneurial background: The participants should be quite heterogeneous, in terms of previous experience related to participation in entrepreneurship programs;
9. Entrepreneurial project: The participants have the opportunity to work on either patented academic technologies or ideas proposed by students.

The first edition, held in September 2021, lasted three weeks and it involved four intensive sessions per week, for a total of 12 sessions of three hours each.

Different types of activities, involving speakers from prestigious American universities, such as UC Berkeley and Hass School of Business, as well as from the Politecnico di Torino, were conducted during these sessions. The sessions were composed of both theorical lessons and workshops. During the theorical lessons, students learned concepts that would be useful for the development of an entrepreneurial project. During the workshops, students had the opportunity to learn by interacting in a participative way. Mentoring and team work sessions were also provided. Each team had the opportunity, during the mentoring sessions, to interact with experienced mentors and discuss the developments, difficulties and bottlenecks that emerged throughout the project. Each team worked, during the mentoring sessions, with the support of a tutor, on the different development phases of the project. In addition, the program also proposed "game" activities. During these

activities, students had the opportunity to learn important entrepreneurial concepts such as scheduling tasks and pitching.

The program ended with a "demo day", during which the teams had the opportunity to present their entrepreneurial project in front of a panel of experts in the field of startup financing: business angels, venture capitalists and industry fellows, who had been involved in the project and had given useful feedback to the teams.

3.2. Variables

The aim of this study was to measure and evaluate the qualitative effectiveness of an entrepreneurial program that adopted a learning-by-doing approach on the entrepreneurial intention, entrepreneurial characteristics (entrepreneurial attitude, entrepreneurial self-efficacy, entrepreneurial mindset, core self-evaluation) and entrepreneurial skills (creativity, financial literacy, marshaling of resources, planning, teamwork) of the students who participated. We considered 10 entrepreneurial dimensions and measured the pre-program and the post-program values for each dimension. Of the 10 dimensions, one is entrepreneurial intention, while the remaining 9 relate to entrepreneurial characteristics and entrepreneurial skills, as can be seen in Table 1. We collected data by means of a survey that had been administered to all the students before the start of the program and after its conclusion.

As only one edition of CAST has been carried out, we built our analysis on a small sample of 34 students. Moreover, a control sample was not available, to compare the possible effect of CAST on other students who did not take part in it. In this vein, results are shown and discussed using a qualitative approach. However, we also conducted statistical tests. More precisely, *t*-tests were performed to compare the mean of each entrepreneurial variable in the pre-course to the mean of the same variable in the post-course for the whole sample and in relation to gender, educational level, entrepreneurial background and type of entrepreneurial project. The results of the *t*-tests are useful to strengthen the results of our qualitative analyses. Unfortunately, the small sample size does not allow to approximate the distribution of the data as a normal distribution, thus limiting the reliability of the results. For the sake of completeness, we report the results of the *t*-tests in Appendix A. However, these results must be interpreted with caution due to the reasons explained above.

Table 1. Domain and description of the 10 entrepreneurial variables.

Domain	Variable	Description
Entrepreneurial Intention	Entrepreneurial Intention	This represents the conscious state of mind that precedes action and directs attention toward entrepreneurial behaviors, such as starting a new venture and becoming an entrepreneur (Moriano et al. 2012)
Entrepreneurial characteristics	Entrepreneurial Attitude	This refers to the degree to which an individual makes a positive or negative evaluation of themselves as being an entrepreneur (Linán and Chen 2009)
	Entrepreneurial Self-Efficacy	This measures the confidence of an individual in their entrepreneurial skills (Boyd and Vozikis 1994; Chen et al. 1998)
	Entrepreneurial Mindset	This captures an individual's sense of initiative and attitude toward challenges, perseverance and determination to complete challenging tasks (Moberg et al. 2014)
	Core self-evaluation	This measures an individual's attitude toward their ability to successfully perform various activities and tasks (Judge et al. 2003)

Table 1. *Cont.*

Domain	Variable	Description
Entrepreneurial skills	Creativity	This is the ability to think in new and imaginative ways, which is crucial for a person to identify and discover new entrepreneurial opportunities (Kirzner 1997; McGee et al. 2009; Foss and Klein 2012)
	Financial Literacy	This represents the ability to understand financial statements and budgets. Oggero et al. (2019) show how this ability is positively and significantly correlated with the probability of being an entrepreneur
	Marshaling of Resources	This is the ability to assemble and organize resources to exploit an entrepreneurial opportunity (Foss and Klein 2012)
	Planning	This refers to the ability to plan and structure tasks (Matthews and Scott 1995; McGrath and MacMillan 2000; Delmar and Shane 2003)
	Teamwork	This is the ability to achieve goals through collaboration, as well as to build effective relationships with others (West 2003)

We included between three and seven questions (items) in the survey for each of the ten dimensions. All the scales used in the analysis had been validated in previous studies. The adopted entrepreneurial intention and entrepreneurial attitude scales had both been developed by Linán and Chen (2009). The scale we applied for entrepreneurial self-efficacy has already been adopted in several studies (Chen et al. 1998; George and Zhou 2001; Zhao et al. 2005). Finally, we used the scales developed and validated by Moberg et al. (2014) for the remaining seven variables.

We used a 7-level Likert scale for each item. In most cases, students were asked about their level of agreement with the proposed statements: "Please indicate your level of agreement with the following statements", in which case the scale ranged from 1 = strongly disagree to 7 = strongly agree. In the case of entrepreneurial self-efficacy, the students were asked about their level of competence in relation to the proposed tasks: "Please indicate your level of competence in performing the following tasks", in which case the scale ranged from 1 = very low competence to 7 = very high competence.

3.3. Sample

As previously stated, we collected the data used for the analysis through a survey administered to the participants before the start of the program and immediately after the end. We carried out analyses on the impact of the program using only data from the students who responded to both surveys. The response rate was 87%; thus, 34 students out of 39 participants responded.

As shown in Table 2, males represent 61.8% of the sample, while females constitute 38.2%. In Table 2, it is also possible to observe the distribution of the students by university. Most participants are affiliated with the Politecnico di Torino (82.4%), while 11.8% is from the Universidade de Lisboa. Finally, 2.9% of the sample is from the Aalto University and 2.9% is from KTH Royal Institute of Technology. In addition, Table 2 shows the breakdown of the students by academic background. Management engineering is the most represented background (32.4%). Computer engineering and biomedical engineering degrees are represented by 11.8% of the students, while 8.8% has a background in aerospace engineering and mechanical engineering. As far as the educational level is concerned, there

is a prevalence of students attending a Master of Science degree course (67.6%), while the remaining part is composed of PhD students (32.4%).

The 34 students in the sample had the opportunity to work on either technologies patented by the Politecnico di Torino or on ideas proposed by other students. Table 2 shows that 67.6% of the students in the sample worked on a technology owned by the Politecnico di Torino, while the rest of the sample worked on an entrepreneurial idea proposed by other students. As far as the participation of inventors is concerned, each team had at least one inventor of a technology among its members. In fact, 14.7% of the students of the sample were also inventors of the technologies involved in the program.

