

Entrepreneurial Engineering Education: What Do Graduates Say?

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Abstract:

Background: The present work aimed to understand the contribution of an engineering course in the training of professionals with creative and entrepreneurial characteristics through the perception of graduates from 2014 to 2019 from the Engineering College of a Federal Institution of Technology Education. From a universe of 119 subjects, 9 who became entrepreneurs were surveyed. The subjects' perception, relating their entrepreneurial perspectives and the development of possibilities offered by the engineering program, was evaluated using the Schein questionnaire, with 40 questions to identify career anchors. Semi-structured interviews were conducted to identify the subjects' perceptions about the contributions of the engineering course in the chosen career. The results pointed to aspects of engineering courses that can be improved to awaken an entrepreneurial perspective in students.

Materials and Methods: In this exploratory research - seek to understand the behaviors and opinions of some former students through the content analysis method. Two data collection instruments were used: a career anchors questionnaire and a semi-structured interview. The questionnaire was applied through Google Forms in April 2021. The sample included 9 graduate students who became entrepreneurs (7.56% of a universe of 119 students who graduated in 2014 to 2019). There were 6 female and 3 male subjects, aged between 25 and 34. One control group was only invited to understand whether the tool effectively yielded reliable results, as the group had distinct characteristics. There were 9 participants, 5 females and 4 males, aged between 29 and 62. The semi-structured interview was conducted in May 2021 through the ZOOM platform.

Results: The results indicated the tool's utility, even though the control group did not undergo the interview process. The results of the questionnaire confirmed the tendency of respondents to become an entrepreneur. It was observed in the interviews that the students do not criticize the course they took in a derogatory way. However, they call attention to the need to look further outside and beyond the walls of the educational institution.

Conclusion: The questionnaire effectively identified the subjects' career anchors (professional inclinations), demonstrating that the entrepreneurial perspective is valid. It was found that the engineering course in focus should contribute more objectively to the perspective of entrepreneurial education.

Key Word: Entrepreneurship Education, Engineering Education, Career Anchors.

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I. Introduction

What would an engineering program look like that contemplated the possibility of combining the knowledge of science and technology in its pedagogical plan with the acquisition of entrepreneurial skills? In Brazil, many programs' projects should already contain the answer to this question, but their execution and implementation sometimes show us otherwise. Understanding the experiences of students who have graduated from an engineering program can significantly contribute to a continuous evaluation process that will ultimately improve the project itself. Seeking to listen to this specific group actively, we started by asking them about their perception of the possible connection between engineering education and their entrepreneurial perspective in a world where the workplace is continuously changing.

Such reflection is linked to the perspective of training individuals with competencies [12] for entrepreneurship who are imbued with promoting innovation in products and processes. This challenge is highlighted by the report "The Future of Jobs Report" [11] and by the United Nations Educational, Scientific and Cultural Organization [7] on the fifth skill for the 21st century, "learning to undertake". Systematically stimulating students for entrepreneurial practice at an undergraduate degree is a challenge for educators in this new era.

Eight professional references were considered to know people's career perspectives [8]: Autonomy/Independence, Security/Stability, Technical-Functional Competence, General Managerial

Competence, Entrepreneurial Creativity, Service or Dedication to a Cause, Pure Challenge, and Lifestyle. Such references are called “Career Anchors” and accompany individuals through their professional lives. “Career anchors” are a tool for self-knowledge and guidance. An individual may present characteristics of several anchors, but understanding the predominant anchor will help identify essential aspects in individual choices. The domain of these anchors could be identified through a questionnaire [9].

When a student, especially those just emerging from adolescence and exploring the possibilities of adulthood, chooses an undergraduate course, they also envision a career in the professional practice they aim to pursue. Stemming from their personal imagination but also influenced by the social context in which they developed, they tend to replicate perceptions, opinions, and expectations that are not necessarily the result of a conscious and clear reflection on the intervening variables. Sometimes, professional, and educational choices are made based on social recognition or status, prestige, and, especially in the turbulence of the socio-economic-cultural environment, the prospect of financial gain. Self-realization and identifying a life purpose become secondary perspectives, in a reversal of values that tends to lead to future frustrations and regrets. In the academic environment, this may result in dropout or a growing loss of enthusiasm and disidentification with the chosen career.

In a study for analysis of 44 former master's students at the Massachusetts Institute of Technology (MIT) over 10 years of research, the author [8] observed how the participants' careers were developed. The decisions they made and the choices they made impacted their lives and professional trajectories. Through observation, categorization, and interviews, it was possible to trace a professional history with a detailed chronology, where the fundamental events and, above all, the reasons that led to their decision-making reflected what the author considered their professional identities. When these professional identities were not fulfilled, subsequent choices involving a return to them were made. From this observation, the author coined the term "Career Anchor," alluding to vessels that, even in unfavorable scenarios, do not let themselves drift away and do not lose their reference. In the author's words, "[...] professional reference points are the discernible areas of competence, objectives, and values that you do not give up because they represent your true identity" [9]. As a result of the study, eight career anchors were identified – professional inclinations, aiming to describe individuals' references, as presented in Table no 1.