Finally, Table 2 also shows the distribution of the students with previous experiences in entrepreneurship courses. Half of the participants had attended other entrepreneurship courses that had adopted a practice-oriented approach before participating in the program, while it was the first experience in this type of course for the other half of the participants.

Table 2. Distribution of students by the following variables: gender, university, education level, type of project, inventor and non-inventor and entrepreneurial background.

Variable	Value	Percentage of the Sample
Gender	Male	61.8%
	Female	38.2%
University	Politecnico di Torino	82.4%
	Universidade de Lisboa	11.8%
	Aalto University	2.9%
	KTH Royal Institute of Technology	2.9%
Academic background	Management Engineering	32.4%
	Computer Engineering	11.8%
	Biomedical Engineering	11.8%
	Aerospace Engineering	8.8%
	Mechanical Engineering	8.8%
	Mechatronic Engineering	5.9%
	Energy Engineering	5.9%
	Naval Architecture and Ocean Engineering	2.9%
	Petroleum Engineering	2.9%
	Others	8.8%
Education level	MSc	67.6%
	PhD	32.4%
Type of project	Technology	67.6%
	Idea	32.4%
Inventor and non-inventor	Inventor	14.7%
	Non-inventor	85.3%
Entrepreneurial background	At least one experience in practical entrepreneurship programs	50.0%
	No experience in practical entrepreneurship programs	50.0%

4. Consistency of the Variables and Analyses

4.1. Consistency of the Variables

The analyses carried out in the paper can be divided into two phases. The first phase is devoted to assessing the validity and reliability of the scales used to measure the students' traits. The second phase regards the qualitative analysis of the impact of the program on the students' entrepreneurial traits.

Regarding the first phase, the validity and internal consistency of the scales were assessed using a confirmatory factor analysis and Cronbach's alpha, respectively. Tables 3 and 4 show the results of the confirmatory factor analysis and Cronbach's alpha for both the pre-program and post-program data. The factor loadings for the pre-program data are greater than 0.50, except for one item—p4—of the "planning" scale. These results suggest a good level of validity for the scales (Fullerton and McWatters 2001). Moreover, the analysis performed on the pre-course data shows a greater Cronbach's alpha than 0.81 for eight of the ten variables, while the remaining two variables have values equal to 0.72 and 0.63. Thus, good internal consistency of the variables built on the pre-program data is confirmed by Cronbach's alpha (Nunnally 1978). The results of the confirmatory analysis and Cronbach's alpha on post-program data are listed in Table 4. The factor loadings referring to the post-program data are greater than 0.50, thus showing a good level of validity. In this case, item p4 has a factor loading of 0.57. Given the good factor loading of the post-program data and the inclusion of the aforementioned item in the scale validated in previous literature, we decided to include the item in the final scale. We also carried out the analysis without including item p4 in the scale to check the robustness of the results, and we obtained similar results.

Table 3. The factor loadings and Cronbach's alpha values obtained from the factor analysis conducted on the pre-program data.

Variable	Item	Loading	Cronbach
Entrepreneurial Intention	ei_1	0.5953	0.9034
	ei_2	0.9208	
	ei_3	0.7256	
	ei_4	0.9029	
	ei_5	0.7065	
	ei_6	0.8628	
Entrepreneurial Attitude	ea_1	0.5725	0.8883
	ea_2	0.8850	
	ea_3	0.8193	
	ea_4	0.8587	
	ea_5	0.8324	
Entrepreneurial Self-Efficacy	ese_1	0.8038	0.9128
	ese_2	0.7405	
	ese_3	0.9121	
	ese_4	0.7455	
	ese_5	0.7871	
	ese_6	0.6462	
	ese_7	0.8415	
Entrepreneurial Mindset	em_1	0.5109	0.6308
	em_2	0.5330	
	em_3	0.6326	
Core Self-Evaluation	cse_1	0.8688	0.8434
	cse_2	0.7135	
	cse_3	0.7128	
	cse_4	0.6826	
	cse_5	0.6453	
Creativity	c_1	0.7498	0.8954
	c_2	0.8972	
	c_3	0.8414	
	c_4	0.7905	
Financial Literacy	fl_1	0.7932	0.9289
	fl_2	0.9339	
	fl_3	0.9748	

Table 3. *Cont.*

Variable	Item	Loading	Cronbach
Marshaling of Resources	mr_1	0.6192	0.8319
	mr_2	0.7342	
	mr_3	0.8282	
	mr_4	0.7714	
Planning	p_1	0.8762	0.8197
	p_2	0.9302	
	p_3	0.8283	
	p_4	0.2025	
Teamwork	tw_1	0.6502	0.7201
	tw_2	0.6121	
	tw_3	0.7562	

Table 4. Factor loadings and Cronbach's alpha values obtained from the factor analysis conducted on the post-program data.

Variable	Item	Loading	Cronbach
Entrepreneurial Intention	ei_1	0.7693	0.9343
	ei_2	0.8957	
	ei_3	0.8280	
	ei_4	0.9216	
	ei_5	0.8012	
	ei_6	0.8523	
Entrepreneurial Attitude	ea_1	0.5771	0.9139
	ea_2	0.8693	
	ea_3	0.8517	
	ea_4	0.9521	
	ea_5	0.9083	
Entrepreneurial Self-Efficacy	ese_1	0.5975	0.9029
	ese_2	0.7371	
	ese_3	0.9367	
	ese_4	0.6808	
	ese_5	0.6743	
	ese_6	0.8563	
	ese_7	0.8486	
Entrepreneurial Mindset	em_1	0.5429	0.7249
	em_2	0.7446	
	em_3	0.7009	
Core Self-Evaluation	cse_1	0.9093	0.8860
	cse_2	0.8174	
	cse_3	0.6947	
	cse_4	0.7220	
	cse_5	0.7849	
Creativity	c_1	0.8497	0.9061
	c_2	0.8504	
	c_3	0.7900	
	c_4	0.8822	
Financial Literacy	fl_1	0.7564	0.8935
	fl_2	0.8671	
	fl_3	0.9108	

Table 4. *Cont.*

Variable	Item	Loading	Cronbach
Marshaling of Resources	mr_1	0.6889	0.8665
	mr_2	0.8472	
	mr_3	0.8605	
	mr_4	0.7757	
Planning	p_1	0.8139	0.8529
	p_2	0.8507	
	p_3	0.8849	
	p_4	0.5700	
Teamwork	tw_1	0.6702	0.8346
	tw_2	0.7812	
	tw_3	0.8883	

4.2. Qualitative Analyses

This section presents the results of the second phase, the qualitative analysis. During this phase, we investigated the impact of participation in the program on the ten variables. Specifically, we measured the impact of the program on the variables in relation to four categories: gender, level of education (MSc or PhD), entrepreneurial background and type of project (technology or idea).

On a practical level, we compared, for each of the ten variables, the average value before and after CAST to assess the impact of the program on the individual entrepreneurial characteristics of the whole sample. We then performed the same comparison by breaking down the sample in relation to the four categories to assess the presence of any possible intra-category difference. The mean value of each variable was calculated as the average of the values of each student's variable, e.g., the mean value of the entrepreneurial intention of the whole sample was obtained as the average of the values of each student's entrepreneurial intention. In turn, the variable value for each student was calculated as the mean of the items of its scale.

We first present the results obtained without using any classification of the sample. We then present the results obtained by categorizing the sample in relation to gender, level of education (MSc or PhD), entrepreneurial background and type of project (technology or idea).

Figure 1 shows the pre-course and post-course values of the entire sample concerning the ten entrepreneurial dimensions of the students. All the variables show an increase from the beginning to the end of the program. A marked increase (0.98) emerges in the case of financial literacy, which shows a particularly low value for before the start of the program, compared to the other variables. This increase is probably due to the particular nature of this knowledge, which engineering students often do not possess. Marshaling of resources (0.64) and entrepreneurial self-efficacy (0.67) also show a large increase. This latter result shows greater confidence of the students in their entrepreneurial traits after participating in the program. These results might be related to a greater awareness of their capabilities, obtained thanks to the practical approach that encourages the students to face all the activities concerning the development of an entrepreneurial project. Finally, the only characteristic that shows an almost zero increase between the pre- and post-course results is teamwork. This could be due to the transversality of this aspect, which the students who decide to participate in programs of this type generally have, regardless of their academic background. Furthermore, this could derive from the online setting of the course, which could have made interaction within teams difficult and consequently hindered any improvement in teamwork skills.

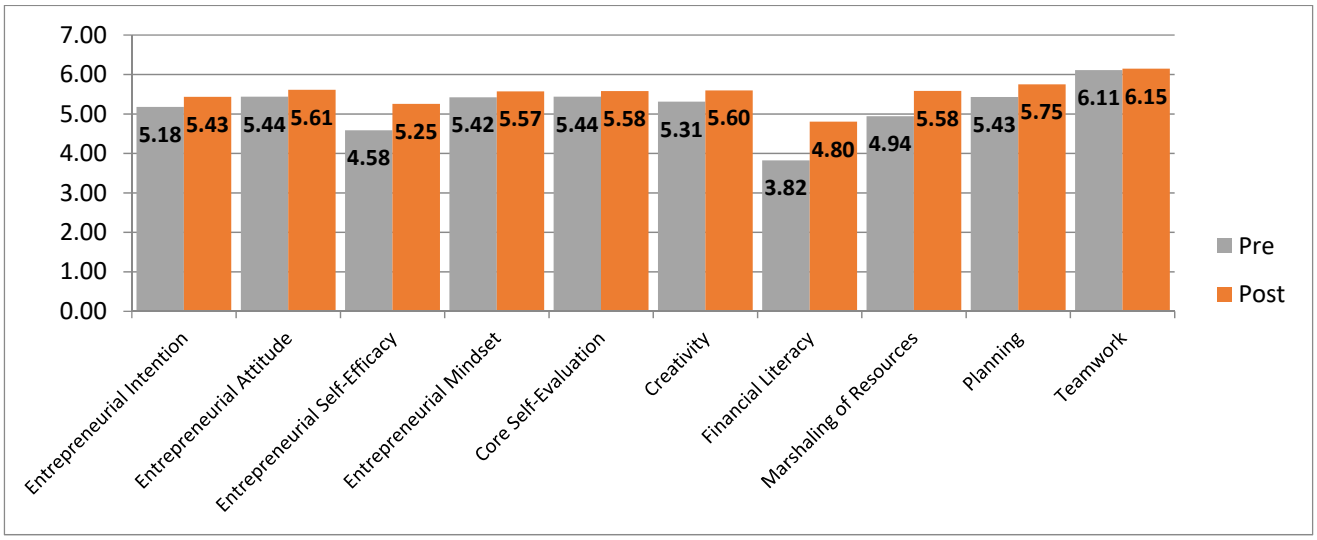

Figure 1. The average values of entrepreneurial characteristics, pre- and post-course.

The values of the pre- and post-course entrepreneurial traits, in relation to the gender of the students, can be observed in Figure 2 (Female) and Figure 3 (Male). Both categories present an increase from the pre- to the post-course values for all the analyzed dimensions. More interestingly, both categories show a similar increase for all the variables, except for the entrepreneurial intention and planning variables. This result suggests that the program with a practice-oriented approach is equally effective in improving the entrepreneurial traits of both categories and is not affected by gender biases.

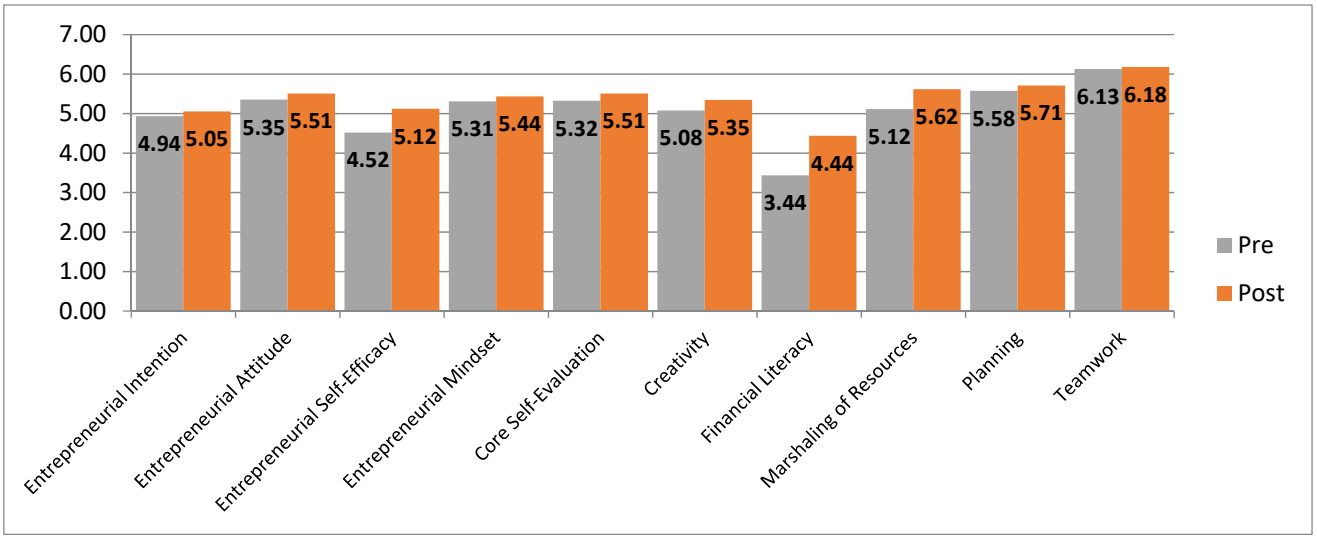

Figure 2. The average values of the entrepreneurial characteristics, pre- and post-course, of the female students.