Table no 1: Career Anchors.

#	Category
1	Technical-Functional Competence
2	General Managerial Competence
3	Autonomy/Independence
4	Security/Stability
5	Entrepreneurial Creativity
6	Service or Dedication to a Cause
7	Pure Challenge
8	Lifestyle

The main characteristics of these anchors are described below:

- **Technical-Functional:** The stimulus and motivation for those with this anchor lie in exercising their abilities, knowing they are experts in something. They dedicate themselves throughout their trajectory to specialization, not aspiring to vertical career progressions linked to positions and power. Maintaining expertise is the desired end. Individuals in this group are driven by challenges, with self-esteem related to exercising their talents. The intrinsic content of the work is what matters most. They enjoy setting goals and do not mind being managed if it contributes to the outcome. Compensation is perceived as satisfactory if it aligns with their expertise level, and recognition by peers of the same professional level and background is pleasing. They seek constant improvement, pay attention to educational opportunities, and appreciate training opportunities.
- **General Administrative:** Individuals with this anchor seek higher hierarchical levels and appreciate managerial functions. Motivators include leadership opportunities, contributing to the success of an organization, and high financial returns. They can identify, analyze, understand, and find solutions in uncertain scenarios. They enjoy interpreting what is happening and making decisions. These individuals possess interpersonal and intergroup skills that allow them to interact with various organizational levels. They are not intimidated by difficult decisions that may generate emotional and interpersonal instability. Challenges, high responsibility, diverse and integrative tasks are the types of work that motivate them. Financially, they seek distinction that provides some sense of stability. In general, individuals with this anchor have a different relationship with positions compared to other members of an organization.
- **Autonomy and Independence:** Regardless of the industry or job type, individuals with this anchor need to do things their way, with standards and rhythms consistent with their convictions. A job is evaluated as good based on the autonomy granted more than any other aspect. They seek high levels of education and

professionalism to ensure independence from organizational standards, making them self-confident and responsible. They tend to become self-employed professionals with well-defined and strictly scheduled tasks in their area of expertise, with the means to achieve them on their own. They seek merit-based remuneration rather than stability.

- **Security/Stability:** Throughout life, everyone seeks a certain degree of security and stability, but for some individuals, this need supersedes all others, and they need to feel secure as a predominant factor. There is a tendency, not a rule, to seek jobs in public or governmental administration where stability is offered. Contrary to the common perception that created a stereotype of disinterest and apathy, these individuals seek long-term predictability, such as constant and predictable progression and development. They accept leadership well, and if they cannot fully utilize their talents, they seek other parallel, even unpaid, activities where they can feel fulfilled.
- **Entrepreneurial Creativity:** Creating products, services, or businesses is the compelling need of these individuals, leading them to pursue ideas and ideals from an early age. Traditional organizations are not their focus; they may remain in them as an intermediate stage to achieve their goals. These individuals are naturally restless and constantly need new and creative challenges. Developing and seeing a new venture thrive is a measure of success, and this vision is not limited to opening businesses. They tend to be self-centered, seeking activities that allow them to implement their creativity. Being able to control what they do is also a facet of those with this anchor.
- **Serve or Dedication to a Cause:** In a more specific sense of values and moral values, individuals with this anchor are guided more by their values than by their abilities or competencies. They desire to improve the world, at least in some aspect. In organizations, they follow a career with fidelity and seek activities that benefit others. Their motivation is to serve. They expect fair compensation, but this is not their motivating factor. They seek to influence the groups and organizations they belong to in the direction of their values.
- **Pure Challenge:** Overcoming obstacles perceived as impossible or defeating strong opponents drives individuals with this anchor. While the desire to overcome challenges is common, it is a determining aspect for these individuals, as overcoming and surpassing themselves are watchwords. They rarely stay in jobs and functions where they do not feel challenged. Aspects such as remuneration and recognition are only perceived as satisfactory if the capacity, they believe they possess is tested. Lack of challenge leads to boredom and irritation. They do not adapt well to organizations, especially traditional ones.
- **Lifestyle:** Those with this anchor seek to integrate their work activities into the lifestyle they adopt for themselves. There is a tendency to believe that individuals like this do not have a professional reference point. They demand that the tripod—individual, family, and professional career needs—can develop in balance. They are more flexible than those seeking autonomy, but the tripod must be guaranteed. Predominantly perceived in women at the end of the 20th century, it assumes a growing character in Generation Y.