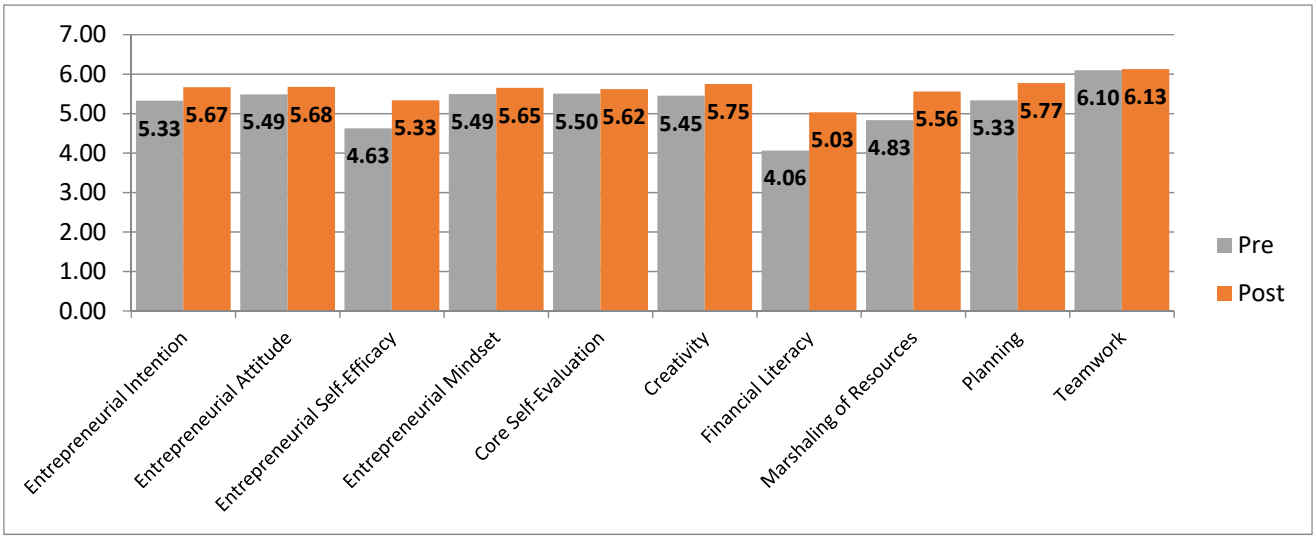

Figure 3. The average values of the entrepreneurial characteristics, pre- and post-course, of the male students.

Figures 4 and 5 refer to the pre- and post-values of the students attending a Master of Science degree program or a PhD program, respectively. Both the MSc and PhD students show an increase in all the variables, except for teamwork for the PhD students. Despite the growth in the variables, it seems that the program had different effects on the MSc students than the PhD students. The MSc students show a higher growth of entrepreneurial attitude and entrepreneurial intention than the PhD students. These results could reflect a higher commitment of the PhD students to an academic career than MSc students, who have not yet entered the job market or an academic path. On the other hand, the PhD students show greater growth than the MSc students in entrepreneurial self-efficacy, marshaling of resources, and planning. PhD students usually operate in high uncertainty and time-constrained environments (Gould 2015). In such an environment, entrepreneurial concepts could be easier to assimilate, appreciate and exploit, thereby resulting in a higher performance of the PhD students (Colombelli et al. 2021b).

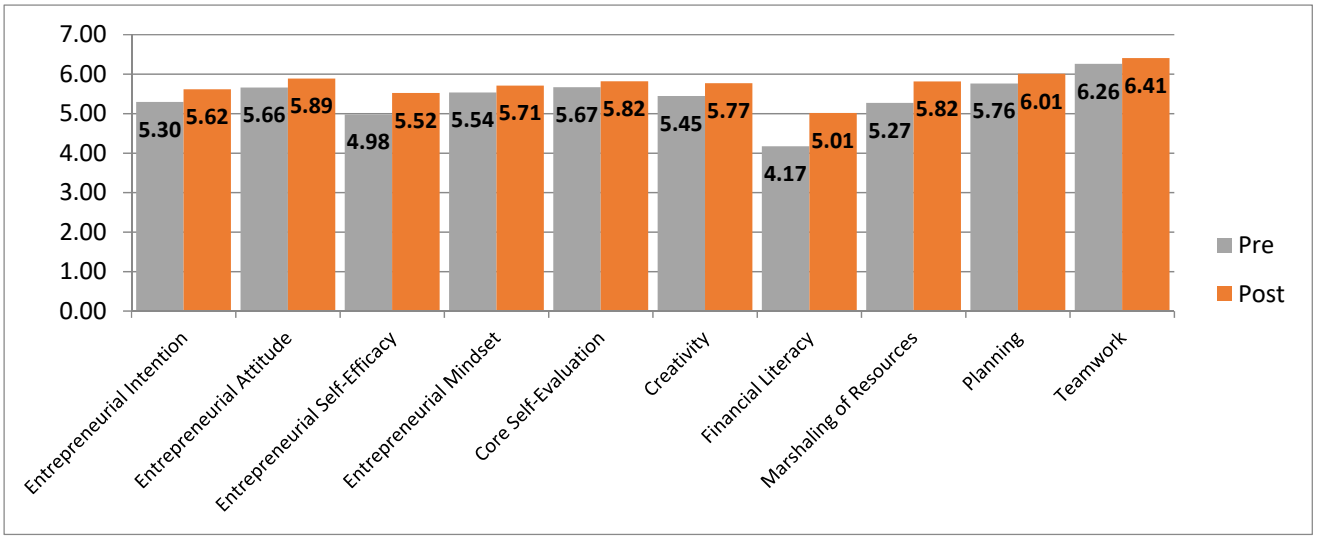

Figure 4. The average values of the entrepreneurial characteristics, pre- and post-course, of the MSc students.

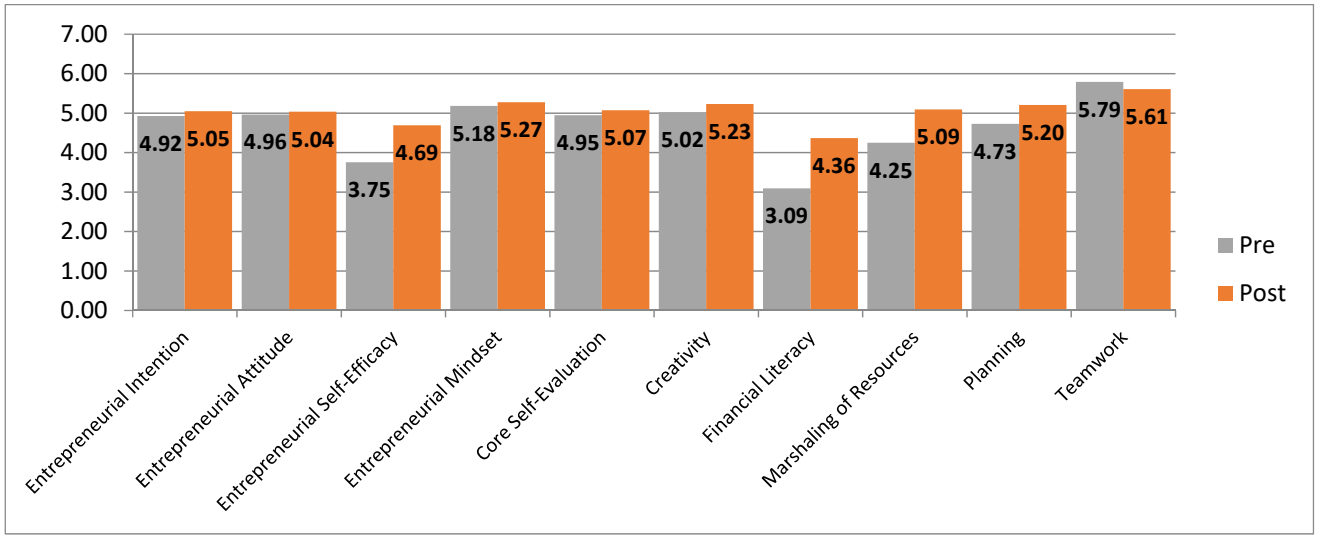

Figure 5. The average values of the entrepreneurial characteristics, pre- and post-course, of the PhD students.

The next analyzed category is the entrepreneurial background of the students. The students were divided into two groups: (1) students who had already taken part in practice-oriented entrepreneurship programs (Figure 6); (2) students without any experience of practice-oriented entrepreneurship programs (Figure 7). As we can see from Figures 6 and 7, there are differences between the two categories. In general, there is an increase from the pre to the post values, except for teamwork (−0.20) and entrepreneurial mindset (−0.02) for those who participated in such a program for the first time. Looking at Figures 6 and 7, it seems that the program was more effective for those who had already participated in other entrepreneurial programs, with respect to the entrepreneurial mindset and teamwork variables. As far as entrepreneurial self-efficacy, financial literacy and marshaling of resources are concerned, there is a clear increase in favor of those who had never participated in entrepreneurial programs. Such a marked increase might suggest that these kinds of entrepreneurial programs may be more effective for those students with fewer entrepreneurial skills and abilities.

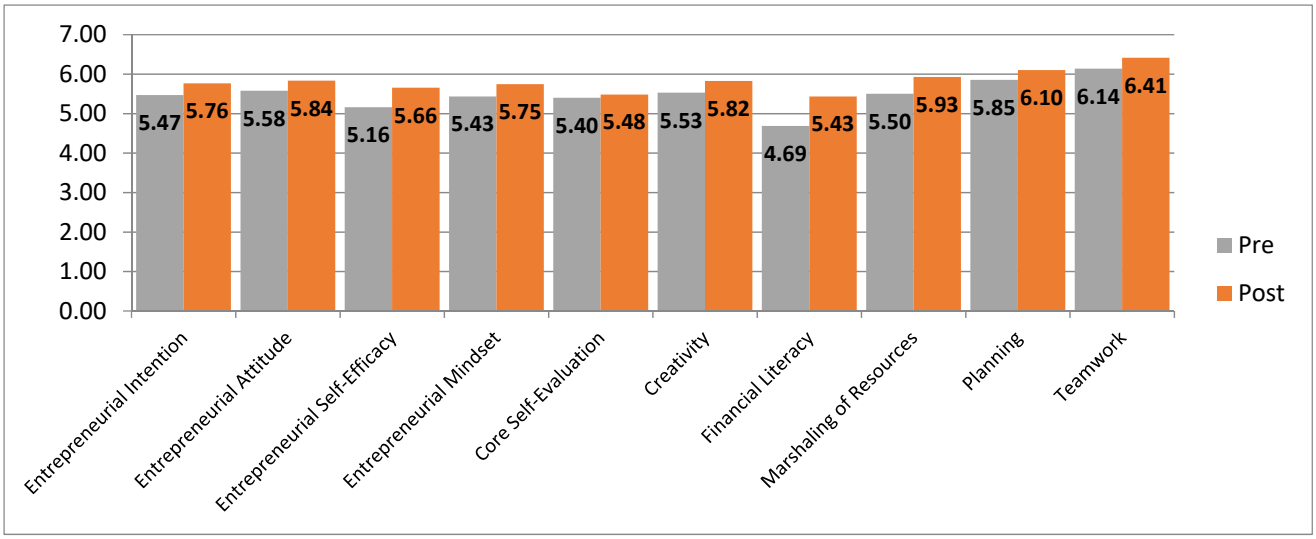

Figure 6. The average values of the entrepreneurial characteristics, pre- and post-course, of the students who had had at least one experience in practical entrepreneurship programs.

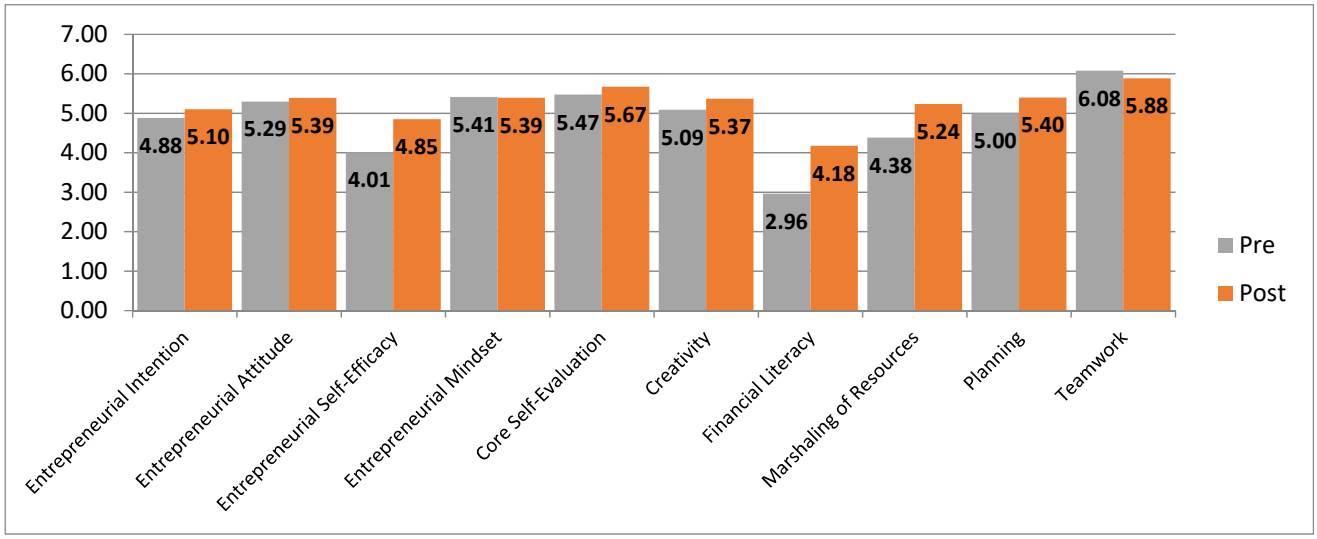

Figure 7. The average values of the entrepreneurial characteristics, pre- and post-course, of the students who had had no experience in practical entrepreneurship programs.