Career anchors are a reference, not a straitjacket; hence, it is an invitation to those who seek it as a tool for self-awareness or guidance, accompanied by another individual (teacher, mentor, etc.). It is also possible for an individual to exhibit characteristics of several anchors, but understanding the predominant one will help identify essential aspects in individual choices. The questionnaire developed for identifying career anchors will be described in the methodology section, where the research process reported in this work will be presented.

II. Material And Methods

The research has been characterized as exploratory research. We seek to understand the behaviors and opinions of some former students through the content analysis method [1].

Two data collection instruments were used: the first was a questionnaire when, in the '70s, the author [8] started following graduated students' careers to identify their career anchors. The second was a semi-structured interview [5] to listen to the interviewees' perceptions about the questionnaire results and how they evaluated the contribution of the undergraduate course to the experience of their professional inclinations.

The questionnaire aimed to identify the professional inclinations of the interviewees and was applied through Google Forms in April 2021. The sample included 9 graduate students who became entrepreneurs (7.56% of a universe of 119 students graduated in 2014 to 2019). There were 6 female and 3 male subjects, aged between 25 and 34 years old. The questionnaire consists of 40 statements where the respondent evaluates how much each one of them represents the perception, they have of themselves. Finally, the questions are grouped according to the 8 professional inclinations and the calculated averages. The highest average represents the dominant professional anchor, the one in which the respondent tends to guide most of their decisions, consciously or not.

The research subjects were selected based on accessibility, as they were part of classes of former students of the researchers who had studied Industrial Engineering at a Federal Institution and, most

importantly, had become entrepreneurs after completing their degree. Their trajectories were listened to and recorded, and they will be part of a broader study to identify actions to be suggested to the original course and subsequently to engineering courses in general.

One control group was only invited to respond to the questionnaire without undergoing an interview. The aim was to understand whether the tool effectively yielded reliable results, as the group had distinct characteristics. There were 9 participants, including 5 females and 4 males, aged between 29 and 62 years, already professionals in the education, research, and training of people in public and private institutions. The results indicated the tool's utility, even though the control group did not undergo the interview process.

To validate the answers, an interview was conducted on the questionnaire results. This semi-structured interview was conducted in May 2021 through the ZOOM platform. The first approach aimed to capture perceptions about the results indicated in the questionnaire. Then it was questioned whether or how the graduation was related to the identified anchor and the course's contribution for those seeking or wishing to undertake. The interviews were submitted to a content analysis tool.

The procedures of the triangulation process to obtain the inferences of this research were based on the answers to the questionnaire, followed by interviews with graduates and content analysis.

Study Design: Exploratory research

Study Location: Brazilian Federal Institute of Education based in Cariacica City, Espírito Santo State, Brazil.

Study Duration: April 2021 to June 2021.

Sample size: 18 students (9 interviewed + 9 control group)

Subjects & selection method: The subjects were selected based on accessibility, as they were part of classes of former students of the researchers who had studied Industrial Engineering at a Federal Institution and, most importantly, had become entrepreneurs after completing their degree.

III. Result

The questionnaire aimed to apprehend the perception of graduates of the Institution's Engineering Course about their professional inclinations that would allow inferring a predisposition to entrepreneurship. This identified predisposition suggests they take a more critical look at the time spent in the undergraduate course, as their inclinations tend to generate expectations.

The analysis considered the four main career anchors obtained by the questionnaire. Respondents presented the following predominant anchors:

Table no 2: Questionary Result

Category	Subjects	Control Group
Technical-Functional Competence	3,7%	7,4%
General Managerial Competence	-	-
Autonomy/Independence	29,7%	-
Security/Stability	-	22,2%
Entrepreneurial Creativity	18,5%	3,7%
Service or Dedication to a Cause	22,2%	25,9%
Pure Challenge	7,4%	7,4%
Lifestyle	18,5%	33,4%

Table no 3: Predominant anchors

Category	Subjects
Autonomy/Independence	29,7%
Service or Dedication to a Cause	22,2%
Entrepreneurial Creativity	18,5%
Lifestyle	18,5%

The results of the questionnaire confirmed the tendency of respondents to become an entrepreneur. The anchors "Autonomy/Independence", "Entrepreneurial Creativity," and "Lifestyle" – make up the profile of those who undertake a business. The anchor "Service or Dedication to a Cause" suggests a strong sense of purpose.

During the interviews, the subjects stated that they agreed with the results, especially when they received an explanation of the categories. The result of the questionnaire reflected critical aspects for those surveyed. Expressions demonstrating this can be recorded as follows: "*I never really thought about it, but it defines me very well*".