Finally, we also investigated the differential impact that the program had on students who worked on patented technologies developed in an academic context (Figure 8) compared to students who worked on entrepreneurial ideas proposed by other students (Figure 9). Figures 8 and 9 show that all the characteristics grew from the pre- to the post-course, except for teamwork (−0.01) for those who worked on patented technologies. Moreover, they also reveal that the increase for most variables is similar for those who worked on a technology and those who worked on an idea. The few exceptions are entrepreneurial attitude and creativity, which increase more for the students who worked on a technology, and core self-evaluation, which increases more for the students who worked on an idea. In general, these results suggest that the program had a similar effect on the students, regardless of the project they were assigned to.

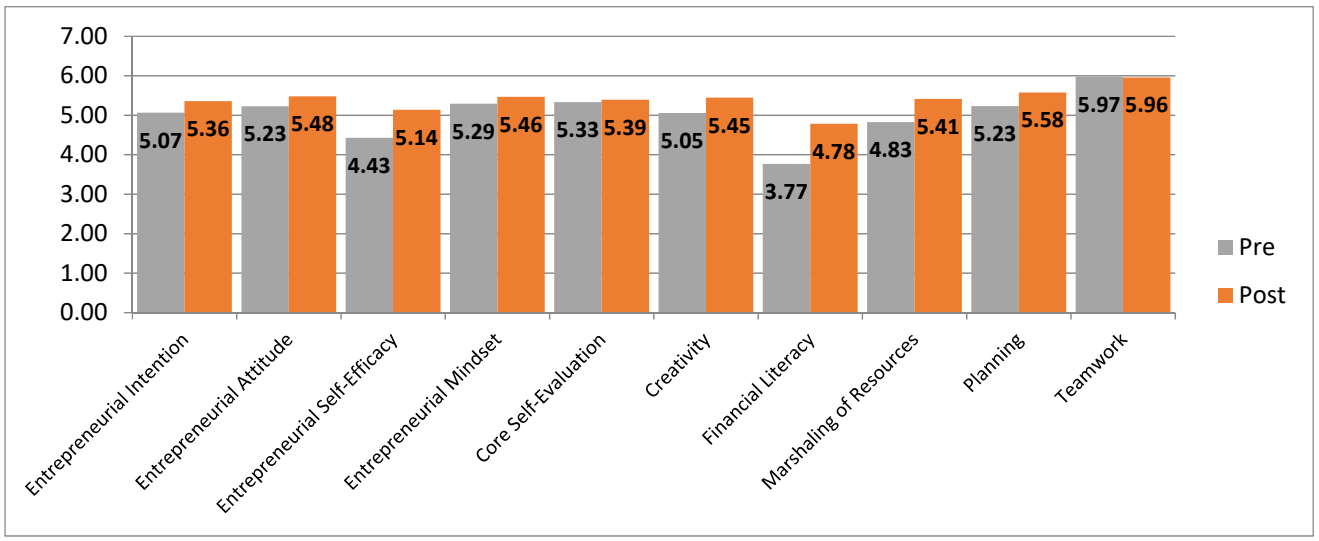

Figure 8. The average values of the entrepreneurial characteristics, pre- and post-course, of the students who worked on patented technologies.

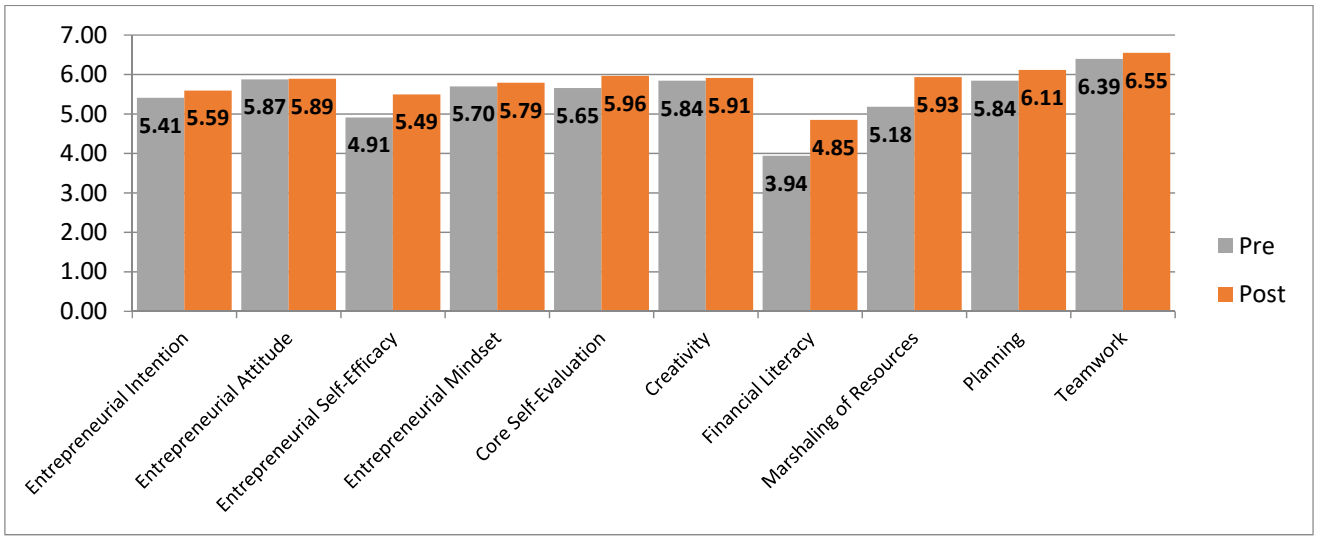

Figure 9. The average values of the entrepreneurial characteristics, pre- and post-course, of the students who worked on entrepreneurial ideas proposed by other students.

In short, the results show that the program had a positive impact on the participants, as it improved their entrepreneurial traits. On the one hand, the results show that the program generated a similar impact, regardless of the gender of the students and the project to which they had been assigned (technology vs. idea). On the other hand, the program seems to be more effective for students with no previous experience in entrepreneurship courses that adopt a practice-oriented approach. Finally, a difference in effectiveness also seems to emerge between MSc and PhD students.

5. Conclusions

This study, by taking part in the recent debate on entrepreneurship education, aims to provide evidence on the effectiveness of short-intensive entrepreneurship programs that adopt a practice-oriented approach to the entrepreneurial traits of students. In this vein, we have analyzed a short intensive online entrepreneurial program that adopts a learning-by-doing approach, which is offered to MSc and PhD students from four European technical universities. Furthermore, the program has also allowed us to study the impact on entrepreneurial traits and to pay attention to various dimensions, such as the level of entrepreneurial background, educational level, gender and the type of entrepreneurial projects to which the students had been assigned. Moreover, both students with previous experience in entrepreneurship programs that adopt a practice-oriented approach and students who had no previous experience of such programs were involved in the program. Finally, the students had the opportunity to choose and work on either a technology from the Politecnico di Torino or an entrepreneurial idea proposed by other students.

We collected pre- and post-course data on the students' entrepreneurial intention, entrepreneurial characteristics (entrepreneurial attitude, entrepreneurial self-efficacy, entrepreneurial mindset, core self-evaluation) and entrepreneurial skills (creativity, financial literacy, marshaling of resources, planning, teamwork), to assess the effect of the program.

The results of the analyses on the pre- and post-course data show a positive impact of the program on the entrepreneurial traits of the students for the whole sample. The results, in particular, show an improvement from the pre- to the post-CAST on all the dimensions, except for teamwork, which remained almost unchanged. The lack of variation for teamwork is probably due to the online setting of the course which may have limited the dynamics within the teams. The analyses we carried out show that the program does not result in any substantial differences, in terms of effectiveness, in relation to gender or in relation to the type of project on which the students worked (patented technology or idea proposed by other students). Instead, differences emerge between the MSc and

PhD students. Indeed, the program appears to increase the entrepreneurial intention and entrepreneurial attitude of MSc students more than those of PhD students. Conversely, there is a higher positive impact of the program on the entrepreneurial self-efficacy of PhD students than that of MSc students. Furthermore, the program seems to be more effective for those students who are participating for the first time in a practice-oriented entrepreneurship course than for those students who have had previous experience in such a course.

This study is not without limitations. First, the study was focused on a single case study, from which few observations are available, thus the sample size does not allow the results to be generalized. Moreover, the program involved students mainly from the Politecnico di Torino, although it was an international program. Consequently, it was not possible to carry out analyses on the impact of the program on students' entrepreneurial traits in relation to their affiliation. Furthermore, no control sample was available.

Future research could be directed toward investigating the impact of similar programs using a larger dataset. Furthermore, by using a larger dataset, future works could investigate other possible dimensions that could affect the impact of such programs, such as the students' field of study and/or their nationality. In addition, it might be useful to collect further data about students' family entrepreneurial background, so as to investigate a possible impact of the program in relation to, for example, the presence of entrepreneurial parents.

In conclusion, the study has shed light on how practice-oriented entrepreneurship courses can affect the entrepreneurial traits of its participants. Furthermore, it shows how entrepreneurship courses may have a differential impact on the participants, taking into account their gender, educational level, prior entrepreneurial experience and the project on which they have worked. The findings of the study have important implications for universities in terms of the designing of entrepreneurship programs. In particular, they show that short, intensive entrepreneurship programs that adopt a learning-by-doing approach are effective. Such programs, as the study shows, help to create awareness in students who have never participated in entrepreneurship courses of this kind. Moreover, the involvement of students with different levels of education in these programs seems to be effective. A further implication concerns the involvement of inventors who conceived and developed technologies on which the teams work in the student teams. Inventors, who often have years of research experience, do not always understand the commercialization potential of their technologies and, from this point of view, students can offer support. However, given their commitment to their academic careers, it is difficult to involve such inventors in long-term programs, and for this reason, it is important for universities to know that even short-term programs are effective in relation to the presence of inventors. Finally, demonstrating how the interaction between students and inventors contributes to the discovery of commercialization potential is also an important implication for university technology transfer offices that have the aim of economically exploiting the results of scientific research.

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Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

T-tests were carried out to analyze the difference between the post- and pre-course values on the whole sample and by breaking down the sample according to gender, educational level, entrepreneurial background and type of entrepreneurial project. In particular, for each of the four categories, two *t*-tests were conducted, one for each of the possible values of the categories. The results of the tests are reported below:

- Table A1 shows the output of the *t*-test in relation to the whole sample;
- Table A2 shows the output of the *t*-test in relation to the male students;
- Table A3 shows the output of the *t*-test in relation to the female students;
- Table A4 shows the output of the *t*-test in relation to the MSc students;
- Table A5 shows the output of the *t*-test in relation to the PhD students;
- Table A6 shows the output of the *t*-test in relation to the students who had had at least one experience in practical entrepreneurship programs;
- Table A7 shows the output of the *t*-test in relation to the students who had had no experience in practical entrepreneurship programs;
- Table A8 shows the output of the *t*-test in relation to the students who worked on patented technologies;
- Table A9 shows the output of the *t*-test in relation to the students who worked on entrepreneurial ideas proposed by other students.

In each table, it is possible to observe for each variable the pre-course value, the post-course value, the difference between the post- and pre-course value, and the *p*-value related to the alternative hypothesis (Ha: difference between post- and pre-course greater than zero).

Table A1. Output of *t*-tests on entrepreneurial characteristics, pre- and post-course, of the whole sample.

Variable	Average Pre CAST	Average Post CAST	diff = avg post CAST − avg pre CAST (Ho: diff = 0)	*p*-Value (Ha: diff > 0)
Entrepreneurial Intention	5.176471	5.431373	0.254902	0.1885
Entrepreneurial Attitude	5.435294	5.029412	−0.4058824	0.9545
Entrepreneurial Self-Efficacy	4.584034	5.264706	0.6806723	0.0068 ***
Entrepreneurial Mindset	5.421569	5.588235	0.1666667	0.2319
Core Self Evaluation	5.435294	5.647059	0.2117647	0.1924
Creativity	5.308824	4.764706	−0.5441176	0.9644
Financial Literacy	3.823529	5.470588	1.647059	0.0000 ***
Marshalling of Resources	4.941176	5.411765	0.4705882	0.0494 **
Planning	5.426471	6.294118	0.8676471	0.0001 ***
Teamwork	6.107843	6.098039	−0.0098039	0.5223

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A2. Output of *t*-tests on entrepreneurial characteristics, pre- and post-course, of the male students.

Variable	Average Pre CAST	Average Post CAST	diff = avg post CAST − avg pre CAST (Ho: diff = 0)	*p*-Value (Ha: diff > 0)
Entrepreneurial Intention	5.325397	5.666667	0.3412698	0.1602
Entrepreneurial Attitude	5.485714	5.047619	−0.4380952	0.9470
Entrepreneurial Self-Efficacy	4.62585	5.380952	0.755102	0.0210 **
Entrepreneurial Mindset	5.492063	5.714286	0.2222222	0.1710
Core Self Evaluation	5.504762	5.904762	0.4	0.0676 *
Creativity	5.452381	4.952381	−0.5	0.9322
Financial Literacy	4.063492	5.47619	1.412698	0.0001 ***
Marshalling of Resources	4.833333	5.47619	0.6428571	0.0407 **
Planning	5.333333	6.285714	0.952381	0.0001 ***
Teamwork	6.095238	6.074074	−0.021164	0.5401

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A3. Output of *t*-tests on entrepreneurial characteristics, pre- and post-course, of the female students.

Variable	Average Pre CAST	Average Post CAST	diff = avg post CAST − avg pre CAST (Ho: diff = 0)	*p*-Value (Ha: diff > 0)
Entrepreneurial Intention	4.935897	5.051282	0.1153846	0.4104
Entrepreneurial Attitude	5.353846	5	−0.3538462	0.7747
Entrepreneurial Self-Efficacy	4.516484	5.076923	0.5604396	0.0906 *
Entrepreneurial Mindset	5.307692	5.384615	0.0769231	0.4351
Core Self Evaluation	5.323077	5.230769	−0.0923077	0.5788
Creativity	5.076923	4.461538	−0.6153846	0.8551
Financial Literacy	3.435897	5.461538	2.025641	0.0004 ***
Marshalling of Resources	5.115385	5.307692	0.1923077	0.3409
Planning	5.576923	6.307692	0.7307692	0.0514 *
Teamwork	6.128205	6.136752	0.008547	0.4894

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A4. Output of *t*-tests on entrepreneurial characteristics, pre- and post-course, of the MSc students.