IV. Discussion

In understanding what an entrepreneur is, two approaches become relevant. The creative destruction [10] suggests that so-called entrepreneurs instigate innovation-related phenomena. Additionally, they are crucial for the innovation and success of any enterprise [3]. Considering this, future engineers, endowed with technical skills for these new demands, cannot be devoid of competence in entrepreneurship.

The initial part of the interviews aimed to validate the questionnaire. In essence, everyone agreed with the results, especially when they received explanations about the other categories. Despite the natural doubts in the investigative process, the questionnaire's outcome reflected essential aspects for the interviewees. Expressions that demonstrate this can be recorded as follows:

- *"Wow, I really identify with this," or "I never thought about it effectively, but it describes me very well."*

Another aspect of the interview addressed whether the degree attended had any relation to the professional inclination discovered in the questionnaire. The interviewees revealed that they chose a course that allowed them greater freedom of choice, not being restricted to the traditional functions of engineering. It was important to keep a range of possibilities open. They chose a more general course perspective.

Given the observed data, it is possible to infer that, specifically for the interviewees in this study, there is a positive relationship between the choice of the course and professional inclination. In a future study with a larger sample of interviewees, it may be possible to identify these relationships in more detail.

After completing the previous steps, the core question of the research was posed: to understand the contribution of the engineering course in the training of professionals with entrepreneurial characteristics. It should be noted here that it was not the focus to say that there was any obligation in the course for this, but if the disciplines and activities contributed to those who identified in themselves the desire to undertake. The result was consolidated in 4 comments extracted from the interviews. Based on the comments of the interviewees, some considerations were pointed out by the researchers to improve the understanding of their statements:

"...only one or two teachers encouraged me to undertake".

This comment drew attention right at the beginning of all the interviews. As previously mentioned, it is not a course aimed at training entrepreneurs, yet it was reported that over at least 5 years of the course, few instructors encouraged the initiative and creativity of the interviewees. There is a perception that many professors have had little exposure to, or currently have little exposure to, the current context of the job market where formal employment is becoming increasingly scarce, and entrepreneurial initiatives in their various forms are skills to be developed, as advocated in The Future of Jobs Report 2020.

"...they thought the course should only form for the industry".

As a result of the initial comment, the understanding of education focused on traditional industries, in the specific case of the interviewed individuals in mining, steelmaking, and manufacturing, is seen as a limitation in developing future engineers. Connected to the facts and events of their time, these young entrepreneurial engineers criticize the course curricula that still carry the conception of the classic 20th-century industry without paying attention to the practices of the so-called Industry 4.0. It is important to note that, according to the interviewees, the content of Industry 4.0 is presented but only as another theoretical subject without application by the students. They seek supplementation outside the university walls in courses offered by other non-formal education institutions.

"...very focused on teaching tools, but with little application".

An interesting aspect is related to the teaching of tools, both traditional and current, in production engineering. There is praise for having access to the main tools and methods used in production and its processes. Some interviewees mention that this was the main contribution of the course to their education because they perceive and discover in the everyday market that these tools are applicable in various contexts. Dissatisfaction or criticism arises regarding the fact that, over the course of their university education, spaces and activities could have been created so that practical exercises would make them more prepared for situations considered predictable in the day-to-day actions of organizations.

"...very academic professors, focused on just writing articles".

This recent comment results from what we could call cognitive dissonance [4]. While they admire their professors for their publications in journals and scientific conferences, criticism arises that this necessary dedication distances the instructors from the everyday reality of contemporary organizations. In this regard, the interviewees even go so far as to believe and suggest a faculty composition that includes academic and market-oriented profiles to balance future engineers' education.

V. Conclusion

It was observed in the interviews that the students do not criticize the course they took in a pejorative way, on the contrary, they admire the teachers and the institution, however, they call attention to the need to look further outside and beyond the walls of the educational institution. Revealing that this would allow better development of the potential of future professionals, even valuing the entrepreneurial perspective.

Using a ready-made and already tested questionnaire allowed us to assess its validity as a starting point for the proposed research, being a safe and credible basis for interviews, focus groups, and new instruments that may be developed.

The proposed objectives were considered achieved. The questionnaire effectively identified the subjects' career anchors (professional inclinations), demonstrating that the entrepreneurial perspective is valid. With that, their views and perceptions of the undergraduate course in entrepreneurship were relevant. An exciting fact worthy of further investigation is that the "serve/dedication to a cause" anchor recorded a significant percentage in both groups where the questionnaire was applied. It is believed that the respondents are firm in their personal values and exhibit a strong trait of what is currently recognized as a search for purpose. Investigating this aspect is advisable for future studies. Finally, it was found that the engineering course in focus should contribute more objectively to the perspective of entrepreneurial education.

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