Variable	Average Pre CAST	Average Post CAST	diff = avg post CAST − avg pre CAST (Ho: diff = 0)	*p*-Value (Ha: diff > 0)
Entrepreneurial Intention	5.297101	5.615942	0.3188406	0.2004
Entrepreneurial Attitude	5.66087	5.130435	−0.5304348	0.9582
Entrepreneurial Self-Efficacy	4.981366	5.391304	0.4099379	0.0808 *
Entrepreneurial Mindset	5.536232	5.913043	0.3768116	0.0880 *
Core Self Evaluation	5.669565	5.73913	0.0695652	0.4121
Creativity	5.445652	4.869565	−0.576087	0.9384
Financial Literacy	4.173913	5.652174	1.478261	0.0000 ***
Marshalling of Resources	5.271739	5.608696	0.3369565	0.1405
Planning	5.76087	6.608696	0.8478261	0.0001 ***
Teamwork	6.26087	6.338164	0.0772947	0.3337

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A5. Output of *t*-tests on the entrepreneurial characteristics, pre- and post-course, of the PhD students.

Variable	Average Pre CAST	Average Post CAST	diff = avg post CAST − avg pre CAST (Ho: diff = 0)	*p*-Value (Ha: diff > 0)
Entrepreneurial Intention	4.924242	5.045455	0.1212121	0.3813
Entrepreneurial Attitude	4.963636	4.818182	−0.1454545	0.6613
Entrepreneurial Self-Efficacy	3.753247	5	1.246753	0.0099 ***
Entrepreneurial Mindset	5.181818	4.909091	−0.2727273	0.8008
Core Self Evaluation	4.945455	5.454545	0.5090909	0.0708 *
Creativity	5.022727	4.545455	−0.4772727	0.8195
Financial Literacy	3.090909	5.090909	2	0.0004 ***
Marshalling of Resources	4.25	5	0.75	0.0828 *
Planning	4.727273	5.636364	0.9090909	0.0125 **
Teamwork	5.787879	5.59596	−0.1919192	0.7137

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A6. Output of *t*-tests on entrepreneurial characteristics, pre- and post-course, of the students who had had at least one experience in practical entrepreneurship programs.

Variable	Average Pre CAST	Average Post CAST	diff = avg post CAST − avg pre CAST (Ho: diff = 0)	*p*-Value (Ha: diff > 0)
Entrepreneurial Intention	5.470588	5.764706	0.2941176	0.2196
Entrepreneurial Attitude	5.576471	5.117647	−0.4588235	0.9339
Entrepreneurial Self-Efficacy	5.159664	5.352941	0.1932773	0.2594
Entrepreneurial Mindset	5.431373	5.647059	0.2156863	0.2499
Core Self Evaluation	5.4	5.882353	0.4823529	0.0847 *
Creativity	5.529412	5.294118	−0.2352941	0.7409
Financial Literacy	4.686275	5.588235	0.9019608	0.0112 **
Marshalling of Resources	5.5	5.764706	0.2647059	0.1863
Planning	5.852941	6.647059	0.7941176	0.0004 ***
Teamwork	6.137255	6.333333	0.1960784	0.1846

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A7. Output of *t*-tests on entrepreneurial characteristics, pre- and post-course, of the students who had had no experience in practical entrepreneurship programs.

Variable	Average Pre CAST	Average Post CAST	diff = avg post CAST − avg pre CAST (Ho: diff = 0)	*p*-Value (Ha: diff > 0)
Entrepreneurial Intention	4.882353	5.098039	0.2156863	0.3039
Entrepreneurial Attitude	5.294118	4.941176	−0.3529412	0.8242
Entrepreneurial Self-Efficacy	4.008403	5.176471	1.168067	0.0037 ***
Entrepreneurial Mindset	5.411765	5.529412	0.1176471	0.3630
Core Self Evaluation	5.470588	5.411765	−0.0588235	0.5678
Creativity	5.088235	4.235294	−0.8529412	0.9697
Financial Literacy	2.960784	5.352941	2.392157	0.0000 ***
Marshalling of Resources	4.382353	5.058824	0.6764706	0.0631 *
Planning	5	5.941176	0.9411765	0.0030 ***
Teamwork	6.078431	5.862745	−0.2156863	0.7855

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A8. Output of *t*-tests on entrepreneurial characteristics, pre- and post-course, of the students who worked on patented technologies.

Variable	Average Pre CAST	Average Post CAST	diff = avg post CAST − avg pre CAST (Ho: diff = 0)	*p*-Value (Ha: diff > 0)
Entrepreneurial Intention	5.065217	5.355072	0.2898551	0.2071
Entrepreneurial Attitude	5.226087	5.130435	−0.0956522	0.6286
Entrepreneurial Self-Efficacy	4.428571	5.173913	0.7453416	0.0164 **
Entrepreneurial Mindset	5.289855	5.347826	0.057971	0.3970
Core Self Evaluation	5.330435	5.608696	0.2782609	0.1555
Creativity	5.054348	4.956522	−0.0978261	0.6103
Financial Literacy	3.768116	5.347826	1.57971	0.0000 ***
Marshalling of Resources	4.826087	5.217391	0.3913043	0.1492
Planning	5.228261	6.086957	0.8586957	0.0014 ***
Teamwork	5.971014	5.913043	−0.057971	0.6053

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A9. Output of *t*-tests on entrepreneurial characteristics, pre- and post-course, of the students who worked on entrepreneurial ideas proposed by other students.

Variable	Average Pre CAST	Average Post CAST	diff = avg post CAST − avg pre CAST (Ho: diff = 0)	*p*-Value (Ha: diff > 0)
Entrepreneurial Intention	5.409091	5.590909	0.1818182	0.3619
Entrepreneurial Attitude	5.872727	4.818182	−1.054545	0.9934
Entrepreneurial Self-Efficacy	4.909091	5.454545	0.5454545	0.1118
Entrepreneurial Mindset	5.69697	6.090909	0.3939394	0.2198
Core Self Evaluation	5.654545	5.727273	0.0727273	0.4430
Creativity	5.840909	4.363636	−1.477273	0.9945
Financial Literacy	3.939394	5.727273	1.787879	0.0028 ***
Marshalling of Resources	5.181818	5.818182	0.6363636	0.0503 *
Planning	5.840909	6.727273	0.8863636	0.0017 ***
Teamwork	6.393939	6.484848	0.0909091	0.3605

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Note

[1] Unite! is a university network for innovation, technology and engineering that has the aim of transforming higher education in Europe through multidisciplinary, multicultural and multilingual education, research and entrepreneurship. The aim of Unite! is to connect engineering, science and technology with important societal challenges and to provide skills for a new generation of European and global citizens through the combined work of university students, faculty members and staff.

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